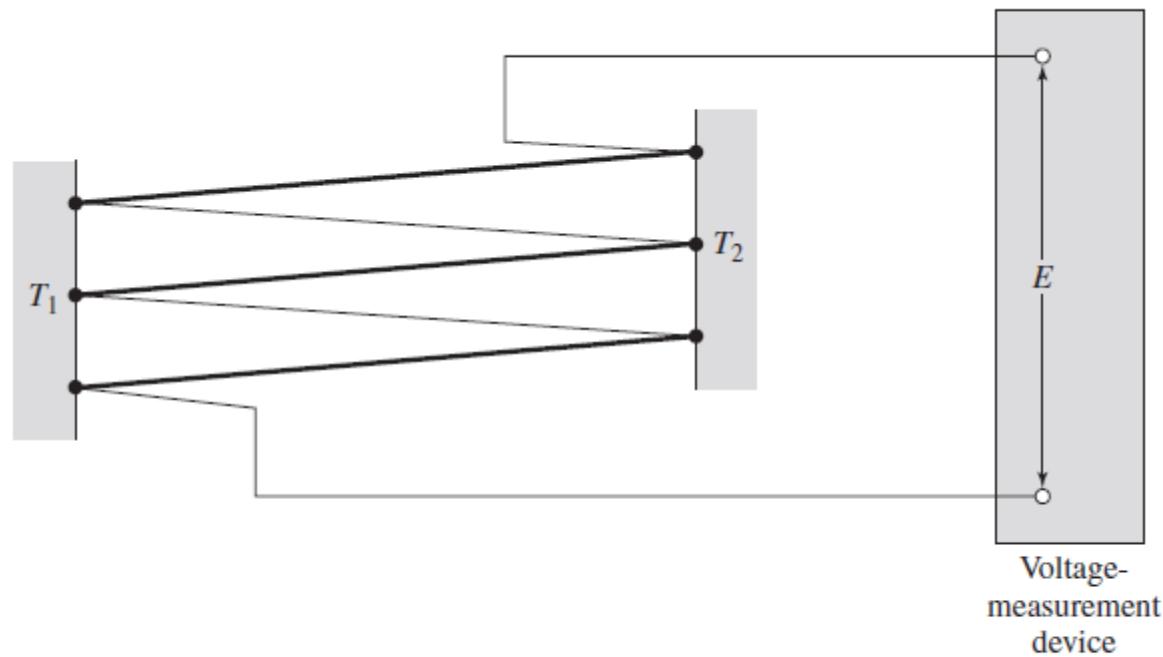
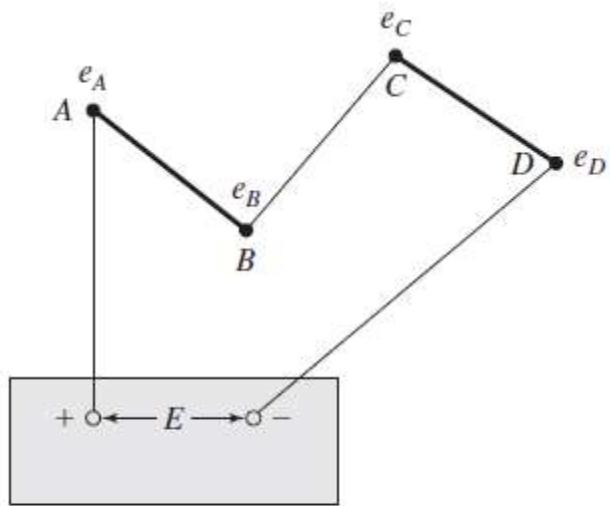


**Figure 8.18** Reference junction compensation using thermistor.

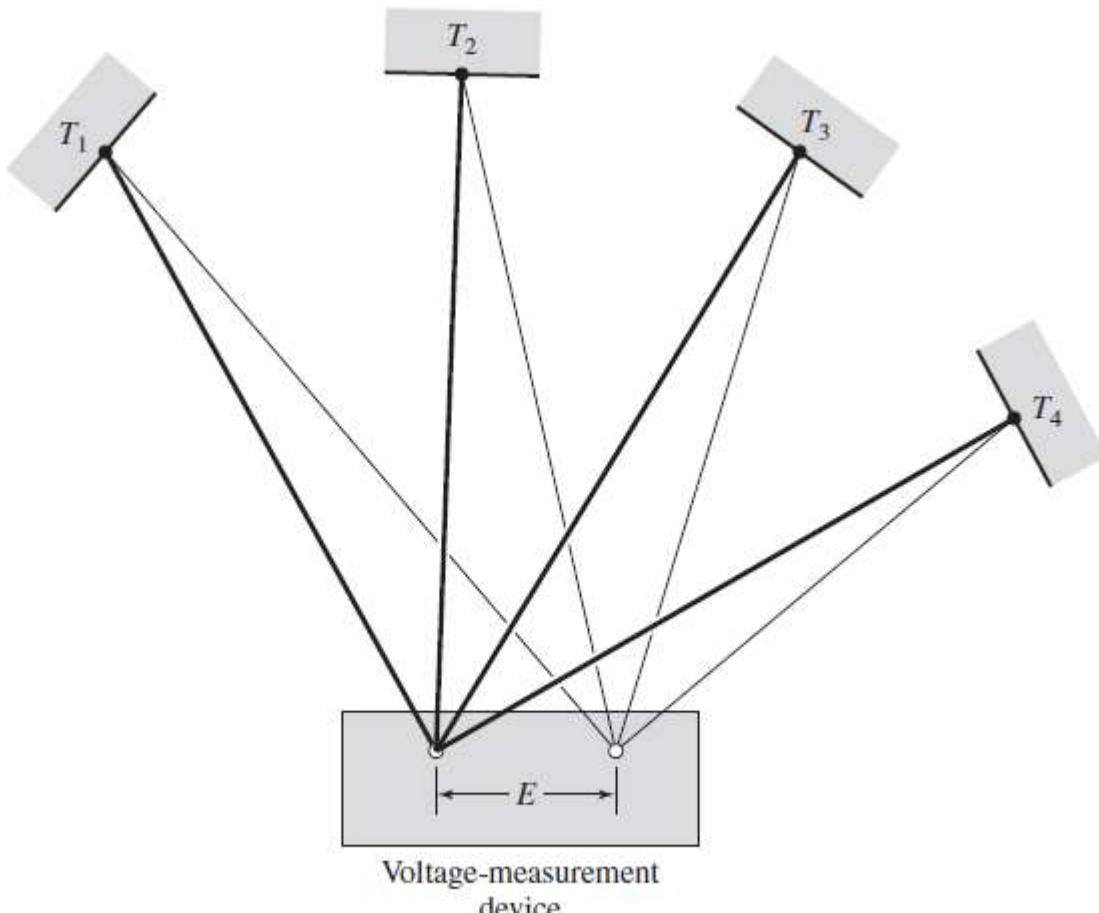
$$E = e_A - e_B + e_C - e_D$$



**Figure 8.19** Thermopile connection.



**Figure 8.20** Series connection of thermocouples.



**Figure 8.21** Parallel connection of thermocouples.

$$E_{av} = \frac{E}{n}$$

# **Pyrometers**

# What is Pyrometer ?????

A pyrometer is a type of thermometer used to measure high temperatures. It is used for measuring temperature without any physical contact. Its is used for measuring body temperature by measuring its electromagnetic radiation.

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- Its principle depends upon the relationship between temperature of a hot body and electromagnetic radiation emitted by the body. When a body is heated it emits thermal energy known as heat radiation. It is a technique for determining a body temperature by measuring its electromagnetic radiation.

## **Principle of Pyrometer**

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- **Radiation Pyrometer**
- **Optical Pyrometer**
- **Thermo - Electric Pyrometer**
- **Photoelectric Pyrometer**

## **Types of pyrometer**

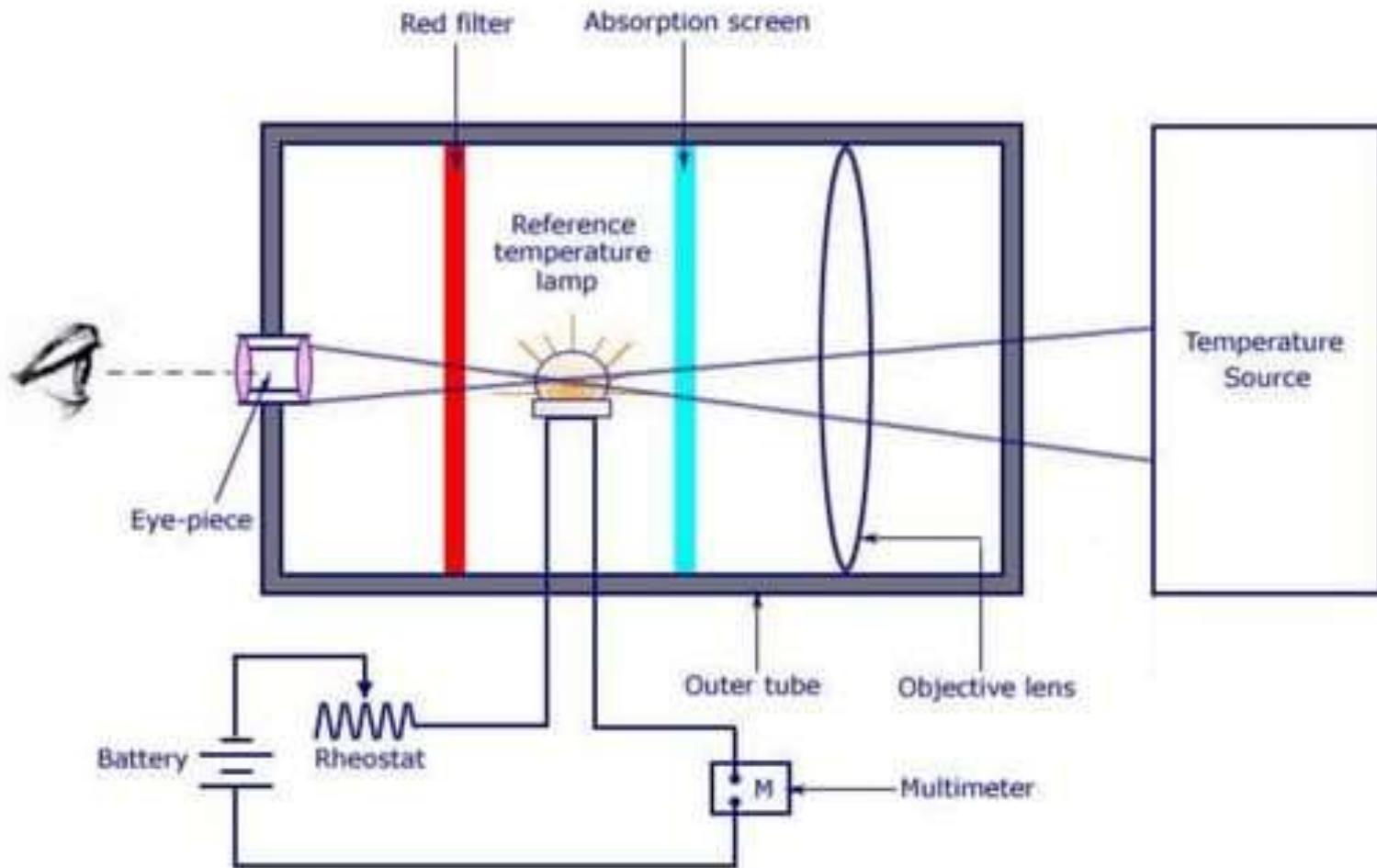
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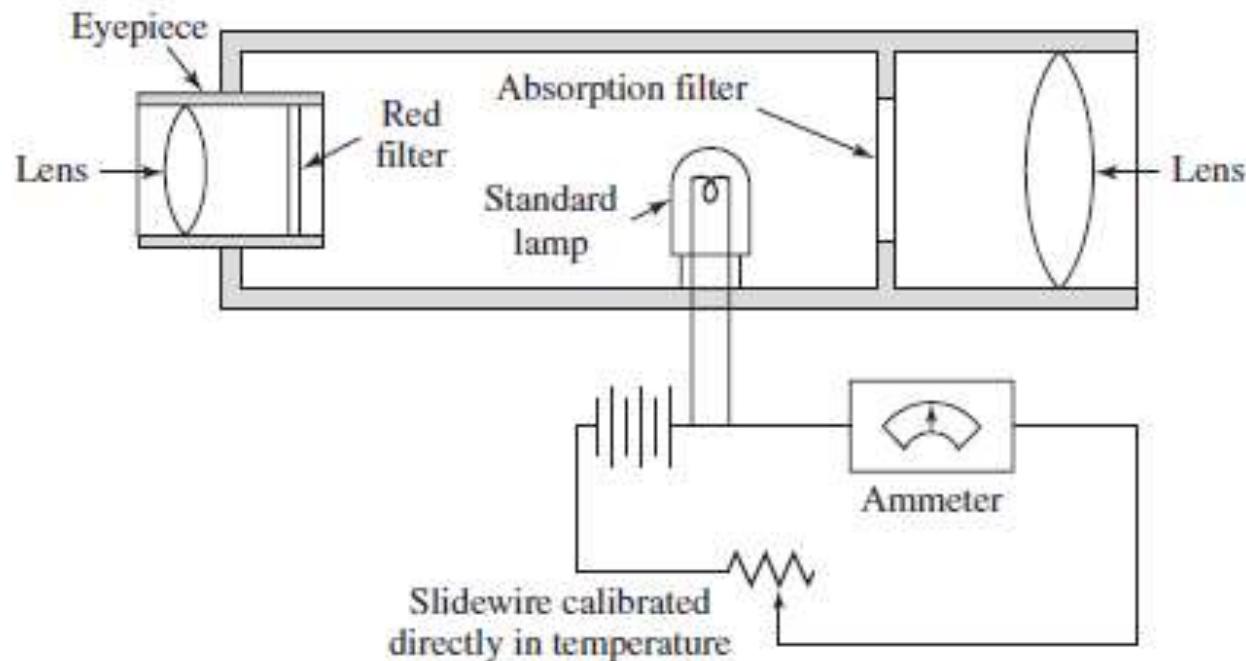
- The Optical Pyrometer is a highly-developed and well accepted noncontact temperature measurement device.
- It is widely employed for accurate measurement of the temperature of furnaces, molten and other heated materials.
- It is primarily used in the range of 1000 to 5000 °F.

## Optical Pyrometer

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## Optical Pyrometer





**Figure 8.25** Schematic of optical pyrometer.

- Optical Pyrometers work on the basic principle of using the human eye to match the brightness of the hot object to the brightness of a calibrated lamp filament inside the instrument.
- The radiation from the source is emitted and the optical objective lens captures it. The lens helps in focusing the thermal radiation on to the reference bulb.

## **Working Principle of Pyrometer**

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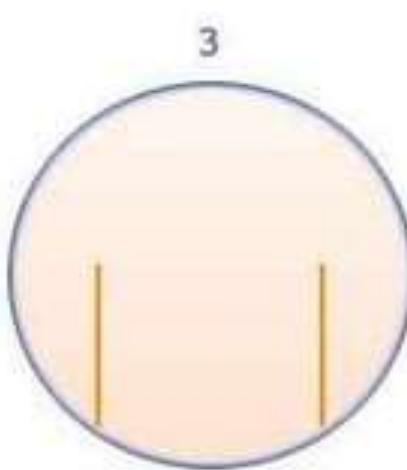
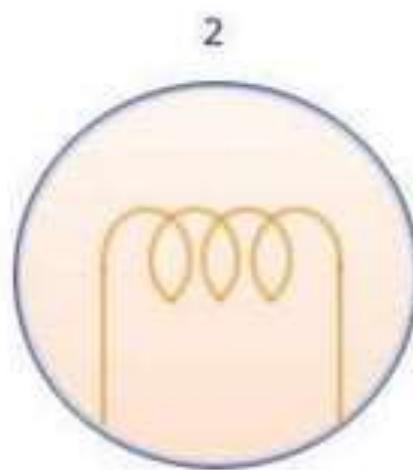
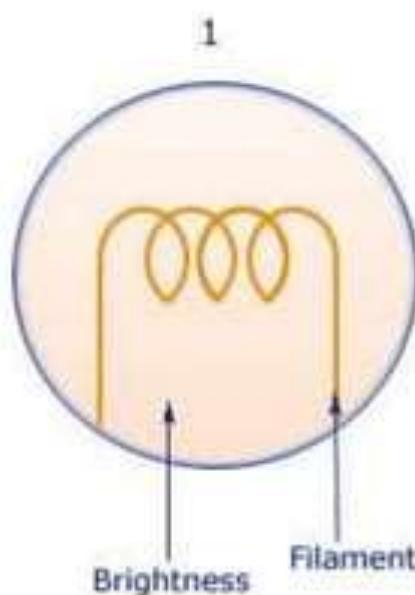
- The observer watches the process through the eye piece and corrects it in such a manner that the reference lamp filament has a sharp focus and the filament is superimposed on the temperature source image.
- The observer starts changing the rheostat values and the current in the reference lamp changes. This in turn, changes its intensity.

## **Working Principle of Pyrometer**

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- This change in current can be observed in three different ways :

#### Optical Pyrometer - Temperature Measurement



1. Filament is dark. That is, cooler than the temperature source.
2. Filament is bright. That is, hotter than the temperature source.
3. Filament disappears. Thus, equal brightness between filament and temperature source.

- Simple assembling of the device enables easy use of it.
- Provides a very high accuracy with +/-5 degree Celsius
- There is no need of any direct body contact between the optical pyrometer and the object. Thus, it can be used in a wide variety of applications.

## **Advantages of Pyrometer**

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- As the measurement is based on the light intensity, the device can be used only in applications with a minimum temperature of 700 degree Celsius.
- The device is not useful for obtaining continuous values of temperatures at small intervals

## **Disadvantages Of Pyrometer**

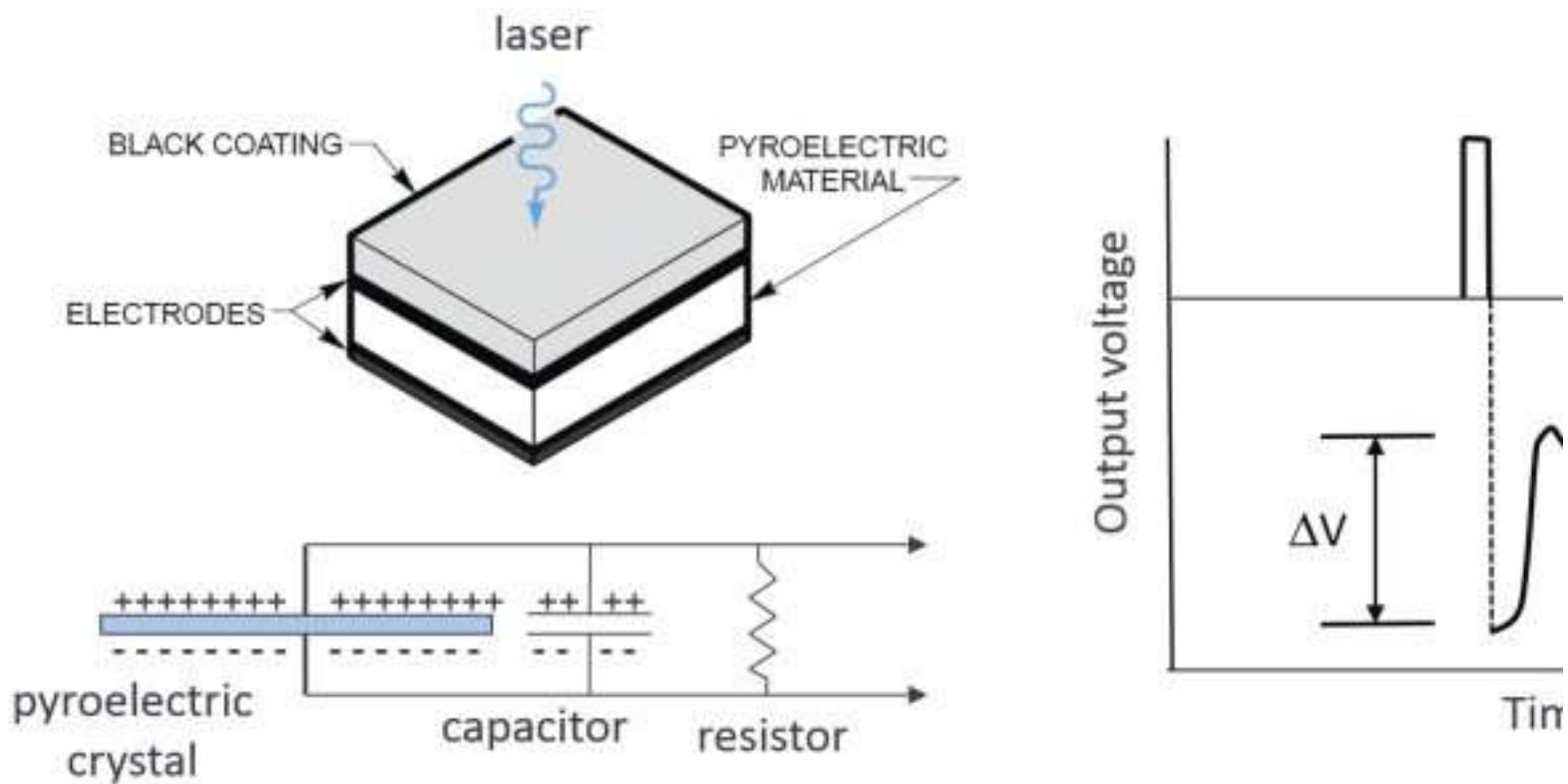
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- Used to measure temperatures of liquid metals or highly heated materials.
- Can be used to measure furnace temperatures.

## **Application Of Pyrometer**

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# Pyroelectric Sensor



Pyroelectric detectors are typically used to measure the energy of pulsed lasers where the pulses may vary in width from fs to ms and in energy from sub  $\mu\text{J}$  to J.

Lithium  
tantalite

Polyvinyl  
fluorides

Gallium  
nitride

# Pyroelectric Optical Energy Sensors

The configuration of a typical [pyroelectric sensor](#) and its operational output can be seen in above Figure.

A pyroelectric material, which is usually crystalline, possesses an electric polarization, even in the absence of an applied voltage.

An incident laser pulse heats the crystal, which causes the material to expand and produce a change in the polarization.

Charge builds up on opposite surfaces of the crystal which generates a current flow that charges a capacitor.

This charged capacitor induces a voltage whose amplitude change is proportional to the original laser pulse energy.

Since it is the change in temperature that produces the current, pyroelectric detectors respond only to pulsed or modulated radiation.

## Pyroelectric effect: charge movement becomes sensor output

