Title : Advances in Metrology (Laser Interferometers)

Date: 23/03/2020

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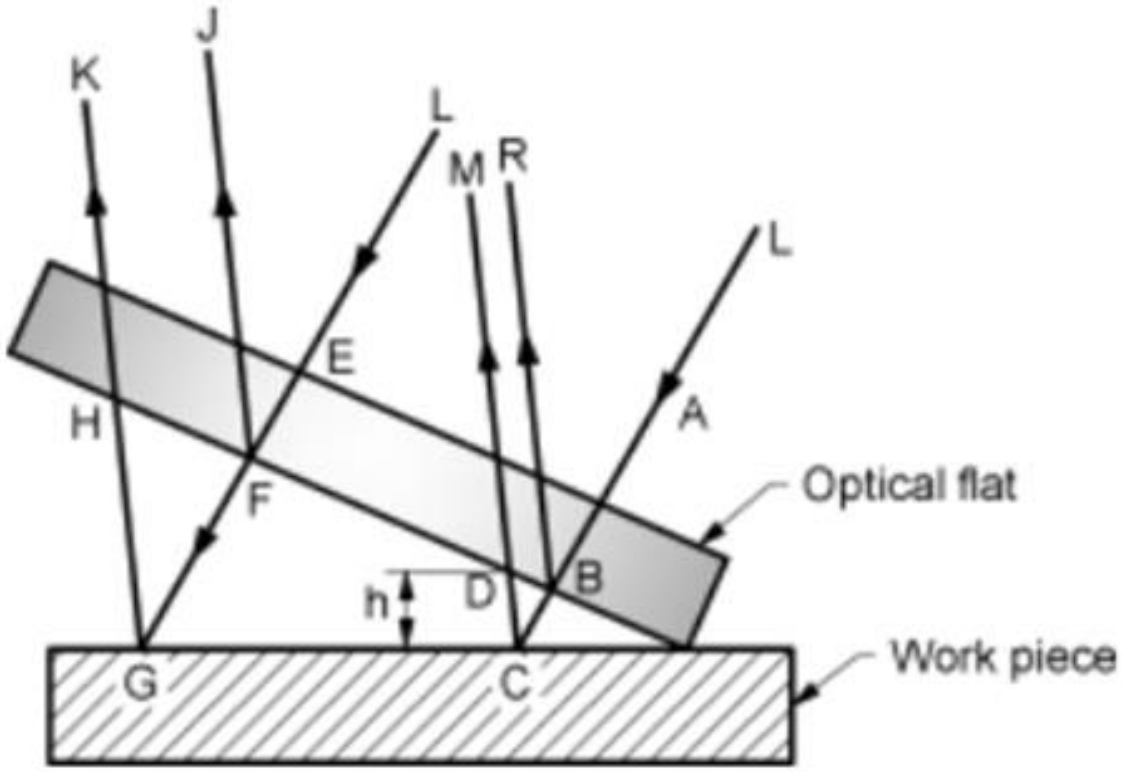
Lecture No : (07) 04:00 to 05:00

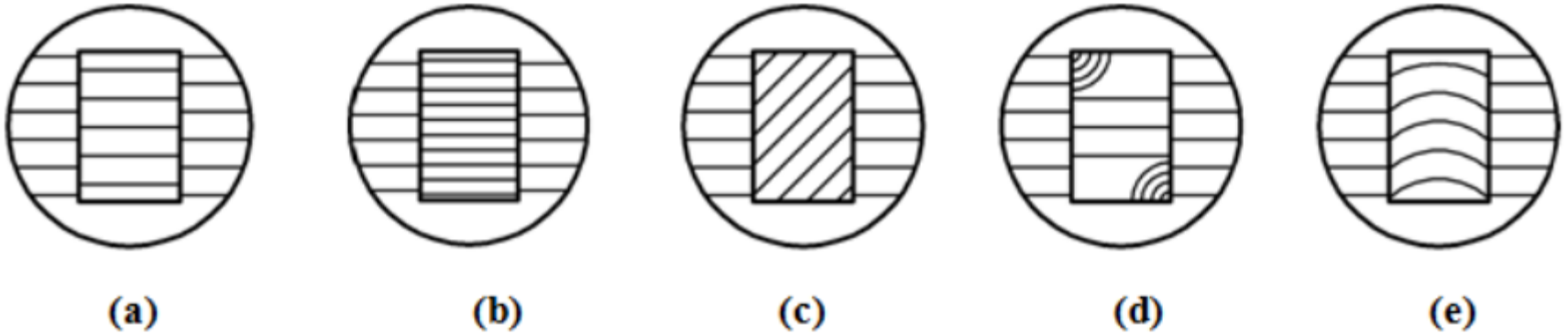
Source of Information : Mechanical Measurements and Instrumentations, Er. R K Rajput, Kataria Publication(KATSON)

Interferometer

- It is the science of making precise measurements upto a few thousands of a millimeter with the help of equipment like optical flats and a monochromatic light source.
- The measurements are based on the phenomenon of light wave interference.



Different Interference Patterns

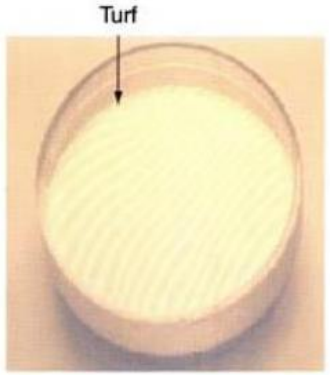


Fringe patterns obtained with flatness interferometer

- **(a) Pattern:** The pitch of the two sets of fringes and the **direction is same** indicating a **perfectly flat & parallel gauge**.
- **(b) Pattern:** The direction of bands is **same but pitch is different** indicating **taper along the larger edge of the gauge.**
- **(c) Pattern:** The pitch is **same but the direction is different** indicates a **taper along the shorter corner of the gauge**.
- **(d) Pattern:** Indicates that the **corners of the gauge are worm out**.
- **(e) Pattern:** Obtained when the gauge surface being tested is **convex or concave**.

Different Interference Patterns

(a) Cylindrical



(b) Turf

(c) Flat

(d) Conical

(e) Convex

(f) Ridge or a valley

(g) Convex

(h) Oval

Precision Instrumentation based on Laser Principles

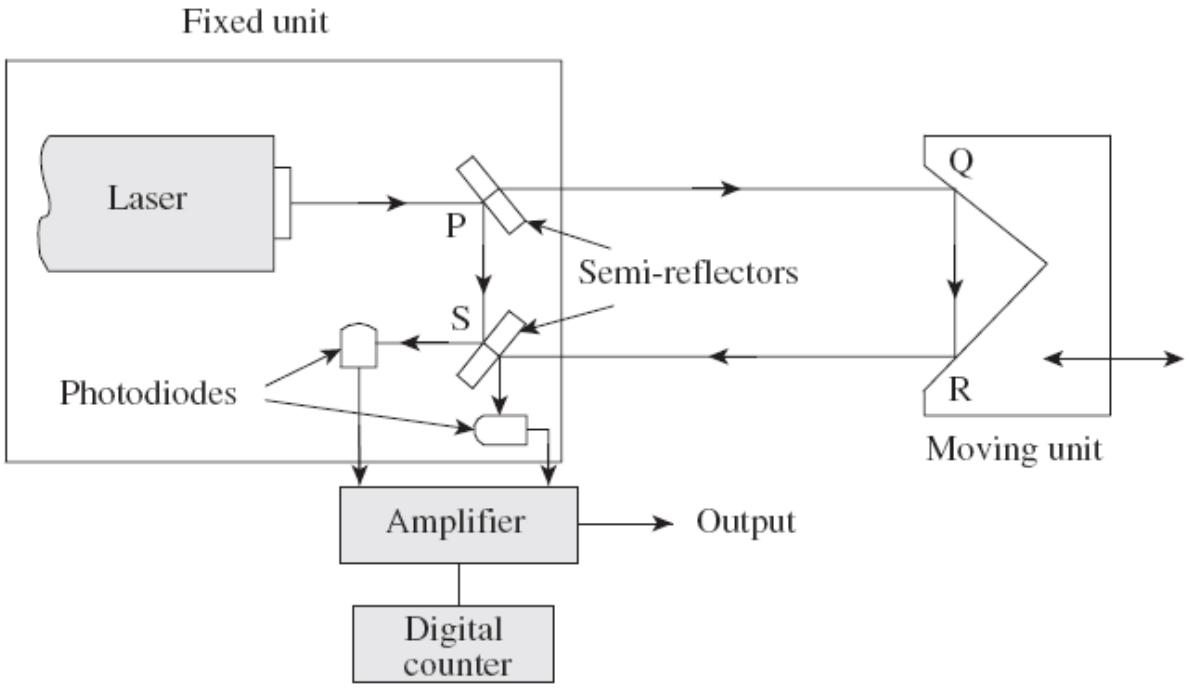
- Light Amplification by Stimulated Emission of Radiation (LASER) produces an intense emergent beam of light that can be parallel to a high degree or can be focused onto a very small area.
- Although a number of materials may be used to produce lasers, the helium-neon gas laser is the most popular for applications in metrology.
- For the purpose of measurement, laser has properties similar to 'normal' light.
- It can be represented as a sine wave whose wavelength remains the same for a given colour.

Properties of LASER

- **Laser light is monochromatic**: It has a bandwidth in the range of 0.4 - 0.5 µm. Stabilized lasers have still narrower bandwidths, with the result that very high resolution can be achieved during measurement.
- **Laser light is coherent:** In normal light, the rays are randomly phased, resulting in partial interference within the beam. In contrast, laser rays are all in phase, producing a coherent beam of light.
- **Laser light is naturally collimated:** The rays in a laser beam are perfectly parallel with line divergence and scatter.

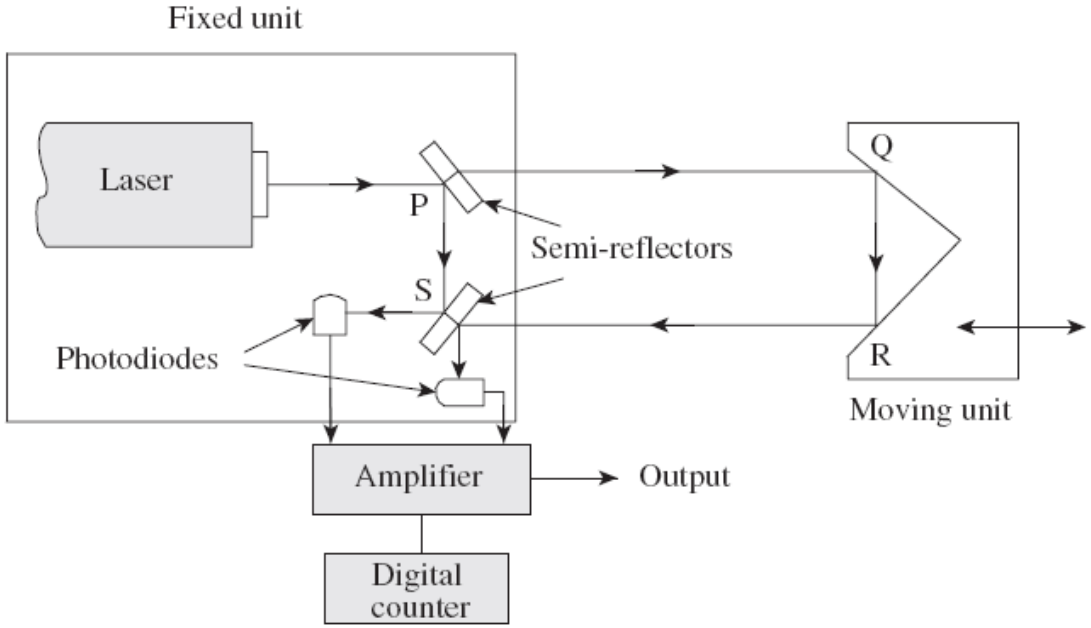
Laser Interferometers

- ✓ Laser interferometers can be used for measurements of small diameters as well as large displacements.
- ✓ Laser light first falls on the semi-reflector P, is partially reflected by 90° and falls on the other reflector S.
- ✓ A portion of light passes through P and strikes the corner cube. Light is turned through 180° by the corner cube and recombines at the semi-reflector S.



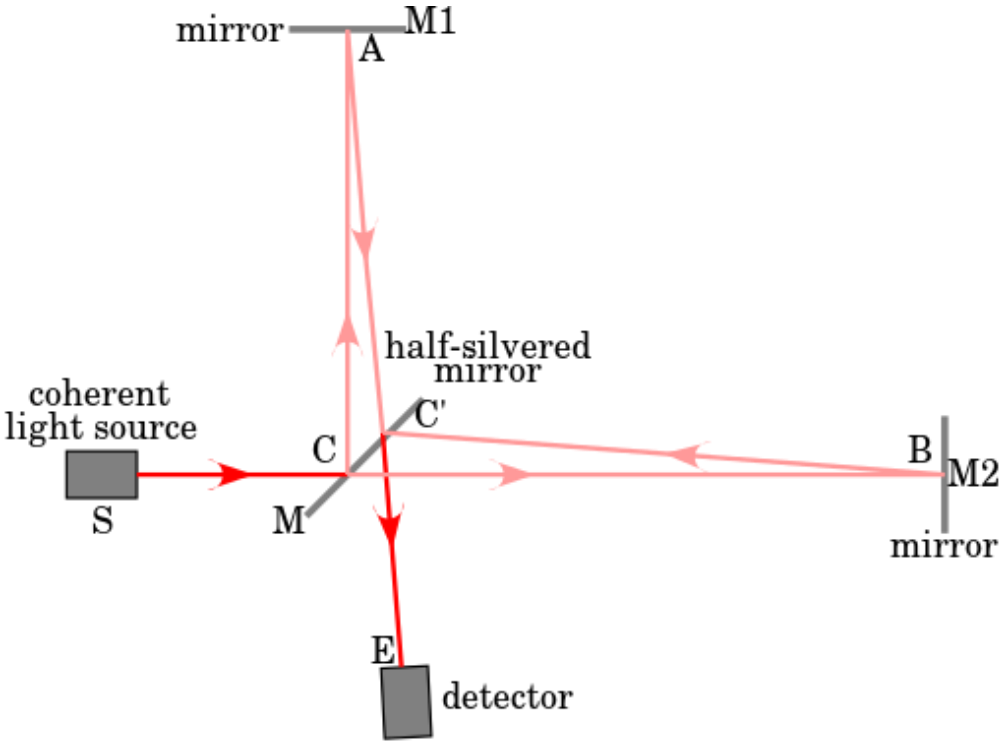
Laser Interferometers

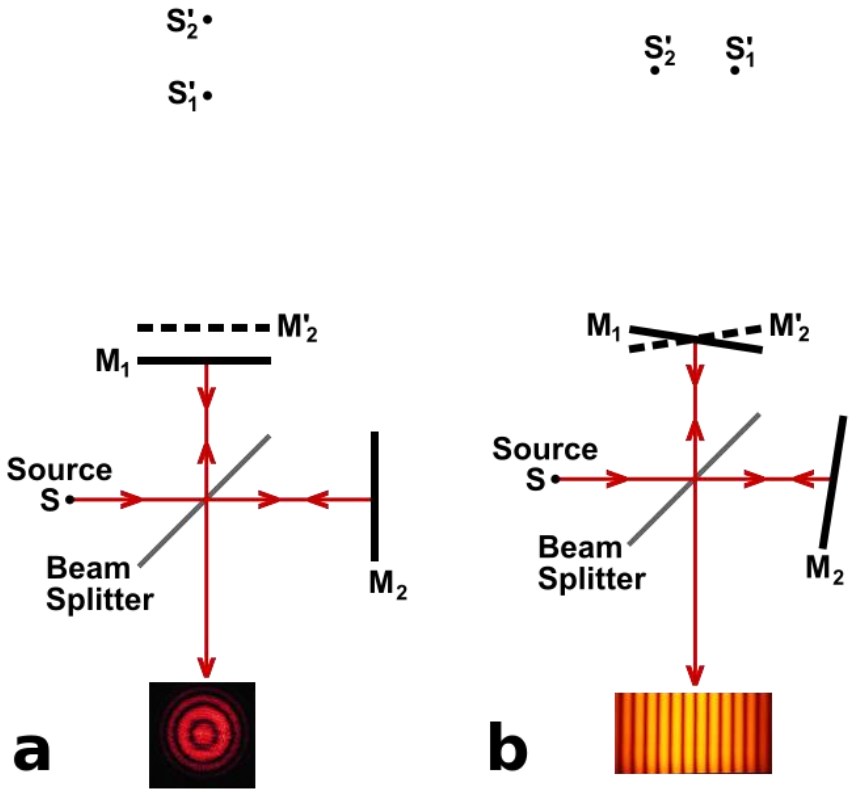
- ✓ If the difference between these two paths of light (PQRS − PS) is an odd number of half wavelengths, then interference will occur at S and the diode output will be at a minimum. On the other hand, if the path difference is an even number of half wavelengths, then the photodiodes will register maximum output.
- ✓ Each time, the moving slide is displaced by a quarter wavelength, the path difference (i.e., PQRS − PS) becomes half a wavelength and the output from the photodiode also changes from maximum to minimum or vice versa.



Michelson Interferometer

- ✓ Its consists minimally of mirrors M1 & M2 and a beam splitter M. In Fig, a source S emits light that hits the beam splitter (in this case, a plate beam-splitter) surface M at point C.
- ✓ M is partially reflective, so part of the light is transmitted through to point B while some is reflected in the direction of A.
- ✓ Both beams recombine at point C' to produce an interference pattern incident on the detector at point E (or on the retina of a person's eye).





Assignment Questions

01	Explain principle of Interferometer.	**03**
02	Explain with neat sketch Different Interference Patterns.	**04**
03	Define LASER. List out property of LASER.	**04**
04	Explain with neat sketch LASER interferometer.	**07**
05	Explain briefly Michelson Interferometer.	**03**

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