EXPERIMENT 9

FABRY-PEROT INTERFEROMETER

PURPOSE

To determine the wavelength of the laser using Fabry-Perot Interferometer.

EQUIPMENT

Laser source, Interferometer kit, Optical bench.

THEORY

Fabry-Perot Interferometer

When one beam of light passes through a plane-parallel plate with two reflecting surfaces, it is reflected many times between the two surfaces and hence multiple-beam interference occurs. The higher the surface reflectance is, the sharper the interference fringes are. That is the basic principle of the Fabry-Perot interferometer.

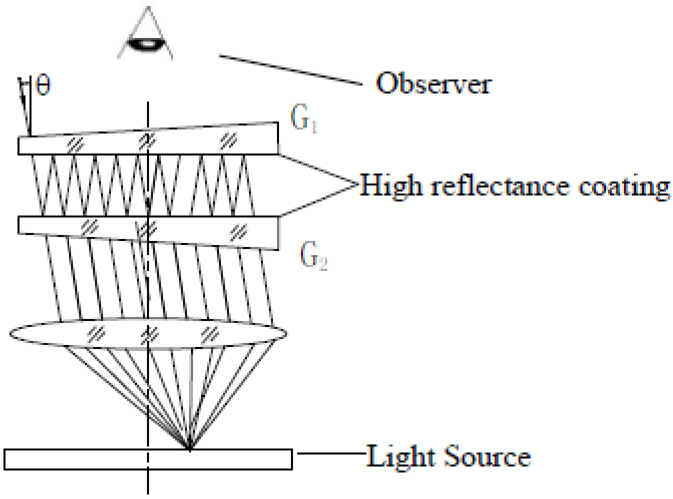

Fig 1 Schematic diagram of Fabry-Perot interferometer.

As shown in **Fig 1**, two partially reflecting mirrors G_1 and G_2 are aligned parallel to each other, which form a reflectively cavity. When monochromatic light is incident on the reflective cavity with an angle θ, many parallel rays pass through the cavity to become the transmitted light. The optical path difference between two neighboring rays is given by δ:

$$\delta = 2nd\cos\theta \qquad (1)$$

Thus, the transmitted light intensity is:

$$I' = I_0 \frac{1}{1 + \frac{4R}{(1-R)^2} sin^2 \frac{\pi\delta}{\lambda}} \qquad (2)$$

Where $\boldsymbol{I_0}$ is the incident light intensity, ***R*** is the mirror reflectivity, ***n*** is the refractive index of the medium in the cavity, ***d*** is the cavity length or mirror spacing, and $\boldsymbol{\lambda}$ is the wavelength of the monochromatic light.

Thus, ***I'*** varies with $\boldsymbol{\delta}$. When

$$\delta = m\lambda \qquad (m = 0, 1, 2 \ldots.) \qquad (3)$$

I' becomes a maximum so that constructive interference of the transmitted light occurs.

When

$$\delta = (2m' + 1)\,\lambda/2 \qquad (m = 0, 1, 2 \ldots\ldots) \qquad (4)$$

I' becomes a minimum and destructive interference of the transmitted light is observed.

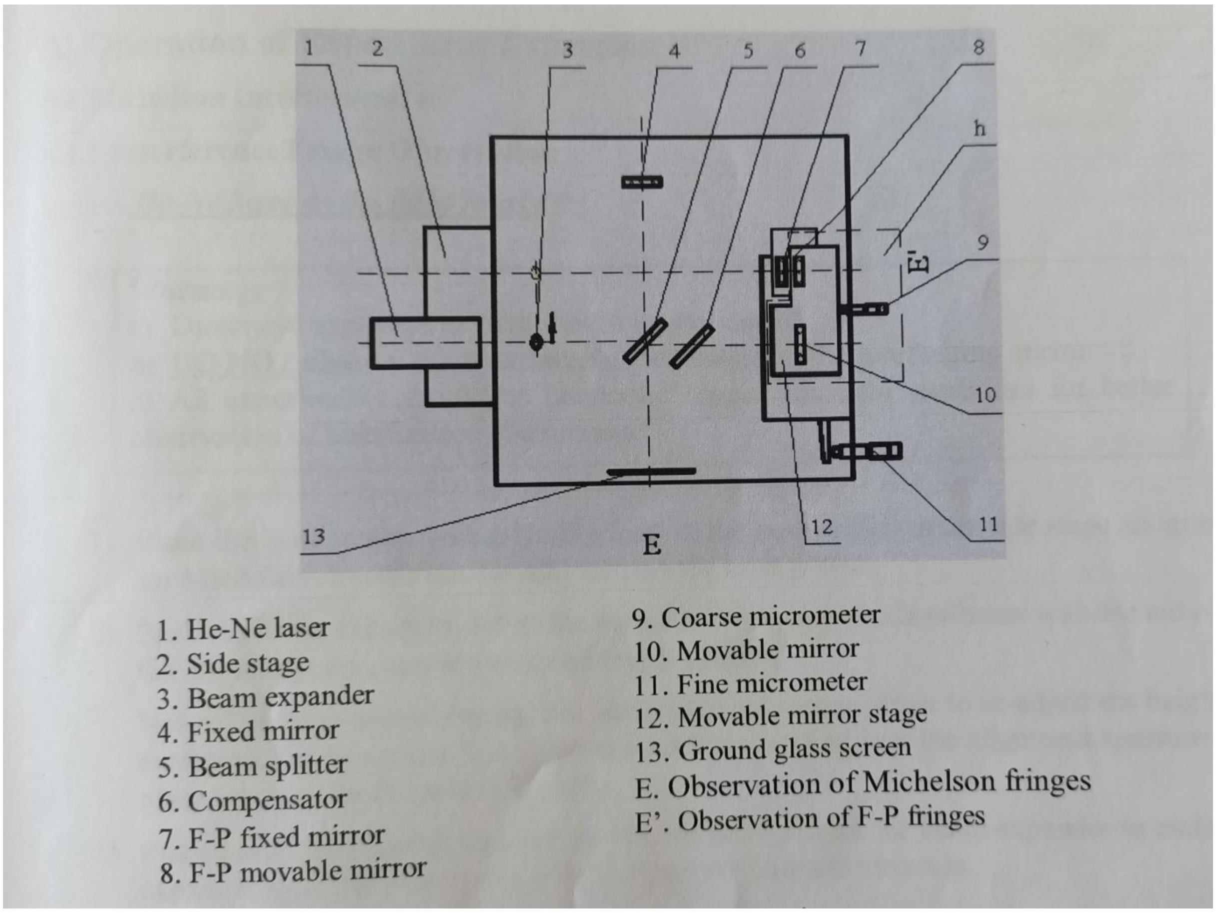

Fig 2 Layout diagram of the instrument.

PROCEDURE

Measurement of the Wavelength of a He-Ne Laser

The interference fringes of F-P interferometer are clearer and thinner than those of Michelson interferometer. Thus, by using the same fringe-counting method with a F-P interferometer, the wavelength of a He-Ne laser can be measured more accurately.

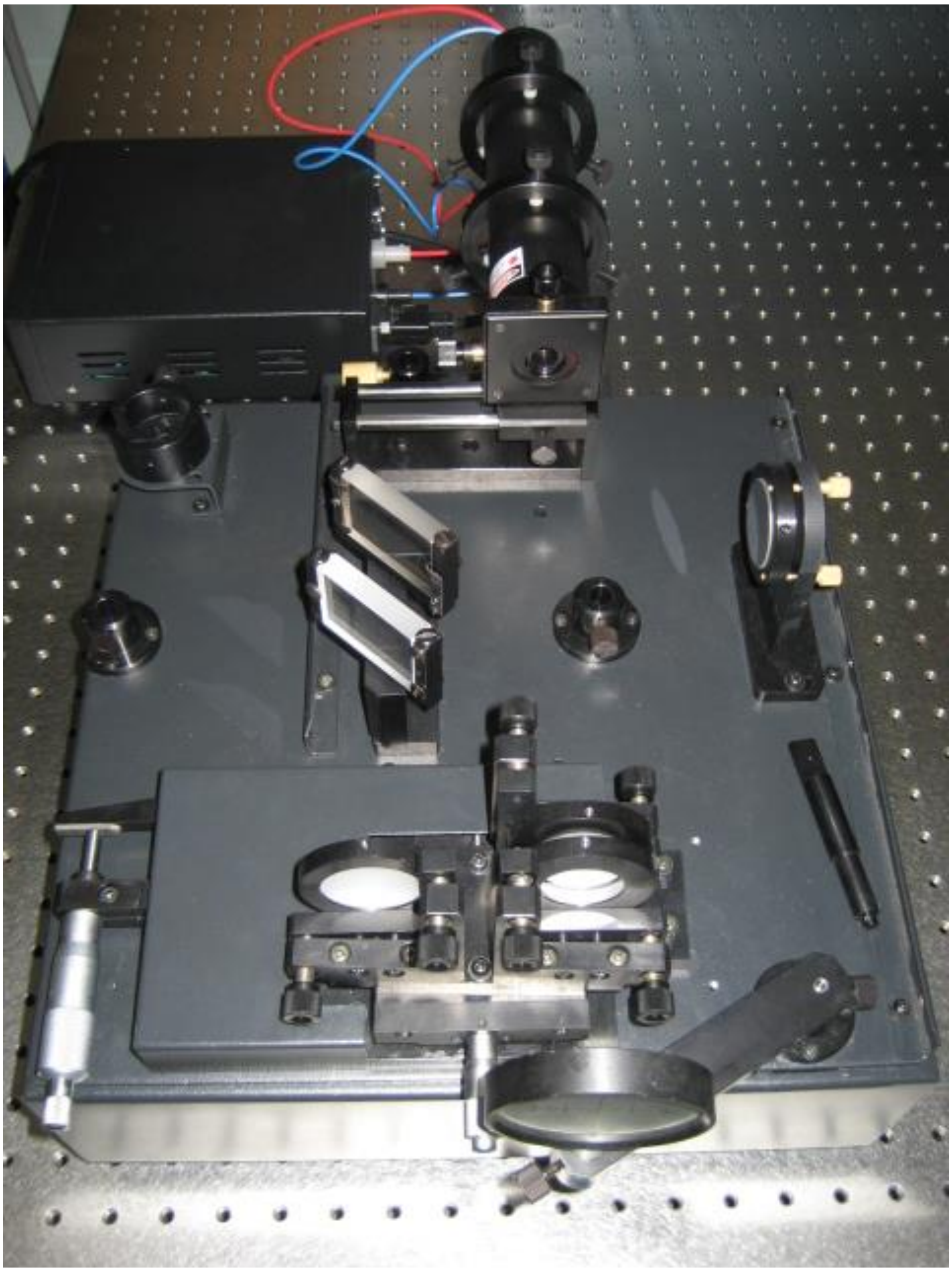

Fig 3 Fabry-Perot interferometer mode.

1. Setup the F-P interferometer.
2. Adjust the interferometer carefully to produce clear circular fringes in the center of ground glass screen.
3. Record the reading d_0 of the fine micrometer.

4. Count the number of fringes that expand (or collapse) in the center of the ground glass screen as the micrometer is turned slowly. After counting 50 fringes, record the micrometer reading again.
5. Calculate Δd. The actual mirror movement Δd is given;

$$\Delta d = \frac{\Delta N \lambda}{2}$$

Here λ is the wavelength of the source, ΔN is the number of fringes counted ($\Delta N=50$). Thus,

$$\lambda = \frac{2\Delta d}{\Delta N}$$

6. To minimize any errors in counting the rings or recording the micrometer reading, steps 1-5 should be repeated at least 3 times.