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Letters to the Editor

Mirrorless interferometer of Michelson type based on single-mode waveguide with semiconductor laser

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In this paper we describe the mirrorless interferometer of Michelson type which enables investigations of the vibrations *in situ*. The interferometer was tested by vibration amplitude measurements of the vibrating piezoelectric plate.

By applying the interference phenomenon to determination of the vibration amplitude of opaque objects for the light it is possible to measure amplitudes of the order of 1/10 of wavelength. For that purpose the Michelson type interferometer has usually been applied in which the vibrating object plays the part of one of the interferometer mirrors, and hence the requirement of its surface being smooth enough. Another inconvenience of applying the Michelson type interferometer is due to the difficulties of performing the measurements *in situ* because of air turbulences and impurity. The above inconveniences can be eliminated by using the waveguide version of Michelson interferometer [1]. The principle of its operation is illustrated in Fig. 1.

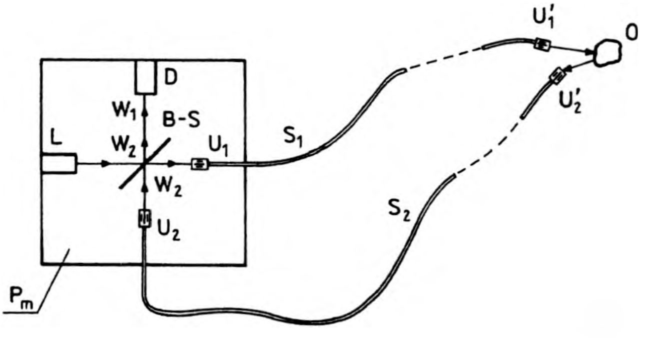

Fig. 1. Mirrorless interferometer of Michelson type on waveguides.

The light beam emitted by the laser (L) is split into two beams with the help of a beam splitter plate (BS). One of the beams is directed to the input (U_1) of the waveguide (S_1), the output (U'_1) of which is located close to the surface of the object

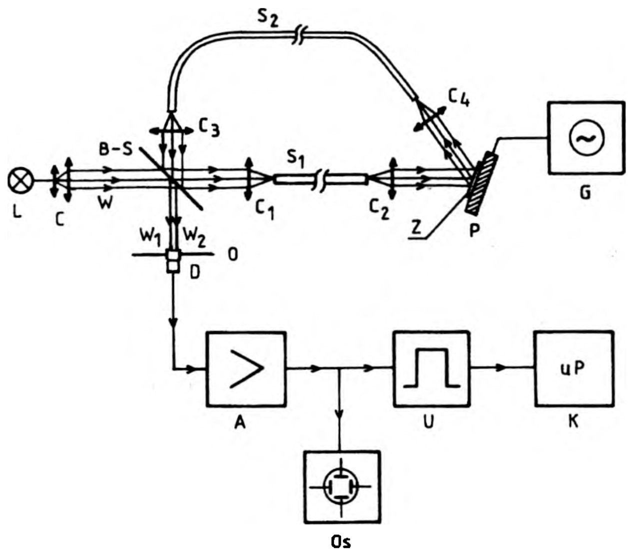

Fig. 2. Measuring system for observation and determination of the vibration amplitude with the help of the Michelson interferometer based on single mode waveguides.

under test (O). The light reflected by the object is introduced to the waveguide (S_2), the output (U_2) of which is localized in the vicinity of the beam splitter. The emerging beam (W_2) propagates in accordance with the direction of the reference beam (W_1). Both the beams (W_1, W_2) create an interference image recorded by the detector (D). The amplitude of vibrations of the object (O) is determined from the changes in intensity of the chosen interference fringe.

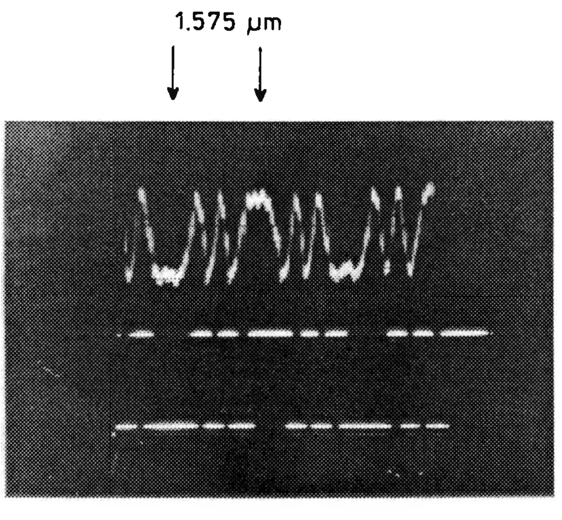

Fig. 3. Changes of the light intensity in an interference fringe caused by the vibration of the piezoelectric plate. Vibration frequency 30 Hz, amplitude of vibrations 1.575 μm.

In Figure 2, an example of experimental system used for determination of the vibration amplitude of a piezoelectric plate (P) excited to vibration by a generator (G) is shown. The laser beam from the semiconductor laser (670 nm) after having been formed as a plane parallel beam by a telescope (C) is divided by a beam splitter (BS) into a reference beam (W_1) and the object beam (W_2). The object beam after leaving the waveguide (S_1) falls on the piezoelectric plate and after having been scattered is introduced to the waveguide (S_2). The output of the waveguide (S_2) is localized in such a way that the emerging beam (W_2) propagates in accordance with the direction of propagation of the reference beam (W_1). In the observation plane just behind the slit (O) the detector (D) is located which records the change of intensity of the chosen interference fringe. The signal from the detector being amplified by the amplifier (A) is next directed to the oscilloscope (Os) and the computer (K).

The change of intensity of the chosen interference fringe is due to the vibrations of the piezoelectric plate (P). In Figure 3, the change of the interference fringe intensity is shown which illustrates the plate vibration with the frequency 30 Hz.

Conclusions: Small sizes of the semiconductor lasers allow the interferometers discussed above to be miniaturized to a significant degree, which after some slight modifications of the system will enable their wide application to examination of vibrations *in situ*. For the purpose of this work a semiconductor laser (670 nm) purchased at the Centrum Techniki Laserowej (Warszawa, Poland) was applied.

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