SMALL PELLICLE LASER INTERFEROMETERS FOR THE SPACE OPTICS TESTING

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Abstract-Simple and small laser interferometers for the Space optical systems testing are discussed. Interferometer consists of a lens in front of the gas laser, flat pellicle beamsplitter, a tiny flat reference mirror, and optics under test. The interferometer is not affected by displacements and the tilts of the lens, the beamsplitter, and the the reference flat mirror, that it is especially recommended for the Space optics testing on the orbit.

***Keywords*: **Interferometer, Space, optics, testing

INTRODUCTION

Well-known Twyman-Green interferometer was successfully used for optics testing long ago [1]. Many useful modifications of the Twyman-Green interferometer had arrived [2,3,4,5,6,7,8].

SIMPLE PELLICLE INTERFEROMETER

Sometimes for example for a testing of optics on orbit in Space, it is necessary to use a light, small, and simple interferometer. It would be convenient if the interferometer can be used also for quite fast optics testing. We propose the arrangement as illustrated in Fig.1. The interferometer consists of a condenser lens 2, installed in front of a helium-neon gas laser 1, a small pinhole 3 placed at the focus of the focus of the condenser lens to reduce diffraction and scattering artifacts resulting from dust particle contamination; an aberration-free lens 4, pellicle beamsplitter 5, a small reference flat mirror 6, a system to be tested 7, and a viewing screen 8, or a detector for example CCD. The light of the laser passes lenses 2 and 4, and beamsplitter 5 to produce the point-like image at the surface of the reference flat mirror 6. The beam is splited by the pellicle beamsplitter into a reference beam and an analyzer beam. The analyzer beam is reflected by the system under test 7, and then this beam is returned and recombined with the reference wavefront to produce Twyman-Green fringes on the viewing screen 8. The reference wavefront is reflected by beamsplitter pellicle from the reference flat mirror 6.

It is used only very small part of the flat mirror, that is why errors of the mirror do not spoil the reference beam, and the reference flat may be a very small, light and cheap one. It is noted that the intensity of each beam would be different, so the reflectance from the reference flat must be adjusted to match the reference beam and the analyzer beam. Of course it is possible to use the number of reference flats with a different reflectance or to make the common reference flat with spots of the different reflectance. It is important that the interferometer is not affected by a wall displacements and tilts of the beamsplitter and the reference flat mirror. That is why if the lens 4 (Fig.2) is designed to be insensitive to small displacements and tilts, the assembled interferometer would be also insensitive to the small displacements and tilts.

Therefore the assembling and the adjustment procedures of the interferometer are very simple too. This interferometer is very simple, small, light and cheap and can be easily manufactured in quantity. It may be especially recommended for optics testing on the orbit in Space, as well as for an optical shop testing. Unfortunately the pellicle is subject to both acoustical and mechanical vibration of the optical shop, that is why it is useful to locate focal points F and F' near the pellicle for diminishing of the vibration artifacts to the fringes errors.

MODIFICATION OF THE PELLICLE INTERFEROMETER

It is possible to advance of the reference mirror beam stability by means of using a corner cube glass prism reflector instead of the flat reference mirror 6 in Fig.2. The matter is corner cube glass prisms are designed to reflect any beam or beam entering the prism face, regardless of the orientation of the prism, back onto itself. A flat mirror will do it only at the normal incidence. Therefore corner cubes are ideal where precision alignment is difficult or time-consuming.

Another variety of the interferometer is pictured in Fig.2. It has different arrangement of the optical details. It is shown in Fig.2: 1 – a laser, 2 – a lens, 3 – a pellicle, 4 – a flat reference mirror, 5 – a system to be tested, 6 – a viewing screen or CCD. This interferometer can be more small then the interferometer pictured in Fig.1. Again, the flat mirror can be replaced by the corner cube reflector for a better stability of the reference beam. There are no the condenser lens and the pinhole therefore the chief disadvantage is the diffraction resulting from dust particle contamination, but it is possible to diminish this phenomenon placing a black point diafragm on the flat reference mirror 4 in Fig.2. Of course the black point diafragm can be used also on the flat reference mirror 6 in Fig.1 to reduce diffraction and scattering artifacts resulting from dust particle contamination of the lens and the pellicle.

Again, the reference flat mirror 4 in Fig.2 can be coated to match the analyzer beam and the reference beam more exactly.

The interferometer pictured in Fig.2 has the same advantages as the previous one (Fig.1): the assembling and the adjustment procedures of the interferometer are very simple; it is small, light and can be easily manufactured. One more advantage of the interferometer pictured in Fig.2 is a possibility to put details 1, 2, 3, 4 into a clean box and therefore to prevent them from a dust particle contamination. Again, it is useful to locate focal points near the pellicle to reduce of the possible vibration artifacts. It may be especially recommended for optics testing at the orbit in Space. This job is intended to be useful for space telescopes T-170 and Sitch-2 testing.

By the way the best lens for interferometers is concentric one, i.e. lens with a common center "c" of the curvature of all surfaces. It is supposed that the lens consists only of the spherical surfaces. The concentric lens is to be designed to get minimum of the spherical aberrations for laser light. Remaindering aberration of the lens has not to exceed tolerance, for example $\lambda/100$ of the optical path difference. The concentric lens has no coma and astigmatism that is why this lens can be tilted to rather big angle without of a breaking of the adjustment.

One more variety of the interferometer is shown in Fig.3. It has quite different design: 1 – a laser, 2 – a condenser lens, 3 – a small pinhole, 4 – an unaberration lens, 5 – a pellicle beamsplitter, 6 – a system under test, 7 – a little folding flat mirror, 8 – a viewing screen, or a detector. The interferometer works of the following way: the light of the laser 1 passes the lens 2, pinhole 3 and lens 4 to produce point like image at the flat surface of the beamsplitter 5. The beam is split by the pellicle beamsplitter into a reference beam and an analyzer beam. The analyzer beam is reflected by the system under test 6, and then it returns and crosses beamsplitter 5, lens 4, and at last it is reflected by the folding flat mirror 7 to ecran 8. The reference beam is reflected by the beamsplitter 5 back to the lens 4 and the folding flat mirror 7 to recombine with analyzer beam at the viewing screen 8. Therefore here only a small part of the pellicle is used like the reference flat, that is why an influence of errors and vibrations of the pellicle is reduced. It is important to place the folding flat mirror 7 and image F' (Fig.3) near the pinhole 3 to diminish off-axis aberrations. By the way in most cases the pellicle beamsplitter (Fig.3) may be replaced by small and very thin glass plate with anti-reflection coating of the first surface and semi-transparent mirror coating of the another surface.

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FIGURES

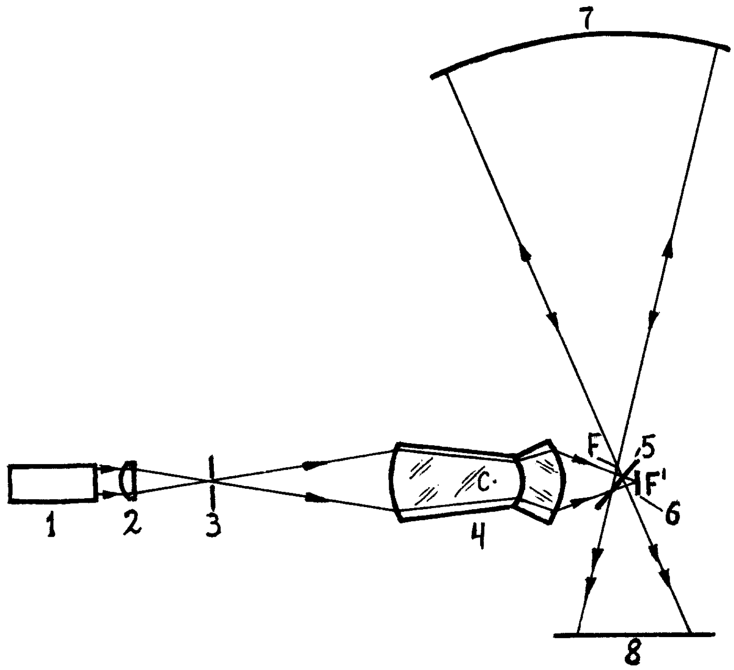

Fig.1. Pellicle and tiny flat reference mirror laser interferometer.

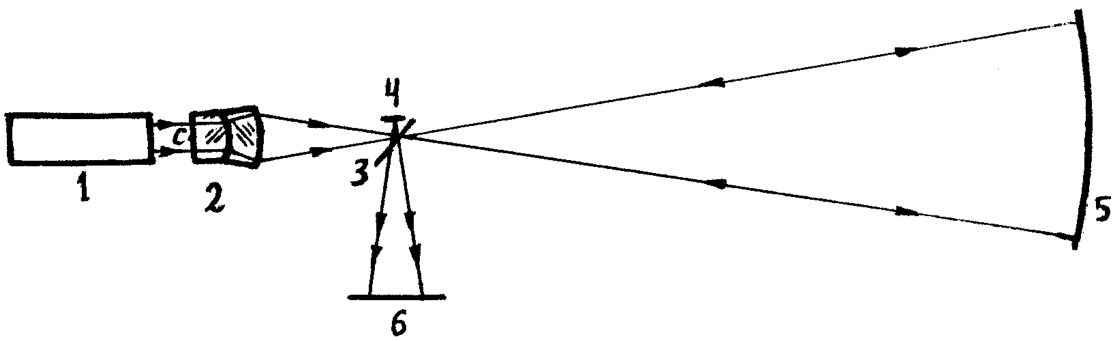

Fig.2. The simple modification of the pellicle and tiny flat reference mirror laser interferometer.

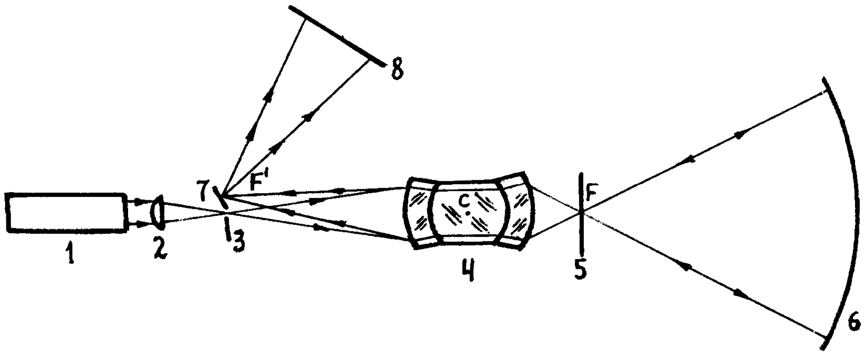

Fig.3. Another modification of the pellicle interferometer without of the reference mirror; the pellicle beamsplitter is used for reference beam creating instead of the flat reference mirror

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