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DEMONSTRATION OF TRANSMISSION INTERCEPTION OF MODULATED OSCILLATIONS WITH A HELIUM-NEON LASER BEAM

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LASERS are finding increasing use as demonstration instruments. We present below a description of a lecture demonstration of the transmission and reception of modulated oscillations with a laser beam.

The setup for the modulation of the laser-beam intensity consists of an LDI-67 laser (laser-beam output power 1 MW), a high-voltage inductor IV-100, a low-frequency amplifier LFA with output power 3 W, and a microphone (Fig. 1).

To modulate the transmitted acoustic signal by the laser-beam intensity, the secondary winding of a high-voltage inductor IV-100, which serves as a matching transformer, is connected in series in the anode circuit of the helium-neon tube supply. The primary winding of the inductor can be connected to the output of any type of low-frequency amplifier, provided that the voltage applied to the primary winding of the inductor does not exceed 1 V.

The signal is applied with a mirror to the photomultiplier of the sound-reproduction system of the "Ukraina" motion-picture apparatus. The background level, the nonlinear distortion, and the bandwidth of the reproduced frequencies are determined mainly by the quality of the low-frequency amplifier and by the rigidity of the supports of the transmitting and receiving systems.

The optimum conditions for signal transmission are realized at a discharge-tube current 15–18 mA. At a larger discharge current, three watts of low-frequency amplifier power are not sufficient to modulate the laser beam in amplitude. The laser is ignited in the usual manner, with the gain control knob of the above-mentioned amplifier in the middle position.

If the signals are transmitted over a distance larger than 30 meters, then, to obtain sufficient amplification of the received signal, the latter must be applied to the photomultiplier with the aid of a concave mirror of required diameter or with the aid of a suitable gathering lens.

The proposed receiving-transmitting system can also be used for lecture demonstrations of wave optics. Thus, it is possible to use the setup to demonstrate interference and diffraction patterns "by ear," when they are not intense enough to be visually demonstrated in a large auditorium. In this case, the laser beam is amplitude-modulated with an acoustic generator of the GC-33 type, connected to the primary winding of the high-voltage inductor. The modulation is at 800 Hz. The amplitude-modulated light beam is aimed on the working surface of an SF2-2 photoresistor, the area of which is varied with an adjustable slit D serving as a diaphragm.

A diagram of the adapter with the photoresistor SF2-2, for use in certain lecture demonstrations on wave optics, is shown in Fig. 2.

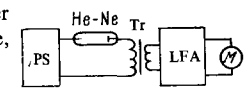

FIG. 1. Setup for the modulation of a laser beam. PS–power supply for helium-neon tube, LFA–low-frequency amplifier, Tr–matching transformer, M–microphone.

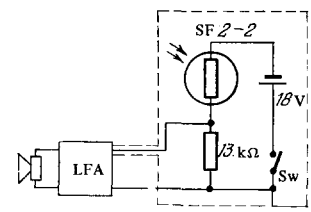

FIG. 2. Diagram of adapter with photoresistor for the performance of certain lecture demonstrations on wave optics.

By way of example, let us examine a demonstration aimed at observing the diffraction pattern from a variable rectangular slit P. The slit P is mounted normal to the laser beam, and a diffraction pattern is obtained on a screen located ~1.5 m away from the slit. The width of the slit P is so adjusted that the fringe width is about 1.5 mm. The photoresistor is placed parallel to the screen, and the presence of the 0-th, ±1st, ± 2nd and ± 3rd maxima is demonstrated.

Since the aim is only to demonstrate qualitatively the presence of diffraction maxima, which cannot be seen in a large auditorium, the maximum width of the diaphragm D of the photoresistor was used, namely, barely less than the width of the diffraction fringe (~1 mm) at the given arrangement of the instruments. The loudness of the sound is then maximal and sufficient to perform this demonstration with the low-frequency amplifier of the "Ukraina" motion-picture apparatus. The electric signal from the adapter with the photoresistor was fed to the microphone input of this amplifier.

If the width of the slit D of the diaphragm of the photoresistor is much smaller than the width of the diffraction maximum, then the light flux of the section of the diffraction maximum is no longer sufficient to demonstrate the lateral diffraction maxima by ear, since the intensity of the diffraction maxima of the orders mentioned above is in the ratio 1 : 0.045 : 0.016 : 0.008.

Obviously, intensity modulation of the laser beam is used in this case to be able to use the sound-reproducing apparatus as an indicator of the spatial distribution of the light intensity.

L. Z. Kriksunov, Sistema informatsii s OKG (Information System with Laser), Kiev, Tekhnika, 1970, A. A. Carra, Am. J. Phys. 38, 926 (1970).

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