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INCREASE OF NOISE IMMUNITY OF LASER SMOKE FIRE DETECTORS

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Future-oriented way to improve the functional characteristics of the smoke fire detector is the use of laser radiation sources instead of currently used diode radiation sources[1]. However, laser smoke detectors, which use the same as in the LED detectors integral principle of scattered by smoke particles radiation recording, are not protected from exposure to microfine particles of non-smoke origin. Signals produced by particles of this nature, indistinguishable from the signals caused by smoke particles, lead to false alarms.

Coherence property of laser light opens up the possibility of introducing in smoke detectors new fire product registration schemes that can substantially reduce the probability of false responses due to non-smoke formations, in particular, the dust particles. These schemes can be borrowed and adapted from the detectors of well-designed laser optical research methods of particle velocities of liquids flows and gases[2].

In this paper we propose to use in optical smoke detectors differential scheme of smoke particles detecting. To implement the scheme the laser source radiation separates into two coherent beams, which are then reduced in volume of smoke detector chamber. At the intersection of light beams an interference pattern is whose period Λ is determined by the wavelength λ, by the refractive index

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[1] Pinnacle Laser Technology Smoke Detector, www.systemsensor.com/pdf/A05-1028.pdf

[2] Rinkevichus B.S.: The Doppler method of local velocities measuring using lasers / / UFN .- 1973 .- .- T.111, Issue 2 .- p. 305–307.

of medium n, in which beams propagate, and by beam convergence angle α. With the passage of smoke particles through the localization interference field volume appears scattered radiation with time-varying intensity. This radiation is collected by the lens on photodetector. If the average particle size is less or equal to the period of the interference field, the photodetector generates an alternating photocurrent. Its main characteristic is the modulation frequency f_x, which is proportional to the particle velocity vector projection u_x on perpendicular to the bisector of the angle of light beams intersection in the amount of flow.

By the maximum value of the velocity vector projection

$$f_x = \frac{u_x}{\Lambda} \tag{1}$$

If the size of a particle moving in the interference field exceeds the size of its spatial period, the frequency and depth of the photocurrent modulation are changing. So typical for the given smoke type (average size of smoke particles and their average velocity) value f_x can be chosen as the selection criterion of smoke particles by size. Practical implementation of this criterion may need to adjust the installation-specific settings of detector signal amplifier to the work in a given narrow frequency range.

For testing of proposed smoke detector scheme model experiments were carried out. The model of smoke formation was a banner with the image of randomly distributed dark circles with a diameter equal to 14 microns. This banner was administered by a sharp forward movement in the plane of the interference pattern with period $\Lambda = 17{,}6$ microns. The dust medium was formed from flour particles sprayed over the localization area of the same interference field.

Figure 1 (a, b) shows the detector photocurrent oscillograms and the relevant power spectra generated by a moving banner a) and a single particle of flour dust b).

It is evident that these photocurrents vary from each other in their temporal structure. If the photocurrent produced by particles of a moving banner is characterized by high-grade time modulation of amplitude, the photocurrent caused by the movement of flour dust particle takes the form of a single pulse. Accordingly, spectra of the photocurrents also differ in frequency. In the spectrum of the photocurrent, which is formed by the banner, is clearly expressed by the intensity one non-zero frequency of component, while in the spectrum of the flour dust photocurrent a number of such intense frequencies is observed. The difference in the frequency spectrum of the photocurrents produced by particles of different sizes, allows selecting by detector signals with a characteristic frequency modulation corresponding to the specific range of particle sizes and their velocities.

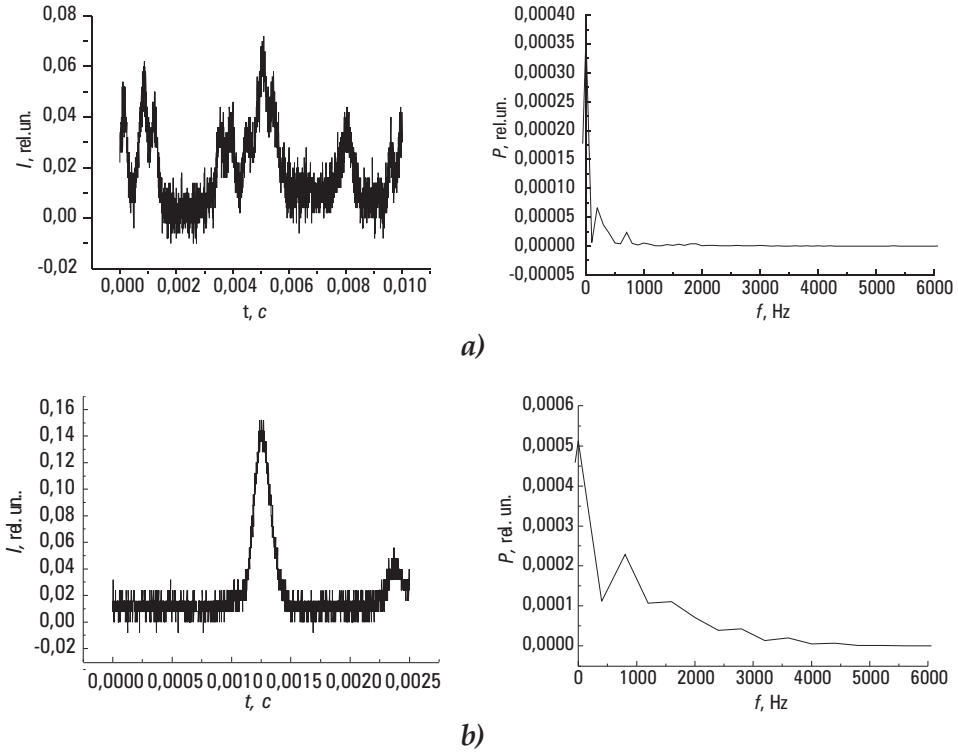

Fig. 1. *Detector photocurrent oscillograms and their power spectra*

SUMMARY

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The article describes of the optical system of the proposed smoke detector construction, in which lightening of a smoke chamber is made by a focused laser beam having, according to the periodic law, a modulated spatial distribution of radiation intensity in the focal spot. This structure of the light field in the smoke

flow allows to generate the algorithm of signals selection produced by the smoke particles with characteristic sizes and velocities. The result is increased stability of the smoke detector under the influence of external noise such as dust, vapor with different sizes of smoke particles and/or velocities. There are carried out model experiments on registration of time signals that are generated by particles of different sizes, crossing the plane of the beam focusing. The spectral characteristics of the recorded signals are researched. There are identificated possible algorithms for selection of signals generated by micro formations with specified medium size and speed of movement.