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CONTROL OF LASER RADIATION PARAMETERS

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Formation of the fundamental transverse mode in the resonator of a laser with electrooptical reflecting gate during autoinjection of initiating radiation

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***Abstract*. The optical diagram of a single-pulse laser with autoinjection of initiating free-running laser radiation, which ensures the development of the fundamental transverse mode in a prism resonator with an electrooptical reflecting gate, is studied experimentally.**

Keywords: *autoinjection, prism resonator, mode selection.*

External injection and autoinjection of initiating radiation are used in lasers for controlling the spectral and temporal parameters of giant pulses [1, 2]. In holographic lasers, the spatial coherence of radiation in a resonator is improved (usually with the help of a diaphragm) by selecting the fundamental transverse TEM$_{00}$ mode. When the end reflectors like roof-shaped prisms are used in a resonator, the formation of the TEM$_{00}$ mode is hampered since the prism edge falls in the centre of the lasing channel. In this work, the optical diagram of a single-pulse ruby laser with autoinjection of the initiating free-running laser radiation, which ensures the development of the fundamental transverse mode in a prism resonator with electrooptical reflecting gate (EORG), is described and studied experimentally.

Fig. 1a shows the optical diagram with autoinjection of initiating radiation from a free-running laser with two cavities connected optically with each other through an MDE-2 EORG (*3*) [3]. One of the extraordinary waves emerging from the switched-off EORG is used for forming the initiating free-running laser radiation in an auxiliary resonator (the path of the beams is shown by dashed lines) with an optical length $l \sim 1.5$ m, formed by the output reflector (*1*) (K8 glass substrate of thickness ~ 10 mm) and an auxiliary reflector (*4*) (a plane mirror with the reflectivity $R \approx 0.38$), as well as the roof-shaped prism EORG. The EORG is controlled by the BPZ-2L unit (*7*) [4], which was triggered by a signal from a FK-19 photoelement (*6*).

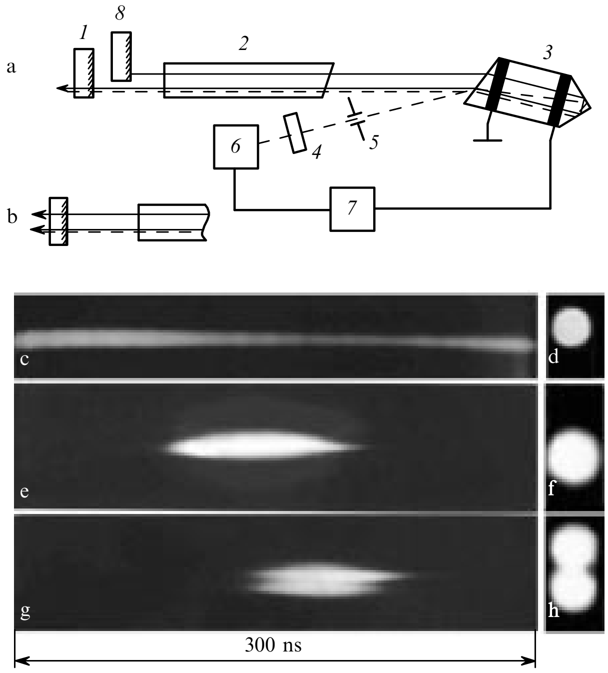

Figure 1. Laser scheme (a); its fragment (b); initiating radiation field pattern (d); and single-pulse lasing without (h) and with a totally reflecting output mirror (f); and sweeps in these regimes obtained with the help of a photoelectron recorder (c, e, g): (*1*) output reflector; (*2*) active element; (*3*) monoblock EORG; (*4*) auxiliary reflector; (*5*) diaphragm; (*6*) photodetector; (*7*) EORG control block; (*8*) totally reflecting mirror.

Upon triggering of the EORG and the formation of a giant pulse, the lasing channel is transformed into the main resonator of length ~ 2 m (the path of the beams is shown by solid lines) having not only a higher Q-factor, but also a 1.5 times larger coefficient of filling by the active substance (this filling factor is defined as the ratio of the optical length of the active element to the optical length of the resonator) [5]. The active element (*2*) was an RLS ruby rod ⌀8 × 120/180 mm, pumped by two ISP 5000 flashlamps in an elliptic reflector made of opal glass. The flashlamps were fed by a Pump-300M power supply. A spherical mirror with a radius of curvature ~ 2 m and reflectivity ~ 0.99 served as the reflector (*8*).

Figs 1c – f show the radiation intensity sweeps and integrated spatial patterns of the initiating free-running laser radiation field and of the giant pulse formed in a laser with diaphragm 1.5 mm. The giant pulse at the output of a laser using the traditional output reflector (*1*) (see Fig. 1b) is shown in Figs 1g, h. The FWHM duration of the

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giant pulses did not exceed 50 ns in both cases. The pumping level of the active element (*2*) corresponds to the generation threshold of the auxiliary resonator, ensuring the flash-to-flash reproducibility of the energy parameters of the single-pulse radiation.

The lasing volume of the active element in the laser can be used more efficiently when giant pulses are generated at the fundamental transverse TEM_{00} mode. An increase in the filling factor of the main resonator makes it possible to improve the energy parameters of the giant pulses being formed. In order to increase the contrast of the spectral line of the single-pulse radiation without using the first free-running lasing spike as the initiating radiation, it is sufficient to interchange the reflectors (*1*) and (*8*) to ensure that the free-running radiation formed in the auxiliary resonator, whose spectral parameters differ from those of the initiating radiation and which is essentially nothing but noise, does not emerge at the laser output. An increase in the filling factor due to lasing by a part of the active element at the stage of formation of the single pulse allows the formation of high-power, narrow-band giant pulses even without a significant increase in the Q-factor of the resonator when the EORG is switched on.

Thus, the laser under study can generate giant pulses at the TEM_{00} mode upon an increase in the Q-factor and/or the factor of filling of the resonator by the active medium, and provides a more efficient use of the lasing volume of the active element, an increase in the energy parameters of giant pulses and the contrast of their output spectrum, as well as a stable pulse-to-pulse reproducibility of the parameters.

Optical schemes with three or four passes of radiation through the active element can be constructed by using a certain set of prism reflectors. If the active elements have a large diameter, the number of passes increases and the nature of transformation of time and energy parameters of lasing must be investigated further in this case. These peculiarities are quite general and are not characteristic of only the above-mentioned ruby laser with an MDE-2 EORG and autoinjection of initiating free-running laser radiation. Similar multichannel lasing mode may also be realised in lasers with external injection of the initiating radiation.

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