GENERATION OF ULTRASHORT LIGHT PULSES WITH STABLE PARAMETERS IN AN ACTIVELY Q-SWITCHED LASER

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The most widely used method today for the generation of ultrashort light pulses (USP) is mode locking in a laser incorporating bleachable filters [1]. The fluctuating behavior of this type of nonlinear element impedes the generation of USP with adequately reproducible parameters.

An analysis of mode locking with external resonance Q-switching of the laser shows that this method can be used to generate USP with stable parameters [2]. The method is implemented in a ruby ring laser (R) with electrooptical Q-switching of the cavity (Fig. 1). A sinusoidal voltage with a half-period ($T/2 = 5 \times 10^{-9}$ sec) equal to the pulse transit time around the cavity formed by the four prisms P is applied to the $LiNbO_3$ electrooptical switch M_1. The KDP (potassium dihydrophosphate) switch M_2 provides additional Q-switching of the cavity in the nonlinear amplification section of the laser and output of the generated pulse from the system through the prism Γ. Mode selection is eliminated in the laser. A time plot of the relative transmissivity A of the Q-switches (modulators) M_1 and M_2 is given in Fig. 1, where t_* is the pumping time of the ruby R and τ_* is the nonlinear amplification time.

We investigated the dependence of the fundamental pulse parameters on the nonlinear rise time τ_l of the laser output and the evolution of a pulse in the nonlinear amplification section. The shape and width τ_q of the output pulse were observed by means of a photoelectric detector with a resolution of $\sim 10^{-11}$ sec. The spectrum width $\Delta\nu$ was determined on a spectrograph with a dispersion of 7.5 Å/mm. Pulse intensity plots and the corresponding $\Delta\nu$ curves are given in Fig. 2 for various τ_l. For small values of τ_l, complex

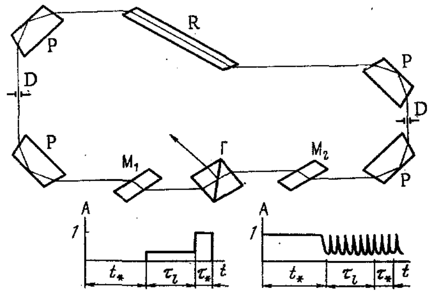

Fig. 1

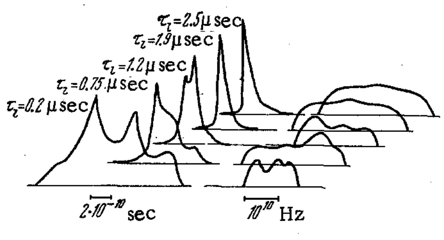

Fig. 2

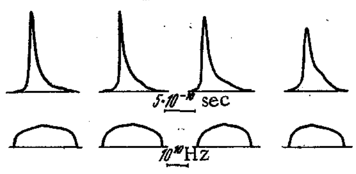

Fig. 3

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pulses are formed in the laser, and their parameters are not repeatable for equal values of τ_l. An approximate estimate of the degree of mode locking in this case yields $\Delta\nu\tau_q = 15$ to 40. With an increase in τ_l the time τ_q becomes shorter, and the shape and spectrum of the pulse acquire greater regularity. For $\tau_l \geq 1.7 \times 10^{-6}$ sec stable pulses are generated with a smooth (up to intermodal structure) spectrum and $\tau_q \approx 10^{-10}$ sec. In this case $\Delta\nu\tau_q \approx 3$.

To study the evolution pattern in the nonlinear amplification section we measured the fundamental parameters of pulses emitted by the cavity at different time after the start of lasing. Intensity plots of the 1st, 5th, 8th, and 13th laser output pulses are given in Fig. 3. It is seen that τ_q, $\Delta\nu$, and the shapes of the pulses are reasonably uniform in the nonlinear amplification section.

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