The absolute values of the magnetic field intensity obtained in our experiments are not the limiting ones for the tested materials. The registered values of the magnetic fields (from 1.6 MOe for aluminum to 3.1 MOe for tantalum) can be increased not only by further increasing the current growth rate, but also by changing the shape and the dimensions of the solenoid. In particular, the limiting field in a solenoid of any shape can be increased by increasing its dimensions while maintaining constant the ratio of the length to the diameter. An increase of the volume of the field requires, naturally, a larger energy source.

An analysis of the results shows that the material most promising for the production of superstrong fields is tantalum. It has the optimal combination of properties: high melting temperature, high density, and good strength characteristics. Under the conditions of our experiments, the amplitude of the magnetic field in a tantalum solenoid was 1.5 times larger than in the analogous copper solenoid.

The high endurance of tantalum and its advantages over other tested materials were confirmed also in experiments in which strong pulsed fields were obtained in solenoids designed for repeated action. A field of 1.0 MOe in a tantalum solenoid with inside diameter 5 mm and length 5 mm could be obtained, in reproducible fashion, several dozen times. A 500 kOe field intensity could be obtained repeatedly in a large-volume solenoid thousands of times.

The use of pulsed solenoids of materials such as tantalum extends the possibility of performing different investigations in fields of the megagauss range without destroying the investigated objects.

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RUBY LASER WITH OPTICAL DELAY LINE INSIDE THE RESONATOR

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1. The characteristics of solid-state lasers were investigated until now at resonator lengths on the order of several meters. The use of optical delay lines (ODL) makes it possible to produce lasers with effective resonator lengths of several hundred meters. The characteristics of such a laser have many distinguishing features compared with the ordinary laser [1]. We present below some results of an experimental investigation of a ruby laser at a resonator length L up to 400 m.

The laser investigated by us consisted of an optical resonator made up of two flat mirrors with reflection coefficients 99.6 and 75%. A ruby crystal, excited by two flash lamps, and the ODL were placed inside the resonator.

The ODL was made up of two spherical mirrors with radius of curvature 5000 mm, diameter 120 mm, and reflection coefficient 99.6%.

We investigated the dependence of the threshold pump energy W_{thr} on the effective length of the laser.

W_{thr} depends relatively little on L (at L = 200 m, W_{thr} increases by a factor 1.5 compared with its value at L = 1 m, and at L = 400 m it increases by 3 times).

2. We investigated the change in the dynamics of the laser emission when L is increased from 2 to 400 m. At resonator lengths on the order of 10 m and more, an ordering of the radiation power pulsations takes place, namely, the random pulsations give way to a regular periodic regime (L equals 10 and 91 m respectively in Figs. 1a and 1b, the markers are spaced 5 μsec apart). The spike repetition period and the spike duration increase with increasing L. Figure 2 shows the dependence of the duration of the first radiation spike, measured at half-height, on L. We see that at values of L in the interval from 50 to 400 m this dependence is close to linear. The increase in the spike duration and in their repetition period with increasing L is apparently due to the increase of the laser resonator Q [1].

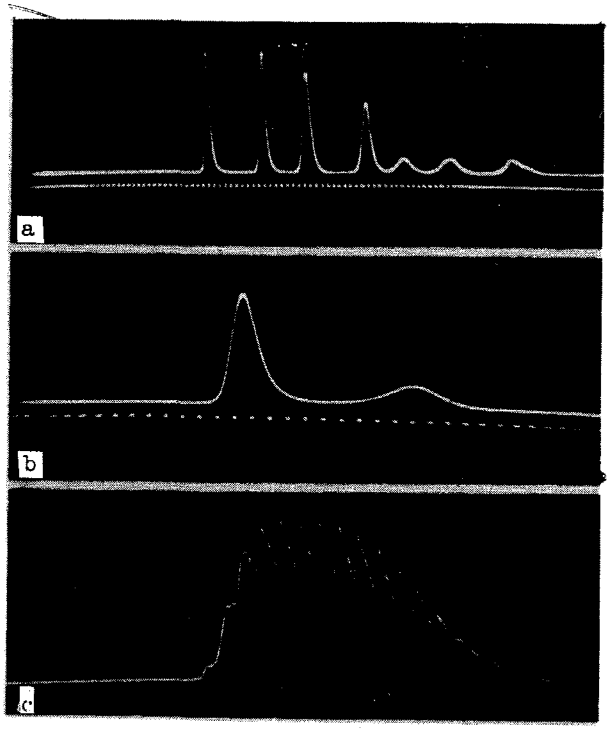

Fig. 1

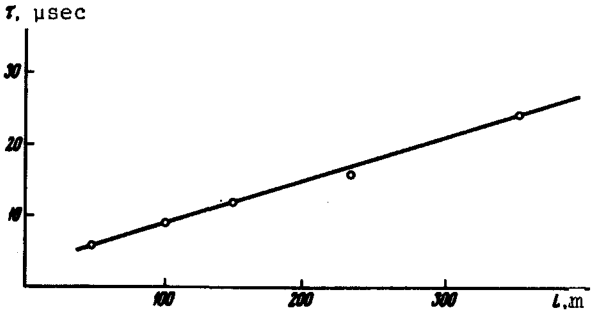

Fig. 2

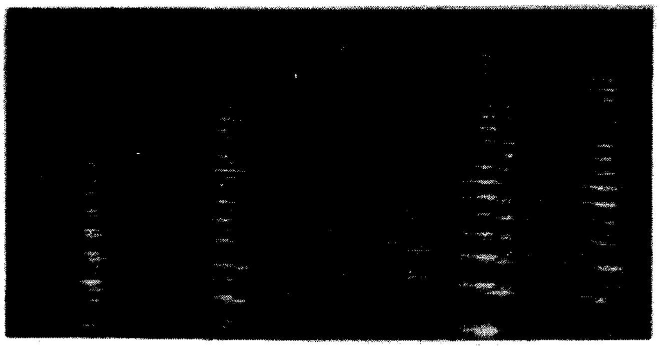

Fig. 3

If the spike duration is estimated from the approximate formula $\tau = (\omega\gamma\eta/Q)^{-1/2}$ (η - excess above threshold pump level, $1/\gamma$ - relaxation time of the inverted population, ω/Q - bandwidth of the resonator), then it must be assumed that $Q \simeq 10^9$ at L = 350 m, $\tau = 23 \times 10^{-6}$ sec, $\eta = 0.1$, and $\gamma = 10^3$. The spike repetition period at a resonator length on the order of hundreds of meters is of the same order of magnitude as the pump pulse duration (measured at half-height). Therefore only one radiation pulse is generated during the time of the pump pulse at large values of L (L > 150 m), and the second pulse appears only at sufficiently large η.

3. It was observed that at large resonator lengths (L ∿ 200 m) the radiation pulses turn out to be modulated at the frequency of the intermode beats (Fig. 1c, L = 352 m). The depth of modulation increases with increasing L. This modulation can be the consequence of self-synchronization of the axial

modes. As was shown in [1], the width of the self-synchronization band increases with increasing L when L > $L_{cr}^{(1)}$ (for a ruby laser $L_{cr}^{(1)}$ is of the order of 50 m).

4. We investigated the dependence of the width of the laser generation spectrum on the time. A narrowing of the generation spectrum during one spike was observed. This narrowing is relatively small at small values of L (L $\sim$ 50 m), but increases with increasing L and becomes appreciable at L $\sim$ 300 m. The interference pattern shown in Fig. 3 is a time-scanned modulated spike of radiation at L = 352 m. We see that, during the generation time the width of the spectrum is narrowed from 5000 to 400 MHz, which is the resolution limit of the employed interferometer at a distance of 1 cm between plates.

These results agree qualitatively with the conclusions drawn in [1].

We measured also the beam divergence of a laser with delay line. It turned out to be equal to the diffraction limit. This allows us to conclude that only longitudinal modes were excited in the investigated laser.

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PARAMETRIC "COOLING" OF A SLOW CYCLOTRON WAVE OF AN ELECTRON BEAM IN CROSSED FIELDS

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Much evidence has been accumulated recently indicating that the instabilities in the operation of powerful beam amplifiers of the magnetron type are due to the interaction between the slow cyclotron noise wave and the fast electromagnetic wave produced between the cold cathode and the case of the instrument [1 - 3].

We discuss in this paper the possibility of developing a parametric suppressor for the slow cyclotron noise wave of an electron beam in crossed fields[1].

The electron beam passes in succession through two high-frequency sections (see the figure) in which a "conjugate" type of interaction is used (a left-polarized electromagnetic wave is excited in the interaction region) [6, 7]. Assume that the noise left-polarized synchronous wave is suppressed at the end of region I at a certain frequency ω_4. The beam "rid" of this wave enters region II, where it is acted upon by an electromagnetic wave with pump frequency ω_p, having a propagation constant β_H. Let us stop to analyze the processes in region II, since the results for section I are known. We use the model and the notation of [5]. Then the equations describing the high-frequency processes in region II can be written in the form

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[1] The method of parametric "cooling" of a space-charge slow wave in type-0 beam devices was discussed earlier [4], but turned out to be ineffective because of the weak dispersion of the space-charge waves.