We have thus calculated, on the basis of the model proposed in [5], the current-voltage characteristic of an irradiated superconducting point contact and its dependence on the radiation intensity. The experimental results are in good agreement with the calculation, thus evidencing the applicability of the model proposed in [5] to the investigated system.

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EXPERIMENTAL INVESTIGATION OF THE "MEMORY" EFFECT OF He-Ne LASERS

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It was shown in [1] that when radiation from an He-Ne laser is fed back to the resonator by a moving reflecting mirror, induced oscillations with frequencies $\nu_0 \pm p\nu_D$ can be excited in the laser under certain conditions. Here ν_0 is the frequency of the probing signal, ν_D the Doppler frequency, and p is an integer. The region of induced oscillations at two frequencies corresponding to one longitudinal mode was determined theoretically in [2]. We have thus established that a gas laser has a "memory." The present paper is devoted to an experimental investigation of the volume of the He-Ne laser "memory."

Experimental Setup

The experiment was performed with the setup described in [1, 2]. The He-Ne laser generated at two wavelengths, $\lambda_1 = 0.63\ \mu$ and $\lambda_2 = 3.39\ \mu$. The discharge length in the laser tube was $\sim$ 60 cm. The pressure in the tube was $\sim$ 1 mm Hg. The He:Ne partial-pressure ratio was 6:1. The resonator length was L = 1 m. The laser operated in the TEM_{00q} mode at several longitudinal modes. The radiation emerging from one of the resonator mirrors was incident on the moving reflector. The energy at the wavelength λ_2 in the backward beam, limited in the plane of the resonator mirror to a cross section diameter equal to the diameter of the emerging beam, was $10^{-2} - 10^{-1}$ the energy emerging from the laser. The frequency-shifted signal fed back to the laser caused modulation of the radiation at the shift frequency. The output radiation traversed the distance between the resonator mirrors and the external moving reflector many times. The beam passed through the second resonator mirror to a photomultiplier. The spectra of the low-frequency beat signals were photographed from the screen of a spectrum analyzer.

Results

1. It was established in the first series of experiments that after the cessation of the feedback signals at the wavelengths λ_1 and λ_2, the stimulated generation simultaneous at the frequencies $\nu_0 \pm p\nu'_D$ and $\nu_0 \pm p\nu''_D$ was revealed (by the beat signals) during a time not exceeding 3 minutes. Here ν'_D and ν''_D are the Doppler frequencies at the wavelengths λ_1 and λ_2. The beat spectrum then revealed signals corresponding to a single wavelength. There was

no stoppage of the generation at the second wavelength, however. Only a few minutes later did the beat signal amplitude again reach a value sufficient to observe it at the previous frequency. The beat frequencies were ν'_D and $2\nu'_D$ in the case of the ν_1 transition and in a number of experiments beats occurred simultaneously at ν''_D, $2\nu''_D$, and $3\nu''_D$ (or $4\nu''_D$) in the case of the λ_2 transition.

2. Following the excitation of the induced oscillations in the laser, the laser beam was again directed to the reflector. The latter was now moved with a different constant speed V_2. The beat spectrum registered after the stopping and screening of the reflector contained signals indicating generation of oscillations induced with the reflector moving at the speeds V_1 and V_2. The induced oscillations at these frequencies continued to generate also after a new beam of radiation was applied to the laser, with a reflector speed V_3. No further increase of the number of induced oscillations could be obtained, since a change of the resonator length stopped the stimulated emission.

3. In the case of simultaneous generation at several induced frequencies, the amplitudes of the oscillations with $\nu_0 \pm p\nu_D$ remained constant for not more than one minute. A decrease of the amplitude at one frequency (or several frequencies) was accompanied by an increase of the amplitudes at the other frequencies. The experimental results are shown in Fig. 1. The spectrograms of Fig. 1a, with beat signals at ν''_D, $2\nu''_D$, and ν'_D and of Fig. 1b with signals at ν''_D, $2\nu''_D$, and $3\nu''_D$, were registered with the external reflector moving at a speed V_1 = 29 cm/min. This speed corresponds to a shift ν''_D = 2.8 kHz. The spectrograms in Figs. 1c and 1f illustrate the changes of the beat-signal amplitudes in the laser, due apparently to the competition between the induced oscillations with frequencies $\nu_0 \pm \nu''_D$, $\nu_0 + 2\nu''_D$, $\nu_0 \pm 3\nu''_D$, $\nu_0 \pm 4\nu''_D$, and $\nu_0 \pm \nu'_D$. The last two spectrograms were registered after stopping and screening the external reflector for ∿ 5 minutes. Figure 1g shows the beat signals due to induced oscillations excited with the external reflector moving at V_1 and at V_2 = 32 cm/min ($\nu''_D \approx$ 3.1 kHz). A change in the distance between the frequencies ν_0 and $\nu_0 \pm p\nu_D$ could occur during the course of generation of the induced oscillations. The relative instability of

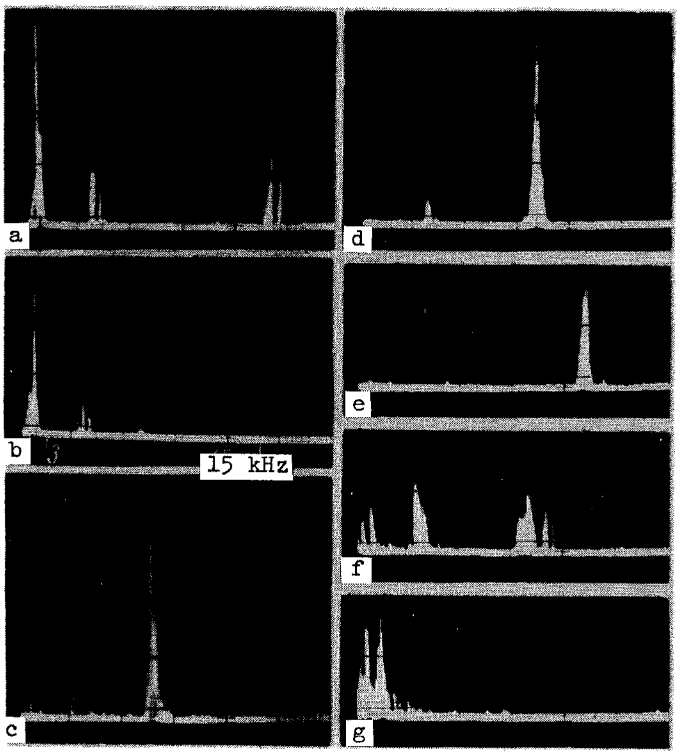

Fig. 1. Beat signals in laser resonator. Frequencies: a - ν''_D = 2.8 kHz, $2\nu''_D$ and $\nu'_D \approx$ 15 kHz; b - ν''_D, $2\nu''_D$, and $3\nu''_D$; c - $3\nu''_D$; d - $2\nu''_D$ and $4\nu_D$; e - ν'_D; f - ν''_D, $2\nu''_D$, and $4\nu''_D$; g - $\nu''_D \approx$ 2.8 kHz and 4 kHz. a, b - Feedback signal; c to g - stimulated emission.

the beat signal frequency, $\Delta\nu_D/\nu_D$, reached $\sim$ 0.2 in the experiments. The maximum stimulated emission time was $\sim$ 40 minutes. The splitting of the beats in Fig. 1f is due apparently to violation of the equidistant character of either the longitudinal modes or the induced oscillations.

4. In another series of experiments, the moving reflector was sounded with a beam of wavelength λ_1 only. The λ_2 radiation was suppressed after its emergence from the laser by a plate of K8 glass. The experimental procedure remained the same. In this series we also observed stimulated laser emission at two frequencies, which were excited with a time interval of several minutes.

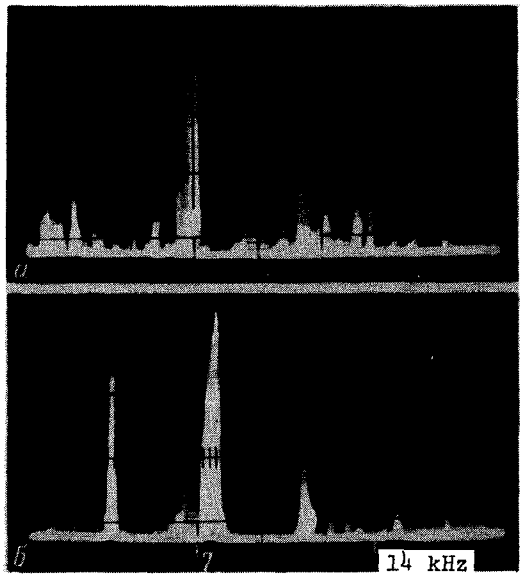

Fig. 2. Splitting of beats: a - feedback signal with shift $\nu''_D \simeq 7$ kHz; b - stimulated emission.

5. The Doppler beat frequency range in which the "memory" of the laser was investigated was 0.5 - 100 kHz. On the other hand, the stimulated emission at the frequencies $\nu_0 \pm p\nu_D$ corresponded to beat frequencies in the range 2 - 40 kHz.

In a large number of experiments, we observed also beats due to the occurrence of combination frequencies, due to the nonequidistant character of the longitudinal modes [3]. The amplitudes of these beats and of the beats at $p\nu_D$ were approximately of the same order. The interaction between the oscillations with $\nu_0 \pm p\nu_D$ and the combination frequencies leads to a complicated beat picture, as illustrated by the spectrogram of Fig. 2a. The splitting of the beats was observed also in stimulated emission following the interruption of the feedback signal to the laser (Fig. 2b).

The experiments have established that induced oscillations at any frequency of the continuous spectrum can be excited in a laser, within a band not less than ± 40 kHz in the vicinity of the natural oscillations of the optical generator. Simultaneous excitation of two oscillations is possible if the frequency separation between them is not less than 1 kHz.

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