[1] Bandzaitis, Karosene, Savukinas, and Yutsis, DAN SSSR 154, 812 (1964), Soviet Phys. Doklady 9, 139 (1964).

[2] Bandzaitis, Savukinas, and Yutsis, JETP 47, 385 (1964), Soviet Phys. JETP 20, 256 (1965).

[3] Yustis, Savukinas, Bandzaitis, Karosene, and Nashlenas, Lit. fiz. sb. (Lithuanian Physics Collection) 4, 173 (1964).

[4] Karosene, Savukinas, Bandzaitis, Vizbaraite, and Ustis, ibid, p. 187.

[5] J. J. De Swart, Rev. Mod. Phys. 35, 916 (1963).

[6] A. R. Edmonds, Proc. Roy. Soc. A268, 567 (1963).

[7] K. T. Hecht, Nucl. Phys. 62, 1 (1965).

[8] G. E. Baird and L. C. Biedenharn, J. Math. Phys. 4, 1449 (1963).

1) A misprint has crept into [2]. In the fourth line from below of the third paragraph in Sec. 386 "b" and (c) should be replaced by "c" and "d."

SPECTRAL CHARACTERISTICS OF A GAS LASER WITH TRAVELING WAVE

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Data were published recently on the possibility of obtaining single-mode operation of a ruby laser in a resonator with traveling wave in one direction [1]. The results of this experiment, in the author's opinion, prove that the ruby R_1 line is uniformly broadened, the relaxation of the excitation along the crystal is small, and the main cause of the multimode generation conditions in the longitudinal-mode regime is the uneven field distribution of these modes along the ruby axis. The multimode nature of the gas laser is connected principally with the inhomogeneous character of line broadening, when waves of different frequencies interact with groups of excited atoms having different velocities.

This raises the question whether any additional "decoupling" of the longitudinal mode is produced also by the difference in the positions of the nodes and antinodes of the mode fields in the standing-wave resonator. To check on this, we constructed a gas laser for a wavelength $\lambda = 6328$ Å, with a ring resonator, in which a traveling wave was generated with one propagation direction, the second direction being artificially attenuated, thus eliminating to a considerable degree the spatial periodicity of the light-wave field. A diagram of the experimental set-up is shown in Fig. 1.

The laser cavity was made up of three mirrors (2, 3, and 4 in Fig. 1), of which two have a transmission of approximately 0.2% (2 and 3), while mirror 4 had a transmission 3.7%. A discharge tube (1) 4 mm in diameter was filled with a mixture of neon and helium in a ratio 1:5 at a total pressure 0.5 mm Hg. In this system there are generated traveling waves of two directions - clockwise (A) and counter clockwise (B). To obtain a traveling wave in one direction an additional mirror was used (5), which produces a unilateral coupling, reflecting part of the energy of wave B into wave A. As a result of this, the intensity of wave A during generation was 5 - 7 times larger than that of wave B. The emission spectrum was observed with the aid of a 10 cm Fabry-Perot etalon (6).

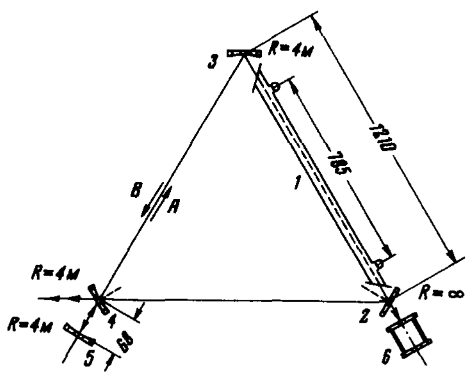

Fig. 1

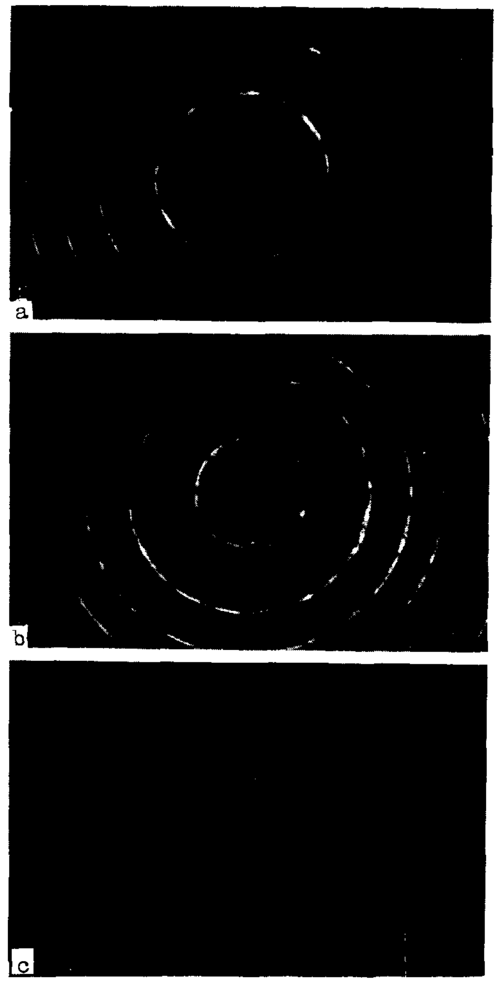

Fig. 2

Figures 2a and b show interference patterns which show that the number of modes in this system fluctuates between 1 and 2. If the excitation level (the discharge-tube conditions) is maintained constant and mirror 5 is covered, then the number of modes increases to 3 (Fig. 2c), and the total power emitted by the laser decreases by a factor 1.9; on the other hand, if the excitation level is increased such that the same radiated power is maintained, as in Fig. 2a and b, then when mirror 5 is covered there will be not less than 4 - 5 modes generated. The transition from the regime of Fig. 2a to the regime of Fig. 2b is connected apparently with thermal readjustment of the resonator. The generated modes do not "move" over the entire spectral line, and are connected with definite sections of the line and the generation power (which in this case is approximately 0.2 mW), remains practically constant in time.

The foregoing data lead to the conclusion that elimination of the spatial inhomogeneity of the field in the laser generator makes it possible to intensify the coupling between the oscillation modes even in the case of a non-uniformly broadened line, and to obtain sufficiently powerful generation with 1 - 2 longitudinal modes.

[1] Tang, Statz, de Mars, and Wilson, Phys. Rev. 136, AI (1964).

CONNECTION BETWEEN REAL AND IMAGINARY PARTS OF SURFACE IMPEDANCE IN THE SIZE EFFECT

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In the measurements of the radio-frequency surface impedance $Z = R + iX$ of thin metallic plates placed in a magnetic field H, a discontinuity ΔZ is observed on the Z(H) curve at that value of the magnetic field for which the diameter of the extremal trajectory of the electron is equal to the thickness of the sample. This type of size effect was observed by Gantmakher in tin [1] and proposed by him as a tool for the study of the Fermi surfaces of pure metals. Subsequently a different type of radio-frequency size effect was investigated, due to the electrons of the turning point [2]. It was noted in [1], where the imaginary part of the impedance was measured, that the resultant size-effect lines are quite varied in shape, and the latter does not depend on the frequency of the external electromagnetic field, or the thickness of the sample, and does not change after the surface of the metal is etched. For further study of the factors influencing the line shape, we have called attention in experiments with indium on the relationship between the changes of the imaginary and real parts of the surface impedance in the size effect.

The experiments were carried out at a temperature $T = 1.3°K$, using single-crystal samples grown from high-purity indium ($\sim 10^{-4}\%$ of impurities) in a dismountable polished quartz mold [3]. The samples constituted discs 18 mm in diameter and 0.3 - 0.4 mm thick. At a temperature $T = 1.3°K$, the mean free path of the electrons, estimated from the experimental data [4], was 0.5 mm. The sample was placed in the core of a radio-frequency oscillator tank circuit. The oscillation frequency was $f \sim 3$ Mcs, the oscillation amplitude $U \sim 0.1$ V. A modulation procedure was used to investigate the Z(H) dependence. The frequency of modulation of the magnetic field was 20 cps. By means of frequency [1] or amplitude detection of the oscillator carrier we registered a signal proportional respectively to $\partial f/\partial H \sim -\partial X/\partial H$ and $\partial U/\partial H \sim -\partial R/\partial H$. The circuits were not calibrated for absolute sensitivity.

The experiments have shown that on passing through a size-effect line the changes in the imaginary and real parts of the impedance are not proportional to each other. A qualitative comparison of the experimental $\partial R/\partial H$ and $\partial X/\partial H$ curves shows that for all the size-effect lines observed for indium, among which curves of a rather complicated form were encountered, the ex-