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# Physics

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**Abstract**

**Full Text**

**Physics**

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## **On the Mechanism of the Appearance of Additional Radiation Peaks in a Pulsed Discharge in Neon**

*(Presented by Academician M. A. Leontovich, February 2, 1965)*

In work (1) it was shown that shunting a discharge in neon with a low-resistance discharger leads to the appearance of an additional radiation pulse, whose amplitude may noticeably (by up to a factor of two) exceed the maximum radiation of the discharge in the absence of shunting.

In an attempt to explain this effect, work (2) considered two possible mechanisms of the phenomenon: 1) the appearance of population inversion of the excited levels and 2) violation of the recombination conditions owing to a change in the course of the decrease of the electron temperature of the discharge.

**Fig. 1.** Oscillograms of the light pulse (*a*) and current pulse (*b*) when the discharge tube is shunted near the maximum current value (discharge-current amplitude 70 A; sweep speed 35  $\mu\text{sec}/\text{cm}$ )

The experimental verification of these assumptions carried out in (2) convincingly refuted the first of the proposed explanations and, it seems to us, provided no evidence in favor of the second.

Analogous investigations carried out by us also refuted the laser mechanism of the appearance of additional radiation peaks. In our opinion, the observed effect is due to vortex currents arising in the discharge plasma at the moment of a sharp change in the discharge current. With sufficiently rapid shunting of the discharge, the emf of self-induction can cause the appearance in the plasma of vortex currents that considerably exceed the main discharge current, and consequently the appearance of more intense light pulses.

Fig. 2

Figure 2: Fig. 2

To test the proposed assumption, simultaneous oscillographic recording was performed of the current and radiation of tubular pulsed lamps filled with neon. Analysis of numerous oscillograms, one of which is shown in Fig. 1, showed that any sharp change in the discharge current, irrespective of the causes that produced it, is always accompanied by the appearance of additional peaks in the neon radiation. The amplitude of these

the peaks proved to be directly dependent on the rate of change of the discharge current and in individual cases exceeded the magnitude of the main radiation by a factor of 8-10.

The appearance of additional radiation peaks was observed not only when the discharge current was shunted, but also as a result of spontaneous disruptions and jumps of the current arising when a sufficiently large ohmic resistance was connected in series with the lamp. Conversely, connecting an inductance in series with the lamp or with the shunting spark gap always led to a decrease in the amplitude of the additional radiation peaks or to their complete disappearance.

**Fig. 2.** Photograph of the distribution of glow intensity over the transverse cross section of the discharge tube: **a**—in the absence of an additional radiation peak and **b**—in the presence of an additional radiation peak (diameter of the discharge channel 8 mm; length of the discharge tube 300 mm; neon filling 50 mm Hg).

An even more weighty argument in favor of the proposed explanation of the nature of the additional radiation peaks is provided by the photographs shown in Fig. 2, illustrating the distribution of glow intensity over the transverse cross section of the discharge tube. As is evident from the photographs, in the absence of a sharp change in the discharge current and of the additional radiation peak caused by it, the entire cross section of the tube is filled uniformly with glow, whereas in the presence of an additional peak only the gas located near the walls of the discharge tube glows. The observed distribution of the glow fully corresponds to one of the possible variants of the current distribution over the cross section of a cylindrical conductor at the moment of switching off the current flowing through it (<sup>3</sup>, <sup>4</sup>), which is decisive confirmation of the proposed explanation.

In conclusion, we note that an 8-10-fold increase in glow intensity at the moment of interruption of the discharge current is not a limiting value, but depends on the parameters of the circuit and of the shunting spark gap. The effect observed in (<sup>1</sup>) and (<sup>2</sup>) may thus find application for obtaining very intense light pulses with a steep front.

All-Union Scientific Research

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### CITED LITERATURE

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*Note: Figure translations are in progress. See original paper for figures.*

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