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CHARACTERISTIC OF BÉU-6 CHANNEL ELECTRON MULTIPLIERS IN DETECTION OF NEUTRAL PARTICLES

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A BÉU-6 is used to measure zone characteristics, pulse-height spectra, the effect of a load, fatigue characteristics, and characteristics as functions of the type of particles during detection of neutral fluxes with an energy of 0.6-2 keV [1].

In performing the measurements we used an arrangement [2] in which a neutral beam was produced by recharging He^+, N_2^+, and H^+ ions. The cross section of the collimated beam was trapezoidal and had a half-width of 0.2 mm. In comparison with the characteristic dimensions of the BÉU-6 (entrance cone diameter 8 mm and channel diameter 1.5 mm), the cross section could be considered as a point. The BÉU-6, which was mounted on a moving platform, moved in a plane perpendicular to the beam axis. A negative voltage, U_m, was applied to the input of the channel emitter connected to the grid whereas the multiplier output was grounded. This kind of circuit is typical of the detection of slow charged particles when preacceleration by the input voltage is employed. The anode signal was fed into the amplifier and then to a PP9-2M scaler or AI-1024-4 pulse-height analyzer. The pulse-height spectrum was recorded by an X-Y recorder (PDS-021M). The pulse distributions were normalized by area, i.e., by the total pulse count.

It was established that the pulse-height distribution does not depend on the type of particle detected for beams of He, N_2, and H with an energy of $E_b = 1200$ eV. Therefore, the characteristics obtained for He atoms are given below.

Zone characteristics are of interest for a channel electron multiplier (CEM) with an entrance cone. Figure 1a gives results of measurements of the counting rate as a function of the point of impact of the beam at various voltages U_m. The modulation of the measured functions corresponds to the grid pitch. In contrast to the case when electrons, ultra-soft x-rays, and ultraviolet radiation are detected [3, 4], the counting rate for neutral particles does not increase when the beam enters the center of the entrance cone. The dip seen in Fig.

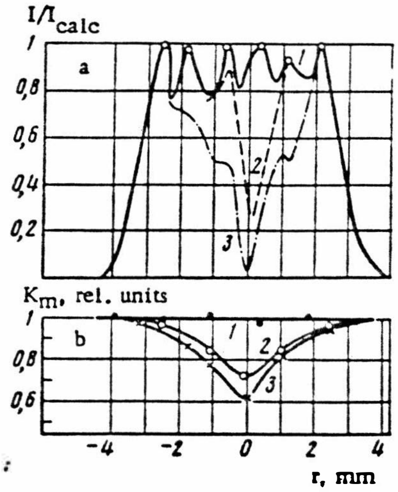

Fig. 1. Counting rate as function of distance to cone center: 1) $U_m = 2.6$ kV; 2) $U_m = 2.2$ kV; 3) $U_m = 2$ kV, $E_b = 600$ eV; b) relative gain as function of distance to center of cone: 1) $U_m = 2.5$ kV, $E_b = 2$ keV; 2) $U_m = 3.5$ kV; $E_b = 600$ eV; 3) $U_m = 2.5$ kV; $E_b = 600$ eV.

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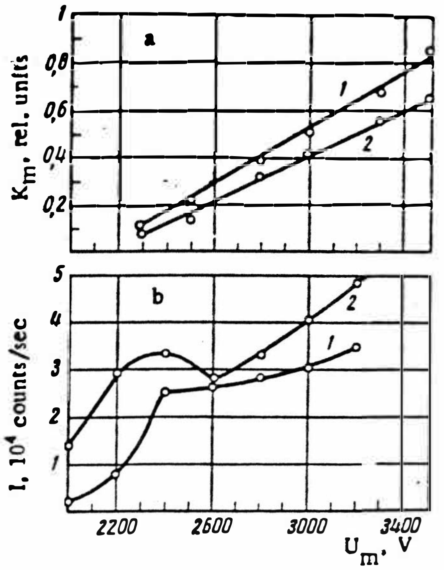

Fig. 2

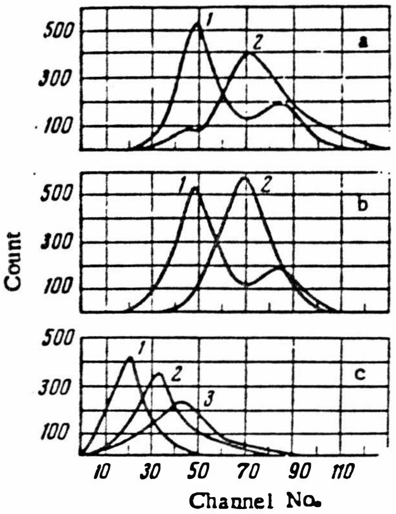

Fig. 3

Fig. 2. a) Gain as function of voltage U_m. Distance to center of cone: 1) r = 3 mm; 2) r = 0; E_b = 600 eV; b) counting rate as function of voltage U_m. Distance to center of cone: 1) r = 0; 2) r = 2 mm; E_b = 600 eV.

Fig. 3. Pulse-height distributions: a) as a function of beam energy: 1) E_b = 600 eV; 2) E_b = 2 keV; U_m = 3.5 kV; r = 0; b) as a function of the distance to the cone center: 1) r = 0; 2) r = 2.5 mm; U_m = 3.5 kV; E_b = 600 eV; c) as a function of the load: 1) 120,000 pulses/sec; 2) I = 40,000 pulses/sec; 3) I = 4000 pulses/sec; U_m = 2.5 kV; E_b = 600 eV, r = 0.

1a for $U_m < 2.4$ kV is due to the decrease in the CEM gain both when the beam is displaced from the periphery of the cone to the center and when U_m decreases. Consequently, the pulse height drops below the scaler discriminating level which is usually set at a background level of $N < 0.1$ pulse/sec.

The most probable pulse height was used for the relative gain K_m of the multiplier [3]. Figure 1b shows K_m plotted as a function of the distance to the center of the cone for two values of U_m and E_b. It is seen from this figure that when E_b = 600 eV, K_m decreases as the center of the cone is approached, as is the case for electrons [3]. If the beam energy is increased to 2 keV, K_m becomes the same over the entire area of the cone. The empirical plots of K_m as a function of the multiplier voltage for various points on the cone are shown in Fig. 2a. These plots are straight lines whose slopes increase with the distance from the point of beam impact to the center of the cone.

Figure 2b plots the counting rate I against the voltage U_m for a fixed discriminating level at the PP9-2M input for two incidence points of the beam. The curves obtained are of a complex nature and do not reach a plateau in the region of voltages U_m studied but instead have a tendency to rise as U_m grows. Note that for the cone center when $U_m > 2.4$ kV the increase in $I(U_m)$ is ~10% per 300 V. Similar results were obtained when ultraviolet radiation was recorded [5] with a Mullard B419BL channel electron multiplier.

The pulse-height distributions obtained for various BÉU-6 operating conditions are shown in Fig. 3. It is especially interesting that at low beam energies $U_m > 3$ kV, the pulse-height distribution displays two peaks (Figs. 3a and b) more and more distinctly as the cone center is approached. For E_b = 600 eV and U_m = 3.5 kV, the height of the second peak is 30% of that of the first.

In various types of measurements the dependence of K_m on the load on the CEM is of great importance. Figure 3c shows typical distributions for the center of the cone. It is seen that K_m decreases by a factor of two when the beam intensity rises from 4000 to 120,000 pulses/sec. It turned out that in the range of intensities from 100 to 4000 pulses/sec the gain K_m does not depend on the load. A distinctive feature of the BÉU-6 is that K_m increases with the beam energy (Fig. 3a).

To study the fatigue characteristics the BÉU-6 was subjected to the action of a beam with an intensity of 10^6 pulses/sec for three hours. It was found that K_m decreases tenfold during the accumulation of a total count of 10^{10} pulses.

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COMPACT HCN LASER

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A cw HCN laser is described and the results of its optimization are presented. The laser is 1 m long, operates at a wavelength of 0.337 mm, has a radiated power of 1 MW, in a stability of ≤5%/h, and a period of continuous operation of up to 300 h.

Because of the active media in common use, HCN lasers have a length of several meters. Reduction of the dimensions to 0.6-1.0 m still allows generation to be observed [1] but small lasers have not as yet been used in practical applications. The desirability of building a more compact HCN laser has been noted on many occasions. Reduction of the laser size makes it possible to decrease the high voltage needed, thus easing the requirements placed on the power supply. Although a decrease in the discharging current generally leads to a drop in radiated power the lifetime of the discharge tube is extended because of the reduced rate at which it is encrusted by the products of chemical reactions in the discharge.

Optimization of the radiated power takes on particular importance in the construction of a laser [2]. To carry out optimization it is necessary to study the principal laser characteristics, including the stability of the radiated power, as a function of the operating parameters and to choose the optimal conditions for the laser operation. Thus far various authors have studied only individual characteristics of a laser and the optimization has been of a limited nature.

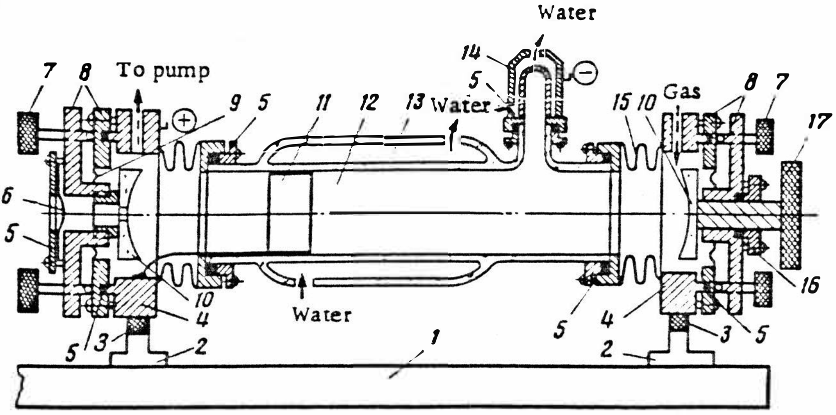

Fig. 1. Arrangement of cyanide laser: 11) anode; 16) vacuum gasket seal.

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