[5] Muga, Bowman, and Thompson, Phys. Rev. 121, 270 (1961).
[6] J. C. Watson, Phys. Rev. 121, 230 (1961).
[7] R. A. Nobles, Phys. Rev. 126, 1508 (1962).

Translated by C. S. Robinson
330

ISOTROPIC DISCHARGE CHAMBER FOR RECORDING TRACKS OF RELATIVISTIC CHARGED PARTICLES

M. M. BUT-SLOV, V. I. KOMAROV, and O. V. SAVCHENKO

Joint Institute for Nuclear Research

Submitted to JETP editor April 3, 1964

J. Exptl. Theoret. Phys. (U.S.S.R.) 46, 2245-2247 (June, 1964)

AT the present time spark chambers have received wide application in experiments with high energy elementary particles. While they possess a number of important advantages over other types of track detectors, they also have some substantial deficiencies which limit the field of their use. Thus, spark chambers have anisotropic properties for particles traversing the working volume at different angles relative to the electric field direction. Furthermore, it is impossible to observe in them the stopping of charged particles in the working volume of the chamber gas. And finally, spark chambers do not allow effective discrimination of charged particles with different ionizing ability. Attempts to remove these deficiencies are continuing at the present time [1,2], based on the obvious idea that, up to the moment of initiation of a streamer in a chamber, a limited multiplication of the primary electrons occurs, which under certain conditions can be localized near the path of the incident charged particle.1)

In this paper we describe an isotropic discharge chamber with which, under conditions of local multiplication of the primary electrons, we have obtained clear images of the tracks of charged particles with ionizing ability near minimum. A general diagram of the apparatus is shown in Fig. 1. The discharge chamber was a plane parallel capacitor with brass electrodes P_1 and P_2 rounded at the edges and about 15 cm in size. The electrodes were placed in a vacuumtight plexiglass case filled with various gases to a pressure of 1 atm. The interelectrode distance was 5 cm, and the working volume of the chamber, i.e., the volume where the electric field is uniform with high accuracy, was about 500 cm^3. Scintillation counters C_1 and C_2, connected to the coincidence circuit, selected cosmic rays passing through the working volume roughly in a vertical direction. The chamber was mounted in two different ways with respect to the cosmic ray trajectories: in the first case the electrodes P_1 and P_2 were arranged vertically, and in the second case horizontally. A pulse from the coincidence circuit was fed to the control circuit CC which produced a high voltage pulse of amplitude 15 to 56 kV. The pulse had an approximately triangular shape with a half-width of about 0.05 μsec. The total delay of the pulse in the control circuits was about 0.7 μsec. On arrival of this pulse at the electrode P_1, local multiplication of the primary electrons produced by the incident cosmic ray occurred in the gas filling the chamber. The resulting weak light arising along the particle trajectory was focused by the objective O onto the photocathode P of the multistage electron-optical image amplifier IA, which is described, for example, by B. A. Demidov and S. D. Fanchenko [5]. The track image, amplified in brightness, was photographed from the screen S by the camera C. Good track images for each cosmic ray passing through the chamber could be obtained only under image amplifier gain conditions allowing observation of light flashes corresponding to single electrons from the first photocathode. Suppression of intrinsic image amplifier noise was achieved by supplying a pulsed voltage to the screens S_1 and S of the image amplifier.

Cosmic ray track photographs obtained with this apparatus are shown in Figs. 2a and b for a chamber filling of helium, and in Figs. 2c and d for a neon filling. In Figs. 2a and c the track direction is approximately perpendicular to the electric field, and in Figs. 2b and d, approximately parallel. From analysis of data obtained for different values of electric field, the conclusion follows that with an electric field strength of 5.0—5.2 kV/cm for helium and 3.2—3.4 kV/cm for neon the intensity

1)Recently papers have been published by Dolgoshein and Luchkov[3] and by Mikhailov et al[4] which describe a discharge chamber whose operating principle consists of terminating the streamer process by a rapid decrease of the electric field intensity in the chamber. Such a chamber is not completely isotropic, since the track brightness depends strongly on the angle between the particle trajectory and the field direction.

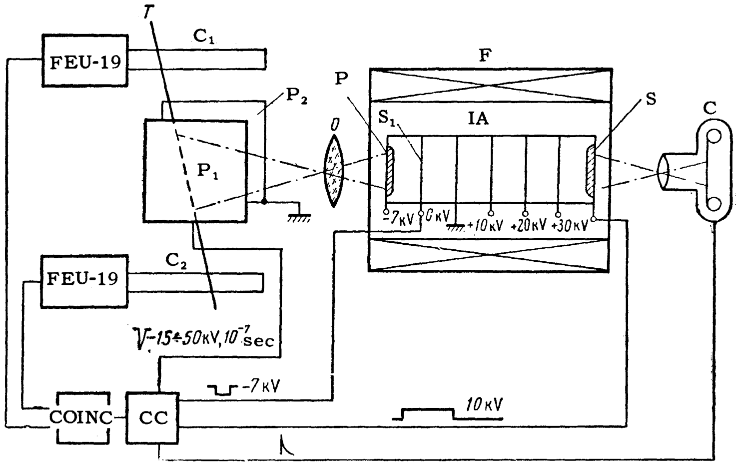

FIG. 1. General diagram of the isotropic discharge chamber. P_1 and P_2, chamber electrodes; C_1 and C_2, scintillation counters FÉU-19, photomultiplier; COINC, coincidence circuit; CC, controlling circuit; O, objective lens; IA, image amplifier; P, image amplifier photocathode; S_1, screen of the first stage of the image amplifier; S, output screen of the image amplifier; F, focusing coil; C, camera; T, trajectory of cosmic ray.

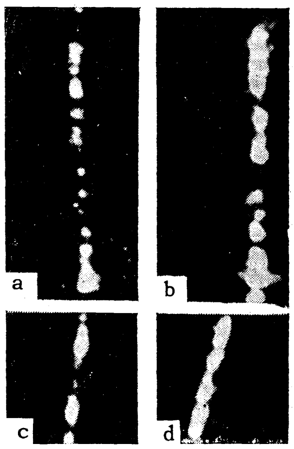

FIG. 2

of the light from tracks parallel and perpendicular to the field is the same, which directly indicates the complete spatial isotropy of such a chamber. With increase in the height of the voltage pulse, there begins a transition of the individual showers into incomplete streamers, which on further increase of pulse height completely span the interelectrode gap of the chamber. Track pictures under conditions of limited multiplication of the primary electrons have a discontinuous nature due to the nonuniform development of the individual showers. The track width under these conditions is on the average about 3 mm. The technique for obtaining a short duration high voltage pulse, which was achieved in the present work by the method of A. I. Pavlovskiĭ and G. V. Sklizkov[6], currently permits increasing the interelectrode gap of the chamber to several tens of centimeters and using this apparatus for performing experiments with elementary particles.

The authors express their gratitude to L. M. Soroko for his constant help in the work and for discussion of the results.

[1] Fukui, Hayakawa, Tsukishima, and Nukushina, Proc. Int. Conf. Instr. High Energy Physics, Berkeley, 1960, p. 267.

[2] Cavalleri, Gatti, and Redaelli, Nuovo cimento **25**, 1282 (1962).

[3] B. A. Dolgoshein and B. I. Luchkov, JETP **46**, 392 (1964), Soviet Phys. JETP **19**, 266 (1964).

[4] Mihhaĭlov, Roĭnishvili, and Chikovani, JETP **45**, 818 (1963), Soviet Phys. JETP **18**, 561 (1964).

[5] B. A. Demidov and S. D. Fanchenko, JETP **39**, 64 (1960), Soviet Phys. JETP **12**, 46 (1961).

[6] A. I. Pavlovskiĭ and G. V. Sklizkov, PTÉ, No. 2, 98 (1962), transl. Instr. and Exper. Techniques, No. 2, 320 (1962).

Translated by C. S. Robinson
331