above the chamber and another plate 2.2 cm thick inside the chamber. Under the lead block a counter tube arrangement similar in many ways to that used by Bothe and Schmeiser[1] for the investigation of narrow angled penetrating showers, was used to control the expansion of the Wilson chamber. The latter is placed between the upper and lower set of counters.[2] The remarkable thing about the burst is the very short distance, about 2-cm length, in which it has developed, considering that for the gas oxygen with which the chamber is filled the characteristic length is 340 m. Another notable feature is that the particles appear to emerge in all directions, though the majority of them are ejected in a downward direction which is the direction of the incident particle. The core of the burst has again produced a large cascade shower in the lead plate inside the chamber, and it presumably contains a number of high energy electrons and photons. The burst produced must be due to a high energy charged

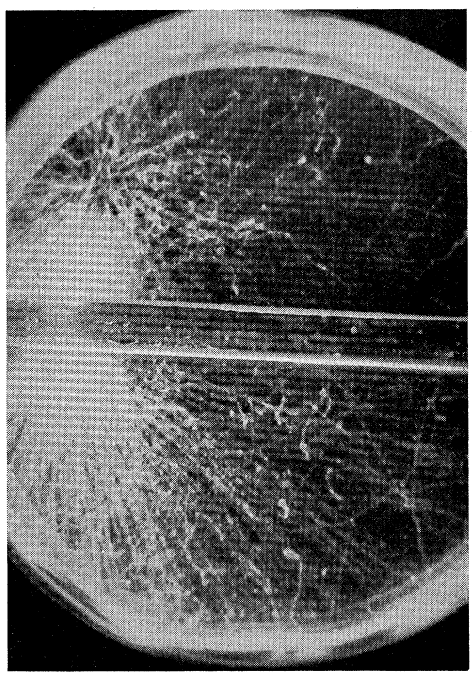

FIG. 1. Photograph of a burst within Wilson chamber.

penetrating particle, presumably a mesotron, which after traversing the lead, either itself or by means of knock-on electron trips the upper counter and produces the burst inside the chamber.

Three different explanations of the origin of this burst are possible. It is due to (1) a cascade process representing an extreme type of fluctuation effect, (2) the simultaneous generation of a large number of high energy electrons, (3) an explosion process of a type envisaged by Heisenberg, about whose mechanism nothing definite can be said. The occurrence of such large multiplication within a short length has been observed in photographic emulsions exposed to cosmic radiation at high altitudes. They usually start from large grains of silver bromide crystals of diameter up to 10μ (equivalent to 3.5-cm air length), and the tracks emerge in all directions, in numbers up to 40. Taylor[3] calls them clusters, to distinguish them from stars—which diverge from points within limited angles, and the number tracks do not exceed seven. Similar clusters have been observed by Miss Bibha Choudhuri of this Institute.

The author desires to record his indebtedness to Dr. R. L. SenGupta for help in constructing the apparatus.

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Corona in Gases at Low Pressures

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THE breakdown processes in air at atmospheric pressure have been studied by Loeb and his collaborators,[1–3] who have clearly differentiated between the forms of corona discharge which take place at voltages lower than the spark breakdown voltage. The corona at pressures <3 cm Hg does not appear to have been studied, and experiments started over a year ago indicate that forms of corona discharge persist at very low pressures (<1 mm Hg) and that the results differ widely with the nature of the gas. Since that time, Weissler's paper[4] has appeared in which, with different techniques and higher pressures, he has clearly shown that various gases, as would be expected, show fundamental differences in their corona discharges. Our results are largely in agreement with those of Weissler, but several new effects have been observed.

The technique adopted, i.e., the use of 50 c.p.s. a.c. in preference to the d.c. used by the above authors, appears to have important advantages in that positive and negative corona are shown together, and the corona is synchronized with the supply voltage. Thus, where rapidly recurrent streamers are observed, they occur at random for d.c. observations and give a confused pattern on an oscillograph with a continuous time sweep, whereas on a.c. they are observed near the crest of each half-cycle. It was necessary to insure that the use of a.c. did not by itself introduce misleading effects, and comparative experiments on d.c. were therefore performed. Any possible effects caused by the sign reversals on alternate half-cycles can be eliminated by the use of half-wave rectified a.c.

A further improvement in technique has been effected by the use of a two-beam oscillograph which enables the tube current to be observed simultaneously with either the tube voltage or a time-calibrating wave.

Owing to present circumstances, facilities for purifying gases were not available, but the impurities present in the commercial-grade gases used are known approximately. We intend to improve the vacuum technique so that the effect of impurities may be further studied.[4] However, the use of different impure gases is of practical importance and leads to widely differing results which are of considerable interest. We hope to extend this work to pressures of one atmosphere and higher, where it would be difficult to obtain pure gases in sufficient quantities.

Figure 1 is a reproduction of oscillograms which show some of the variations in results. All the effects are accurately reproducible. The figure was taken on a 1/100 second sweep; the voltage rises from zero to its maximum value and then falls to zero again, once for each sweep of either polarity. The maximum corona current corresponds approximately to the maximum tube voltage. Figure 1A shows the current flowing on the positive and negative half-cycles, 1180 volts crest, for a 1-cm gap between a 0.16 cm diameter hemispherically-ended tungsten point and a molybdenum plane in air at 0.57 cm Hg pressure (Apiezon oil manometer). Corona onset was at 670 volts negative and 970 volts positive. The current discontinuities reveal the presence of streamers on both polarities. With a 1-cm gap between a sharp tungsten point and a molybdenum plane in hydrogen at 0.14 cm Hg and an applied voltage of 635 volts crest, the streamers are present on the positive half-cycle only (Fig. 1B), whereas on the negative half-cycle the current is continuous (corona onset at 430 volts negative, 545 volts positive). No streamers are present for a discharge in oxygen at 1.52 cm Hg pressure in a copper cathode Geiger counter, of wire diameter 0.127 cm (tungsten) and cylinder diameter 2.54 cm, at

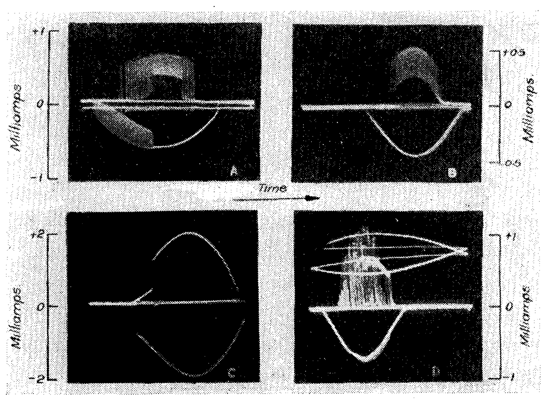

FIG. 1. Reproductions of oscillograms.

2330 volts crest (corona onset at 1370 volts negative, 1190 volts positive), when the discharge is disruptive on both polarities, as seen in Fig. 1C. The form of the discharge in the same counter when filled with CCl_2F_2 at a pressure of 0.69 cm Hg, and a 50-cycle timing wave, are shown in Fig. 1D (1560 volts crest). Many positive streamers are seen to be present whereas with a negative wire, the current is more or less continuous with indications of streamers near the crest (corona onset at 1050 volts negative, 1380 volts positive).

A detailed analysis of the results will be published in the near future.

We wish to thank Dr. A. P. M. Fleming, Director, Research and Education Departments, Metropolitan-Vickers Electrical Co. Ltd., for permission to publish this note.

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The Multiple Production of Secondary Cosmic-Ray Particles in the Lower Atmosphere

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A DETAILED study of secondary processes of the cosmic radiation was made at altitudes between sea level and 14,000 feet. The instrument consisted of 125 counter tubes placed above and between six layers of lead *A* to *F* (Fig. 1), which are 1, 5, 5, 5, 9, 10 cm thick,

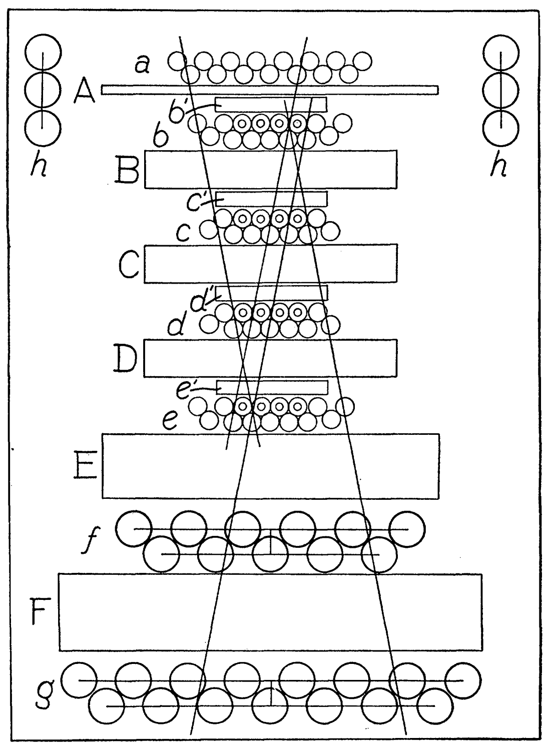

FIG. 1. Schematic diagram of the arrangement of counters and absorbers.

respectively. The counter tubes of groups *a* to *e* are individually connected to one indicating neon lamp each. All neon lamps are arranged on a panel in places corresponding to the actual positions of the counter tubes to which they belong. A "master pulse" flashes a neon lamp for the duration of 0.5 sec., provided that a particle coincident with the master pulse (resolving time 10^{-5} sec.) traversed the counter tube to which the neon lamp belongs. The ring-marked counters and six counters in each group

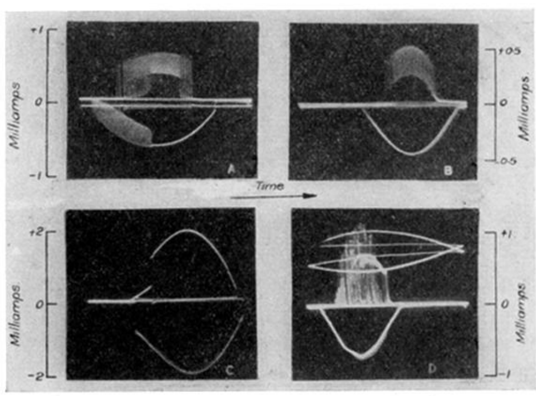

FIG. 1. Reproductions of oscillograms.