Physics. — *Sparks in air of atmospheric pressure.* By G. HOLST.

(Communicated at the meeting of March 25, 1933).

R. STRIGELS's experiments [1]) show that at voltages as high as 180 % of the static sparking potential, every electron leaving the cathode, produces a spark. The discharge takes place between spheres of 5 cm diameter, at a distance of 1.1 mm, the static sparking potential being 5000 Volts. A large condenser, charged by a transformer and rectifier, supplies the current.

F. G. DUNNINGTON [2]) studied the early stages of breakdown by his electro-optical shutter and found that a luminous filament is formed in the space between the electrodes, which starts from the cathode and may or may not proceed to the anode. This shows that the breakdown takes place in a very limited part of space.

The time between the moment the voltage on the gap rises above the sparking potential and the moment this voltage drops to a small value again, may be divided in two periods: *a* the time before an electron leaves the cathode, *b* the time during which the ionisation in the gas increases to such an extent that the condenser discharges.

This latter period will be discussed hereafter.

W. ROGOWSKI [3]) has demonstrated that this time may be extremely short, 10^{-7} or even 10^{-8} sec. He pointed out, that these short times cannot be accounted for by TOWNSEND's theory of the sparking potential. The potential difference per free path being very small, it is probable that + ions will be able to liberate fresh electrons only at the cathode surface. The time, during which the discharge develops, is thus determined by the speed of the + ions and this is not by any means sufficient to account for such short times 10^{-7} or 10^{-8} sec.

A. V. HIPPEL and J. FRANCK [4]) suppose that space charges can give the explanation. The electrons formed by ionisation move quikly to the anode, leaving the slow + ions in the gap, resulting in a concentration of the field near the cathode. This increases the ionizing power of the following electrons.

At lower gas-pressures the discharge takes place a great deal more slowly and can be explained by TOWNSEND's theory [5]). H. VIEHMANN [6])

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1) R. STRIGEL. Wissensch. Veröff. Siemens Konzern (11), 52, 1932.

2) F. G. DUNNINGTON. Phys. Rev. (38), 1535, 1931.

3) W. ROGOWSKI. Arch. f. Electr. (16) 496, 1926 and following àrticles.

4) A. V. HIPPEL and J. FRANCK. Zeitschr. f. Phys. (57), 696, 1929.

5) M. STEENBECK. Wissensch. Veröff. Siemens Konzern (9), 42, 1930.

6) H. VIEHMANN. Arch. Electr. (25), 253, 1931.

using ROGOWSKI's methods, found that the discharge time decreases with the rate, at which the voltage impressed on the gap rises and with the overvoltage. In the case that no overvoltage is applied, the discharge time is 10^{-4}—10^{-3} sec. in accordance with TOWNSEND's theory.

We now return to STRIGEL's experiments. At 180 % overvoltage every electron leaving the cathode produces a spark. At 0, 20, 40, 60 % overvoltage the number of pairs of ions generated by a single electron from the cathode is $2{,}2.10^4$, $2{,}7.10^9$, 5.10^{16}, 1.10^{24} resp.

Compare this to the number of electrons on the charged condenser, which is of the order of 0,01—0,1 μ F. Take 0,1 μ F. The impressed voltage being of the order of 10000 V, the charge of the — plate is equal to $0{,}1.10^{-6} \,.\, 10000 \,.\, 6{,}3.10^{18} = 6{,}3.10^{15}$ electrons. At 40 % overvoltage and more one electron leaving the cathode produces a number of ions sufficient to completely discharge the condenser, *without the need of a second electron liberated at the cathode.* Such discharges will take place very quickly.

It is easy to see that as long as $e^{\alpha l}$ in TOWNSEND's formula is small compared to the density of surface charge on the electrodes, + space charges will not materially help to produce the spark. The + ions will have to proceed to the cathode to do their duty.

If $e^{\alpha l}$ becomes of the order of these surface charges the field is distorted by + space charges, concentrating it near the cathode, thus enhancing the ionizing power of the following electrons. The + ions in the space add to build up the discharge current a long time before they reach the cathode.

At still higher values of e^{α} one electron leaving the cathode may generate a sufficient number of pairs of ions to completely discharge the condenser. The + ions produced will be contained in a channel of small cross section, which moreover contains a great number of excited molecules. These will return to their normal state only after some lapse of time. Any fresh electron entering this channel during the life of these excited molecules will find very favourable ionizing conditions. The same holds for + ions, moving through this channel to the cathode. This explains the highly conductive filament between the electrodes. It also shows why a spark spectrum is produced under conditions, where the potential difference per free path is exceedingly small.

Physics. — *Das Entstehen einer kanonischen Gesamtheit.* Von
L. S. ORNSTEIN und W. R. VAN WIJK.

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In seinem berühmten Buch "Principles in Statistical Mechanics" hat J. W. GIBBS ein aus vielen Teilchen bestehendes mechanisches System betrachtet, das mit einem zweiten System von sehr grossem Energie-