

# ALTERNATING CORONA AT THRESHOLD VOLTAGE AND SUPERIMPOSED D. C. FIELD\*

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КОРОНА ПЕРЕМЕННОГО ТОКА ПРИ ПОРОГОВОМ НАПРЯЖЕНИИ  
И СУПЕРПОЗИЦИИ ПОСТОЯННОГО ПОЛЯ

Alternating corona of a frequency 50 Hz in point-plane arrangement, in air, under normal conditions is investigated. Electrode distances range from 5 up to 40 mm, hemispherical points employed are of radii 0.5 to 1.5 mm.

Three types of corona well distinguishable according to corona oscillograms appear.

Formation of the corona current in half-periods following the corona ignition is followed. We have determined that one part of the space charge created during one half-period is conserved and affects the corona in the next one.

Further, the influence of a d. c. voltage on the alternating corona is studied. Various effects of the d. c. field on the individual corona types are found.

Under the above mentioned conditions there originate three types of a corona, which can be differentiated best according to the oscillograms of the corona current. The most typical corona current oscillogram is shown in Fig. 1, where the capacity current combines with the corona current. In the negative half-period, there appear Trichel pulses. Besides the current pulse in the positive half-period a sharp peak is formed, which we assume to correspond to the pre-onset streamer. This kind of corona is identified as the second-type corona. If the oscillogram does not show any sharp peak we speak of the first type of corona and in case there appear several peaks in one positive half-period we obtain a corona of the third type. However, most frequently, the corona of the second type is observed. We may, sometimes, observe coronas of transient types, too. The shaper the point is, the more frequently a corona of the second or third type is created.

The schematic drawing of the experimental set-up is shown in Fig. 2. The triac switch worked at as reduced a voltage as possible. The number of half-periods of voltage pre-chosen for the time interval during which the triac switch was at work was adjustable. Further, it was possible to vary the polarity of the first half-period of the voltage. The resistance  $R_1$  was 3 M $\Omega$ , the resistance  $R$  varied from 15–200 k $\Omega$ . The voltage of the resistance  $R$  was scanned by an ORION TR-4401 oscilloscope. The time basis started with an input signal. The spot crossed the screen only once. Exposition time at photographing was about 3 sec.

The voltage between the electrodes was adjusted so that its maximum value was equal to the corona threshold voltage. A typical oscillogram is shown in Fig. 3. In most cases the corona ignition takes place

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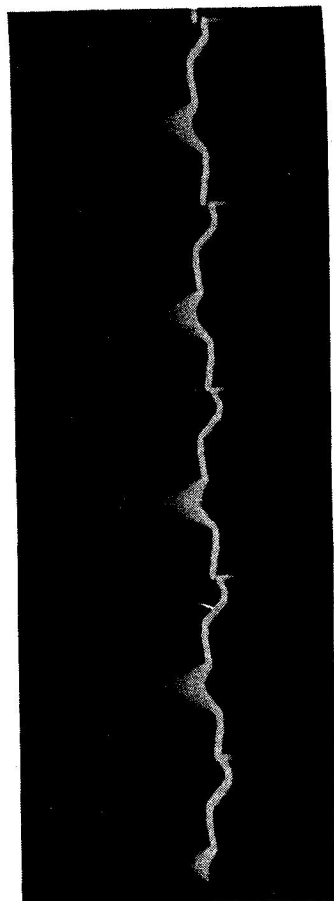


Fig. 1. Oscillogram of the corona current.

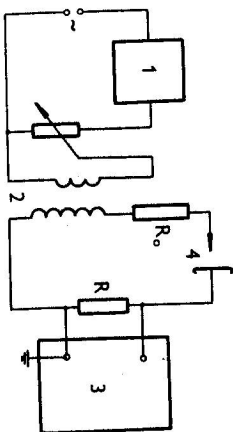


Fig. 2. A schematic drawing of the apparatus: 1 — the triac switch; 2 — the high-voltage transformer; 3 — the oscilloscope; 4 — the point-to-plane gap.

in the negative half-period, irrespective of the polarity of the first half-period of the voltage. Frequently this occurs only some half-periods after voltage superposition. We have not observed any regularities concerning current changes in the positive half-period. The current in the negative half-period behaves quite differently. The first series of Trichel pulses differs from those which follow. First, the corona ignition starts with increased voltage values and, therefore, the first series of the Trichel pulses is shorter. In most cases already the second series of the Trichel pulses obtains its final shape. The above facts may be observed in all three types of the corona. Thus, the occurrence of pre-onset streamers neither affects current formation in the negative half-periods, nor is the point affected by an air current.

The difference between the Trichel pulses in the half-period, when the corona ignites for the first time and those in the following half-periods may be the consequence of the influence of the space charge on the corona. Therefore we assume that one part of the space charge created during one half-period is conserved and affects the corona in the next. This is proved by the fact that after the corona ignition in the negative half-period, the corona ignites in the following positive half-period as well.

If there burrs between the point and the plate an alternating corona of a frequency 50 Hz, we may observe a glow around the point and hear a characteristic noise. If, moreover, we superpose a d. c. voltage on the electrodes, a change and in some cases, a reducing of the above effects may be induced. Since the effect considered might find some applications in practice, we decided to study the problem in greater detail.

A schematic drawing of the set-up used is given in Fig. 4. The capacitance  $C_0 = 4$  nF insures the high voltage transformer against a d. c. voltage. The resistance  $R_2 = 19$  M $\Omega$  protects the d. c. source against the alternating voltage. Oscillograms of the corona current may be taken from the resistance  $R$ . The mean current values of both polarities are measured by using two series diode voltmeters.

## REFERENCES

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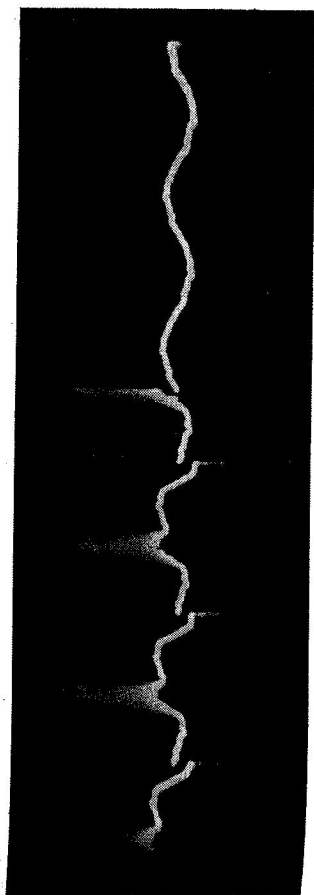
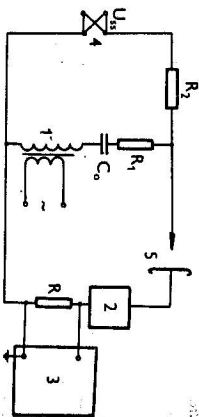


Fig. 3. Oscillogram of corona current.

Fig. 4. A schematic drawing of the apparatus: 1 — the high-voltage transformer; 2 — two series diode voltmeters; 3 — the oscilloscope; 4 — the source of direct voltage; 5 — the point-to-plane gap.



According to expectations the point positive d.c. voltage increases the time interval in each period of the positive corona burning, and on the other hand, it shortens the time interval when the negative corona burns. The point negative superposed d. c. voltage had a similar effect. With an increasing d.c. voltage, there always grows the mean current value of that polarity which is the point d.c. voltage polarity, while the mean value of the current of the opposite polarity decreases. The sum of these currents, however, does not show any decrease. At the point negative d.c. voltage the sum of currents increases, at the point positive d.c. voltage it remains constant within certain limits of the d.c. voltage and then it increases.

By measuring the mean current values, however, we cannot differentiate between corona types and hence draw conclusions concerning the amount of losses as well. More information is obtained by oscillograms of the corona current. They make it possible to determine the occurrence or decay of the pre-onset streamers due to d.c. voltage on the one hand and show a varying influence of the d.c. voltage on various types of the corona on the other. In a first-type corona there appear pre-onset streamers at such a point positive d.c. voltage value, where in the negative half-periods the Trichel pulses cease to form, which fact is accompanied by more pronounced sound effects.

In the case of coronas of the second and the third types, the positive d.c. voltage induces mostly a breakdown. At the point superposed negative d.c. voltage the decay of the pre-onset streamers occurs, reducing the sound effects; moreover, in the case of the third type corona, a light emission decrease takes place. On the photographs of the corona it is seen that the narrow burning channel, extending up to the plane electrode, disappears. Further, the photographs show that with the increase of the point negative d.c. voltage the light beam extends and the corona appears around the greater part of the point.

From the above discussion it may be concluded that in the case of a third type corona, the negative d.c. voltage prevents formation of pre-onset streamers and thus induces an explicit reduction of the corona and hence a lessening of the losses.