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solution to the problem no. 11
presented by the team of Slovakia
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Current system

In a Petri dish (shallow bowl), small metal balls, e.g. 2 mm in diameter, are immersed in a layer of castor oil. The inner rim of the dish contains an earthed metal ring. Above the centre of the dish there is a metal needle which does not touch the oil surface. Investigate what happens when the voltage between needle and earth is about 20 kV.

Warning: The high voltage should be obtained by means of a safe generator, e.g. an electrostatic generator!

Abstract

This task is useful to show some interesting phenomena of high voltage circuits, like coronary discharge or electron wind. The following words are intended to explain some basic facts about this task, as long as we do not have enough place in this publication to write full description of all phenomena.

Overview

- Experiments and Discussion

1 Experiments and Discussion

The best way to examine a given phenomenon is to experiment.

We poured castor oil into Petri's dish and added lead balls. We connected the system to a variable DC source. We increased the voltage slowly and we observed several interesting phenomena.

The disruption of the oil surface was caused by the electron wind. This is a stream of particles caused by a movement of electrons from the needle towards the oil surface and then to earth, hitting surrounding particles and setting them into motion and forming the electron wind. The electrons themselves are coming from ionized particles of air at the top of the needle. During ionization, the coronary discharge occurs as well, which we can hear as a buzzing sound. This sound, which can also be observed near high voltage wires is an indicator of both high voltage and the coronary discharge.

The balls in the oil attempt to stabilize themselves in the position where they'd have lowest potential energy. Therefore, they move in direction of the gradient of the electric field, that is towards the needle, and to form current channels. They do not reach the needle, because the electron wind pushes them away.

It is possible that the initial situation would be in a potential hole, but this could only happen with low voltages. With voltages we have used the strength of the electric field and the electron wind both contributed to a movement in the oil and therefore the balls were forced to move.

Finally, the balls form a pattern similar to the one shown in picture, thus forming a current channel in the oil. Once formed, if the distance between the needle and any ball falls below critical distance, the ionized air would turn into plasma and the current would flow through the conducting layer to the earth. It is the same phenomenon as with lightning, accompanied with similar sound.

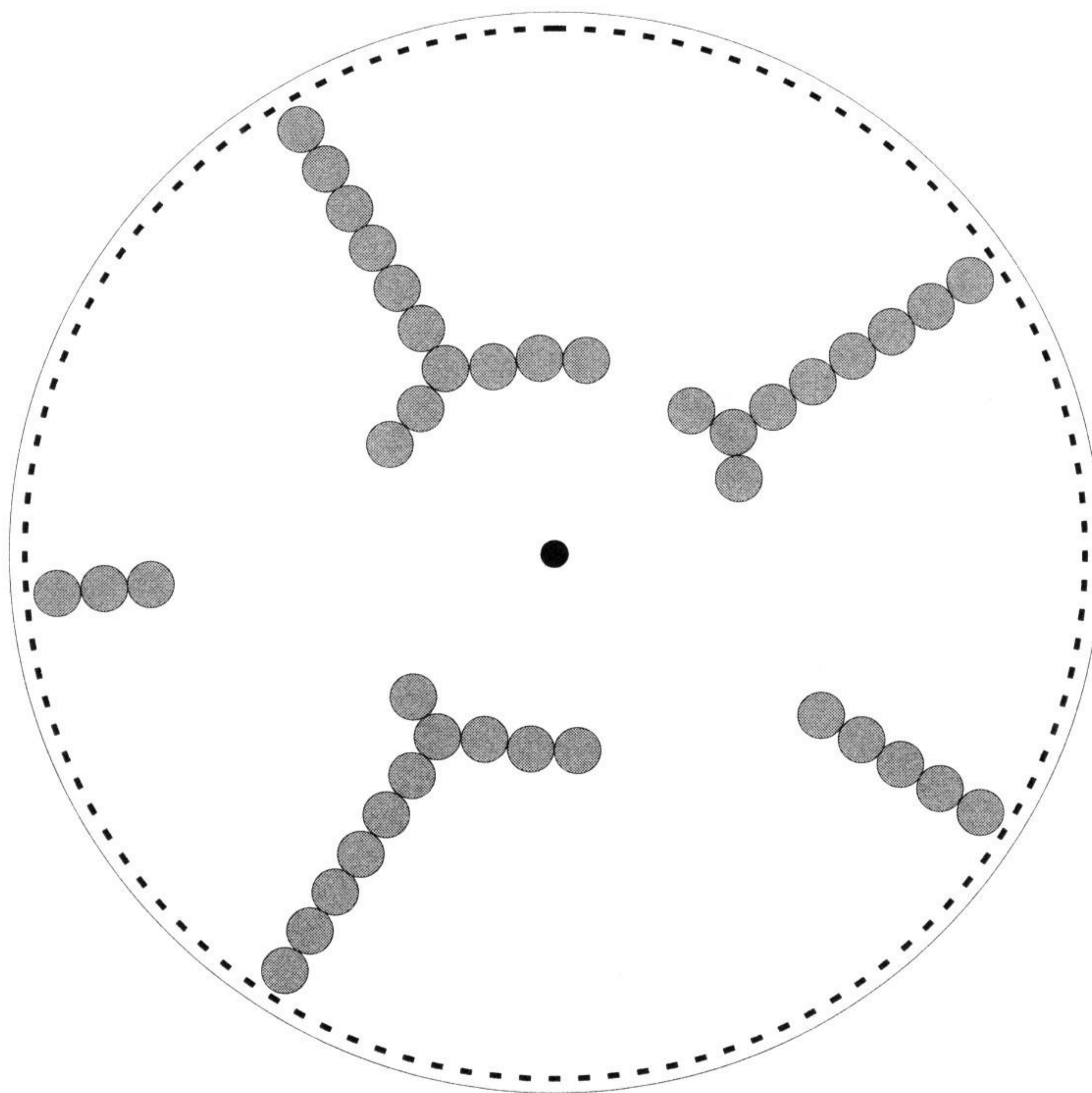


Figure 1: Current system