SOME FURTHER OBSERVATIONS ON THE RADIATION PRODUCED IN AN ALTERNATING CONDENSER FIELD.

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IN an article published in the PHYSICAL REVIEW of December, 1903, Vol. XVII., p. 441, the present writer described some experiments which had been made on a form of radiation which is given off from the kathode of an air condenser connected to the terminals of an induction coil. It was shown that this radiation is capable of refraction, total reflection and polarization, but when the article was written its wave-length had not been measured. Since that time I have succeeded in measuring the wave-length of the radiation from several metals and have made some observations which enable me to explain some of the phenomena which were not before understood and to correct an erroneous conclusion as to the two kinds of radiation which were supposed to be sent off from metal plates placed in the field of the condenser.

The wave-length measurements were made by means of a Wallace celluloid replica of a Rowland plane grating having 14,438 lines to one inch. This grating was found to be fairly transparent to the radiation and to give definite spectra of the first order. The grating was placed over a slit about 3 mm. wide cut in a hard rubber screen which was placed between the source of the radiation and a photographic plate. The distance of the grating from the sensitive plate was, in the various experiments, from 4 cm. to 5 cm. This distance gave a displacement of the first diffracted image of the slit of from 8 mm. to more than 1 cm. The bands were generally sharply defined in the photographs, indicating that the radiation was virtually all of one wave-length from a given metal, and their displacement could be measured to within two or three tenths of a millimeter. The distance between the grating and the sensitive plate could be measured with a still higher percentage of accuracy, so that the error of measurement of the wave-length ought not to exceed four per cent. As a matter of fact, four different measurements of the wave-length from copper were made at different times using different copper strips as radiators and with different distances between the grating and the plate with a maximum difference in the four measurements of only 1 per cent. This close agreement must be regarded as accidental, but it is believed that the measurements are in general accurate to within four per cent.

The wave-lengths so far determined are as follows: For the radiation from aluminum and from silver, $\lambda = 350\,\mu\mu$. For the radiation from copper $\lambda = 372\,\mu\mu$ and for the zinc radiation $\lambda = 377\,\mu\mu$. As predicted in the preceding paper, this radiation is in the ultraviolet part of the spectrum and only a short distance beyond the visible spectrum.

No difference was found in the wave-length of the radiation from a piece of sheet copper when it was connected to the kathode of the induction coil and when it was insulated between the plates of a tinfoil condenser and gave off the radiation by induction. This observation contradicts one of the conclusions of the former paper concerning two kinds of radiation from a metal plate when insulated in the condenser field. The preceding paper mentioned the fact that when a strip of sheet metal was used as the radiator and an opaque screen with a slit was placed between the radiator and the sensitive plate two images of the slit were regularly formed on the plate, and that when a prism was placed across a part of the slit these two images were sometimes differently refracted. In the experiments where the radiating plate was connected directly to the kathode but one image of the slit was produced, and reasons were given for believing that these two images were produced by reflected and induced radiation. A further attempt to trace the origin of the two images has shown that they were due to the radiation from the two opposite edges of the metal strip. Even the earliest experiments in coin photography showed that the intensity of the radiation from the edges and convex surfaces of the coins was greater than from the plane faces, and this fact was mentioned in the paper on "Some Experiments in Electric Photography" in the Physical Review, Vol. II., p. 60, but this difference was not thought to be great enough to account for the phenomenon of the double image, though it was several times suspected to be the cause. The experiments with the radiator connected to the kathode seemed to exclude this explanation, but in those experiments a larger radiator was used and it was arranged so that only the radiation from the central part of the plate could reach the sensitive plate through the slit.

Later experiments have shown that when a thin piece of sheet metal is used as a radiator nearly all the radiation is from its edges. This radiation is diffuse, and apparently goes off in one direction nearly or quite as well as in another. Accordingly when a narrow strip of sheet metal was used as a radiator, as described on page 451 of the former paper, each edge served as a line source of radiation and two images of the slit were produced. Since the radiation from the two sources passed through the prism at different angles of incidence their deviation by the prism was different, and accordingly there seemed to be two kinds of radiation having different refractive indices. Many experiments have since been made with radiators of various width, both connected to the kathode and insulated in the condenser field, and there can be no doubt of this being the true explanation of the two images of the slit. In the latest experiments the radiating plate has been placed horizontal between the two horizontal condenser plates with one edge in front of and parallel to a horizontal slit in the opaque screen. With this arrangement only one image of the slit is produced and a narrower slit can be used than in the former experiments.

The sharp lines of separation between the radiations from the two radiating surfaces when separated by the glass prism as shown in the photographs on pp. 446 and 447 of the former paper are also explained by this phenomenon. When feeble radiators, as wood, paper, mica and glass are used, the principal source of radiation which reached the photographic plate was the edge of the radiating strip nearest the prism. The other edge of the strip was so far away that its effect upon the central part of the photographic plate was inappreciable in the photograph. When a metal plate was used as a radiator the radiation from its farther edge was still strong enough to be appreciable on the part of the plate which also received the radiation from the wood or paper on the other side.

The same phenomenon likewise explains the fact that when a window was cut in the top of the box camera and covered with the metal kathode the intensity of the radiation upon the sensitive plate beneath was not sensibly greater than when the whole box was covered by the *papier maché* slide. This was due to the fact that but little radiation was sent off from the central part of the kathode plate which was placed over the window.

To sum up the observations to the present time, it may be said that when the terminals of an induction coil are connected to the plates of an air condenser and the current is interrupted in the primary coil the kathode plate gives off a radiation which possesses many, if not all, the properties of ordinary ultra-violet light. The wave-length of this radiation differs when the kathode plate is made of different metals, and for the metals aluminum, silver, copper and zinc it lies between 350 $\mu\mu$ and 380 $\mu\mu$. If a plate of metal or other substance be placed between the condenser plates it gives off the same radiation as when joined by conducting wires to the kathode, but with less intensity. In the case of a copper plate between tinfoil condenser plates this induced radiation has the same wave-length as when the copper plate is made the kathode of the condenser. Every body which has yet been tried may serve as a source of this induced radiation.

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