# Note on the Polarization of Light Emitted by Electrically Exploded Wires

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The polarization of light emitted by an electrically exploded wire was photographically investigated. No polarization was found, within the limits of accuracy. It is concluded that scattered and reflected light do not contribute to the emission from electrically exploded wires. This leaves temperature radiation and continuous electron radiation as the only factors causing the emission of the continuous spectrum.

THE discharge of one or several condensers through a thin wire will cause, for a very short period of time, the appearance of an intense light. Characteristics of "exploded wires" have been investigated by several authors.[1] During the initial part of the explosion a purely continuous spectrum is emitted which is followed by line plus continuous spectra. The intensity of the continuous spectrum depends upon pressure, surrounding gas, etc. Originally, it was thought that the continuous spectrum is due only to temperature radiation emitted by incandescent particles and vapors. The temperature during or immediately following the explosion was estimated to reach 20,000°K. However, later work showed that the intensity distribution in the continuous spectrum is different from the intensity distribution in the spectrum of a blackbody, particularly in the ultraviolet part.

Our present knowledge indicates that three distinct phenomena may contribute to the continuous emission observed. They are: (1) continuous blackbody radiation due to high temperature; (2) luminescent radiation due to continuous electron radiation; and (3) radiation scattered or reflected by gases, vapors, and fragments of the wire formed during or immediately after the explosion. It has not been possible, so far, to distinguish between the components of the continuous spectrum during the various parts of the explosion or to determine their relative amounts.

The polarization of the light emitted by an exploding wire was investigated in order to obtain a lead toward the identification of the components of the continuous spectrum. Scattered or reflected light will be completely or partially polarized depending on size and shape of particles, whereas both temperature radiation and continuous electron radiation will produce unpolarized light.[2] The relatively weak emission lines are unpolarized.

Experiments were carried out simultaneously with a study of the spectrum of wires exploded at atmospheric pressure (unpublished). The set-up was similar to that used in earlier work. It included a Campbell x-ray transformer with mechanical rectifier, a spark-gap, the wire to be exploded, and the condensers. Part of the work was carried out with five glass plate condensers, total capacity 0.28 microfarad, the remainder of the work being carried out with five General Electric condensers, type 9-CEIA-56, total capacity 1.8 microfarads. Voltages ranged from 20,000 to 31,000 volts. The wire was clamped to copper bars of $\frac{5}{8}\times\frac{5}{32}$ in. cross section which served as electrodes. The background was carefully screened by ivory-black "velours" paper in order to eliminate reflected light. The spectrum

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[2] W. M. Cohn, Zeits. f. Physik **70**, 662–694 (1931); **72**, 392–422 (1931); **73**, 662–676 (1932); **75**, 544–554 (1932). W. Finkelnburg, Phys. Rev. **45**, 341–342 (1934); *Kontinuierliche Spektren* (Springer, Berlin, 1938).

shows a strong continuous background, together with numerous emission lines.

The polarigraph consisted of a Voigtlaender camera, focal length, $35\frac{1}{4}$ in., equipped with a quartz Wollaston double-image prism. An auxiliary lens was inserted between the wire and the polarigraph. Two enlarged images of the explosion were obtained on the same photographic plate, the images being polarized in perpendicular planes. Since the dispersion of the Wollaston prism amounts to 1.1° the images overlap to some extent in the central part of the plate. Exposures were obtained with the shutter remaining open during the entire period of an explosion. Part of the plates received, after exposure, standard marks by means of a neutral wedge. Details of the polarigraph and the wedge may be found in an earlier publication.[3] Eastman Kodak plates of types Universal and 40, and Wratten hypersensitive panchromatic plates were used.

The images on the plates were measured with microphotometers of types Hartmann and/or Zeiss. Fig. 1 presents a microphotometer record through images $A$ and $C$; part "$B$" of the curve due to the overlapping of the images was not used in the reduction. The reduction was carried out as previously,[3] the polarization $p$ being computed from $p=100\cdot(l-r)/(l+r)$, in which $l$ and $r$ are the relative intensities of the two pictures. The probable error amounts to $\pm 0.2$ percent polarization.

Wires of copper and constantan, 0.0013 in. and 0.0027 in. in diameter were exploded, the free length of the wires varying from 5 to 22.5 mm. A single explosion produced a record on the plate of sufficient density for microphotometer work.

The results of this work are summarized as follows:

(1) The emission of copper and constantan wires exploded at atmospheric pressure is, within the limits of accuracy, not polarized in integrated ("white") light, wave-lengths 389–565 m$\mu$.

(2) The emissions from copper and constantan wires appear identical (spectrographically confirmed for the continuous spectrum, whereas the lines are partly different).

(3) While these tests integrate over the various parts of an explosion, the conclusion seems justified that, within the limits of accuracy, scattered or reflected light do not contribute to the emission during any part of the explosion.

The absence of polarized light in the emission of exploded wires leaves temperature radiation and continuous electron radiation the only factors causing the continuous emission from exploded wires. Therefore, the continuous emission of the exploded wire belongs to the group of phenomena which includes the radiation emitted if the front of a shock wave accompanying the detonation of a solid or gaseous explosive meets an obstacle, e.g., a solid wall or another shock wave; the radiation from the condensed and underwater sparks; the radiation from the high current arc and the high current vacuum tube. All these continuous spectra seem due to the superposition of temperature radiation and continuous electron radiation in the field of positive ions formed during the discharge.

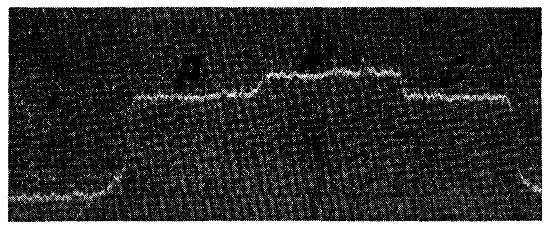

FIG. 1. Microphotometer record MZ 10167a of the images of an exploded constantan wire.


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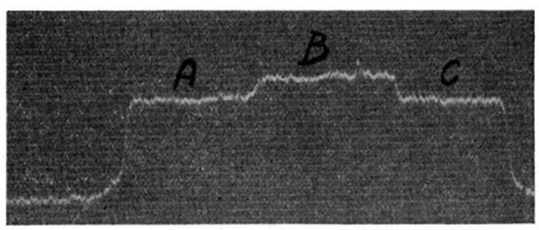
[3] W. M. Cohn, Astrophys. J. **87**, 284–334 (1938); Astron. Nachr. **267**, 205–216 (1938).

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