Excitation of Enhanced Lines of Tin in Arcs and Zeeman Effect of Certain Enhanced Lines of Tin.

By

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ABSTRACT

Excitation of the enhanced lines of tin in arcs: —
The enhaced lines of tin have already been classified by Kimura and Nakamura into spark, super spark and super-super spark lines. In this investigation the excitation of these lines in arcs was studied, a grating spectroscope being used. The lines λλ 5800, 5590, 5563, 5333, etc. belonging to the first type were observed clearly in the light emitted from the alternating current arc and Poulsen's arc charged with metallic tin. Using Poulsen's arc without self-induction it was found that the light emitted at the instant of the break of this arc takes a spark character when the capacity shunted between the arc terminals is increased to 0·25 microfarad, and the current before the break to 7 A. In this light the lines λλ 5370, 5344, 5289, 5225, 5101, 5021, 4934, 4858, 4615, 4586 belonging to the second type were newly observed. These results will show that the excitation energy of the super spark lines is greater than that of the spark ones.

Zeeman effect of the lines λλ 5800, 5590, 5563 and 5333: —
As the light source a discharge tube containing $SnCl_3$ was used. When the light was analysed by a spectrograph containing a 20-plate echelon grating and a large direct vision prism, these lines seemed to be single lines in the zero field. When the self-induction and capacity in the discharge circuit were adjusted these lines resolved into magnetic triplets in the field of 15900 gauss. Their separations were about one third of the normal triplet.

An arc spectrum of tin, especially in the visible part of the spectrum, consists of a few lines, while its spark spectrum contains many lines. The lines enhanced in passing from arc to spark are generally called enhanced lines. Recently Kimura and Nakamura[1] classified the enhanced lines of tin into spark, super spark and super-super spark ones. In the

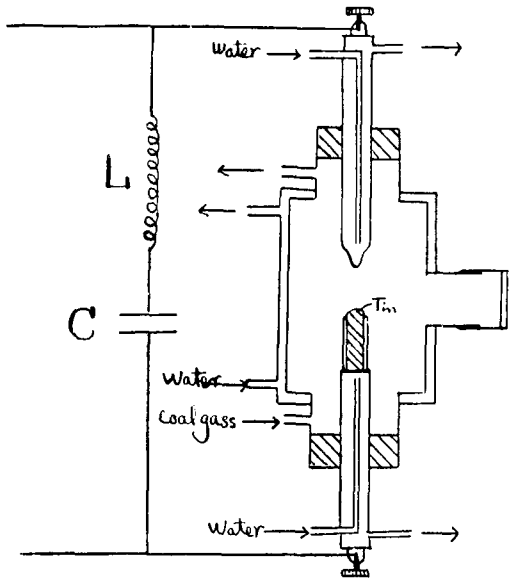
1 Jap. J. Phys., **3**, 29 (1923).

present experiment an effort was made to see how such lines can be excited in lights emitted from various sources. As sources of light, the alternating current arc, Poulsen's arc employed in the production of undamped electric oscillations, and the light emitted at the instant when a circuit was broken, were used.

(1) Alternating Current Arc: A vertical arc was started between carbon electrodes by 440-volt A.C. circuit through a proper resistance. A small hole was made in the lower carbon and was charged with a piece of metallic tin. The image of the light from such an arc was projected on the slit of a spectrograph having a good replica grating for the dispersing system, and the spectrum was photographed with a camera provided with a photographic lens of 50 cm. focus. The spectrum thus taken showed that the enhanced lines $\lambda\lambda$ 6453, 5800, 5589, 5563 and 5333 are emitted in the neighbourhood of the lower electrode containing the metal. These lines are, according to Kimura and Nakamura, the spark lines of tin emitted by a singly ionized atom of the element. In the same spectral region the spark spectrum contains such lines as $\lambda\lambda$ 5370, 5344,....., but they could not be detected in the present arc.

(2) Poulsen's Arc: Next, the light emitted from Poulsen's arc was studied. The arrangement for obtaining the arc is shown in the accompanying figure. The upper electrode consists of a water cooled copper tube provided with a copper cup and the lower one the carbon rod perforated with a small hole containing a piece of tin. Such electrodes were placed in a water-cooled chamber having a glass window, coal gas being circulated through it. A large condenser of the capacity of about 0·3 microfarad and a suitable coil were connected in series with the arc terminals and the arc was started by 440-volt D.C. circuit. The light emitted from this arc was studied by the above grating spectrograph. The spectrum

Fig. 1



thus obtained is represented in Fig. 3 which shows both arc and spark lines.

The enhanced lines observed in the spectrum are λλ 6453, 5800, 5589, 5563, 5333, etc. which according to the above investigators are the lines of Sn^{+}, no lines of Sn^{++} being observed. By reducing the self-induction and increasing the capacity of the condenser, spark lines got intensified at the expence of the arc lines, but no super spark lines made their appearance yet.

(3) The light emitted at the instant of the break of a 440-volt D.C. circuit: The self-induction in the Poulsen's arc was taken out from the circuit, and the upper electrode was first brought into contact with the lower tin electrode, and then quickly separated from it. The spectrum of the light thus emitted consisted of arc and spark lines. The capacity shunted between the arc terminals was gradually increased from 0·02 to 0·3 microfarad, and the current flowing in the circuit when both electrodes were in contact was also increased from 5 to 8 amperes. This increase of both the current and the capacity gave the light a spark character, reducing the intensity of the arc lines and augmenting that of the spark lines. The enhanced lines λλ 5370, 5344, 5289, 5225, 5101, 5021, 4934, 4858, 4615, 4586 were newly observed when the capacity reached the value of about 0·25 microfarad, and the current of 7 amperes. These lines were intensified as the capacity of the condenser was increased. They are lines of the super spark spectrum of tin. Thus, the spark and then super spark lines were excited in this light when the capacity was gradually increased and the above group of enhanced lines consequently required greater energy for their exciation than those of the former group of the enhanced lines. The order of the appearance of such enhanced lines leads to the same conclusion as that obtained by Kimura and Nakamura.

Lastly the influence of the presence of such electronegative gases as bromine, chlorine and iodine on the spectrum of the light emitted by an electric arc in it was studied. The result of the experiment will be given in a separate paper.

Zeeman Effect of the lines λλ 5800, 5590, 5563 and 5333.

The Zeeman effect of the lines of tin has been studied by Purvis[1]. The greater part of the lines studied by him being arc lines, and a few, enhanced ones. It is very desirable to examine the Zeeman pattern of

1 Proc. Camb. Phil. Soc., **13**, 82 (1906).
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Phys. Zeits., **8**, 594 (1907).

more enhanced lines. In the present experiment, the tube containing $SnCl_3$ excited by an induction coil giving 15 cm. spark in air was used as the light source. The form of the discharge tube is shown in Fig. 2, the internal diameter of the capillary being about 3 mm. L representing a coil of various self-induction, and C the condenser of the capacity of about 0·001 microfarad. As the spectroscopic instrument a 20-plate

Fig. 2

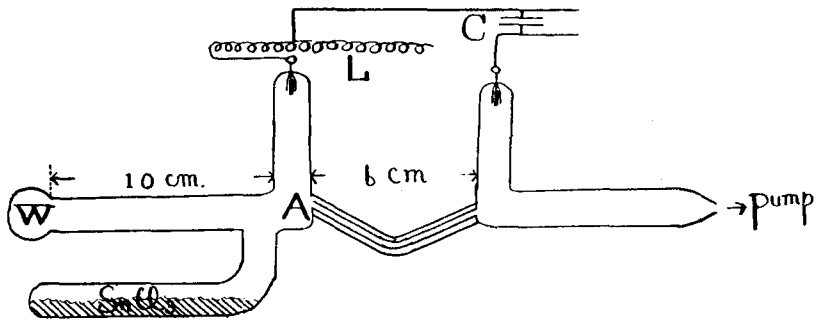


Table.

λ	Δλ	Nature of the polarization	$\frac{\Delta\lambda}{\lambda^2 H}\times 10^1$	$\frac{\lambda\Delta}{\lambda^2 H}\Big/0{\cdot}94\times 10^4$
5800	+0·18	s.	0·34	0·36
	0·00	p.		
	−0·17	s.	0·32	0·33
5590	+0·17	s.	0·34	0·36
	0·00	p.		
	−0·17	s.	0·34	0·36
5563	+0·16	s.	0·33	0·35
	0·00	p.		
	−0·17	s.	0·35	0·37
5533	+0·15	s.	0·33	0·35
	0·00	p.		
	−0·15	s.	0·33	0·35

echelon grating combined with a large direct vision prism was used. This echelon is the same one as used by Hori[1] in his study of the structure of bromine lines and its constant was fully described in his paper. The part A of the capillary was placed between a pair of truncated pole pieces of an electromagnet of the Du Bois type, the diameter of the end of the pole piece being 7 mm., and they were set at a distance of

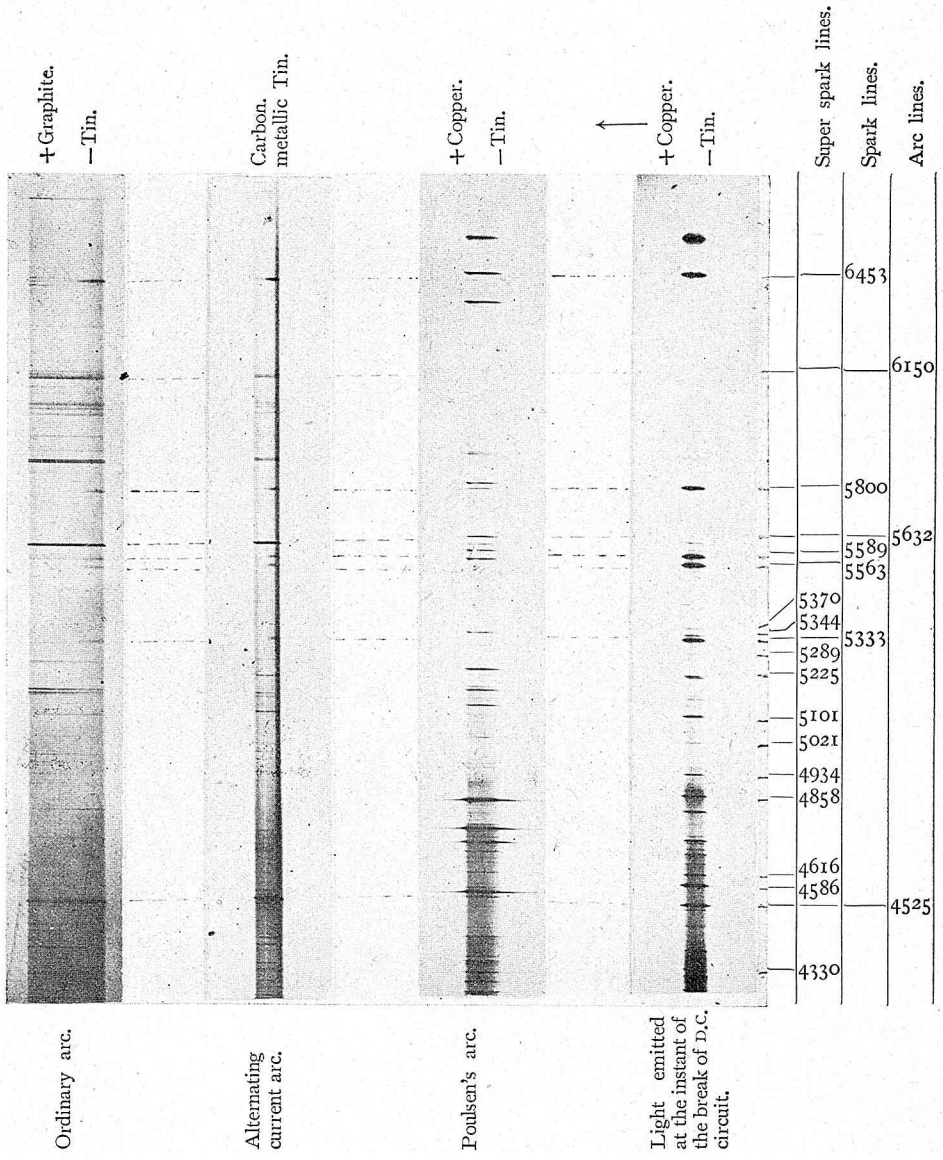
1 These Memoirs, **9**, 307 (1926).

7 mm. apart. The light emitted from the part A of the tube through the window W was analysed by the above echelon spectroscope. The lines $\lambda\lambda$ 5800, 5590, 5563 and 5333 seemed to be single lines in the zero field, but they were resolved into magnetic triplets in the magnetic field, though they were not sharp. Proper adjustment of the self-induction and the capacity in the discharge circuit made the lines sharper and their magnetic separation in the field of 15900 gauss could be photographed with an exposure of about 6 hours. The polarization was studied by means of a calcite plate.

The results obtained are given in the table. Thus, these lines were resolved into magnetic triplets, but their separations were about one third of these normal triplets.

In conclusion, the writer wishes to express his best thanks to Prof. M. Kimura under whose guidance the present experiments were carried out.

Fig. 3.


+Graphite.
−Tin.
Carbon.
metallic Tin.
+Copper.
−Tin.
←
+Copper.
−Tin.
Super spark lines.
Spark lines.
Arc lines.
6453
6150
5800
5632
5589
5563
5370
5344
5333
5289
5225
5101
5021
4934
4858
4616
4586
4525
4330
Ordinary arc.
Alternating current arc.
Poulsen's arc.
Light emitted at the instant of the break of D.C. circuit.