

Exhibition and Description of Wehnelt's Current-Interrupter

This content has been downloaded from IOPscience. Please scroll down to see the full text.

1897 Proc. Phys. Soc. London 16 419

(<http://iopscience.iop.org/1478-7814/16/1/342>)

View [the table of contents for this issue](#), or go to the [journal homepage](#) for more

Download details:

IP Address: 130.15.241.167

This content was downloaded on 03/10/2015 at 08:04

Please note that [terms and conditions apply](#).

equation

$$EC = R''C^2 + \frac{d}{dt} \frac{1}{2} L''C^2,$$

and also

$$EC = Q + \frac{dT}{dt},$$

where Q is the waste and T the magnetic energy. But the mean Q is not the same as the mean $R''C^2$, nor the mean T the same as the mean $\frac{1}{2}L''C^2$, save when $\alpha=0$, or the vibrations are undamped. It is true, however (as I have investigated), that the mean $Q\epsilon^{2at}$ and $T\epsilon^{2at}$ are the same as the mean $R''C^2\epsilon^{2at}$ and $\frac{1}{2}L''C^2\epsilon^{2at}$, so that if ϵ^{2at} does not change sensibly in a period, R'' and L'' are sensibly the effective resistance and inductance in the same sense as R' and L' .

*XL. Exhibition and Description of Wehnelt's Current-Interrupter. By A. A. CAMPBELL SWINTON.**

[Abstract.]

A GLASS cell contains a large cylindrical negative electrode of lead, and a small positive electrode consisting of a platinum wire about $\frac{1}{4}$ inch in length, in a solution of 1 part sulphuric acid to about 5 parts water. The platinum wire may project from the top of the shorter arm of a J-shaped ebonite tube, so that it can point upwards, immersed in the solution. Or it may be fused into a similar glass tube; but glass is apt to crack in the subsequent heating. Wehnelt's interrupter replaces the make-and-break apparatus of an induction-coil; it also replaces the ordinary condenser of that apparatus. In its present form it requires rather a strong current. The resulting spark at the secondary terminals differs in character from the ordinary spark of an induction-coil; it is almost unidirectional, and in air takes a Λ -form—bright, continuous, and inverted—somewhat like a pair of flaming swords rapidly

* Read March 10, 1899.

crossing and re-crossing one another at their points. By blowing upon the discharge it breaks up, and then more nearly resembles the customary discharge of a coil. The sound emitted by the spark has a pitch that varies with the conditions of the circuit. As the self-induction of the circuit is diminished, the spark-pitch rises ; it becomes infinite when the self-induction vanishes, *i. e.*, the Wehnelt interrupter will not work in a circuit devoid of self-induction. As the applied potential difference diminishes, the spark-pitch diminishes. In the author's experiments 25 volts was the minimum primary voltage at which the apparatus would work. The spark-pitch also varies with the length of the platinum-wire electrode in the solution. If the circuit is closed by slowly dipping this electrode into the solution, the apparatus will not work ; the wire should be dipped in before closing the circuit, or at any rate immersed with considerable rapidity. After working for about a quarter of an hour the action often ceases ; this fatigue effect is not due to heating of the solution, for it is not obviated by keeping the temperature constant by a water-bath. It is supposed that the oxygen generated at the platinum electrode forms a more or less insulating film which interrupts the current until absorbed by the surrounding water. The fact that oxygen is more easily absorbed than hydrogen, may explain why it is necessary to connect the platinum electrode to the positive pole of the battery or dynamo. When the platinum electrode is dipped gradually into the solution, the wire gets red-hot, and the interruptions do not take place. Again, when the apparatus stops from fatigue the platinum gets red-hot. The action is further complicated by a series of small explosions, and by the formation of a kind of intermittent electric arc at the platinum electrode. The coil exhibited was connected to the 100-volt electric light mains at Burlington House ; in this case the potential difference at the terminals of the primary was 30 volts, and that across the interrupter 150 volts—a total of 180 volts, showing the effect of self-induction. For Röntgen-ray work the apparatus would be very effective, but unfortunately the sparks produce great heating, so that the terminals of the tubes are liable to be melted.

The author suggests that, as the sparks are more nearly continuous than ordinary discharges if used for producing Hertz waves, the trains of waves would follow one another at shorter intervals than those from the sparks at present employed. In fact it might eventually be possible in this way to obtain the almost absolutely continuous trains of waves that are necessary for proper syntony in wireless telegraphy.

DISCUSSION.

The PRESIDENT asked whether the self-induction of the primary coil was not sufficient of itself to form the induction factor in the impedance necessary for perfect working. He would like to know how the apparatus behaved when an alternating current was used. Did the secondary coil become damaged by over-heating? Did reversal of the current assist the recovery from the fatigued condition of the apparatus? The natural period of the circuit probably depended upon its capacity and its self-induction. There must undoubtedly be some capacity at the surface of the platinum electrode in the liquid; this capacity might act with the auxiliary self-induction and the self-induction of the rest of the circuit in the orthodox way, and possibly there was automatic adjustment of resonance to the frequency of the interruptions, for instance, by variations of the capacity at the electrode. The heating effect when a wire was made to close a circuit with a liquid was discovered many years ago.

Prof. G. M. MINCHIN thought that the usefulness of the apparatus would be greatly increased if it could be made to work with less current. He had himself succeeded with an applied E.M.F. of 12 volts, but not with 10 volts. As a tentative experiment he had used a horizontal lead plate—with disastrous effect, for the apparatus went suddenly to pieces. Explosions were frequently obtained, but they were not attended with much real danger. In a later and safer apparatus he used a platinum wire about $\frac{3}{4}$ inch long, projecting from a glass tube, around which the lead plate was bent. There appeared to be a definite depth of immersion of this wire,

at which the apparatus worked with minimum current. In his apparatus this critical position was when half the wire was below the surface of the liquid, the other half projecting into the air. He attributed the fatigue to the presence of gas about the electrodes, for he observed that a mechanical tap to the base of the apparatus restored the working condition.

Mr. ROLLO APPELYARD pointed out that the improved result at half immersion observed by Prof. Minchin, taken together with the phenomena described by Mr. Campbell Swinton as to the effect of dipping the electrodes into the solution, suggested that the liquid immediately around the submerged part of the wire was at some instants in the spheroidal state. The breaking-down of the spheroidal state would be facilitated by heat lost by the immersed part to the non-immersed part of the wire. The capacity for heat of the non-immersed part, and the degree of roughness or smoothness of the immersed part, would thus appear as factors in the explanation. No doubt the evolved gases were the primary cause of the interruption of current, but the wire having once become red-hot the spheroidal condition would introduce a further cause of electrical separation between the wire and the liquid.

Prof. C. V. BOYS asked whether it was the liquid or the electrodes that became fatigued. Experiments should be made to determine the effect of variations in the hydrostatic pressure around the platinum electrode.

Mr. T. H. BLAKESLEY said that the rise of potential at the terminals of the interrupter proved that the arrangement possessed capacity. Such a rise of potential could not occur without there being capacity any more than it could without self-induction.

Dr. D. K. MORRIS described experiments he had made with a Wehnelt interrupter, using a 1 kilowatt transformer with a transformation ratio of 4 to 5, intended for 10 amperes at 100 volts. The anode of the interrupter was designed to have an adjustable surface to correspond with the load on the secondary—a platinum wire at the end of a copper wire could be projected more or less through the drawn-out lower end of a glass tube containing oil. The best results with the

interrupter were obtained with about 45 volts on the primary circuit. At this pressure, an average current of 1 ampere sufficed to give 125 (alternating) volts very steadily on the secondary, as measured by an electrostatic instrument. The "no-load" loss was thus only 45 watts. The secondary could then be loaded up with lamps, provided that the exposed surface of platinum wire was proportionately increased. The energy delivered to the lamps, however, was not at any load much greater than 45 per cent. of that taken from the mains. By connecting the interrupter with a condenser of $\frac{1}{2}$ microfarad capacity, the efficiency at small loads was increased to nearly 60 per cent. He had observed that the fatigue of the interrupter could be temporarily remedied by reversing the current.

Mr. C. E. S. PHILLIPS asked whether Mr. Campbell Swinton had tried other liquids than dilute sulphuric acid. So far as his own experiments went, he had only obtained good results with that electrolyte.

Mr. CAMPBELL SWINTON, in reply, said that with the apparatus arranged in a simple circuit, an alternating current applied to the primary of an induction-coil through a Wehnelt interrupter produced only about half the effect of the corresponding direct current—apparently only the currents in one direction got through. But if two interrupters were connected in parallel circuits, it was possible so to arrange them that one took one half and the other the second half of the alternations. It might therefore be possible to design an induction-coil with two primary windings to correspond to the two interrupters, so as to give an additive effect. The ten-inch induction-coil he had used had suffered no damage from the currents employed in the experiments exhibited; though he had used as much as 20 primary amperes, there was extremely little heating of the secondary. He could not with his apparatus restore the working condition by any mechanical disturbance of the interrupter when once the fatigue effects had set in to any marked extent. He had tried other liquids in place of the dilute sulphuric acid. Whilst a saturated solution of potassic bichromate gave fair results, strong hydrochloric acid would not work at all.

The PRESIDENT said he did not altogether agree with Mr. Campbell Swinton's remarks as to the chances of being able to maintain electric oscillations, and so of improving Hertzian telegraphy, by the use of these interrupters. The rate of interruption with this apparatus was something like 1000 per second, but the vibrations corresponding to Hertz waves were of the order 100,000 per second. The wave-trains from oscillations excited by the new interrupter would still be series of damped vibrations; the amplitudes would not be maintained. It might be advantageous to have sparks following one another so rapidly, but he doubted it. For Hertzian telegraphy, the spark at the oscillator should 'crackle'; to produce the best effect, the air about the oscillator should be in a non-conducting condition.
