Demonstration of Some Electrical Properties of Neon-filled Lamps

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DEMONSTRATION of Some Electrical Properties of Neon-filled Lamps. By Messrs. S. O. PEARSON, *B.Sc., and* H. ST. G. ANSON.

THE Demonstration exhibited the behaviour of "Osglim" lamps (made by the General Electric Company) when shunted by a condenser and connected in series with a high resistance to a D.C. voltage supply. In these circumstances an intermittent current passes through the lamp, as indicated by the intermittency of the orange glow on the cathode (formed in this case as a letter of the alphabet of considerable area, the anode being much smaller); this fact was also shown by use of a loud-speaking telephone. The frequency of the flashes can be varied by altering the capacity and resistance of the circuit. In a particular case a resistance of 1 megohm and a capacity of 1 mf. on a 200-volt supply gave a frequency of about 1·2 flashes per second.

The phenomenon may be explained as follows: When cold the lamp fails to pass any current until subjected to an E.M.F. of about 171 volts. If, however, the voltage be reduced when the lamp is glowing, current continues to pass until about 140 volts is reached, when the current falls suddenly to zero. When, therefore, an E.M.F. of 200 volts is applied, some time elapses while the condenser is charging up to the necessary 171 volts. At the end of this time the lamp begins to take current, the current increases and the voltage across the lamp falls to the limit of 140 volts, when the lamp goes out. This cycle of operations then repeats indefinitely.

It was suggested that the arrangement might be used at low frequency for flashing signs for advertising, &c., at audio-frequency for telephonic measurements, and at high frequency (up to about 15,000 ~) for radio-signalling.

The phenomenon was discovered by accident by Mr. Anson.

DISCUSSION.

DR. R. H. RAYNER: It will be most valuable to have an account of this interesting phenomenon in the records of the Society. I should imagine that the highest frequency as yet obtained with the apparatus—viz., 15,000 ~—is by no means an upper limit, as I have seen a neon lamp taking 60,000 ~. A tube 8 inches long was rotated about a perpendicular axis through its middle point at a distance of 1 foot from a C.W. aerial. The apparent illumination was thus drawn out into a disk with radial striæ, the spacing of which indicated the frequency I have mentioned.

DR. J. H. VINCENT: Can the author tell us whether the lamp exhibits any degree of unilateral conductivity? If so, a good many possible applications suggest themselves. It would also be interesting to know how far the critical voltages depend on the construction of the lamp. The usefulness of the arrangement would be greatly extended if the working voltage could be brought down to, say, 12 volts by suitable design. Has the author made any experiments with suitably arranged inductances instead of condensers?

Mr. J. W. RYDE: Some results which I have obtained may help to answer the last speaker's questions. It appears that the electrical quantities concerned are related as follows:

$$I=(V-e)/\{(MA)^{-1}+R\}$$

where

I = steady current through lamp,
V = voltage across lamp,
e = constant (viz., the extrapolated intercept on the V-axis of the straight part of the I/V curve when produced),
M = a constant,
A = area of cathode,
R = resistance fitted in series with the lamp.

It will be seen that if the electrodes be of unequal area, the conductivity will be unilateral. The constant M is of the order 10^{-4}, and depends on the shape and material of the electrodes, the

nature and purity of the gas in the lamp, and the pressure. It is particularly affected by occluded impurities. If the gas be pure, there is no change of current with time; but the current drops to an asymptote with time if impurities be admitted—as they are in practice in order to reduce the critical voltage and to prevent sputtering and consequent blackening of the glass.

Prof. C. L. FORTESCUE: I must congratulate the authors on their interesting exhibit. I should like to know whether the frequency is constant, say, to one part in a thousand or ten thousand. As regards the use of the apparatus for wireless transmission, the question of efficiency arises, and my impression is that there would be considerable waste of energy. As to priority of discovery, the late William Duddell used a somewhat similar arrangement in a demonstration at the Royal Institution about 11 years ago; but, instead of a lamp such as those before us, he employed a bulb which had been improvised for the purpose.

Mr. F. E. SMITH: We have been told that Mr. Anson discovered this phenomenon "by accident," but such accidents only happen to observant persons. I should say the arrangement would be useful for low rather than high frequencies. For the latter purpose the thermionic valve is perfectly satisfactory, while low frequencies can only be obtained with it by using cumbrous inductances and condensers. If the frequency obtained with the neon lamp turns out to be constant, the apparatus might be used for measuring frequency.

Dr. G. B. BRYAN inquired whether the pressure in the bulb remained constant during the life of the lamp.

Mr. W. C. S. PHILLIPS (communicated): In the case of an "Osglim" lamp used as a night-light, I have noticed some curious facts which may be of interest. When current is switched on, as much as 10 seconds may pass before the lamp lights up. The supply is A.C., but when the frequency of the illumination is tested by moving the hand rapidly, one gets the impression that this latter frequency is somewhat lower than that of the supply. Again, when current is off, so that one electrode is alive and the other insulated, a glow can be noticed on the glass of the bulb in any region to which the hand is approached, as if a capacity-current were flowing through the body of the observer.

The PRESIDENT, remarking that Mr. Anson had begun making discoveries very early in life, invited the authors to undertake a written account for the Society's Proceedings.