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DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH AND FIRE OFFICES' COMMITTEE
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THE FIRE HAZARD DUE TO STATIC ELECTRICITY PRODUCED IN A CHAIR

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1. Introduction

Electrostatic discharges can be obtained from certain types of chair which are charged by the movement of persons sitting on them. The purpose of this note is to describe the evaluation of the energy of the electrostatic charge on a particular chair and to state the extent of the fire hazard which it presents.

2. Description of chair

The chair consisted of a plywood back and seat screwed to an aluminium alloy frame having a rubber foot on each of its four legs. The back was approximately 1 ft 4 in. x 9 in. in size and the seat was about 1 ft 3 in. square. The pieces of plywood had been given an acid catalysed plastic finish. The seat was approximately 1 ft 6 in. high while the overall height of the chair was about 2 ft 9 in.

3. Evaluation of the energy of charge

No instrument was readily available by which the voltage attained by the metal frame of the chair could be measured, so an indirect method was used. A 0 - 130 volt electrostatic voltmeter was connected between the metal frame of the chair and earth with a known capacitance in parallel with the meter. A person then sat on the chair and slid about on its seat for such a length of time that a charge approaching the maximum obtainable was produced. When the person stood up the voltage was noted. The experiment was repeated with different value capacitors, five readings being taken for each capacitor.

The capacitance of the chair was measured by a 1,000 c/s bridge. The chair was put on a sheet of aluminium foil placed on the floor. A length of twin p.v.c. flexible cable was connected to the terminals of the bridge. One conductor of the cable was connected to the aluminium foil, the other conductor, terminated with a crocodile clip, was left unconnected. The capacitance of the cable was determined by balancing the bridge. The crocodile clip was then attached to the metal frame of the chair and the bridge again balanced. The capacitance of the chair was found by difference.

It was then possible to calculate the energy of the charge on the chair.

4. Results

A graph of $\frac{1}{V}$ against additional capacitance (C_A) is shown in Fig. 1. The slope of the graph gives the value of the charge (Q) since

$$C_A + C_o = Q \times \frac{1}{V} \quad \text{where } C_o = \text{capacitance of chair}$$

and hence $\frac{d\,C_A}{d(\frac{1}{V})} = Q$. A value of $1{\cdot}8 \times 10^{-6}$ coulomb was obtained.

The capacitance of the chair (C_c) was found to be 24 pF, hence the energy of the charge (with no additional capacitance)

$$= \frac{1}{2}\frac{Q^2}{C_c} = 0{\cdot}064 \text{ joule.}$$

5. Conclusion

Fordham Cooper [1] states that the static spark energy necessary to ignite a gas or vapour varies from about 0·0005 joule for benzine to 0·01 for dioxine. For dust clouds it varies from 0·1 to 2·5 joules. It would appear, therefore, that a spark from the chair described would be capable of igniting most flammable vapours if the vapour concentration was within the explosive limits, but that it is unlikely that a dust explosion could be caused by such a spark.

The high level of static charge is associated with the plastic finish and could be eliminated (1) by rendering this particular finish more electrically conducting, if this is possible, (2) by adopting another finish such as a hard gloss varnish wood stain, or (3) by removing the rubber feet where the flooring provides an adequate earth path (e.g. $< 10^9\ \Omega$).

6. Reference

(1) COOPER, W. FORDHAM. "The practical estimation of electrostatic hazards". Brit. Jour. App. Phys. Supp. No. 2, 1953. p. S76.

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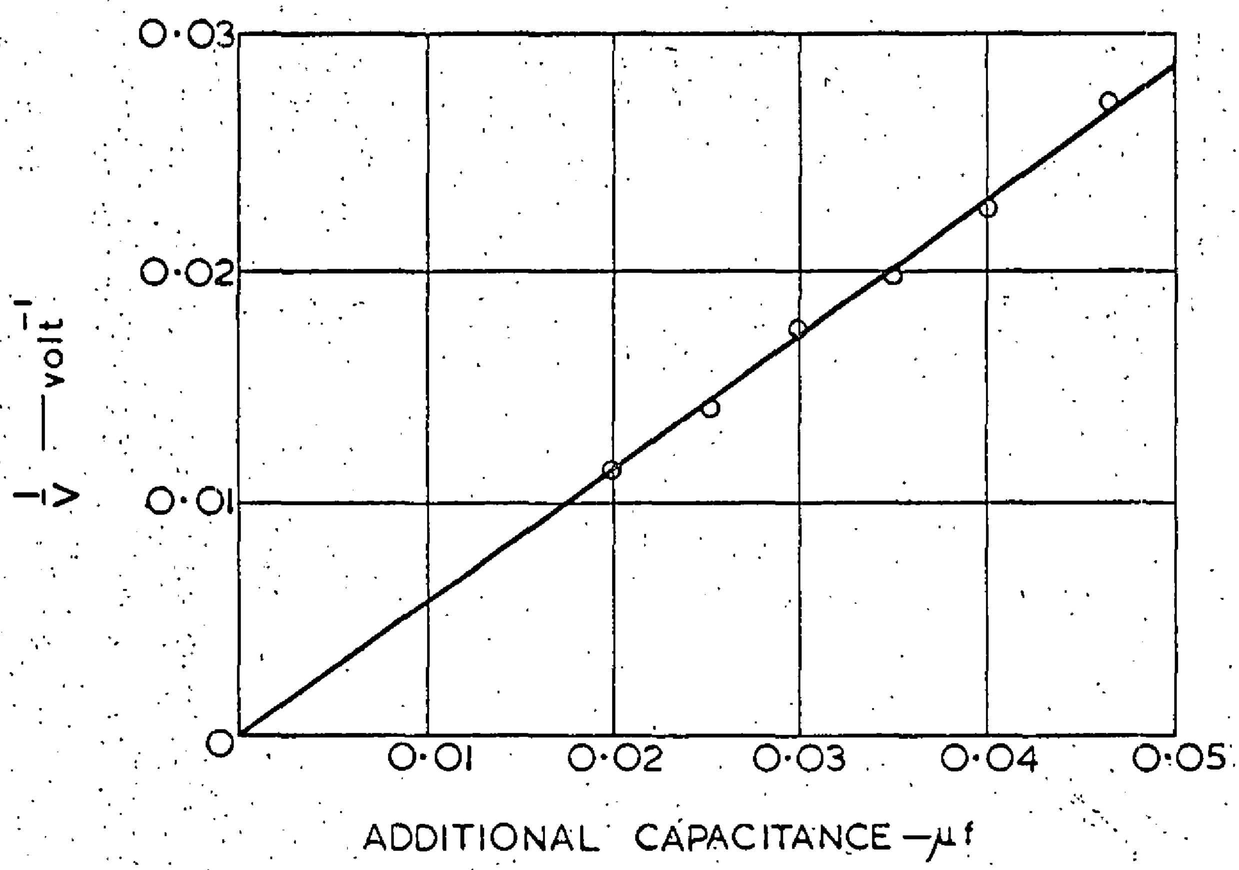

FIG. I. QUANTITY OF CHARGE PRODUCED IN CHAIR