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A1_6 Ali G Cracks The Safe

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Abstract

Ali G and his crew set up a plan to break into a safe - they link a series of cars together via their batteries to a human chain, to carry an electric current along, break into a safe and retrieve a video tape. We found the current needed to melt the lock of the safe to break in to be 7.98x10^{5}A. The current calculated that reaches the safe is 4.59x10^{-5}A, therefore it would not be possible to break into the safe using this method.

Introduction

In the film Ali G Indahouse, Sacha Baron Cohen portrays a wannabe gangster from Staines. After somehow getting involved in politics, he needs to retrieve a video from a locked safe and, with the help of his crew, comes up with a plan to blow the electric system in the safe [1]. To do this, they link the batteries of the cars outside, and transfer the current through a human chain until it gets to the safe. We chose to look at whether this would be possible by melting the lock, and if not, then how many cars would have been needed to use.

Theory

Firstly, we needed to calculate the amount of current that would be reaching the end of the human chain. To do this, we roughly counted the number of people in the chain (≈ 32), along with the number of cars used (6) from the film. We calculated the total resistance, R_T, of the whole system using

$$R_T = \sum_{n=1}^{n=32} R_n \tag{1}$$

where R_n = resistance of humans (50500Ω [2]).

To calculate the current that would be present when it reached the safe, I_S, we used

$$I_S = \frac{V_T}{R_T} \tag{2}$$

where V_T = total voltage of the system ((12.4V) x (number of cars used) [3]).

We then calculated the current required to melt the metal of the lock mechanism of the safe. It was assumed this was made of steel, and had the dimensions 15cm x 8cm x 8cm.

Joule's first law, also known as Joule heating, relates power, P, to current, I, with a constant resistance, R [4],

$$P \propto I^2 R. \tag{3}$$

To form an equation from the proportionality above, the constant $j = 4195\text{Jkg}^{-1}\text{K}^{-1}$ [5] is introduced, which is Joule's mechanical equivalent of heat, giving

$$P = \frac{Q}{t} = \frac{1}{j} I^2 R \tag{4}$$

where Q = heat energy and t = the time between the current reaching the safe and the safe opening (3s shown in the film), $R = 1.76\text{x}10^{-5}\Omega$, and was calculated using

$$R = \frac{\rho \ell}{A} \tag{5}$$

where ρ = the resistivity of steel ($7.5\text{x}10^{-9}\Omega$m) [6], ℓ = the length of the lock (0.15m) and A = the surface area of the face of the lock ($6.4\text{x}10^{-3}\text{m}^2$). The heat energy can be found from the following equation,

$$Q = mc_s\Delta T \tag{6}$$

where m = mass of the lock (7.65kg), c_s = specific heat capacity of steel ($510\text{Jkg}^{-1}\text{K}^{-1}$) [6] and ΔT = the temperature difference between room temperature and the required temperature to melt steel [6](1370K). The mass of the lock was calculated by multiplying the density of steel ($7.97\text{x}10^3\text{kgm}^{-3}$ [6]) by the volume of the assumed bolt lock.

By joining Equations (4) and (5) into Eq (6),

$$I = \sqrt{\frac{jmc_s\Delta T}{Rt}}, \tag{7}$$

the current required to melt the lock of the safe (in order to open the safe), was calculated.

To find how many cars would have been needed for this to actually work, this new current was placed back into Eq (2), to find the new V_T, which was then divided by the voltage needed to start the ignition of one car (12.4V).

Results

We calculated the total resistance of the system, R_T, to be $1.62\text{x}10^6\Omega$. This was used to find the total current that would reach the safe, I_S, to be $4.59\text{x}10^{-5}$A after passing through the bodies. The current that would have been needed to melt the lock of the safe, I, was calculated to be $7.98\text{x}10^5$A, which shows that Ali G would definitely not have been able to get into the safe by melting the lock using this method. The new voltage that they would have needed to start with, V_T, was calculated to be $1.29\text{x}10^{12}$V, making the number of cars needed be $1.04\text{x}10^{11}$.

Discussion

Assumptions made in this paper included assuming that the lock on the safe was melted, as opposed to blowing the circuit, this was due to the fact that blowing the circuit would not actually open the safe but melting the lock would mean that the door would no longer be held shut, allowing them access to the tape. The dimensions of the lock were assumed to be 15cm x 8cm x 8cm as this was the same length as a door lock, but double the width [7]. We also assumed that when the current passed through each human in the chain, no dissipation occurred and they were able to function as normal and continue to hold hands and maintain the chain. Another assumption we made is that there are no losses to the ground each of the humans stood on as they all wore rubber-soled shoes.

Conclusion

To conclude, the scene depicted in Ali G Indahouse, where they form a human circuit and and pass an electric current through them to break into a safe would not be possible under the method of melting the lock as there is an insufficient amount of current to do so. Further work could be done by investigating the method of blowing up a circuit to open a safe lock and if this method would actually work.

References

[1] `https://goo.gl/IBUuyL` accessed 14/11/16

[2] `https://goo.gl/qHlI2A` (pg 7) accessed 14/11/16

[3] `https://goo.gl/Ur18bU` accessed 14/11/16

[4] `https://goo.gl/Tkib2Z` accessed 14/11/16

[5] `https://goo.gl/k4ApZS` accessed 14/11/16

[6] `https://goo.gl/OMkRQL` accessed 14/11/16

[7] `https://goo.gl/oQDKts` accessed 15/11/16