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A5_4 Bang Goes that Theory

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Abstract

This paper investigates the plausibility of a handgun firing a bullet due to heating it up on a gas stove, as seen in the 2011 film Final Destination 5. We find that for a firing pin made out of steel it would take a temperature change of 2858.8K to cause the firing pin to expand the 0.2cm. We have also found that this temperature could not be attained by a gas stove.

Introduction

In the 2011 film Final Destination 5 there is a fight scene towards the end of the film. In this scene two men were fighting in the kitchen of a restraint and one pulls out a handgun and fires it towards the other but he misses him. The two men then come together and the man with the gun drops it on a lit stove. After a length of time the gun then fires due to the heating of the gun. In this paper we explore the plausibility that a bullet would be fired due to the heating of the firing pin of the gun.

Theory

First we need to look at how a gun fires a bullet. If there is a round (cartridge of powder, percussion cap and bullet) in the chamber of the gun and someone pulls the trigger, then a hammer will strike the firing pin of the gun causing it to go into the percussion cap of the round. This then ignites the powder in the cartridge and accelerates the bullet to leave the end of the gun [1].

In this paper we are only going to investigate whether the heating of the gun will cause the firing pin to expand enough so that it makes contact with the percussion cap of the round. Using the equation for linear thermal expansion[2],

$$\frac{\Delta L}{L} = \alpha \Delta T \tag{1}$$

where ΔL is the change in length of the firing pin, L is the length of the firing pin, α is the coefficient of linear expansion and ΔT is the change in temperature, we can work out the change in temperature required for the firing pin to expand so that it comes in contact with the percussion cap.

Now that the change in temperature can be found, we can find the time taken for the firing pin to get to this temperature to see if it would happen in the time scale that the film shows. For this we can use the equation for thermal current[3],

$$I = \frac{dQ}{dt} = -kA\frac{dT}{dx} \tag{2}$$

where dt is the change in time, k is the thermal conductivity, A is the cross-sectional area, dT is

the change in temperature, dx is the distance and dQ is the amount of heat conducted through the material. Where dQ is given by

$$dQ = mcdT, \tag{3}$$

where m is the mass and c is the specific heat capacity.

Results

The gun that they used in the film is the M1911-A1 [4] which uses a steel firing pin, but we have also investigated to see if changing what the firing pin was made out of would change the result. For this we have also looked at cast iron and lead. After some research we found that the length of the firing pin, $L = 5.83(\pm 0.02)$cm [5] and have assumed that the change in the firing pin's length, $\Delta L = 0.2$cm. Putting these values and the values for the respective coefficient of linear expansion in to equation (1), we can work out the change in temperature, as in table 1 [6].

Material	α K^{-1}	ΔT K
Steel	12×10^{-6}	2858.8
cast iron	10.4×10^{-6}	3298.6
Lead	28×10^{-6}	1225.2

Table 1: Table to show the coefficients of linear expansion, α, and the temperature required to increase the length of the firing pin by 0.2cm, for 3 different elements.

Now if we can find the time taken for the gun to be heated up to the temperature for the case of the firing pin being made of lead, the reason we are only considering lead as the temperature change is the lowest. If we assume that for lead $c = 0.128$KJKg^{-1} K^{-1}, $k = 35.3$Wm^{-1}K^{-1} [3], $A = 0.02$m^2, $m = 0.5$kg and $dx = 0.1$m. This then gives a time taken $dt = 9.1$s.

Discussion

This gives that the lowest change in the temperature to expand the firing pin is for lead where $T = 1225.2$K. We now need to compare this to the possible temperature that the gun could reach. If we assume the flame that is coming out of the stove is produced by pure methane (in reality it would be a mix of methane with higher alkalies) [7] and that the temperature that methane burns at is 1950 °C [8], this means that if the firing pin had been made out of lead then it could have expanded to set off the percussion cap and fire the bullet. The time for the gun to heat up to this temperature is similar to that in the film.

Conclusion

As stated above the scene could be correct if the firing pin was made out of lead, however the firing pin would not have been made of lead and more likely that it would have been mad out of steel. Then we have to come to the conclusion that the bullet would not have been set off due to the expansion of the firing pin, however there could have been a different method that could make the bullet fire, for example the heat setting off the percussion cap. We suggest that this is an area for further investigation.

References

[1] `goo.gl/J3lYBZ` accessed on 01/11/2016

[2] Paul A. Tipler and Gene Mosca, *Physics For Scientists and Engineers* 6th Edition, Pg.666

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[4] `goo.gl/OODAJw` accessed on 01/11/2016

[5] `goo.gl/o8gdSC` accessed on 01/11/2016

[6] `goo.gl/5tfWfu` accessed on 01/11/2016

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