



***ADVANCES IN LEAD-FREE  
FRANGIBLE BULLETS FOR  
TRAINING AMMUNITION***

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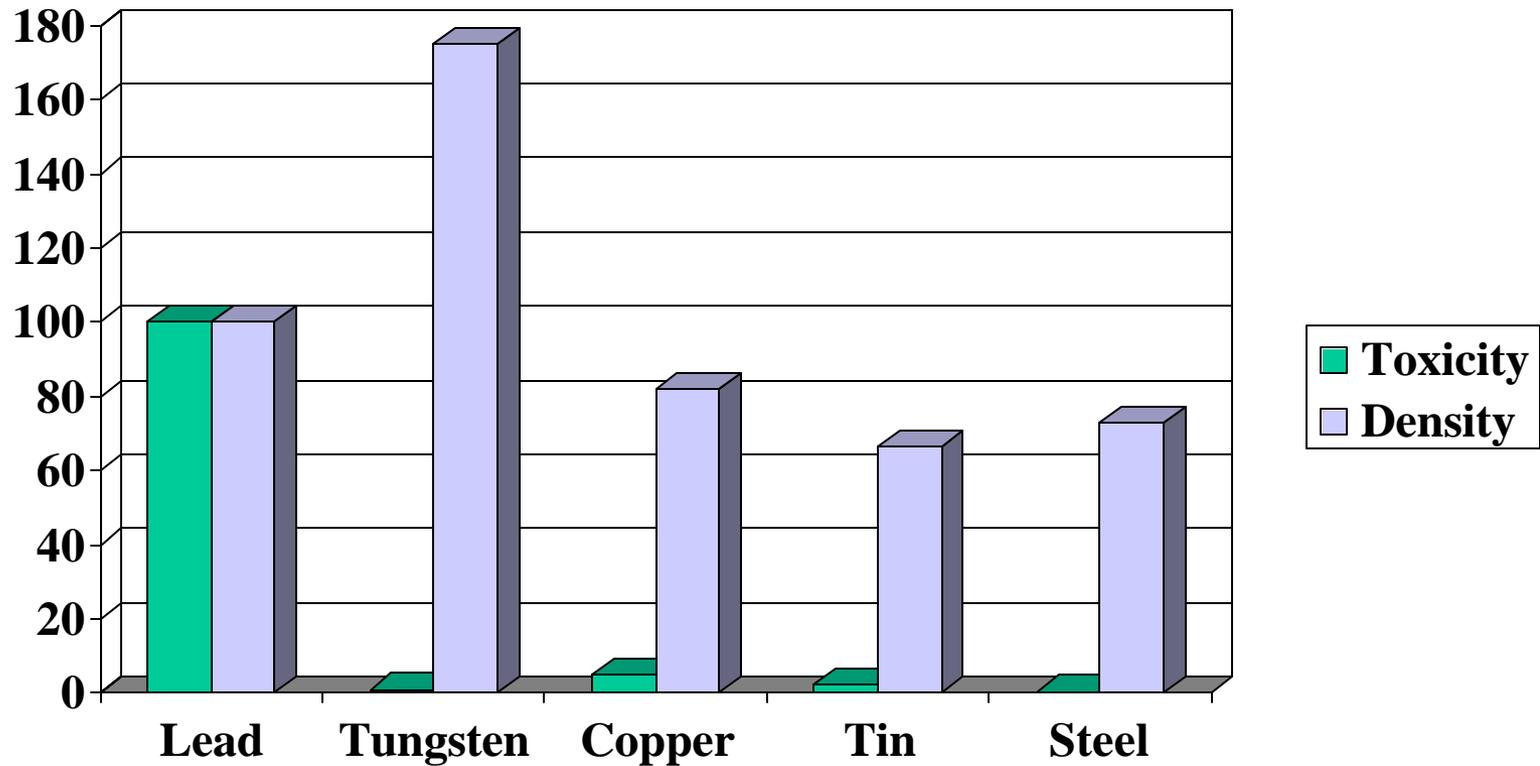
# **Requirements for Non-Toxic Training Bullets**

- 1. Free from Toxic Metals***
- 2. Ballistic Match to Service Ammunition out to at least 25 yards (Pistol Calibers) and 200 yards (Rifle Calibers)***
- 3. Must function all Weapons without Attachments or Modifications***
- 4. Comparable Recoil and Noise Levels to Service Ammunition***
- 5. Break up against Steel Targets (reduced Ricochet)***
- 6. Low Cost***



# Relative Toxicity and Density of Bullet Materials

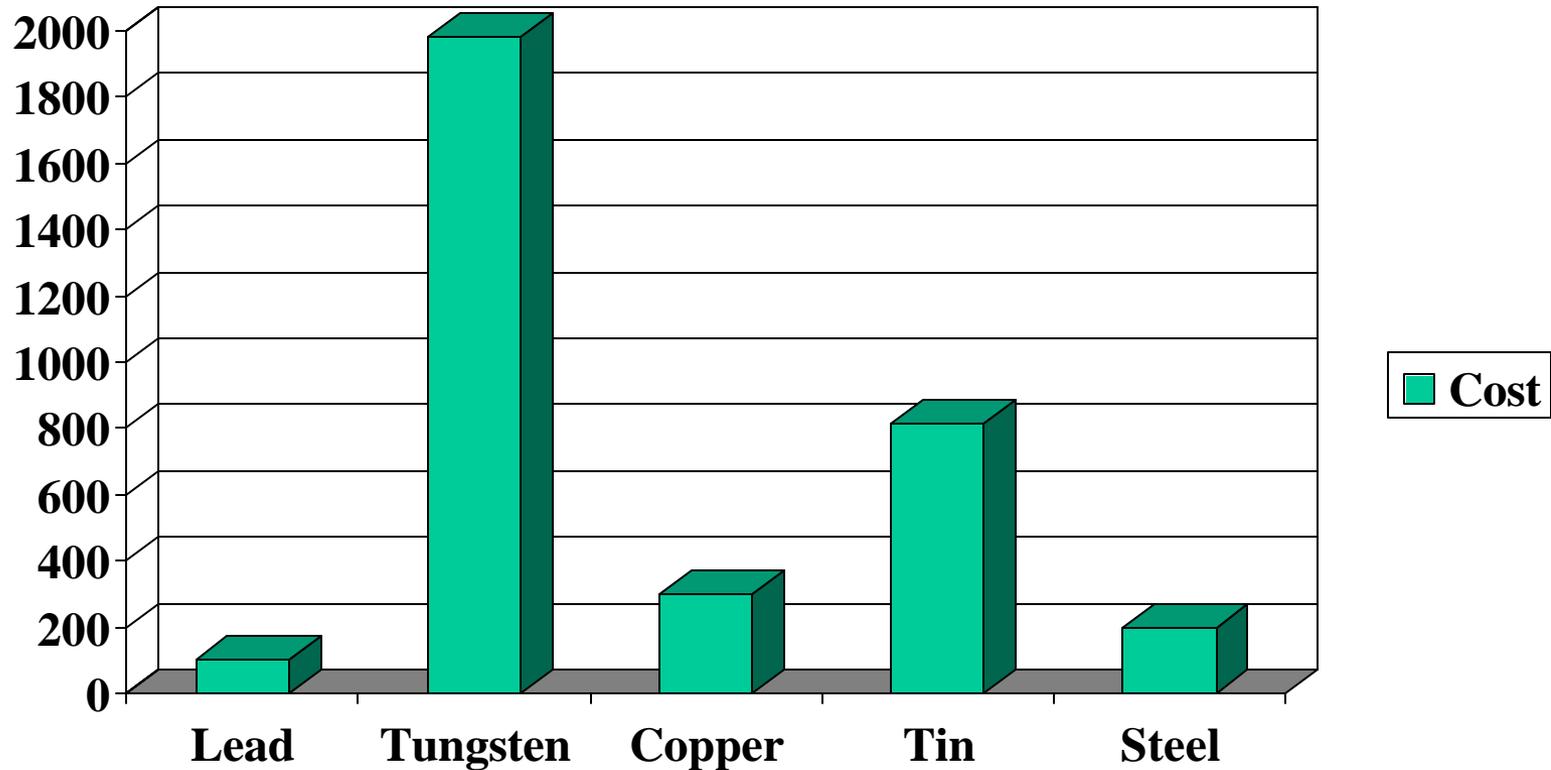
*Lead = 100*





# Relative Cost of Bullet Materials

*Lead = 100*





# *Advantages of Copper*

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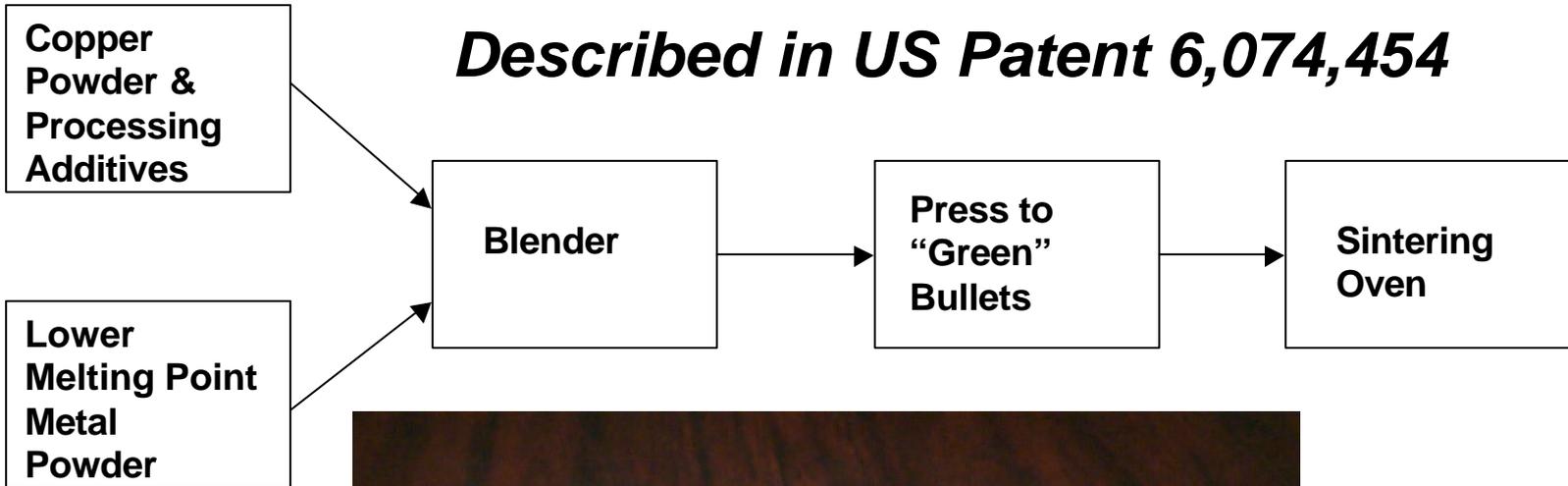
- 1. Low Toxicity***
- 2. Relatively High Density (80% of Lead)***
- 3. Much Cheaper than Tungsten***
- 4. No Bullet Jacketing Needed***
- 5. Can equal Lead Bullet Weights (e.g. 115 grain 9mm, 55 grain 5.56mm)***



# *Pressed Copper Powder Bullets*

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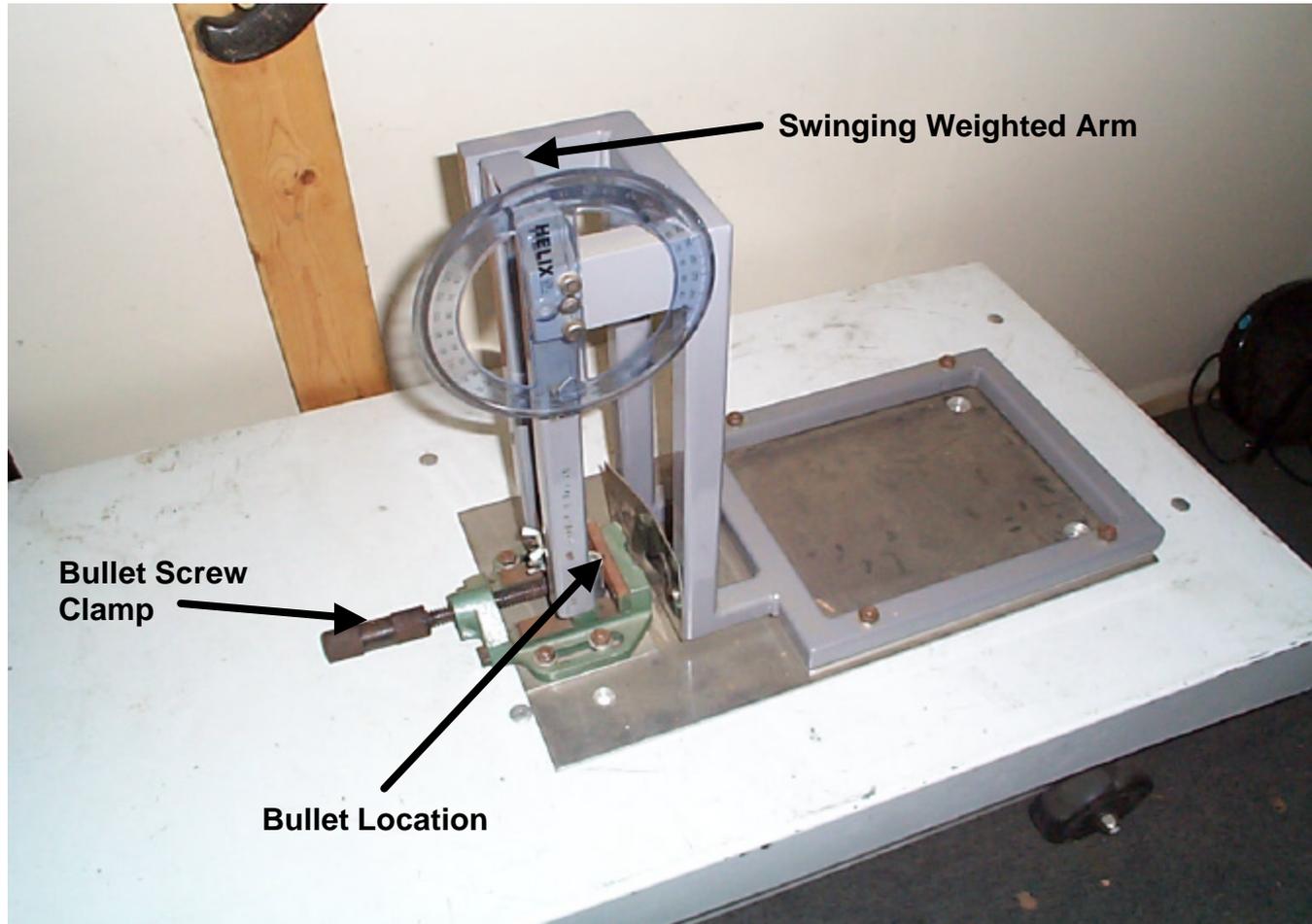
*Described in US Patent 6,074,454*





# Swinging Weight Impact Test

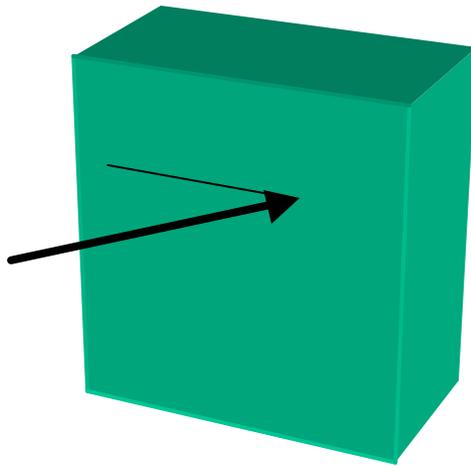
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# *Frangibility Testing*

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**Wooden Catch  
Box with Steel  
Backplate**



**Collected Powder and Lumps**



## ***Characteristics of Pressed Copper Bullet Ammunition***

<b><i>Caliber</i></b>	<b><i>Bullet Weight (grains)</i></b>	<b><i>Muzzle Velocity (fps)</i></b>	<b><i>Chamber Pressure (psi)</i></b>
<b><i>9mm Luger</i></b>	<b><i>115</i></b>	<b><i>1,153</i></b>	<b><i>35,615</i></b>
<b><i>38 Special</i></b>	<b><i>140</i></b>	<b><i>955</i></b>	<b><i>17,727</i></b>
<b><i>357 Sig</i></b>	<b><i>115</i></b>	<b><i>1,266</i></b>	<b><i>35,594</i></b>
<b><i>40 S&amp;W</i></b>	<b><i>155</i></b>	<b><i>1,049</i></b>	<b><i>37,743</i></b>
<b><i>45 ACP</i></b>	<b><i>195</i></b>	<b><i>926</i></b>	<b><i>20,924</i></b>



## ***Comparison between Pressed Copper and Injection Molded Polymer/Metal Bullets***

	<b><i>Pressed Copper Bullets</i></b>	<b><i>Injection Molded Polymer/Metal Bullets</i></b>
<b><i>Cost</i></b>	Cheaper (100)	More expensive (130-200+)
<b><i>Ease of Fabrication</i></b>	Conventional PM technology	Specialist application of injection molding
<b><i>Bullet Weight</i></b>	Equal to lead bullets	Lighter than lead bullets
<b><i>Frangibility</i></b>	Reduced hazard ammunition - not suitable for CQT	Break up completely against hard target - suitable for CQT