Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(3), 2664-2669 | ISSN:2251-6727

Engraved Codes in Chamber for Tracing Firearm- A Forensic Approach

Pratham Kasera[1], Jatin Saini[2] , Supriya[3], Vaishali[4] ,Komal Yadav*[5]

[1]Student of MSc Forensic Science, National Forensic Science University, Delhi Campus, MHA,GOI

[2]Director, RJ Forsec solution, New Delhi-110030, India

[3]Digital Forensic Consultant, RJ Forsec solution, New Delhi-110030, India

[4]Assistant Professor, Dept of Forensic Science, National Forensic Science University, MHA,GOI

[5]Assistant Professor, Dept of Forensic Science NFSU, Delhi Campus

***Corresponding author: Komal Yadav (komal.y@nfsu.ac.in)**

(Received: 16 March 2025 Revised: 20 April 2025 Accepted: 15 June 2025)

KEYWORDS
Forensic ballistics, firearm tracing, engraved codes, serial numbers, microstamping, laser engraving, firearm identification, crime investigation.

ABSTRACT:
Tracking where a gun has come from and finding out who used it is very important when solving crimes. Normally, guns have serial numbers on the outside that help in identifying and tracing them. But sometimes, criminals damage or remove these serial numbers to hide the gun's past. To solve this problem, a new and safer method is being used — putting secret codes inside the gun's chamber and other hidden parts. These codes are placed in areas that are hard to reach and cannot be easily erased. This paper explains the different types of these hidden codes, such as serial numbers, microstamps, QR codes, and barcodes. It also describes the modern methods used to mark these codes inside guns, like laser engraving and microstamping. These methods help police and forensic experts find out where the gun has come from and help them solve cases faster. Although this system can help in reducing gun crimes, there are still some challenges like high costs and the need for new laws. Overall, using hidden engraved codes inside guns is a big step forward in improving gun tracing and making communities safer.

1. Introduction

Forensic firearm examination is the forensic process of examining the characteristics of firearms or bullets left behind at a crime scene. To solve the problem of tracing guns, experts now put special codes inside the gun's chamber and other hidden parts. These codes are made to last and can't be easily erased or damaged. This helps the police find out where the gun came from, who owns it, and if it was used in a crime—even if the outside marks on the gun have been wiped away. This makes it easier to catch criminals and keep people safe.

Engraved Codes in Firearm Chambers

1.1. Definition

Engraved codes are numbers, letters, or symbols that are marked or carved (engraved) into parts of a firearm — usually on the frame, barrel, or chamber (the part where the bullet sits before firing).

These codes can include:

- Serial numbers (a unique ID for every gun)
- Manufacturer codes
- Batch or lot numbers
- Production dates or locations

These markings are permanently carved into the metal to make sure they cannot be easily removed or changed. This helps law enforcement and manufacturers track and identify firearms, especially in investigations or when tracing a gun's history.

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(3), 2664-2669 | ISSN:2251-6727

1.2. Purpose and Importance

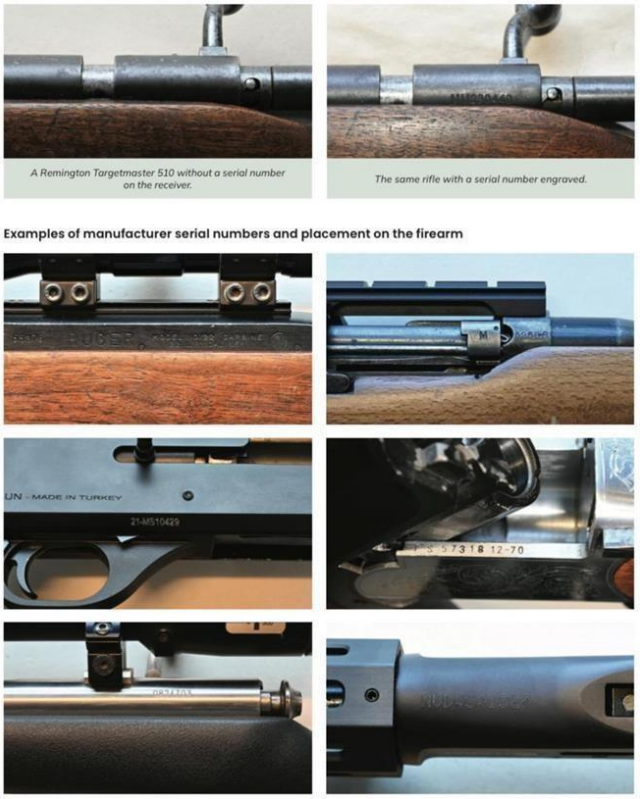
The internal engraving of codes in firearms plays a critical role in enhancing firearm identification and security by:

- Significantly increasing traceability
- Preventing tampering and removal
- Ensuring long-term identification
- Used as evidence in court
- Tracing the gun's history

2. Types of Engraved Codes in Firearm

2.1. Serial Numbers

- These are special numbers engraved on each gun to identify it.
- They are like the gun's ―name tag.‖
- Police and governments use them to track who owns the gun.



2.2. Microstamping Codes

- Tiny codes are engraved on parts inside the gun, like the firing pin.
- When the gun is fired, these tiny codes get stamped on the bullet casing.
- This helps police find out which gun fired a bullet, even if they don't have the gun itself.

2.3. QR Codes

- These are small square codes that can store a lot of information.
- They can be scanned with special devices to quickly get details about the gun, like who made it and its serial number.

2.4. Barcodes

- These are the familiar lines you see on products in stores.
- Barcodes on guns hold basic information and can be scanned easily.
- They don't store as much information as QR codes but are simple to use.

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(3), 2664-2669 | ISSN:2251-6727

3. Engravings methods

3.1. Laser Engraving

Laser engraving involves using a laser machine to etch or engrave markings directly onto metal surfaces. A laser uses a high-power beam to melt away material in precise patterns. Laser engraving is highly accurate and can create clean, crisp lines for engraving. Fiber lasers are the most practical and popular for engraving firearms parts. They are very powerful, with wattages the most common wattages ranging from 30 up to 80 watts.

Fiber lasers excel at marking metals, even those that are difficult to engrave like stainless steel and titanium.

Pros:

Extremely accurate and controllable

- Fast engraving process
- Clean and precise lines
- Minimal setup time

Cons:

- Requires investment in laser machine
- Can damage surface if settings aren't calibrated properly

3.2. Rotary Tool Engraving

Rotary Tool engraving uses a rotary tool like a Dremel with a mounted engraving bit. The high speed of the rotary tool spins the engraving bit to grind away material. This can be done freehand or with a template or fixture for accuracy. This is also often referred to as an electro pencil.

Pros:

- Very affordable option
- Widely accessible tools
- Ability to engrave freehand or with templates
- Variety of bit sizes and shapes

Cons:

- Requires a steady hand and practice
- More challenging depth and size control
- Slower process than laser
- Can damage surface if too much pressure applied

3.3. Stamping

Stamping uses steel letter and number stamping sets to imprint markings by hammering the stamps into the metal. The stamps bite into the metal with each hammer strike.

Pros:

Inexpensive stamp sets readily available

- Simple manual technique
- Easy to touch up imperfections

Cons:

- More challenging depth and size control
- Hammers can damage surface if not careful
- Requires some practice to get straight alignment

3.4. Hand Engraving

Hand engraving is the traditional method of using engraving tools like burins pushed by hand to cut grooves into metal. It takes great skill but allows for artistic flourishes.

Pros:

- Ability to create artistic, custom scrollwork
- Highest precision control

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(3), 2664-2669 | ISSN:2251-6727

Cons:

- Very steep learning curve
- Extremely time consuming
- Costly for professional hand engraving

4. Serial number restoration techniques

4.1. Magnetic Particle Inspection Restoration or Magnetic flux

The magnetic particle inspection technique is used to detect surface or subsurface irregularities in ferrous materials such as steel and iron. In conjunction with surface preparation, use of this

procedure can be an effective, non-destructive method to restore obliterated characters. The magnetic particle inspection technique may be applied at various stages during the restoration procedure, even after chemical restoration is attempted.

4.2. Chemical Restoration

The chemical restoration procedure, sometimes referred to as the chemical etching procedure, is suitable for restoration of serial numbers in metal. This procedure, in conjunction with the surface preparation procedure, is an effective way to restore an obliterated serial number in metal.

Magnetic (Ferrous) Substrate:

- Davis Reagent
- Turner's Reagent
- Fry's Reagent

Non-magnetic (Non-Ferrous) Substrate -

- Zinc Ferric Chloride
- Phosphoric Acid/Nitric Acid (Knowles Reagent)

Non-magnetic (Non-Ferrous) Substrate –

- Aluminum Ferric Chloride
- Acidic Ferric Chloride
- 10% Sodium Hydroxide
- 25% Nitric Acid

4.3. Heat Restoration in Plastic Surfaces

The application of heat can be a suitable restoration method for serial numbers in plastic. The die stamping or embossing process is a form of cold-working plastic. A side effect of cold- working is the decrease of that item's ability to resist heat.

4.4. Electrochemical Restoration

The electrochemical technique using the standard chemical etchants is an enhanced form of chemical restoration, in which the application of a voltage potential assists with the oxidation of the specimen. This procedure, in conjunction with the surface preparation procedure, may be an effective way to restore an obliterated serial number in ferrous metal.

4.5. Digital Imagery

This method involves capturing high-resolution photographs of the suspected area and enhancing the images using software such as Adobe Photoshop.

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(3), 2664-2669 | ISSN:2251-6727

Digital enhancement can clarify partially obliterated serial numbers or barcodes, making them readable or scannable even when traditional chemical methods fail, especially with laser-etched markings.

4.6. X-Ray Imaging

X-ray techniques, including infrared thermal imaging, exploit differences in thermal conductivity or material density caused by the original stamping process. These non- destructive methods can detect residual metal deformation beneath the surface paint or corrosion, revealing serial numbers that have been sanded or defaced.

4.7. Ultrasonic Cavitation

This technique uses high-frequency sound waves in a liquid medium to induce cavitation (formation and collapse of tiny bubbles), which helps to etch away surface layers without damaging the underlying metal deformation. Ultrasonic cavitation has been successfully applied to restore serial numbers on gun parts where chemical etching failed, although it may be less effective on heavily obliterated or restamped items

5. Observation

- Microstamping technology uses lasers to engrave unique microscopic alpha- numeric and geometric codes on the firing pin and breech face of a firearm.
- When the gun is fired, these engraved codes are imprinted onto the primer of the cartridge casing, leaving a traceable mark that forensic experts can read under a microscope.
- This process organizes the natural toolmarks left by firing pins into clear, identifiable codes, making it easier to link spent casings to a specific firearm without needing to recover the gun itself.
- Studies have shown that the legibility of these codes can vary depending on the firearm model and ammunition used, with some degradation occurring after repeated firing, especially in certain calibers like .22 rimfire pistols.
- Despite some wear, research indicates that microstamped codes remain readable for thousands of rounds in many firearms, supporting their use in forensic investigations.

6. Current Applications

A number of jurisdictions have already adopted chamber coding:

- California requires microstamping on semi-automatic pistols
- Unique marking of critical parts is mandated by the EU Firearms Directive
- Technology for global firearm tracing is promoted by INTERPOL

7. Future Prospects

The future of firearm tracing likely includes:

- Universal adoption of microstamping and nanotechnology.
- Development of tamper-proof engraving methods.
- Integration of firearms with global tracking databases.
- Real-time firearm verification systems accessible to law enforcement.

8. Challenges and limitations

- **Wear and Tear:** Repeated firing causes mechanical wear on the chamber and firing pin, which can degrade or erase the microscopic engraved codes transferred onto cartridge cases, reducing their clarity and legibility.
- **Tampering and Alteration:** Codes can be deliberately altered, removed, or obscured by criminals to prevent tracing, either by modifying the firearm parts or through chemical or mechanical means.
- **Environmental and Usage Factors**: Exposure to corrosion, dirt, and cleaning processes can affect the engraved surfaces and the resulting markings on cartridge cases, making code transfer inconsistent.
- **Technical Limitations:** The microscopic size of engraved codes makes them susceptible to damage and difficult to consistently imprint on cartridge cases, especially with varying ammunition types and firing conditions.

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(3), 2664-2669 | ISSN:2251-6727

9. Lack of Standardization and Implementation: Variability in engraving methods and absence of universal standards can affect the reliability and persistence of these codes in forensic contexts.

Conclusion

The use of engraved codes inside firearm chambers, including serial numbers, microstamping, QR codes, and barcodes, represents a significant advancement in forensic firearm tracing. These hidden, durable markings enhance traceability by providing unique identifiers that are difficult to tamper with or erase, thereby enabling law enforcement to link firearms to their origins and users even when external serial numbers are removed or damaged. Microstamping, in particular, allows microscopic codes engraved on firing pins to imprint onto cartridge casings when fired, giving investigators a direct and reliable method to trace crime guns without recovering the weapon itself.

This forensic approach not only aids in solving crimes more efficiently but also serves as crucial evidence in court and helps identify trafficking networks. While challenges such as cost, legislative adoption, and durability under extensive use remain, the integration of these technologies marks a pivotal step toward improved firearm identification and public safety. Future prospects include universal microstamping adoption, tamper-proof engraving, and real-time tracking systems, which together promise to strengthen crime gun control and community protection worldwide.

In conclusion, engraved codes in firearm chambers provide a robust forensic tool that significantly enhances firearm tracing capabilities, supporting law enforcement efforts to solve gun-related crimes and deter illegal firearm use.

References

1. Giffords Law Center. (2024). Microstamping & ballistics. Retrieved from https://giffords.org/lawcenter/gun-laws/policy-areas/consumer-safety/microstamping/
2. Hare, E., Hofmann, H., & Carriquiry, A. (2016). Automatic matching of bullet land impressions. arXiv preprint, arXiv:1603.04742. https://arxiv.org/abs/1603.04742
3. Henwood, T. M., Helliker, S. G., Hazael, R., & Hewins, C. R. (2023). Recovering obliterated laser engraved serial numbers in firearms. Science & Justice, 63(3), 316–324. https://doi.org/10.1016/j.scijus.2023.01.002
4. Khan, S. S., & Carriquiry, A. (2022). Shining a light on forensic black-box studies. arXiv preprint, arXiv:2207.10158. https://arxiv.org/abs/2207.10158
5. Kumar, P., Sharma, D., Walia, V., Singh, R., & Verma, M. (2023). Firing pin micro- printing for identification of firearm. Indian Journal of Forensic Medicine & Pathology, 16(1), 17–23.
6. Lizotte, P. A., Olson, D. L., & Kristensen, E. M. (2004). Method and apparatus for reading firearm microstamping. U.S. Patent No. 6,833,911 B2. Washington, DC: U.S. Patent and Trademark Office.
7. National Research Council. (2008). Ballistic imaging. Washington, DC: The National Academies Press. https://doi.org/10.17226/12162
8. Tai, X. H., & Eddy, W. F. (2020). Automatically matching topographical measurements of cartridge cases using a record linkage approach. arXiv preprint, arXiv:2011.10149. https://arxiv.org/abs/2011.10149
9. Wikipedia contributors. (2024, June 12). Microstamping. Wikipedia. https://en.wikipedia.org/wiki/Microstamping
10. Wikipedia contributors. (2024, June 12). Forensic firearm examination. Wikipedia. https://en.wikipedia.org/wiki/Forensic_firearm_examination
11. Robert E. Walker (2013). Cartridges and Firearm identification