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Latent Fingerprints on Cartridges and Expended Cartridge Casings

Crime-scene technology, criminalistics literature, and fiction all stress the importance of dusting a suspected firearm for latent fingerprints. Less attention, however, is devoted to the value and technique of fingerprint examination of cartridges in the weapon or expended cartridge casings found at the scene of a crime.

The opinions of crime-scene technicians vary widely regarding the time a latent print will remain on a cartridge, and no information was found in the technical literature about the effects of firing a cartridge on which there is a fingerprint.

The purpose of this study was to investigate the effects of detonation on the retention of latent fingerprints on cartridges.

Background

Four areas of concern to this investigation were identified and will be mentioned individually.

Composition of Latent Fingerprints

Latent fingerprints result from the transfer of some substance on the friction ridges of the human skin to a touched object. The substance left behind that reproduces the pattern of the friction ridges can be of two general types.

Foreign Substances—The gunsmith can easily leave his prints on a weapon merely from having a light coating of machine oil on his fingers. Any viscid material or fatty substance inadvertently transferred to the hands will leave latent fingerprint impressions.

Bodily Secretions—More commonly, the latent print will be the residue of bodily secretions from the person handling the object. Perspiration present on the friction ridges is approximately 98% water; the other material of interest to fingerprint technicians is composed of inorganic salts and amino acids. Often present in latent print residue are body oils transferred to the friction ridges through contact with secretions from sebaceous glands.

Environment of the Cartridge

The duration of latent fingerprints is greatly affected by the temperature and humid-

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ity of the surrounding environment. In a limited study on the interaction of temperature and humidity by the Flint, Mich. Police Department [1], significant loss of ridge detail of an impression was observed under conditions of increased temperature and lowered humidity.

The mechanical environment is also important to preservation of ridge detail. The fewer particulate contaminants present and the less contact there is with other objects, the better the preservation of ridge detail.

Composition of the Cartridge Casing

The two major types of casings encountered on the current market are brass and nickel-plated brass. Most commonly available ammunition has the plain brass casing. Nickel plating of cartridges was instituted primarily as a method of preventing the corrosion and verdigris common to brass ammunition stored in leather cartridge belts and pouches. Sales of nickel-plated ammunition are also influenced to some degree by a psychological or aesthetic appeal.

Thermodynamics of Detonation

A great deal is known about the general principles of thermodynamics of a gun system and the final energy breakdown of projectile movement. It is known that approximately 54% of total propellant energy is converted to thermal energy, and from 10 to 25% of this ends up as heat in the barrel wall [2]. What does not seem to be known is the actual temperature of a cartridge case with a given powder charge at the moment of detonation. The Internal Ballistics Laboratory personnel at Aberdeen Proving Ground[2] thought that, because of the extremely short ignition-to-projectile exit time, the bulk of the thermal energy would be expended outside the casing and that what heat was generated in, or transferred to, the wall of the casing would be quickly distributed throughout the metal, thereby keeping outer skin temperatures relatively low.

Method

To evaluate the effects of detonation on latent fingerprints on cartridges, 108 brass, .38-caliber cartridges (Smith & Wesson .38 Special, 148-grain wadcutter) and 108 nickel-plated, .38-caliber cartridges (Remington Special, 158-grain lead) were first thoroughly cleaned with chloroform to remove any pre-existing fingerprints and to assure a standard oil-free surface on all cartridges.

Six randomly selected persons from a population of adult male students (a Naval Investigative Service basic class for agents) were asked to pick up, one at a time, 18 brass cartridges and 18 nickel-plated cartridges and place them in a compartmented tray. This method of obtaining fingerprint impressions on the cartridges was felt to be a valid and conservative simulation of finger contact pressure and time interval involved in the actual loading of a weapon. No firearms were used in this procedure for three reasons.

1. To minimize psychophysical reactions. For many individuals the loading of a firearm, whether for sport competition or in anticipation of violence, stimulates emotional reactions attended by hidrosis. It was hoped that the absence of a weapon would minimize such reactions and the attendant increase in perspiration.

2. To eliminate extraneous sources of oil. It is difficult to render a firearm totally free of oils. Unless such a weapon was used in this exercise the last cartridges loaded would

[2] Internal Ballistics Laboratory, Aberdeen Proving Ground, Md., personal communication, 1975.

quite likely have heavier oily fingerprints than the first cartridges handled because of oil transferred to the fingers from the weapon during loading manipulations.

3. To observe rules of safety. A classroom or office environment is not the place for live ammunition loading drills.

The brass cartridges were marked for identification and then divided into nine groups, each group containing one pair of cartridges handled by each of the six men. A similar procedure was followed for the nickel-plated cartridges. One cartridge from each pair was used for firing, the other retained unfired as a control. The schedule of testing is outlined in Table 1.

Treatment of control cartridges from each group was as indicated in Table 1 with the exception of firing; the controls were dusted and lifted in an unfired condition.

Prior to firing, all cartridges were stored in loosely covered plastic trays in an environment where temperatures fluctuated between 21 and 24°C (70 and 75°F) and the relative humidity was approximately 30%. After they had been fired, all cartridges and expended casings were returned to the same trays in the same environment. No attempt was made to isolate the individual cartridges to prevent rubbing or friction against other objects.

The weapon used for firing was a Smith &Wesson model 19, .357 Combat Magnum. Control rounds were chambered and extracted but not fired.

Dusting was carried out with black commercial powder (Sirchie Laboratories Co.), a camel's-hair brush, and commercial lifting tape (Remco Tape Products Co.)

Results

In the following analysis, identification is defined as a latent image with sufficient detail to allow visualization of at least ten points of comparison (Galton's details or minutiae).

Group A

All cartridges from this group, fired and control, brass and nickel, yielded excellent latent fingerprints with no apparent decrease in quality from firing.

TABLE 1—*Schedule of firing cartridges and lifting latent fingerprints.*

	Treatment					
Group	Day 1	Day 5	Day 9	Day 13	Day 17	Day 21
A	Print	...	...	...	...	...
	Fire	...	...	...	...	...
	Lift	...	...	...	...	...
B	Print	Fire	...	...	...	...
	...	Lift	...	...	...	...
C	Print	Fire	Lift	...	...	...
D	Print	...	Fire	...	...	...
	...	...	Lift	...	...	...
E	Print	...	Fire	Lift	...	...
F	Print	...	...	Fire	...	...
	...	...	...	Lift	...	...
G	Print	...	...	Fire	Lift	...
H	Print	...	...	...	...	Fire
	...	...	...	...	...	Lift
I	Print	...	...	...	...	Lift
	Fire	...	...	...	...	...

Group B

Easily identifiable latents of good quality were lifted from all control cartridges, brass and nickel-plated. In five of the six brass specimens no decrement in quality could be seen as the result of detonation. Some decrement in print quality was seen in two of the six nickel casings. All prints from this group (four days old), both brass and nickel, fired and control, were identifiable.

Groups C and D

While the clarity of ridge detail recovered from this eight-day-old group showed some degradation, latent fingerprints on all brass cartridges and casings were easily identifiable. Five of the six nickel control cartridges were identifiable, and four of the six fired casings yielded sufficient detail for comparisons to be made.

No significant difference was seen between findings on Group D and on Group C.

Groups E and F

All brass casings and cartridges yielded latent prints of good quality and with sufficient detail for identification. Prints on all nickel-plated control cartridges were identifiable, as were five of the six fired cartridges.

Results from Group F were essentially identical to the findings of Group E.

Group G

All control cartidges (both brass and nickel) yielded acceptable to good ridge impressions, and all were identifiable. Prints on five of the six fired brass rounds were identifiable, as were prints on three of the nickel-plated rounds.

Groups H and I

Again, latent impressions from all control cartridges were identifiable. Four of the six nickel-plated fired casings were identifiable, and all fired brass casings were identifiable.

Results from Group I were essentially the same as those reported for Group H.

Discussion

Because of the large number of variables influencing the duration of latent fingerprints, no set standards can be defined regarding their persistence [3]. No significant degradation in print detail as a function of time was noted during the three-week period of this study. The largest shift in latent image quality found in control groups was the difference in the density of the powder (as reflected in the amount adhering to latent ridge impressions) between Group A and the remainder of the groups. Group A liftings displayed heavy adherence of powder, while Groups B and I were uniform in having less content and density of the powder.

It is the author's belief that this difference in density between Group A and the remainder of the groups was due to the complete evaporation of the watery portion of fingerprint residues within the first 24 h after the latent impressions were obtained. After this period, secretions other than perspiration traces govern the adherence of fingerprint powder to ridge impressions. Prior to dusting, all cartridges were briefly exposed to water vapor from the author's warm breath. This is a well-known technique to improve the adsorptive quality of dry friction-ridge residues.

The effects of detonation on latent fingerprints from cartridge casings were explored. While latent impressions less than eight days old did not seem affected by firing, older latents began to show degradation as a result of factors associated with detonation. This effect was not uniformly displayed over the entire cartridge casing but was especially apparent in the area of gaseous blowback. The casing cannot fill the chamber evenly and completely because the diameter of the chamber must be somewhat greater than that of the cartridge body, and a hot, gaseous blowback will normally occur along the portion of the cartridge body not completely sealed against a chamber wall. The effects of this are illustrated in Fig. 1. It is in this area that a latent impression will undergo the greatest deterioration or obliteration. Thus it would seem that heat effects of detonation on the latent fingerprint image originate primarily on the outside of the casing rather than from internal temperatures.

A second effect of detonation is mechanical rather than thermal in nature. Because of the great internal pressures generated by burning powder, the casing will expand, and extraction will produce varying amounts of abrasive friction on the fingerprint area, depending on the powder load and the fit of the cartridge in the chamber. This expansion and the resulting obliteration of ridge detail upon extraction is not uniform, however, along the length of the casing. Expansion will be less at the head end of the casing than at the mouth end because of the increased thickness of casing metal in the area of the flash hole and extractor groove. It is in this area of minimum expansion that intact ridge detail can often be found, even on high-powered loads extracted with difficulty. An example of such a latent print is seen in Fig. 2.

A comparison of results between Groups C and D, E and F, and H and I indicates that the time period between firing and lifting does not exert an effect upon latent print quality; it is the period between application of the latent and its development that produces differences in print quality. In other words, there is no noticeable difference

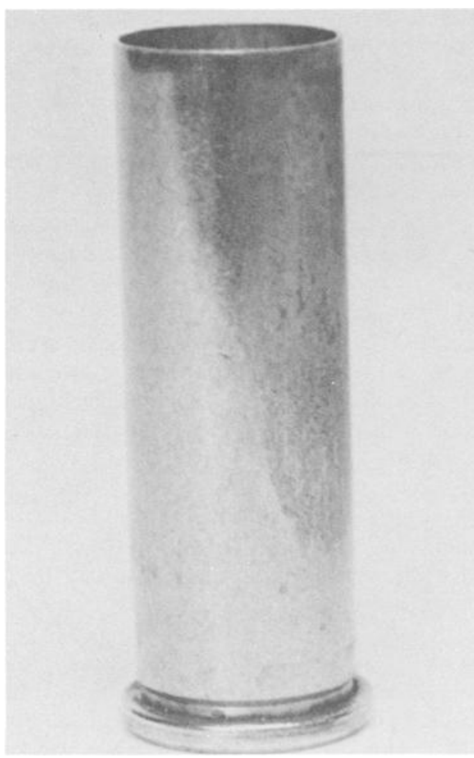

FIG. 1—*Discoloration of a brass cartridge casing caused by blowback of hot gases at time of detonation.*

FIG. 2—*Lifting of latent fingerprint from expended cartridge casing. The upper portion of ridge detail has been obliterated by mechanical friction during extraction from the chamber. Ridge detail at the head end of casing* (bottom portion of photo) *was preserved because the casing did not expand at the time of detonation.*

between a latent print on a cartridge casing fired on Day 1 and lifted on Day 21 and a latent print from a casing both fired and lifted on Day 21.

The effects of detonation temperatures on oily friction-ridge deposits are not fully known. Since the temperature increase is both short in duration and of relatively small magnitude (except in the area of blowback), little change should be expected. These deposits, however, are known to be much more stable than aqueous components of friction-ridge deposits and, in older impressions, account for almost all of the fingerprint powder's adherence to ridge impresssions.

To further explore the degree of stability associated with the lipid fraction of friction-ridge deposits, expended cartridge casings from all groups were exposed to the fumes of nitric acid (HNO_3) for varying periods of time. It was felt that these fatty residues would act as a resist and allow the acid fumes to etch the fingerprint pattern into the casing. The results of such treatment to a casing from Group C is seen in Fig. 3. A comparison of the powder lifting with the etching revealed greater and finer detail in the latter. Of interest is the fact that the etching was accomplished *after* the casing had been dusted and lifted. This procedure yields a permanent record of the latent print directly on the evidence itself.

To minimize mottling on the casing from water vapor during the etching procedure, the apparatus illustrated in Fig. 4 was designed. The acid is briefly and gently heated in the flask shown at the left until vapors are noted. Suction is applied to the specimen flask on the right, which draws the vapors through a packing of glass beads in the center flask and into the specimen chamber. Time of exposure to the acid is important, as is the concentration of acid used. While these conditions will vary with age and density of the deposits on the ridges, 20 to 40 s of exposure to fumes from a 20% solution of HNO_3 should be adequate for most cases. If the fumes are too vicious in their attack on the metal, the dilution of acid can be increased. Further experiments are in progress by the author with Dutch mordant [*4*], which does not break up fatty deposits along the ridge impressions to the extent produced by HNO_3, allowing finer and more well-defined etching.

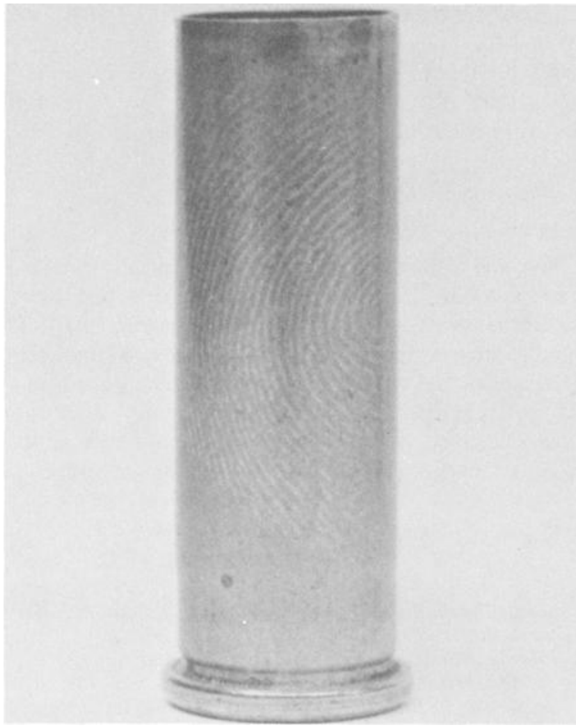

FIG. 3—*Nitric acid etching of latent fingerprint impression on a Group C brass casing.*

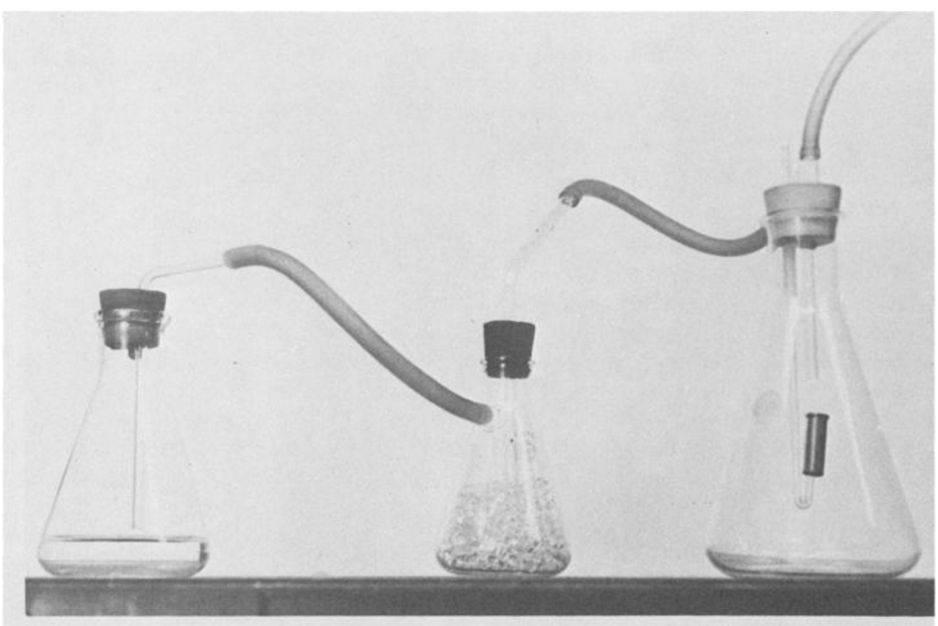

FIG. 4—*Apparatus for acid etching of cartridge casings. Fumes of nitric acid heated in left flask are drawn through a packing of glass beads in center flask and on into right flask containing the casing.*

As seen from the Results section, the nickel-plated casings consistently yielded poorer latent images. It is thought that this is accounted for by the more impervious surface offered by the plating process as well as the greater friction encountered at the time of extraction. Greater difficulty was also experienced in etching these casings. Satisfactory results were often obtained by a 5-s immersion of the casing in a 20% solution of the acid.

Summary

The effects of time and detonation on latent fingerprints from cartridges and cartridge castings were explored. Time alone did not appear to seriously degrade latent fingerprint quality over the three-week period of experimental trials. The greatest effect of detonation seemed to stem from hot gaseous blowback on the external surface of the cartridge casings. Nickel-plated casings, because of their greater chemical resistance and more polished surface, were found less satisfactory as a substrate for latent impressions than brass casings. An interesting technique for development and permanent preservation of latent fingerprint impressions on cartridge casings was also described.

References

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