

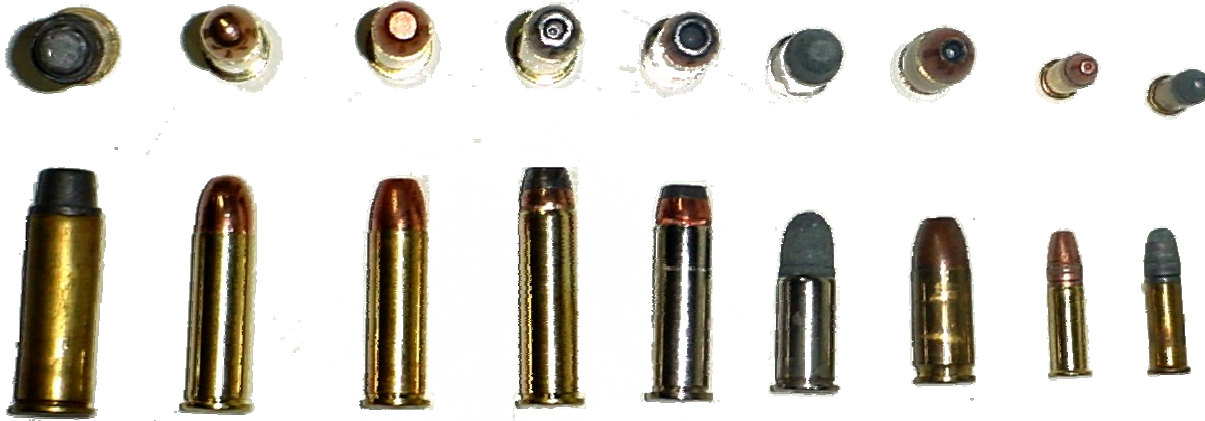


Ammunition & Ballistics Analysis (Unit 7)

61

Ammunition

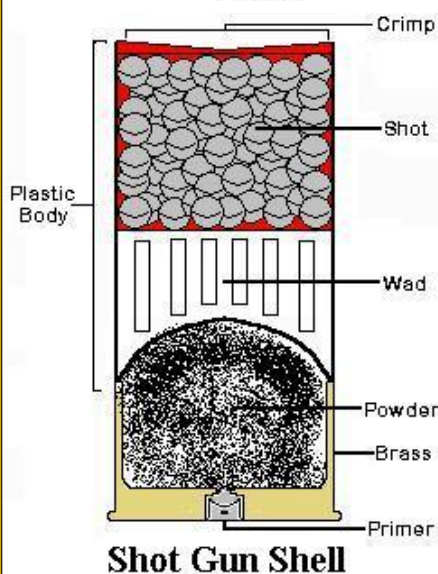
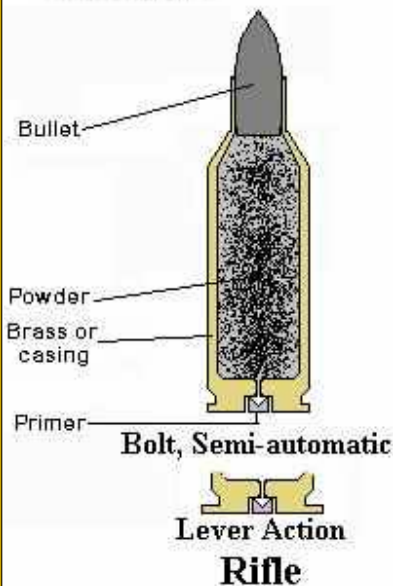
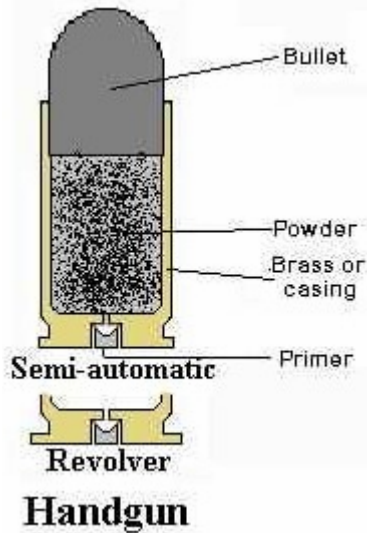
Just as there are many different types of weapons, there exist a plethora of different types of ammunition. Some weapons use one type of ammunition, while other guns are capable of handling several different types. Each of these different types is configured to accomplish a specific task. All in all, it is important to know the purpose of and the appropriate type of ammunitions used by each of these weapons. Becoming familiar with each and every type and configuration of ammunition would take years of study and will not be attempted in this book. We will, however, discuss the most common types and configurations as related to the most common types of firearms. Although these are only a small sampling of the vast array of productions, most are only slight variations on these basic designs.



A good place to start is a quick review of terminology. Many of the terms used when talking about ammunition are used improperly. For example, many say that they are going to “load their gun with bullets,” but the term bullet refers specifically to the projectile which exits the barrel when the gun is fired. Placing only “bullets” in a gun would not equip the piece with the ability to discharge, since a bullet itself contains no primer or gun powder. A kind of slang has developed which uses many words incorrectly or for multiple meanings. In this book we will adhere to strict definitions. Please refer to the Firearms Terminology section of this for these terms.

Ammunition Design

Although there are many different designs of ammunition, each is a variation of a basic design. Nearly all include a primer, shell, powder, and bullets. The primer, when struck by a hammer or firing pin, sparks and ignites the powder. Once the powder is ignited, it burns quickly causing an abundance of gas formation, and finally an explosion which forces the bullet forward down the barrel of the weapon. There are several different bullet designs; these will be discussed later in this chapter. The final piece, the shell, is the part of the round that holds the primer, powder, and bullet together.



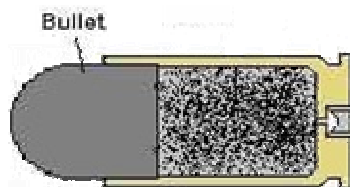
Handgun ammunition is simple in design. There are a few slight variations in the shell, also known as the brass or casing. The primer side of the round for a pistol is narrower than that of a revolver round. This is important in both cases. A pistol has to eject a spent shell and reload a new round in milliseconds. Thus, the shell must be of equal diameter so as to allow a smooth transition from clip to chamber. A revolver round is different only by the width of the rim of each shell. Empty cartridges must be ejected manually from these type weapons and there is no sliding of the shells. The lip of the shell is wider to make it easier to handle and eject the shells.

The design of rifle rounds is extremely similar to that of handguns. The most obvious difference is the amount of gun powder in the casing as compared to the size of the bullet. Many rifles fire the same bullets as handguns. Rifles however, are designed to fire bullets farther distances with greater accuracy. This requires more muzzle velocity which is accomplished by an increase in gun powder and a longer barrel. Bolt actions and semi-automatic rifles work much as semi-automatic handguns do. Lever action rifles work similarly to revolvers. These similarities are reflected in the lips of the shell design.

Shotgun rounds have a similar design to handgun and rifle rounds, but exhibit several modifications. The entire round is larger and wider to accommodate a larger primer, more powder, a wad, and shot. Shot, which can come in a number of different sizes, takes the place of a bullet. This produces multiple small projectiles instead of a single bullet. In order to achieve good exit velocity a wad is used to provide a uniform pressure on the shot when the gun powder explodes. A much larger primer is used to burn the larger amount of powder quickly. Although the base of most shotgun rounds is brass, the main body is usually plastic.



Bullet Design



The term “bullet” refers to the part of the round that, when fired, exits the barrel and proceeds toward a target. There are many different shapes and compositions of these, each with its own specific purpose. Most of these are variations on the three basic shapes, in some combination of the three basic compositions.

Three Basic Shapes



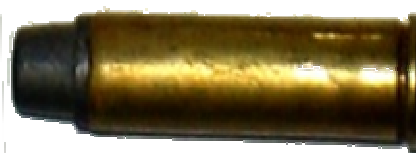
Round nose bullets (also know as solids) are the simplest of bullet designs. The round nose is shaped to allow for good aerodynamics, good penetration, and also lends itself to permanence of shape. Depending on the object penetrated and the composition of the round nose, it is common to recover one of these bullets completely intact and only slightly disfigured or not disfigured at all. The squared off butt of the bullet, common to all designs, is shaped to encourage equalized pressure from the explosion of the gun powder.



Hollow point bullets are exactly what they sound like. The point of the bullet has been hollowed out to encourage mushrooming. A bullet tends to mushroom, spread out at the tip until the bullet takes the shape of a mushroom, as it travels through a target. In light of this design, a hollow point is designed to enlarge itself for the purpose of inflicting a more damaging wound. Unless an object is fairly soft, these bullets normally do not exit a target. In addition, a hollow point commonly leaves small pieces of lead along the entry path of the bullet. This causes quite a mess with attempting to extract a bullet and its fragments from a wound.



Wadd cutters are less common than round noses and hollow points. Although they may be used to inflict damage on living targets, there only true purpose is for target practice. While target practicing or zeroing in the sights on a weapon, it is common to shoot a paper target. Since most bullets are designed with a rounded nose, the bullets simply split the paper making it hard to see where the bullet hit the target from any distance. Wadd cutters have a flat nose, so when one penetrates a sheet it will punch out a round hole. This allows a shooter to see where they are hitting on a target as they shoot.



Bullet Compositions

Lead is the most common component in bullets. This is so for several reasons. Most importantly, lead is extremely dense; this lends itself well to bullets. The more dense a projectile, the more inertia with which it can be endowed with, meaning a small bullet can hit very hard. Lead is also relatively soft for a metal, allowing a bullet to be molded and mushroom when impacting a target. Finally, lead is inexpensive when compared to other possible metals which could be utilized in the production of bullets.



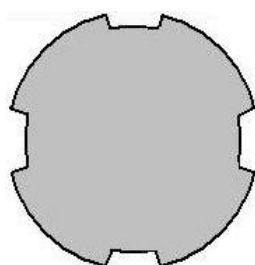
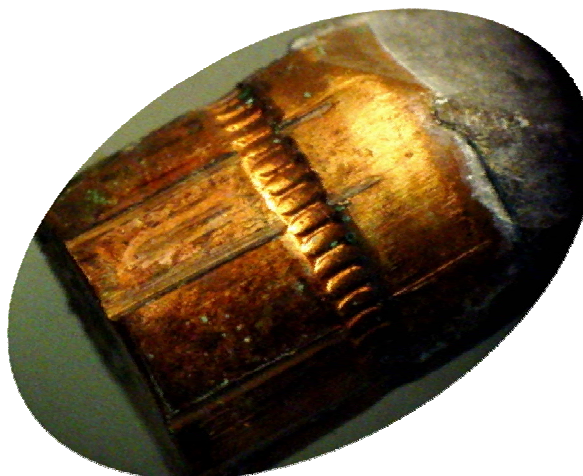
Half-jacketed is the term associated with bullets which are primarily lead with copper coating (jacket) on the bottom part of the bullet. Most half-jacketed bullets are actually more than half coated. While examining a bullet in a round, only part of the bullet is visible. This part of the bullet actually appears to be about half coated. This is likely the origin of the term “half-jacketed”. Although most half-jacketed bullets are hollow points, some other shapes of bullets are half-jacketed as well. The exposed lead tip is softer than the copper-coated back of the bullet allowing the tip to spread and mushroom. The copper-coated base of the bullet is harder and encourages a much improved exit velocity by providing a hard base against which the gun powder explosion pushes.

Full metal jacket bullets, also called *jacketed*, are those which are lead bullets completely coated in copper. This composition of bullet is most often used with round nose bullets. The purpose of a jacketed bullet is to discourage any disfiguration of the bullet while providing a hard base for the gun powder explosion to push against. This design also improves the penetration of a bullet. A copper coated bullet is extremely resilient. A jacketed round nose retrieved from a target often appears unscathed and could theoretically be reloaded in a new shell and fired again.

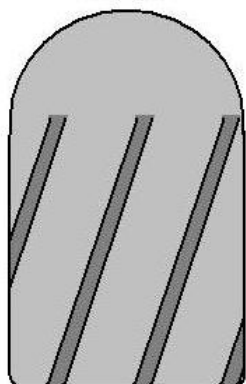


Bullet Analysis & Comparison

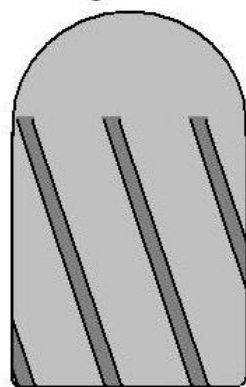
It is extremely difficult to convict someone of a murder without possession of the murder weapon. In the case of a shooting, matching a bullet with a gun is essential in most cases. The inside of the gun barrel scars a bullet passing through it. These markings are unique to each gun. If a bullet found at the crime scene displays the same markings as a second test-fired from a suspect's gun, then both bullets were fired by the same weapon.



Base of Bullet



Right Twist



Left Twist

Although the purpose of rifling is to spiral a bullet for increased accuracy, this process is responsible for what is arguably the basis of ballistics. Just as natural variations in fingerprint patterns and characteristics provide a key to human identification, minute random markings on the surface of a bullet can individualize a bullet to a firearm. Structural variations and irregularities caused by scratches, nicks, breaks, and wear permit the criminalist to relate a bullet to a gun. Individualization, a goal so vigorously pursued in all areas of forensics, is frequently a reality in ballistics.

If one could cut a barrel open lengthwise, a careful examination of the interior would reveal the existence of fine lines or striations, many running the length of the barrel's lands and groves. These striations are placed into the metal as the negatives of imperfections found on the rifling cutter's surface, or they are produced by small chips of steel pushed against the barrel's inner surface by a moving cutter. The fact is that the random distribution and irregularities of these markings are impossible to duplicate exactly in any two barrels. **No two rifled barrels, even those manufactured in succession, will have identical striated markings.** These striations form the individual characteristics of the barrel.

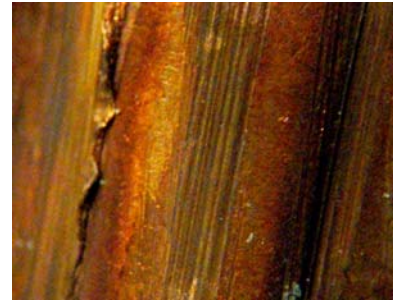
As a bullet passes through a barrel, its surface is impressed with the rifled markings and imperfections of the barrel. The bullet emerges from the barrel carrying the impressions of the bore's interior surface; these impressions reflect the characteristics of the barrel. Because there is no practical way of making a direct comparison between the markings on the fired bullet and those found within a barrel, an examiner must obtain test bullets fired through the suspect barrel for comparison. In order to prevent damage to the test bullets and to facilitate the bullet's recovery, test firings are normally made into a recovery box filled with cotton or water.



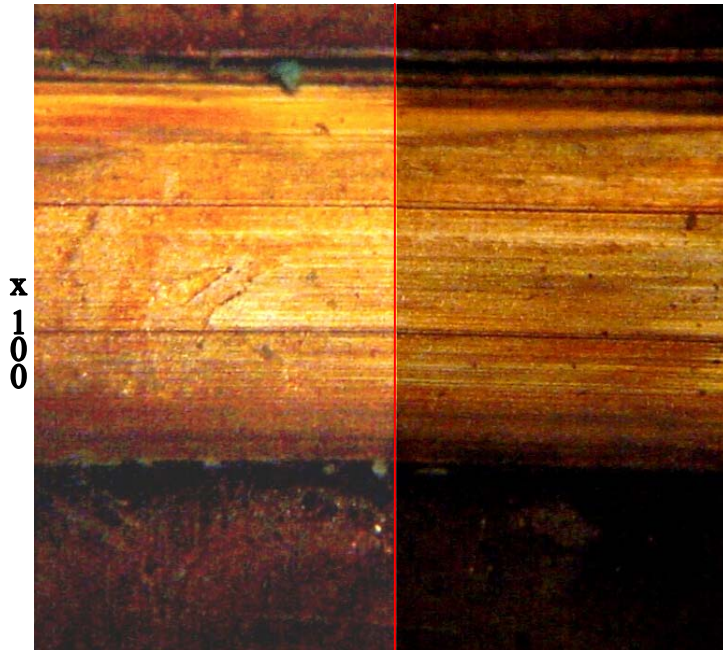
x 40



x 40



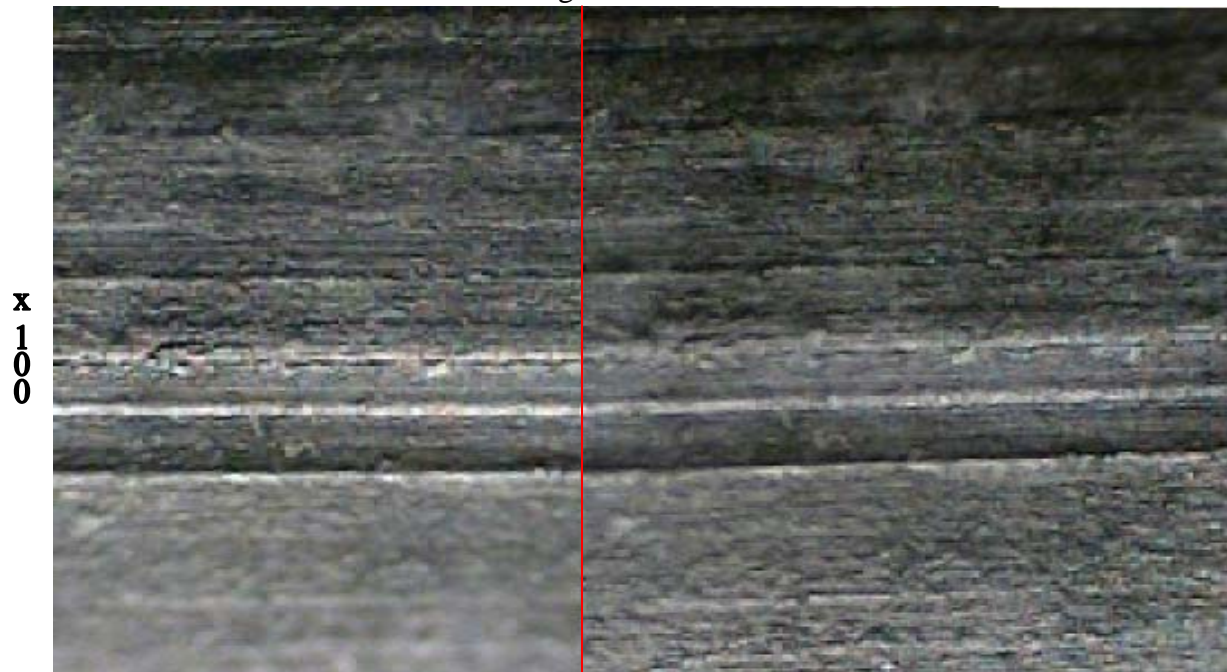
x 40



x 100

The numbers of lands and grooves, and their direction of twist, are obvious points of comparison during the initial stages of the examination. Any differences in these class characteristics will immediately serve to eliminate the possibility that both bullets traveled through the same barrel. A bullet having five lands and grooves could not possibly have been fired from a weapon of like caliber having six lands and grooves, nor could one having a right twist have come through a barrel impressed with a left twist. Once it has been ascertained that both bullets carry the same basic characteristics, an effort must begin to match the striation markings on both bullets. Each picture

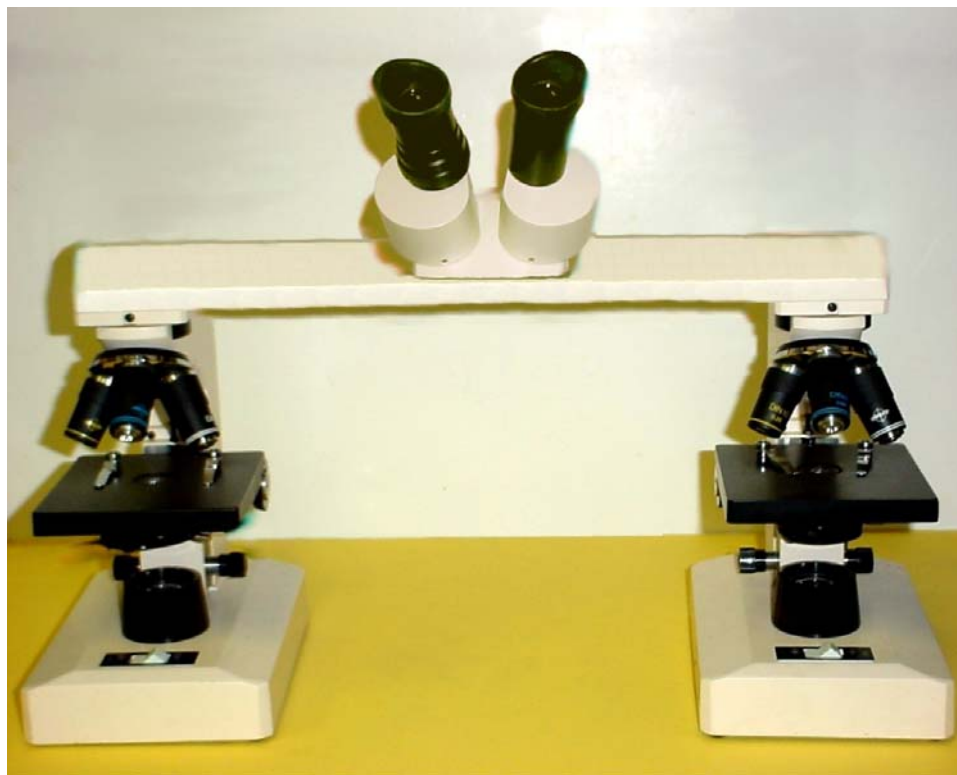
above and below are split screens of two different bullets. On the left is a bullet found at a crime scene. On the right is a bullet fired from a suspect gun. The matching up of striations proves that these bullets were fired from the same gun.



x 100

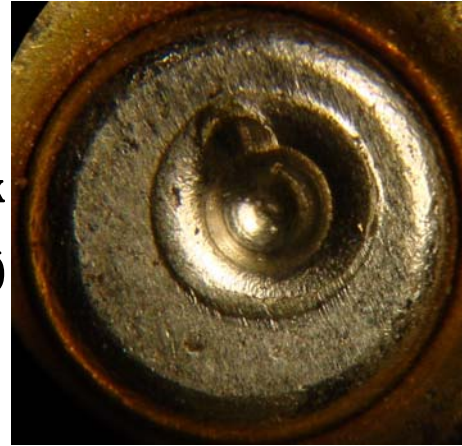
Comparison Microscope

It is no coincidence that modern firearms identification began with the development and utilization of the *comparison microscope*. This instrument is one of the most important tools at the disposal of a firearms examiner. The lenses of the microscopes each point in the same direction. Both bullets are observed simultaneously within the same field of view, and the examiner can rotate one bullet until a well-defined land or groove comes into view. Once striation markings are located on one bullet, the other bullet is rotated until a matching region is found. Not only must the lands and grooves of the test and evidence bullet have identical widths, but the striations on each must coincide. When a matching area is located, the two bullets are simultaneously rotated to obtain additional matches around the exterior of the bullets. This is not always easy or possible. More commonly, recovered bullets may become so mutilated or distorted on impact as to provide only a small part with visible markings. It is currently possible to perform similar procedures using a single microscope fitted with a digital camera, but without the help of a comparison microscope the procedure is slower and much more tedious.

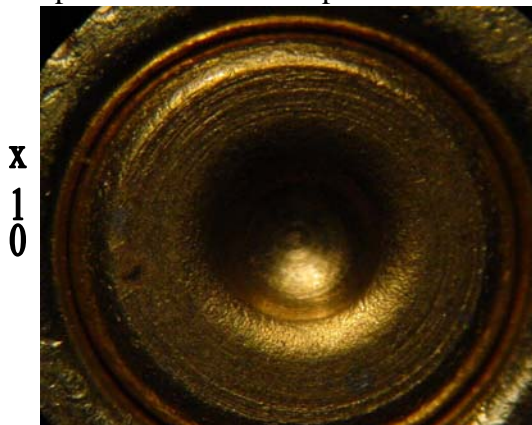


Cartridge Cases

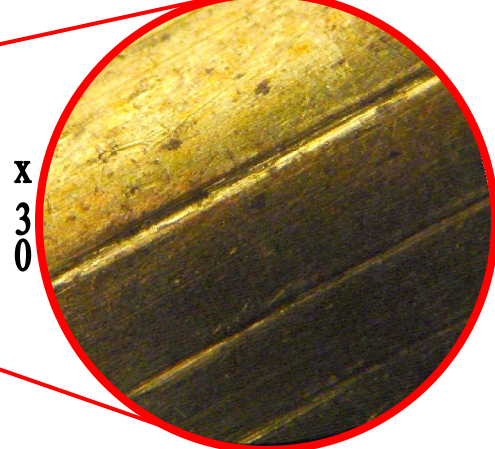
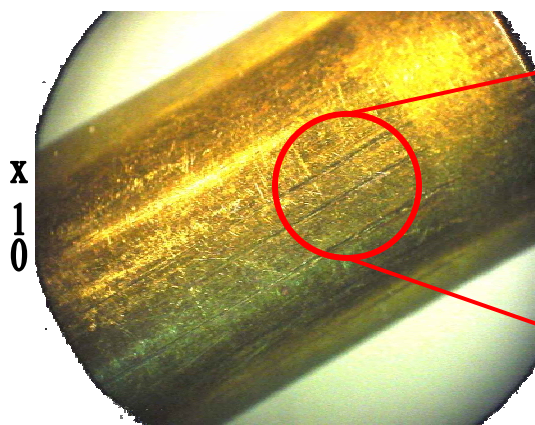
The act of pulling a trigger serves to release the weapon's firing pin, causing it to strike the primer, which in turn ignites the powder. The expanding gases generated by the burning gunpowder propel the bullet forward through the barrel, simultaneously pushing the spent cartridge case or shell back with equal pressure to the barrel. This impresses the shell with markings by its contact with the metal surfaces of the weapon's firing and loading mechanisms. As with bullets, these markings can be reproduced in test-fired cartridges to provide distinctive points of comparison for individualizing a spent shell to a rifled weapon or shotgun.



The pictures above show the match up of firing pins through the use of a comparison microscope. The bottom two primers were struck by completely different firing pins.



The shape of the firing pin is impressed into the relatively soft metal of the primer on the cartridge case, revealing the minute distortions of the firing pin. These imperfections may be sufficiently random to individualize the pin impression to a single weapon. Similarly, the cartridge case, in its rearward thrust, is impressed with the surface markings of the breech block. The breech block, like any machine surface, is populated with random striation markings that become a highly distinctive signature for individualizing its surface. Other distinctive markings that may appear on the shell as a result of metal-to-metal contact are caused by the ejector and extractor mechanism and the magazine or clip, as well as by imperfections on the fire chamber walls. Below: 44 cartridge is scared by imperfections of the fire chamber.



Since a shotgun does not fire a singular bullet and has a smooth barrel, it is impossible to match the projectiles to a gun. However, the firing pin, breech block, extractor, and ejector marks may be impressed onto the surface of the brass portion of shells fired by a shotgun. These impressions can provide just as valuable points for individualizing the shell to a weapon as do cartridge cases discharged from a rifled firearm. In the absence of a suspect weapon, the size and shape of a firing pin impression and/or the position of ejector marks in relationship to extractor and other markings may provide some clue to the type or make of the weapon that fired the shell in question. In the least, such markings may eliminate a large number of possible weapons.

Gunpowder

The powder in a round of ammunition is never totally burned. When a firearm is discharged, unburned and partially burned particles of gunpowder, as well as smoke are propelled out of the barrel along. If the muzzle of the weapon is sufficiently close, these products will be deposited onto the target. It is the distribution of gunpowder particles and other discharge residues around the bullet hole that permits an assessment of the distance from which a handgun or rifle was fired. This type of analysis is useful up to about four feet, after which distance most weapons, will leave no visible residue. Shotguns, however, exhibit a shot pattern at greater distances and may be gauged from approximately ten to sixty feet.



Effect on Targets

Contact. Residue tends to spread out more as the distance between muzzle and target increases. A contact discharge allows no time for the powder to spread. In addition, a lot of the powder is still burning as it exits the barrel. Often loose fibers surrounding a contact hole will show scorch marks from the flame discharge of the weapon, and some synthetic fibers may show signs of being melted as a result of the heat from the discharge. The following are test fires for a 22, 44, and 12 gauge shotguns respectively.

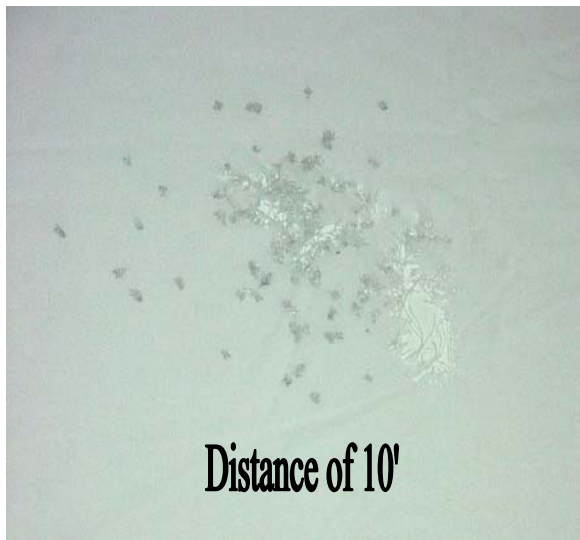


There are several different effects from the discharge of a firearm in contact with the skin. Smaller caliber weapons often burn or bruise the surface of the skin, leaving behind an impression of the weapon's barrel (left). Average caliber weapons are more likely to leave a star shaped entry wound as a result of the force of powder exiting the gun barrel with the bullet (above center). Larger caliber weapons discharged at such a close range can nearly disintegrate a target (above right). These weapons produce such a large amount of expanding gas that the bullets cause much less damage than the gas itself. If such a weapon is fired while the muzzle is contacted with a body cavity or a head, the result would be an exploded body cavity.

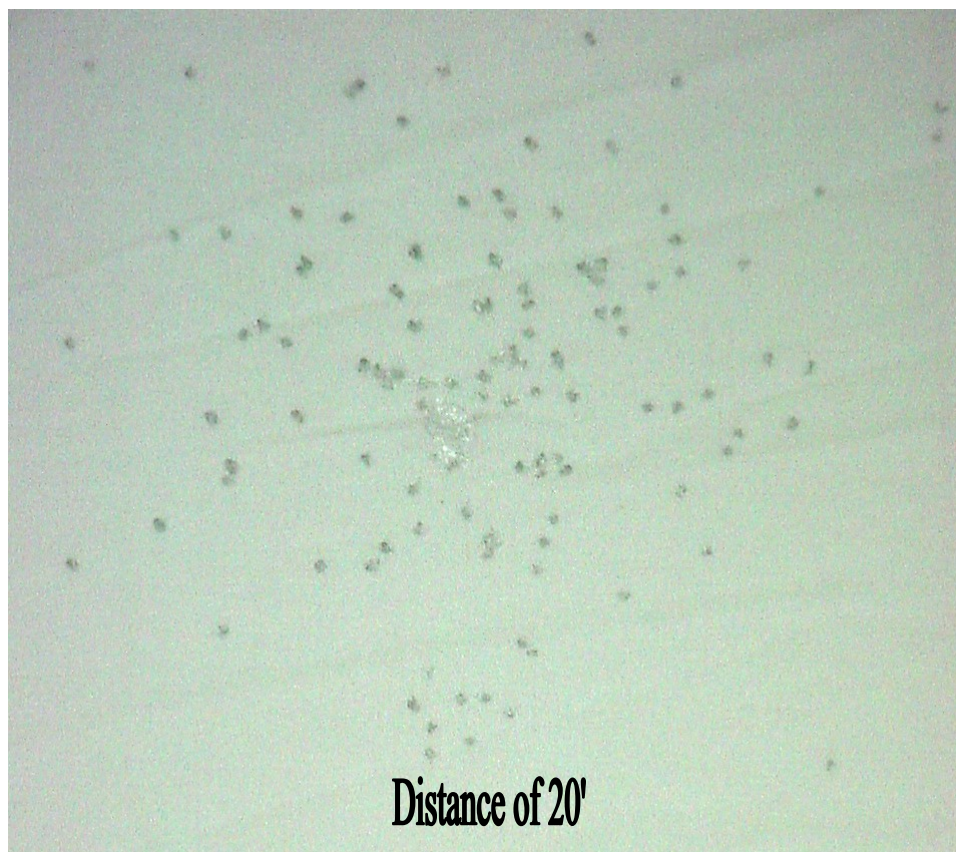
Using multiple projectiles and much more gun powder than other weapons, a shotgun often has a devastating affect at close range. Similar to large caliber handguns and rifles, a shotgun fired at less than a couple of inches from a body cavity or a head, results in an exploded body cavity. A large hole will likely be the result of a shot gun blast up around six to eight feet. More distant shot will likely allow enough time for the shot in the weapon to spread out and form a patter of small holes. Different shot gun barrels, however, are designed specifically for the shot to spread at different distances. While a longer barreled shotgun will cause the shot to stay in a tight patter longer, a shorter barrel or "sawed off" barrel allows the shot to scatter faster.



Distance of 1"



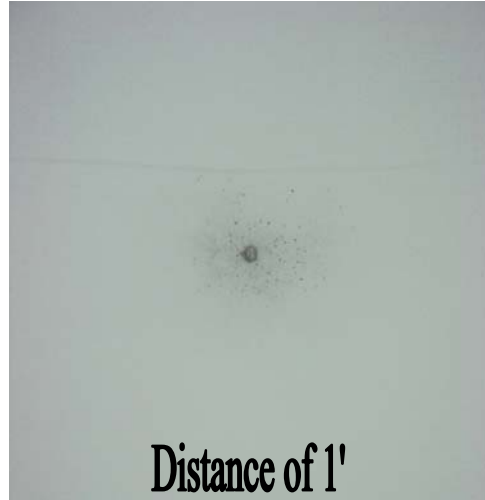
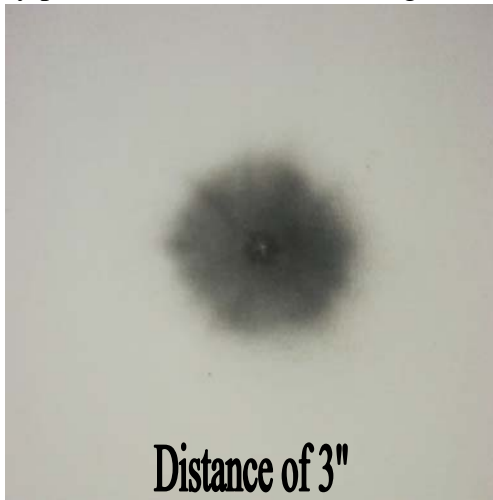
Distance of 10'



Distance of 20'

Other distances. A halo of vaporous lead (smoke) deposited around a bullet hole is normally indicative of a discharge 18 inches or less from the target. The presence of scattered specks of unburned and partially burned powder grains without any accompanying soot can often be observed at distances up to approximately 25 inches. With black powder weapons, this distance may be extended to 6 to 8 feet. A weapon fired more than 3 feet from a target will usually not deposit any powder residues onto the target's surface.

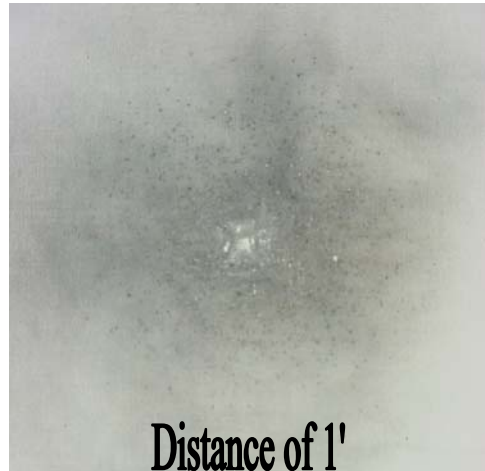
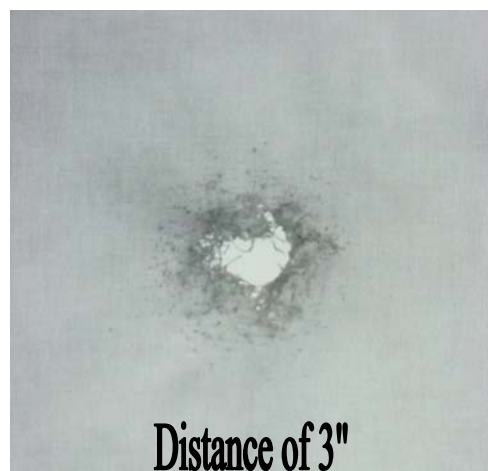
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9mm



44



Primer Residues on the Hands

The firing of a weapon not only propels residues toward the target; gunpowder and primer residues are also blown back in the direction of the shooter. As a result, traces of these residues are often deposited on the firing hand of the shooter. For many years the "dermal nitrate test" was the test of choice for gunshot residue. However, common materials such as fertilizers, cosmetics, urine, and tobacco all give positive reactions that are indistinguishable from those obtained from gunpowder.



Current efforts to identify a shooter are now centered on the detection of primer residues deposited on the hand of a shooter at the time of firing. These residues are most likely to be deposited on the thumb web and the back of the firing hand of a shooter. Determination of whether or not a person has fired or handled a weapon is normally made by measuring the amount of barium and antimony on the relevant portions of the suspect's hands. These elements are considerably less common than nitrates and almost never give a false positive.



Serial Number Restoration



Today, many manufactured items, including firearms and automobile engine blocks, are impressed with serial numbers for identification. Increasingly, the forensic chemist is requested to restore such a number when it has been removed or obliterated by grinding, rifling, or punching. Serial numbers are usually stamped on a metal body or on a plate, with hard steel dies. These dies strike the metal surface with a force that allows each digit to sink into the metal at a certain depth.

Thus the metal crystals in the stamped zone are placed under a permanent strain that extends a short distance beneath the original numbers. When a suitable etching agent such as hydrochloric acid and copper chloride is applied, the strained area will dissolve at a faster rate as compared to the unaltered metal, permitting a pattern to appear in the form of the original numbers (bottom right). However, if the zone of strain has been removed, or if the area has been impressed with a different strain pattern, it is usually not possible to restore the number.



Before any treatment with the etching reagent, the obliterated surface must be thoroughly cleaned of dirt and oil, and then polished. The reagent is best applied when the polished metal is swabbed with a moistened cotton ball. The choice of etching reagent will depend on the type of metal surface being investigated. A solution consisting of hydrochloric acid (100 ml), copper chloride (75 g), and water (84 ml) generally works well for steel surfaces. At left are the reagents copper chloride and hydrochloric acid. Above is the resultant reaction when an etching solution is placed on a steel surface.