THE ORIGIN OF SOME MARKINGS ON FIRED BULLETS

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A technician at the RCMP Crime Detection Laboratory, Regina, explains the differences in the various markings that appear on fired bullets.

764 THE science of firearms identification has recourse to many natural and physical laws. The cause and effect relationships of these laws may be manifest in marking a tangible object. When this occurs, the operation furnishes a means for determining the identity of its product. A microscopical examination and analysis of the effects of the operation by the firearm on its product — fired ammunition — will often confirm or preclude an identification. It is imperative therefore that a thorough understanding and appreciation be had of the origin of all markings and engravings found on fired ammunition. As this discourse deals with one component, the fired bullet, an effort will be made to trace the cause of all the numerous markings and engravings found thereon to their source.

Before chambering a cartridge, inspect the bullet under a microscope. Numerous marks, dents and scratches will be observed on its surface. These impressions will have a random and haphazard placement, resultant from accidental cause in handling, carrying and loading and may appear on any of the exposed portions of the bullet. On metal jacketed bullets, die markings — caused during the operation of drawing the jacket in manufacture — may be observed. These marks appear as lines running parallel to the longer axis of the bullet on its surface and converging toward the nose. These lines are rather uniform in character and are lacking in intensity of engraving. The majority of die markings, with the exception of those on the ogival surface, will be obliterated during subsequent engraving as the bullet passes through the barrel of the firearm.

Other markings found on the bullet may be caused by either cannelures or stab crimps. Cannelures are usually plain or knurled trenches in a bullet, running circumferentially to the longer axis of the projectile. A cannelure — especially in modern ammunition — may act as a receiver for the crimp of the cartridge, to hold the bullet in place in the cartridge case. Stab crimps are indentations placed in the neck of a cartridge to serve a like purpose and to prevent the separation of the bullet's jacket from the lead alloy core. Reference will be made to cannelures and stab crimps in a later paragraph when dealing with the movement of the bullet. Any of the above markings will not and cannot have any bearing on identification as they bear no relationship to the firearm. Some may and could be confusing when studied in conjunction with other markings received by the bullet when in contact with the firearm, unless an understanding of their origin be known. (See Fig. 1.)

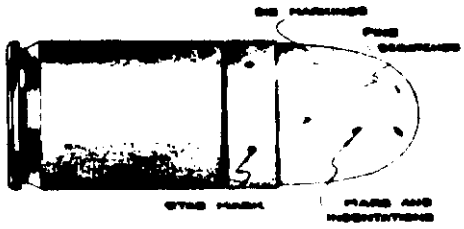


Fig. 1

Insert the cartridge in the chamber of the firearm and close the breech. Under ideal conditions, assuming the cartridge is properly chambered with the allotted head space, the ogive of the bullet will abut or be close to the chamfered ends of the rifling in the leed or forcing cone of the weapon. Pause for a moment to refresh the memory regarding relationship of bullet and bore (calibre) diameters. The diameter of the bullet should be greater than the bore of the firearm in which it is to be fired, yet smaller than the groove diameter of the weapon. (See Fig. 2.) The diameter of the bullet is so designed that when the bullet moves forward into the rifling, the volume of the bullet displaced by the lands of the arm will be forced into the adjacent grooves, such transition causing the bullet to completely fill the irregular surface of the bore. With

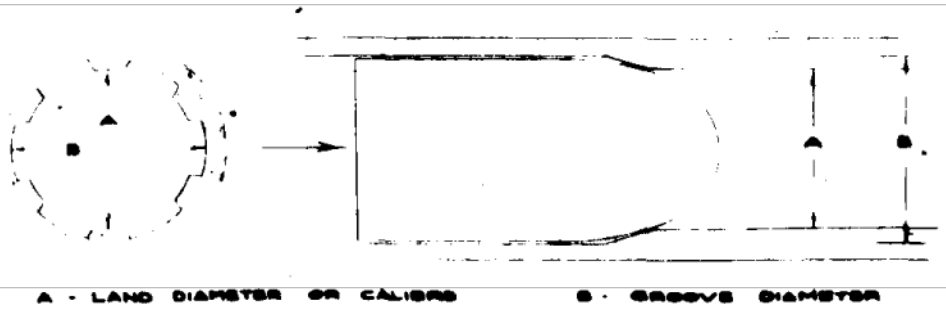


Fig. 2

lead alloy bullets, this condition is more easily accomplished than with metal jacketed projectiles because the pressure developed behind the bullet, when the cartridge is fired, causes the softer lead alloy to upset or deform and to fill the grooves in the barrel. It should be noted also that lead alloy bullets usually found in revolver ammunition, are made nearer to groove diameter than are jacketed projectiles. The bullet, seated in its deformed position, acts as an obturation — like a piston — to prevent the escape of gases past it. (See Fig. 2.)

Next, discharge the firearm. The firing pin or *striker moves forward actuated by a hammer or* spring. The striker crushes the primer cap containing a sensitive explosive charge against the anvil within the primer, the friction causing the priming charge to ignite. This hot flash ignites the powder or propellant in the cartridge which burns very rapidly and releases a large volume of hot gases, many times the volume of the cartridge chamber. These expanding gases exert their pressure equally in all directions. The cartridge case expands within the limited tolerances of the firearm's chamber. It is forced or set back till it is obstructed by the breech face, a distance equal to approximately the thickness of a sheet of paper. A like force is acting on the base of the bullet, which — as will be seen — remains the only avenue of escape for the gases. When the force, which is increasing as the powder or propellant is consumed, becomes great enough to overcome the force of friction holding the bullet, the projectile is pushed forward. Here then is the initial stage of a bullet's engraving by the firearm, for it is then that the missile comes in contact with the weapon.

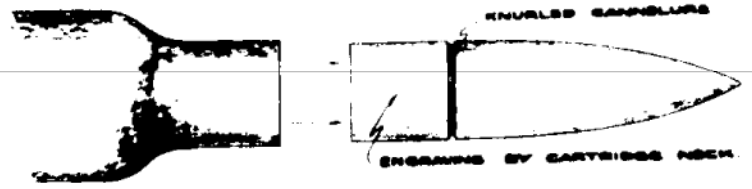
The bullet is forced forward, separating it from the cartridge case. As the projectile moves out of the neck of the cartridge case, the area of the bullet which has been encased by the neck of the cartridge will be subjected to the scraping action of the wall of the cartridge neck and the lip where the case was crimped into the cannelure. Depending on factors in the firearm and in the ammunition, the bullet may or may not take up motion of rotation before the projectile has parted from its component case. Should it leave the case or cartridge in a straight forward motion, all marks on the bullet caused by its contact with the case in separating, will run parallel to the bullet's longer axis. Should the bullet begin to rotate before it has left the case — a condition seldom if ever encountered — scratches *engraved by the separating process will run in an* angular direction to conform to the amount of rotation. These scratches will be lightly engraved, for the brass — with which the bullet is in contact — is a comparatively soft metal. The majority of these fine engravings will be obliterated by the heavier overengraving caused by the bullet's contact with the steel bore of the firearm. (See Fig. 3.)

Engravings resulting from the effect of stab crimps are easily distinguished. They will extend from the stab impression rearward to the base of the bullet. Their direction will depend on the motion of the bullet as described in the preceding paragraph. Any engravings resultant from the above causes, will be of no use for identification as they are not associated with the firearm. They therefore must not be confused with elements of identity which result from the bullet's contact with accidental characteristics in the weapon's chamber, leed, lands or grooves. (See Fig. 4.)

It has been stated previously that under ideal conditions, the shoulder of the bullet, when chambered, should abut or be in close proximity to the chamfered ends of the lands in the leed. The word chamfered designates, cut on a bevel, so the lands increase in depth or thickness along an

Fig. 4

Fig. 3



inclined plane or ramp until their uniform thickness is attained, commencing at the bore proper. Any movement of the bullet forward will tend to wedge it in this funnel-shaped leed, where, as the bullet is pushed forward, the lands will plough into or embed themselves in the softer metal of the bullet. The force exerted on the base of the bullet by the gases, will be reacted upon by the driving edges of the lands in accordance with the laws of moments of force, whereupon the bullet will commence to rotate. Assuming the bullet starts to rotate as soon as it comes in contact with the lands, that area of the bullet's surface which lies in the path of the chamfered land will first be scraped to an ever-increasing depth as the bullet moves forward until the full depth of the land has been reached. Then it will be subjected to the sliding action of the driving edge and bottom of the land. The first major engraving will be caused by the ploughing action of the land; the second, by the sliding action of the bullet over the bottom and driving shoulder of the land. Within the impression ploughed by the land and running parallel to its driven edge, may be found fine striations, the effect of accidental characteristics left on the land of the firearm by the reaming tool during manufacture or accumulated through fortuitous causes.

During manufacture, the breech end of the rifled barrel is chamfered with a reaming tool to form a leed from the chamber to the bore proper, and the opportunity is ever present for accidental characteristics to be imparted to the leed. When a metal jacketed bullet enters this leed and is directed to the bore proper, protuberances and irregularities, accidentally left by the reaming tool, especially at the very entrance to the bore, may make contact with the bearing surface of the bullet. The effect of contact may be noticed on the bullet's surface between the land engravings or more properly within the bullet's groove area, provided the bullet has not bottomed the grooves in which case these engravings would be partially or totally obliterated. This is rarely the case with metal jacketed bullets. When they do make contact with the groove of the firearm, the result is noticed as a small patch of engraving between the land impressions. Engravings created by the accidental characteristics in the leed of the weapon are called axial engravings. The direction of the striations will be dependent on the motion of the bullet. Lead alloy bullets, entering the leed, are subject to the same engravings. But because of several factors — to be explained in later paragraphs — axial engravings on lead alloy bullets are seldom if ever encountered, due to their being over-engraved and obliterated. (See Fig. 5.)

Consideration has been given to the passage of a bullet from the cartridge case into the bore under more or less ideal conditions. These conditions are the exception rather than the rule, as many factors affect the bullet's entrance into the bore of a firearm. The cartridge may be short, the leed long; cartridges in revolvers are positioned in separate chambers, resulting — when the cartridge is fired — in the bullet moving forward some considerable distance before it strikes the leed. In moving this distance it has gained considerable speed and momentum, so much in fact that the driving edges of the lands have difficulty in turning the bullet and the projectile moves forward across the lands. Such a condition will cause that area of the bullet's

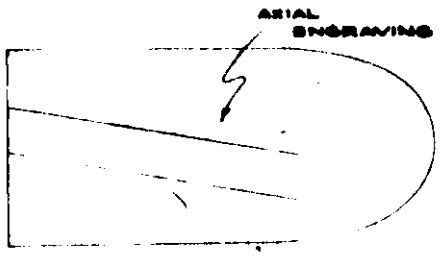


Fig. 5

surface in the path of the land as well as its driving edge, to be scraped. The result will be noticed as lines engraved running parallel to the longer axis of the bullet. This scraping condition will exist as long as the bullet moves with motion of translation without the full rotation provided for by the rifling. Such a condition is referred to as stripping.

Should a bullet be undersize or should a normal sized bullet be fired in a worn and oversize barrel, the bullet may continue through the bore in a purely translational motion when its entire surface will be stripped. Total or complete stripping is not common, however. It is customary, especially with lead alloy bullets and high velocity ammunition, for the projectile to strip a considerable amount before full rotation as provided by the rifling has taken place. The effect of stripping is recognized on the engraved portion or area of the bullet adjacent to the trailing land's edge, in the form of a wedge or triangle, with the apex towards the base of the bullet. A casual inspection would give the impression that the land was wider at the nose of the bullet than at its base. The striations caused by stripping run parallel to the bullet's longer axis and converge with those resultant from the land engraving, after the bullet has taken up its full motion of rotation. It should be noted that should the base of the projectile enter into the bore proper without motion of rotation, the apex of the triangular stripped area will extend to the base of the bullet.

Due to the stripping that must necessarily take place under the above conditions, the land has ploughed a furrow wider than itself. Hot gases will now force past the bullet and bore along the trailing edge through this channel. The escaping hot gases will cut deep grooves in the lead alloy bullets. These cuts are easily recognized as they appear as irregular furrows without signs of engraving, resulting from the combined effect of two surfaces in

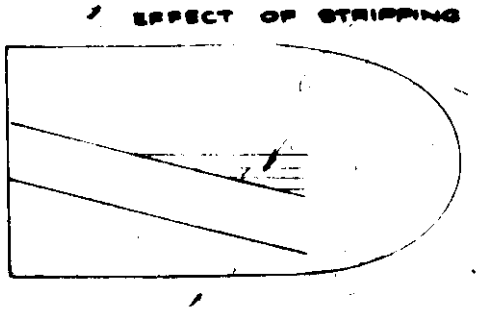


Fig. 6

contact under pressure and motion. The escaping gases will not cut the harder jacketed bullets but their effect will be noticed as hard carbonaceous incrustations along the trailing edge. As soon as the bullet takes up full motion of rotation in conjunction with its motion of translation, the scraping action of the driving land will cease and only that area of the bullet coming in contact with the chamfered end of the land will be scraped and later ploughed by the land until the bullet has entered the bore. Then it will be subjected to the abrasive action of the surfaces of the lands and the grooves where the bullet makes contact with the grooves. Lead alloy bullets are more subject to stripping due to their soft composition, though metal jacketed bullets are subject to the action under certain conditions. (Figs. 6 and 7.)

In many of the cheaper revolvers and with ones badly worn, the chamber, which is separate from the leed and the barrel, may not line up with the bore. The bullet, on leaving the chamber may be paralled to but not coincident with the leed. As the bullet strikes the leed, the projectile may be slightly off centre, resulting in what is commonly known as "shearing lead from the bullet". This condition of being off centre as it strikes the leed will have a decided effect on the bullet insofar as the resulting marks are concerned. The action may be likened to driving a car into a garage with a narrow opening. Unless the car is centered with the open-

Fig. 7

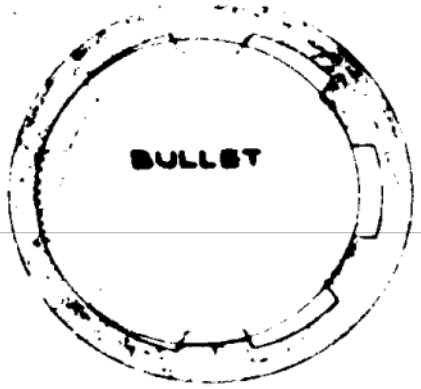


Fig. 8

ing, one side or other will be scraped. With a bullet, the lands of the arm on the off side will engage with and embed themselves in the bullet before those on the near side. (See Fig. 8.) This will cause the land impression on the off side of the bullet to be longer than those on the near side as the lands on the off side engage the bullet lower down on the ogive nearer the nose of the bullet. (See Fig. 9.)

It frequently happens that the bullet strikes the lead with its longer axis at an angle to the axis of the bore. (See Fig. 10.) When this condition occurs, the forward portion of the bullet will be engraved by the lands and possibly the grooves until such time as the bullet travels into the bore to such an extent that any tendency to oblique movement is checked. It then aligns itself with the axis of the bore. When it is forced to change from the oblique to true nose-on movement, the angle of rifling on the bullet will be

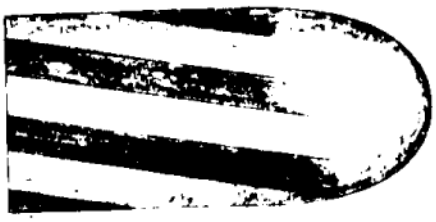


Fig. 9

changed. A doubling of the land impression or a change in the angle of rifling of the land impression will be noted. (See Fig. 11.)

Consider now the final stage of a bullet's engraving as it continues its course down the bore of the firearm to the muzzle. Moving through the bore with a motion of pure translation, a bullet would receive scratches on its surface parallel to its longer axis; moving with rotation without translation it would receive striations circumferentially to its longer axis. Therefore a bullet moving with translation and rotation would receive scratches, the direction of which would lie between those parallel to the longer axis and those at right angles to that axis. As the rifling in a firearm is made to a predetermined angle, the angle of the scratches on the bullet could not exceed the angle of twist of the rifling of the arm.

As the factors affecting a bullet's passage through the bore are, for the most part, variable, the angles of striation found on a bullet will be variable, lying between the extremes of parallelism to the bullet's longer axis and that of the angle of rifling. These scratches or striations are the cumulative and resultant effect of the characteristics of the bore.

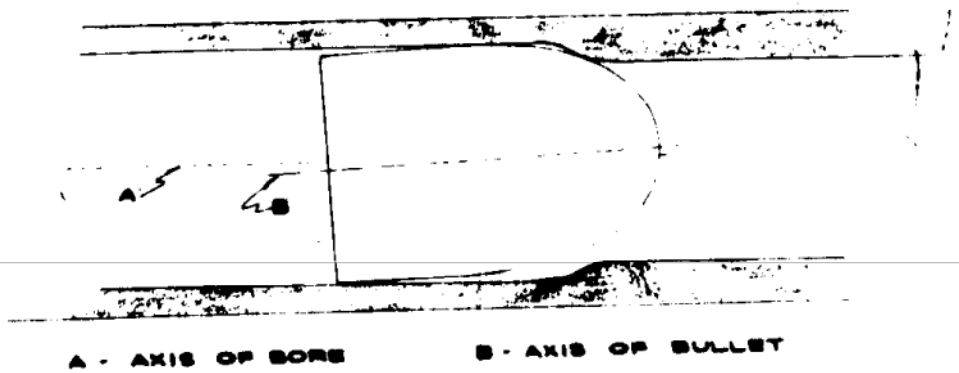


Fig. 10

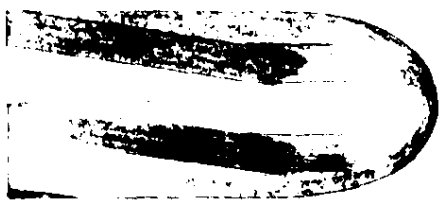


Fig. 11

Characteristics may be either class or accidental or a combination of both. Class characteristics are such features as are predetermined by man and bear relationship to size, shape and placement within limited tolerances. The rifling in a firearm would therefore be a class characteristic of the weapon as it would to a degree proclaim the type or class of arm by giving such dimensions as the number of lands and grooves, their width, depth, direction and angle of twist.

During the cutting and machining of the rifling in the bore of a firearm, divers characteristics are accidentally imparted to the rifling by the tool. One of several methods may be employed to cut the rifling in the bore of a firearm. Rifling cut with a broaching tool will have certain outstanding characteristics resulting from the use of that tool. Inspr. J. A. Churchman in his article "Reproduction of Characteristics in Signatures of Cooey Rifles", names these characteristics as "B" or Broach Series Characteristics and divides them into two distinct types. The B1 type, wherein the broaching tool, through malfunction, folds and presses the cut metal onto the edge or edges of adjacent lands. A bullet engraved by such a land will show a wide trough on the corresponding land engraving. B2 type characteristics are observed as heavy stria or as shelf-like formations on the edge of land engravings and are caused by the minor defects of the broaching tool imparting their characteristics to the bore. It must be borne in mind that the characteristics, class and accidental, of a firearm's bore, are added to and are changed by rust and corrosion and by subsequent use of the arm. (See Fig. 12.)

It will be observed that some bullets possess scratches and striations whose direction or angle is greater than the angle provided for by the rifling. As has been noted such markings were not and could not have been produced while the bullet passed through the bore. Observation will soon determine whether they were placed on the bullet before or after its journey through the barrel of the gun. Should they be before, then it will be observed that the scratch will likely be overengraved at some stage by the land or groove. If the scratches occurred after the bullet left the bore, then the land or groove engraving will be overengraved by the scratch. Loose particles of grit or metal deposited in the bore during normal use will cause markings of unpredictable character and design on bullets subsequently fired through that bore. The effect will likely appear on the first bullet to traverse the particles and additional bullets will not be so marked.

The differentiation between the effects of mutilation and deformation on impact and the engravings by the pertinent class and accidental characteristics of the firearm should present no problem. The markings on the bullet caused by impact can have a profound and disastrous effect as they may distort and obliterate such features as are vital to the identification.

The origin of the numerous markings and engravings on a bullet having been established, any reconciliation between the differences in the signatures of the same weapon or different weapons, rests on the skilled interpretation of this knowledge by the firearms examiner in rendering an opinion of identity or diversity.

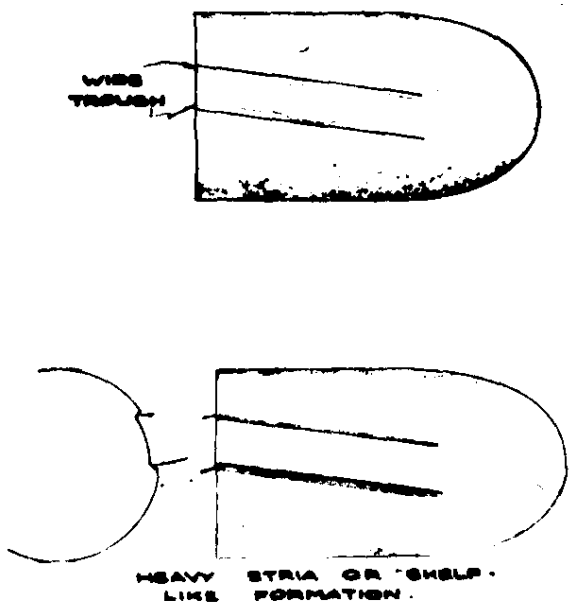


Fig. 12