

The Reproduction of CHARACTERISTICS IN SIGNATURES OF COOEY RIFLES

by

Inspector J. A. Churchman, M.M., F.R.M.S.

Royal Canadian Mounted Police

446

AN outstanding feature of the signature of the Cooley rifle is a series of scorings located on the edge of, and not infrequently in, the land engravings on bullets fired from rifles of this particular make. This characteristic is a significant feature of a Cooley bore and can help to establish a certain relationship. However, by virtue of their origin, it is necessary that the investigator be aware of the comparative value of these elements in the signature; otherwise, they may become a definite hazard. A complete and thorough study of the origin of the elements in the signature of any type of bore is necessary before a correct evaluation of engravings can be made.

Before commencing a study of the reproduction of engravings in signatures of rifled bores, we would do well to read what J. D. Gunther, A.B., LL.B., and O. O. Gunther, M.E., have recorded on the matter. They state, in part, at p. 72 of IDENTIFICATION OF FIREARMS as follows:

"... The reproduction of groove engraving creates a situation which is not only serious but extremely significant and conveys a warning that may not be ignored. Lead lapping a barrel will to a large extent destroy the evidence of the reproduction of the groove engraving in barrels rifled with a hook cutter. . .

"Before considering the six types of problems in the identification of firearms from the ammunition fired therein, it should be noted that the problem of identification involves, first, a skilled observation and perception of the data; and second, a skilled interpretation of the data. The investigator

must not only be able to ascertain the pertinent data but he must also be capable of determining the significance and the comparative value of the characteristics relative to the identification. The art of identification concerns reasoning with respect to similarities and differences. It is found that there are differences in the signatures of a particular firearm and that similarities exist in the signatures of different firearms. Therefore an investigator can never intelligently ignore either similarities or differences—the identification must always be predicted upon a proper consideration of both. When identifying two signatures as having been made by the same firearm, he must be able to reconcile the differences found therein; and, likewise, when of the opinion that two signatures have not been made by the same firearm, he must be able to reconcile any existing similarities in the two signatures. It is quite obvious that a skilled investigator will necessarily have spent considerable time in acquiring the proper experience based upon training and controlled research."

An experienced investigator is aware of the danger connected with the existence of similarities in the signature of different firearms and will take the necessary steps to differentiate between

what might be reproduced engravings and those engravings which are genuinely accidental and characteristic of a given bore. The danger of reproduction associated with the product of the scrape and hook cutters is also present when dealing with barrels rifled with the broaching tool—a method of rifling employed by the H. W. Cooley Company and a growing number of other small arms manufacturers.

The term "broaching tool," is defined in

AUTHOR'S NOTE: This treatise has been written with a view to demonstrating the dangers associated with incorrect interpretation of characteristics in the signature of H.W. Cooley Company rifles, and to outline, for the technician and for counsel, a classification of such characteristics.
 No attempt has been made to produce comparisons of engravings, as they should be, for production in a court of law. The bullets used in this investigation were not specially selected. Two bullets were fired from each of three barrels and specimens were selected at random.
 No criticism is intended of the Cooley product which enjoys merited popularity in Canada and, I understand, Australia. The co-operation of the Cooley Company, which supplied the barrels, the broaching tool and rifling specifications, is greatly appreciated.

WEBSTER'S NEW INTERNATIONAL DICTIONARY as an instrument

"for shaping nonround holes, especially in metal in which the hole to be broached has been roughed out previously by drilling or otherwise. It consists of a bar of suitable length, having a cross section similar to that of the hole to be formed, and provided on its surface with a series of cutting edges each of which lies in a plane at right angles to the axis. The broach is fed through the work by a translational movement along its axis, and since the cutting edges are progressively higher, each succeeding tooth removes an additional amount of metal. A push broach cuts when pushed through the hole, a pull broach when pulled through it".

There are two methods of broaching barrels. In one, all the broaches are mounted on a single rod and pushed through at the same time, each succeeding broach removing an additional amount of metal; the other, that followed by the Cooley Company, requires the passage of each broach separately.

A total of six broaches is required to rifle a Cooley barrel. Each of the first five broaches removes approximately .005" of metal, and the sixth broach removes approximately .00025" of metal from the grooves in the tube which was previously drilled to .204" and reamed to .215". These broaches are made of high-speed tool steel rod reduced to the required diameter and bored to the diameter of the stud on the tool end of the rifling rod. Perforated discs, approximately 3.16" thick, are cut from the prepared tool steel. The cutting edges which make the grooves in the bore of the rifled tube are formed by cutting eight more or less equally spaced grooves round the circumference of the disc at an angle which conforms to the specified 14" pitch. The cutting edges of the broaching tool cut the grooves in the bore which in turn, when a bullet is fired through it, will form the groove engravings. The cuts or grooves on the broaching tool form the lands in the bore which in turn form the groove-like land engravings on the fired bullet.

A close examination of the broach will show that all the groove cutters are not exactly the same in width and that the spaces between them are correspondingly irregular. The "bit" and "web" and "depth of cut" measurements of a used Cooley broach are

| BIT | WEB | DEPTH OF CUT |
|--------------|--------------|--------------|
| .94 mm. | 1.24 mm. | .20 mm. |
| .92 " | 1.20 " | .21 " |
| .99 " | 1.17 " | .22 " |
| 1.02 " | 1.17 " | .19 " |
| 1.05 " | 1.15 " | .16 " |
| 1.02 " | 1.09 " | .19 " |
| 1.08 " | 1.12 " | .22 " |
| 1.00 " | 1.18 " | .20 " |
| Average: | | |
| 1.0025 mm. | 1.165 mm. | .1987 mm. |
| or .0394 in. | or .0458 in. | or .0078 in. |

It is also found that some of the groove cutting edges vary slightly in width from front to rear and that longitudinal irregularities appear on the surface of the groove cutters over the grinding marks. The web contains comparatively rough tool marks, caused by the cutting tool. Particularly outstanding irregular tool marks appear on some cutter shoulders.

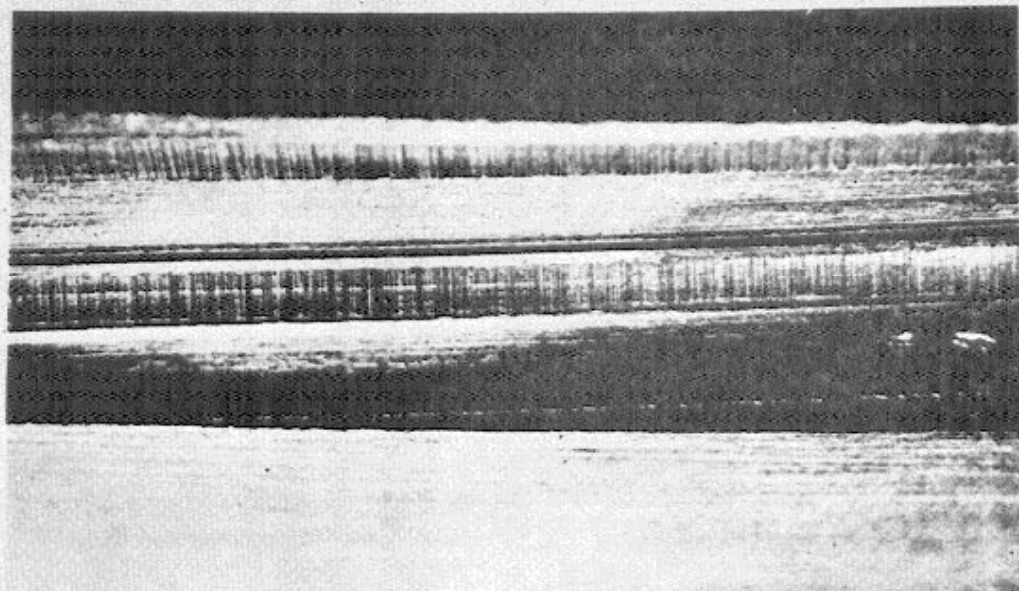
The cutting edge of the broach is sharpened by grinding a concave face on its front. This operation is performed as and when the tool becomes worn, and results in:

- (a) a change in the cutting-edge characteristics after each regrinding;
- (b) a progressive change in the dimensions of the cutting edges (the cutting edges become wider or narrower with each regrinding, according to whether the widest or narrowest edge of a cutter on the broach is at the front), and
- (c) a possible change or removal of the irregular tool marks, particularly the outstanding marks on cutter shoulders, as recession of the cutting edge progresses with each regrinding.

The broach cutters are made in ten sizes from .215" to .224", a set of six is required to complete the rifling of a barrel. The grooves of the bore are broached to .003" in depth and a tolerance of .004" is allowed in reaming. Hence if the .215" broach slips the .216", .217" or .218" cutters may be used as the primary cutter and the next five cutters employed to complete the operation.

Experience dictates that caution be exercised when comparing engravings with a view to determining whether or not they have the same origin. Caution is doubly necessary when, with the same object in view, groove engravings on two bullets, fired from barrels rifled with scrape or hook cutters, are compared. But as great a measure of caution is necessary when comparing both land and groove engravings on bullets fired in Cooley rifles. The identification of a Cooley firearm, by

Fig. 1. Photomicrograph
(X 8.8).



means of fired bullets, resolves itself into a problem the solution of which is possible.

- (a) if the evidence bullet carries sufficient engravings;
- (b) if the differentiation between types of engravings is correctly made, and
- (c) if the different types of engravings are properly evaluated.

The Differentiation and Evaluation of Engravings.

THE engravings on the bearing surface of fired calibre .22 bullets fall within three classifications: The **"C" or Class characteristics**—the width of land and groove engravings, depth of land engravings, pitch of rifling and the general form of rifling, whether Whitworth, Enfield or the product of a broach. It is possible by examination of the class characteristics to indicate the make or makes of firearms which could have fired a given bullet. When the engravings indicate uncommon rifling characteristics, a high degree of accuracy may be achieved; the **"B" or Broach series characteristics**—the outstanding characteristics of a signature attributable to irregularities in the series of broaches employed to cut the rifling; the **"A" or Accidental characteristics** which are peculiar to a given bore and, by virtue of their origin, constitute elements of identity of such bore. A characteristics exist only when the C characteristics correspond on two or more bullets and when such bullets are in phase, and when the B characteristics are in agreement and indicate a relationship.

C CHARACTERISTICS: C characteristics of the Cooley rifle, the land and groove engravings, are so uncommon as to justify the assumption that any bullet so engraved is very probably the product of a rifle of this particular make. The eight well defined land and groove engravings on a bullet fired from the bore of a Cooley rifle are readily recognizable.

B CHARACTERISTICS: The presence of broach series characteristics will confirm the identity of the make of firearm. They should appear

- (a) on all calibre .22 bullets fired from a given rifle, and
- (b) on all bullets fired from an unknown number of rifles broached with the same series of cutters or those cutters in a series which are responsible for the broach series characteristics.

B characteristics result from certain irregularities on a broach or the combined effect of irregularities

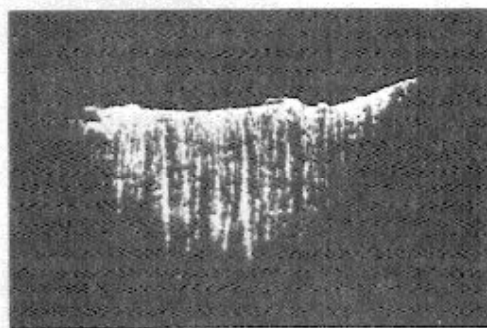


Fig. 2. Photomicrograph (X 21.1).

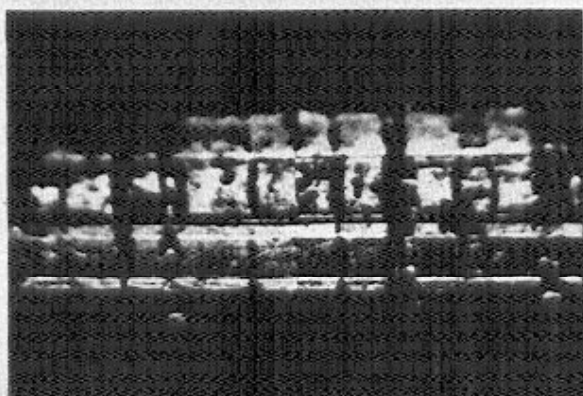


Fig. 3. Photomicrograph (X 13.2). Land engraving 1, bullet 1, barrel 1; land engraving 1, bullet 2, barrel 2.

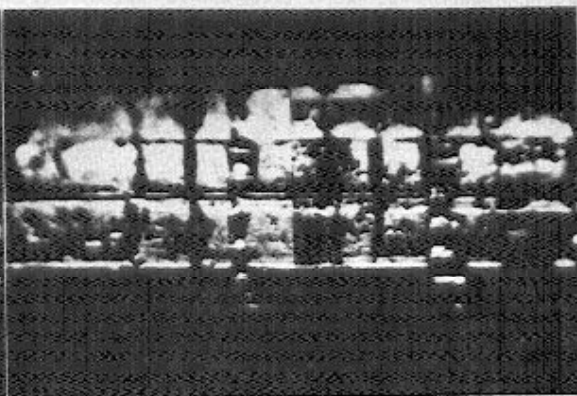


Fig. 4. Photomicrograph (X 13.2). Land engraving 4, bullet 2, barrel 1; land engraving 4, bullet 1, barrel 2.

on two or more of the broaches in a series. They will persist until the combination is broken. The replacement of any one of the broaches contributing to the B characteristics may effect a change in formation of such engravings.

B characteristics may be found in two distinct forms:

The "B₁" type — when one or more of the broaches in a series, which do not conform exactly to specifications, have either irregularly spaced cutting edges or one or more excessively wide cutting edges, and thereby cause a mal-function of the tool and metal to fold onto the edge or edges of adjacent lands. See Figs. 1 and 2. This fold of metal may be cut, pressed and scored by the web surface between groove cutters of a broach or it may be pressed by the broaching tool rod. This metal on the land edge cuts a wide trough on the corresponding edge of the land engraving. See Fig. 3.

The "B₂" type — a heavy stria or series of striae of varying weights, or a shelf-like formation on the edge of land engravings, may be caused by minor defects or irregularities in the cutting edge of one or more of the broaches. See Figs. 4 and 5.

REPRODUCTION OF "B" CHARACTERISTICS:

The B₁ characteristics can be expected in all bores rifled with a given series of broaches. They will continue to appear in the same order and general form until the series of broaches is broken by the removal of any one or more of the broaches responsible for this formation. The B₂ characteristics will continue to appear until the series of broaches is broken or the broach or broaches responsible are removed or have been ground to a point where the irregularity, or irregularities, creating the characteristic ceases to exist.

Three consecutively broached barrels, obtained

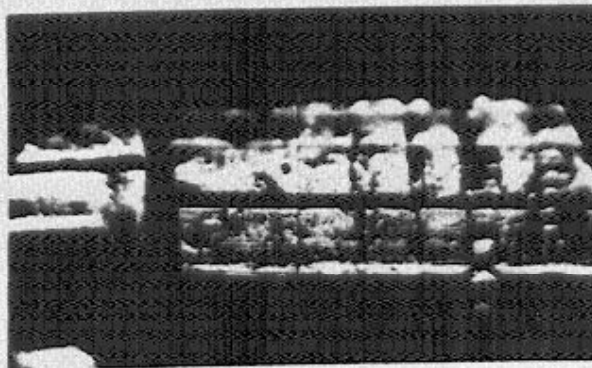


Fig. 5. Photomicrograph (X 13.2). Land engraving 7, bullet 1, barrel 1; land engraving 7, bullet 2, barrel 2.

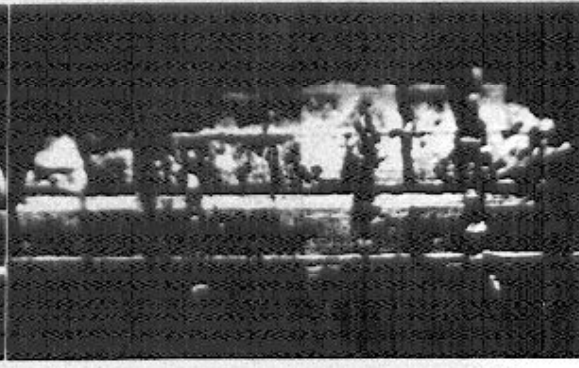


Fig. 6. Photomicrograph (X 13.2). Land engraving 2, bullet 2, barrel 1; land engraving 2, bullet 1, barrel 2.

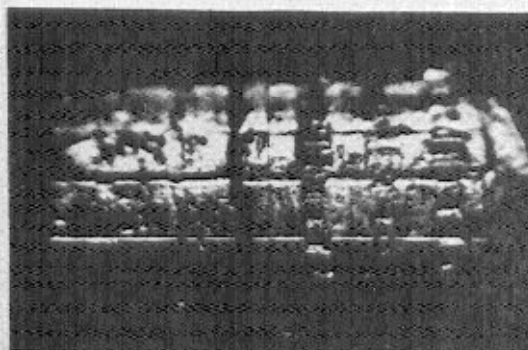


Fig. 7. Photomicrograph (X 13.2). Land engraving 3, bullet 2, barrel 1; land engraving 3, bullet 1, barrel 2.

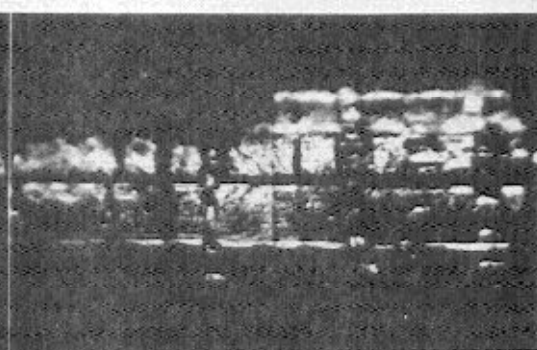


Fig. 8. Photomicrograph (X 13.2). Land engraving 5, bullet 2, barrel 1; land engraving 5, bullet 1, barrel 2.

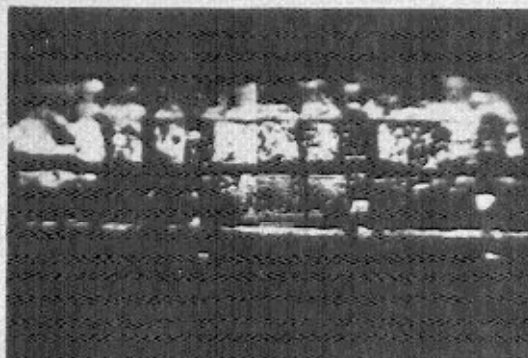


Fig. 9. Photomicrograph (X 13.2). Land engraving 6, bullet 2, barrel 1; land engraving 6, bullet 1, barrel 2.



Fig. 10. Photomicrograph (X 13.2). Land engraving 8, bullet 2, barrel 1; land engraving 8, bullet 1, barrel 2.

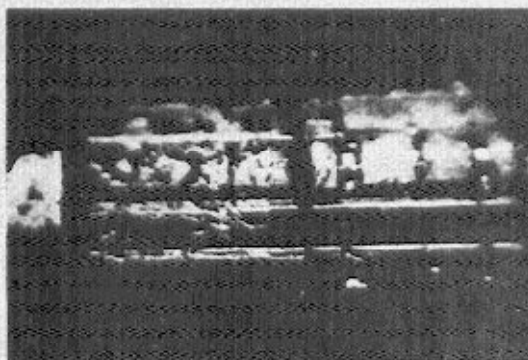


Fig. 11. Photomicrograph (X 13.2). Land engraving 1, bullet 2, barrel 1; land engraving 1, bullet 1, barrel 3.

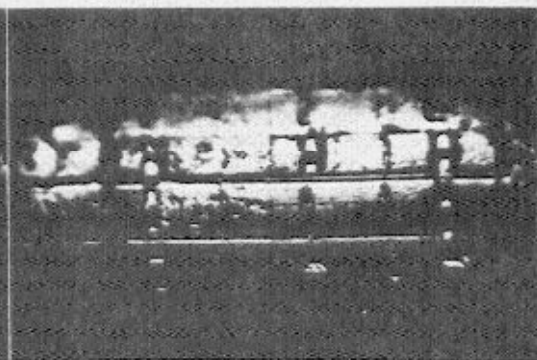


Fig. 12. Photomicrograph (X 13.2). Land engraving 3, bullet 2, barrel 1; land engraving 3, bullet 1, barrel 3.

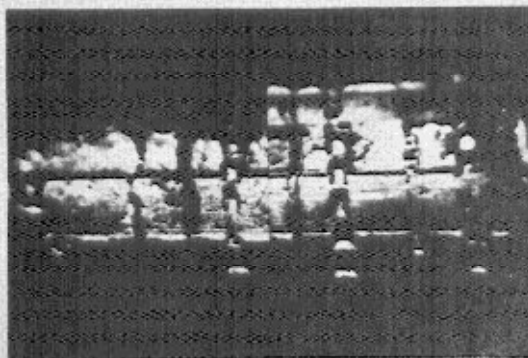


Fig. 13. Photomicrograph (X 13.2). Land engraving 5, bullet 2, barrel 1; land engraving 5, bullet 1, barrel 3.

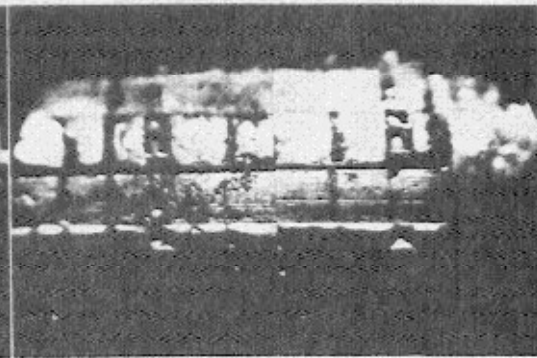


Fig. 14. Photomicrograph (X 13.2). Land engraving 7, bullet 2, barrel 1; land engraving 7, bullet 1, barrel 3.

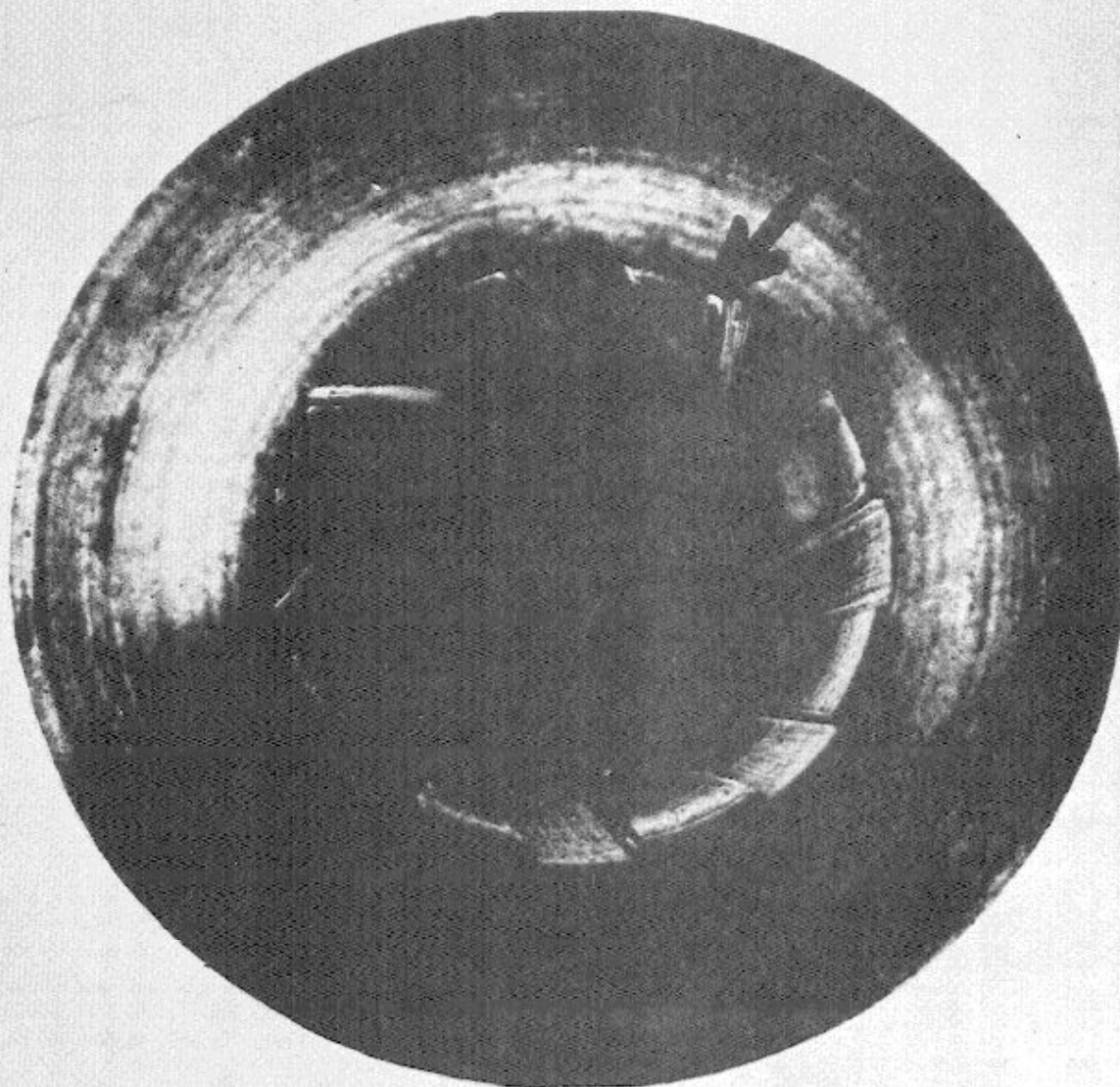


Fig. 15.

from the Cooley Company, have been test-fired many times since they were received in 1940.

Some of the test bullets were submitted to a microscopical examination and comparison. The B_1 and B_2 characteristics have persisted. Recently two test bullets were fired (into water) from each barrel and recovered. One of the two bullets from barrel 1 and from barrel 2, picked at random, were submitted to a microscopical comparison. In Figs. 3 to 10 note the reproduced B_1 and B_2 characteristics in the land engravings.

The same bullet from barrel 1 and a bullet from barrel 3 were then compared. See Figs. 11 to 14, which illustrate the reproduction of B_1 and B_2

characteristics in land engravings 1, 3, 5 and 7.

It will be noted from the comparison in Fig. 3 that there is a wide B_1 characteristic on both edges of the land engravings of the two bullets, the engraving opposite the driven edge being the wider. By determining the relative position of these characteristics, and other B characteristics in other land engravings, it is possible to identify the land in the barrel which cut this engraving. Barrel 1 was chosen for further study. See Fig. 15. The land under review is slightly to the right of 12 o'clock. A section of the barrel approximately 1" from the muzzle was cut away and then cut longitudinally to expose this land. See Fig. 1. Note

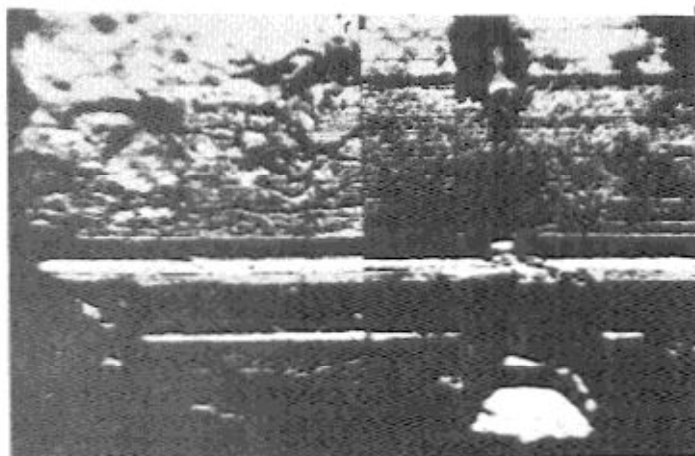


Fig. 16. Photomicrograph (X 51.0). Land engraving 3, bullets 1 and 2, barrel 3.

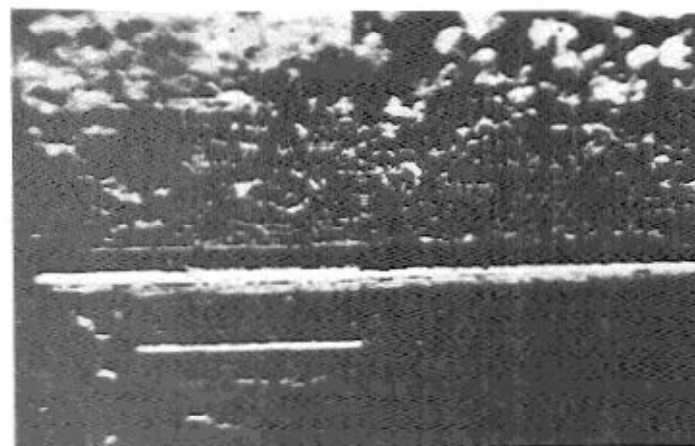


Fig. 17. Photomicrograph (X 51.0). Land engraving 3, bullet 1, barrel 3; land engraving 3, bullet 1, barrel 2.

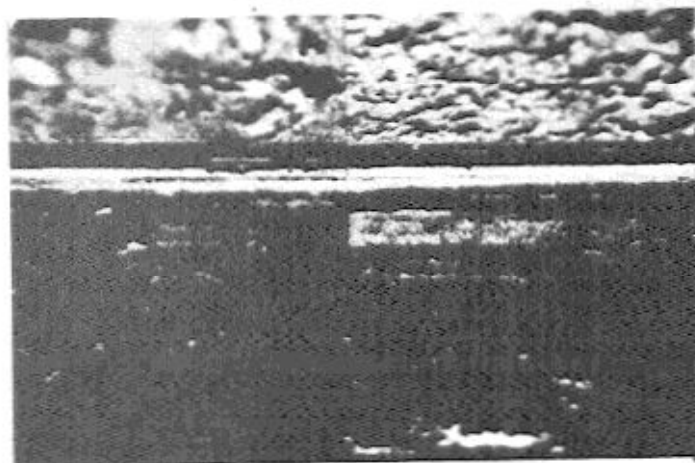


Fig. 18. Photomicrograph (X 51.0). Land engraving 3, bullets 2 and 1, barrel 2.

the fold of metal which engraved the B_1 characteristic under review, also the transverse reamer marks. This section of barrel was smoothed off at one end and a photomicrograph made to illustrate the fold of metal onto the land edges. See Fig. 2. Note the slight separation between the fold of metal on the right and the land surface. The width of this B_1 characteristic would be equal to the width of the widest portion of the folded metal on the land.

"A" OR ACCIDENTAL CHARACTERISTICS:

A characteristics are those elements of the signature caused by imperfections of a given bore. They may be attributable to the tearing of the metal at time of rifling, or erosion or corrosion. The A characteristics, which by reason of their origin constitute elements of identity, appear on properly-sized bullets fired from a given firearm. The number of bullets on which any one, or a group, of such characteristics will appear, will vary according to conditions and the circumstances surrounding their causation.

A characteristics may be found on land engravings between the B characteristics, where they may be the resultant effect of irregularities on the reamer-marked surface of the land, and in and on the B_1 and B_2 characteristics at the edge of land engravings.

Such engravings however require careful scrutiny under reasonably high magnification, otherwise a fine B characteristic might be incorrectly classified.

The A characteristics in land engraving No. 3 on two bullets from barrel No. 3 were compared. See Fig. 16, and note the fine cut-like stria opposite the letter N.

The bullet from barrel No. 3 was then compared with a bullet from barrel No. 2, and the same area on land No. 3 was examined and compared. See Fig. 17 and note the disagreement in A characteristics.

The barrel No. 3 bullet was removed and the other No. 2 barrel bullet was mounted in its place. See Fig. 18. It will be noted that the group and arrangement of corresponding A characteristics in the B_2 characteristics differ from those illustrated in Fig. 16. The fine line opposite the letter N in Figs. 16 and 17, appears in the signature of both barrels and could be misinterpreted by an inexperienced investigator.
