Perplexing Ballistic Identification Problems with Contemporary Hi-Point C9, 3-Left 9mm Pistols

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ABSTRACT

A unique change in the rifling characteristics of 9mm Hi-Point pistols to 3-left was introduced in September of 2011 with C9 pistol number P1622200, making it an easy classification task for forensic firearms examiners in no-gun cases when presented with fired bullets bearing these general rifling characteristics. Associating fired bullets with the responsible pistol, however, is often no easy matter, and in fact, may not be possible in some cases. This is due to the minimal engagement between common 9mm bullets and the three lands in these pistols. Only very small areas immediately adjacent to the driving edges of the lands display striae. These striae often fail to exhibit patterns of suitable reproducibility necessary for identification purposes. The brand of ammunition also plays an important role in the production of any reproducible striae patterns on fired bullets, adding another level of difficulty for the firearms examiner if the brand of ammunition involved in a shooting incident is unknown or uncertain. This brand sensitivity remains true even when the bullets of different brands have the same basic jacket composition, weight, diameter, length of the bearing surface and comparable muzzle velocities. This research addresses three subjects: 1) the settling-in process for five, consecutively-manufactured, button-rifled, 3-left C9 barrels, 2) the difficulties in associating fired bullets with the source pistol, and 3) the presence or absence of subclass carryover between consecutive 3-left C9 barrels.

Introduction

It quickly became apparent during test-firing of an evidence C9 Hi-Point pistol received in 2016 that successful matches of the very limited striae patterns generated by the driving edges of the 3 lands was dependent on the brand of fired ammunition. **Figure 1** provides a typical example of a fired 9mm bullet from a 3-left, C9 barrel. The striated area in the yellow rectangle is approximately 0.014-inches in width, whereas the lands in these barrels are approximately 0.132-inches in width. A simple calculation (0.014/0.132 x 100%) will reveal that the available area in which the examiner can work represents less than 11% of an actual land width.

A total of seven ammunition sources were ultimately employed in the study of the submitted evidence pistol, two reference pistols, and five consecutively manufactured 3-left, Hi-Point barrels obtained by this writer during the lengthy investigation associated with a criminal case.

The brands and types of bullets involved in these tests were:

- •Blazer Brass 115gr full metal-jacketed, round nose (FMJ-RN),
- •Federal 115gr FMJ-RN,
- •Fiocchi 115gr FMJ-RN,
- •Independence 115gr FMJ-RN,
- •Remington 115gr FMJ-RN,
- •Winchester 115gr FMJ-RN, and
- •Winchester 124gr FMJ-RN

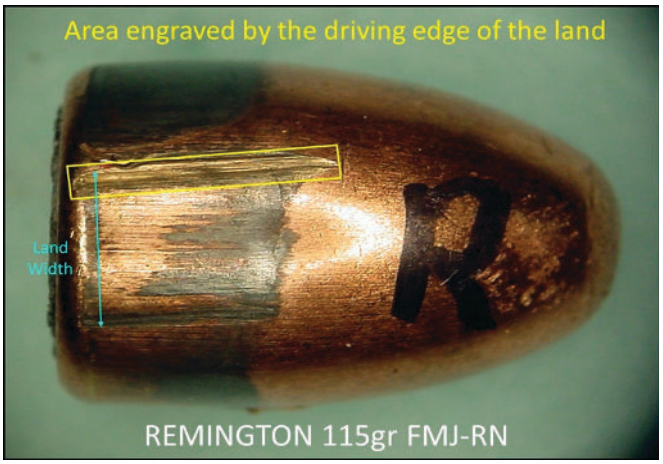

Figure 1

Suitable matches for test-fired bullets from the evidence pistol were only obtained with the Federal, the Independence and the Remington brands of ammunition. The reason(s) for this sensitivity to the brand of ammunition remains unknown at the time of this writing (June 2020). This was particularly bothersome for at least 3 reasons:

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1. All of the bullets in these seven sources were copper-jacketed bullets of standard 0.355-inch (9mm) diameter.
2. The muzzle velocity values for the six 115gr loadings, determined with Doppler radar, were in good agreement with each other and all bullets were adequately spin-stabilized in flight by the 3-L rifling in C9 pistols.
3. The brand of the recovered evidence bullets (115gr FMJ-RN) was unknown.

Matters were further complicated because no fired cartridge cases were recovered at the multiple shooting scenes.

Background Information

In September of 2011, at serial number P1622200, Hi-Point Firearms in Mansfield, Ohio began rifling their C9, 9mm pistols with three (3) lands and grooves and a left twist with land widths of approximately 0.13-inches (3.3mm) (2016 personal communication with Mike Strassel; unreferenced). This rendered the general rifling characteristics (GRCs) unique among firearms in this caliber at the time of this investigation.

As with Hi-Point's previous manufacturing practice, the breechfaces of the 'new' pistols continued to be intentionally roughened slightly leaving an array of 6 o'clock to 12 o'clock toolmarks to aid forensic firearms examiners in associating fired cartridge cases with the specific firearm. As a consequence, matching cartridge cases from their C9 pistols continues to be straight-forward and quite easy, but the matching of bullets to a particular C9 pistol was found to be challenging to impossible. Common 9mm jacketed bullets of 0.355-inch diameter very seldom contact the relatively deep grooves. Moreover, only the driving edges, and occasionally the trailing edges, of the lands contact these bullets to such a degree as to leave arrays of striae of potential identification value. Land width measurements, when available or apparent, were often found to vary considerably among test-fired bullets. Some values exceeded the actual land widths, strongly suggesting slippage to be a factor.

An excellent and very thorough description of the manufacture of the 3-left, 9mm Hi-Point barrels can be found in Scott Owens' article in the Fall 2017 issue of the AFTE Journal **[1]**. The author not only described, in detail, all of the steps in the manufacturing and button rifling of these barrels, but also conducted a study of five consecutively manufactured, 3-left, 9mm barrels. Owens' article effectively excluded any chance of subclass characteristics in these barrels and concluded that their working surfaces (the driving edges of the three lands), although very limited, are unique. Mr. Owens did, however, encounter a frequent inability to match sequentially fired bullets from some of these barrels.

Procedure

This writer purchased a new C9 9mm Hi-Point and promptly prepared a CerroSafe® cast of the bore near the muzzle. Measurements across a land to the opposing groove gave a value of 0.357-inches (9.07mm). This casting was trimmed to approximate the length of a 9mm bullet and scanned with the Evofinder® device which allowed for the land widths and depths of the grooves to be measured. These measurements produced values of 0.130-inches to 0.132-inches (3.30-3.35mm) for the land widths. These results are very close to those obtained and reported by Owens, which he derived from Mikrosil® bore casts. The Evofinder® value for the groove depth was 0.014-inches (0.36mm); a substantial value compared to more typical values of 0.004 to 0.005-inches (0.10-0.13mm) for other firearms, but one which is intentionally deep according to the manufacturer (done to reduce peak operating pressures in this straight-blowback pistol). **Figure 2**, prepared by the author, provides a cross-sectional diagram of a 3-left barrel and the measurements derived from the previously described bore castings.

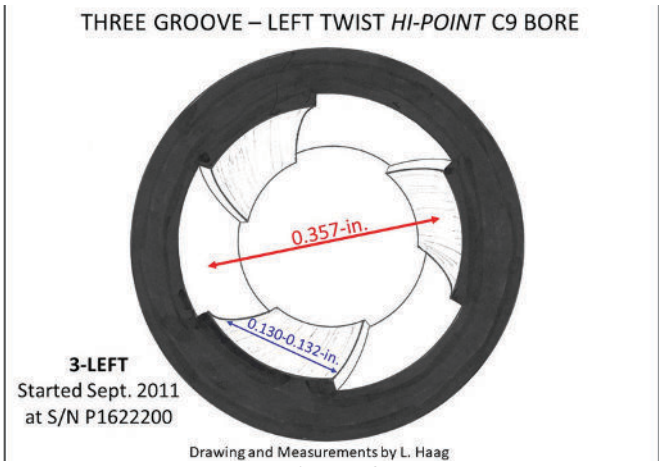

Figure 2

A second, new C9 pistol was obtained along with five (5) virgin barrels which were provided by the manufacturer and stamped "1" through "5" on the right side of the chamber area. An examination of the bores of these barrels quickly revealed that the black epoxy coating given to new barrels was undisturbed. According to the manufacturer (2017 personal communication with Mike Strassel; unreferenced), this coating is added to each new barrel following the rifling and chambering process. It may or may not be effectively removed from the bore by the manufacturer's test-firing process involving the discharge of four (4) rounds of 9mm ammunition. This raised a question as to any influence this coating might have on the striated toolmarks on the first few bullets fired through a new barrel, and how these toolmarks might change with continued use of a C9 pistol.

Phase 1 of the Procedure

A new Hi-Point C9 pistol with the 'new' 3-left rifling was purchased, serial number P19234--, manufactured on November 10, 2015. A right-side view of this pistol with the slide removed is shown in **Figure 3**. According to the manufacturer, each C9 pistol is test-fired four (4) times before it leaves the factory. Therefore, the first five shots through this pistol by this writer stand to be the 5th through 9th bullets to journey down the bore of this pistol.

Figure 3

Before any test shots were carried out, a full length bore and chamber cast was made with the AccuTrans® device and its brown silicone rubber medium. This product was preferred in this instance because a full-length cast with CerroSafe® would be difficult to remove. This was also carried out for the five virgin barrels obtained from the manufacturer. The casting results for four of the five virgin barrels are shown in **Figure 4a**. The assembled C9 pistol containing barrel number 5 with the previously-manufactured barrels 1 through 4 appear in **Figure 4b**.

The ammunition used for this and all subsequent test shots was Remington product L9MM3 loaded with 115-grain (7.5g) full metal-jacketed, round nose (FMJ-RN) bullets of 0.355-inch diameter. This commercial ammunition produced some of the best, most reproducible arrays of matching striae on test-fired bullets from these barrels as well as the barrel in the evidence 2016 pistol. Ten rounds of this ammunition were disassembled and found to be loaded with 5.6-grain charges of a flattened ball propellant. The flat-based, FMJ-RN bullets weighed an average of 114.7 grains (high 114.8 – low 114.6gr).

Exterior Ballistic Performance

The first five bullets fired from the purchased C9 pistol with its original barrel were collected from Forensic Science Services Inc.'s (FSSI) water tank and marked in accordance with their sequence. Prior to discharge, index marks were placed on these five bullets and cartridge cases so that they could be aligned "in phase" when compared microscopically. This was also done for the five initial test shots from each of the five virgin barrels.

Figure 4a

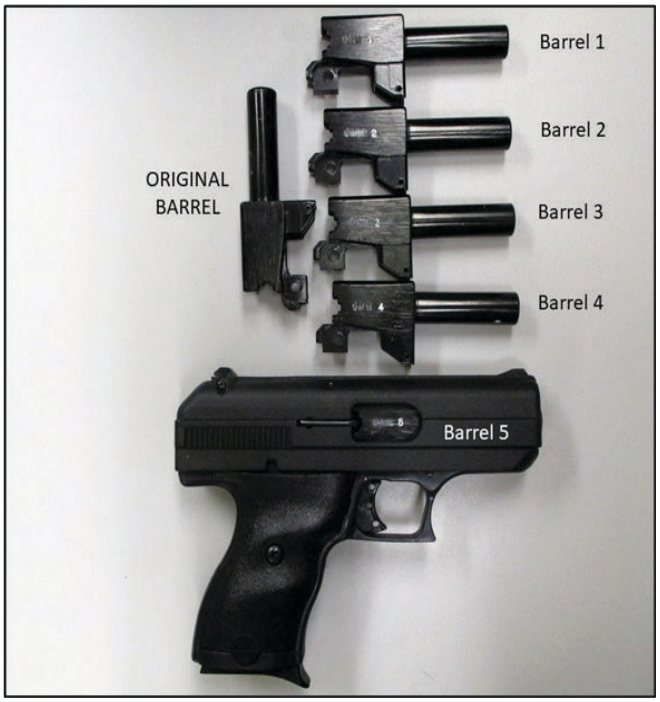

Figure 4b

The purchased C9 pistol was fired 10 more times as a part of the settling-in process before obtaining the average velocity for 5 shots from this pistol-ammunition combination using an Infinition® Doppler radar system. This allowed for a measurement of muzzle velocity as well as the in-flight stability of the bullets. The latter was determined from the velocity versus distance plots. The effective ballistic coefficient (BC), based on the G1 drag model, was also calculated for each shot from the muzzle velocity value and the downrange value listed in the velocity versus time plot. These G1BC results were compared to those obtained with a Glock 17, an S&W M39 and a Beretta 92FS discharged with the same Remington reference ammunition and the same physical setup. The results are shown in **Table 1**. The G1BC values provide some insight as to these bullets' in-flight stability with the higher BC (produced by shots from the Beretta 92FS) indicating the best in-flight stability.

Additional Striae Comparisons

Subsequent to these velocity tests, ten more Remington 115-grain (7.5g) bullets were collected, representing shots 25 through 34 following the purchase of this pistol and inclusive of the presumed four shots by the manufacturer. These specimens were also scanned with the Evofinder® device followed by comparisons with the first five test-fired bullets obtained from this purchased C9 pistol. This quickly revealed continued changes beyond the 5th bullet in the meager striae arrays at the driving edges of the 3 lands.

For the purposes of this article, it was deemed more useful to illustrate these changes with a limited number of the virgin barrels. **Figure 5** provides a vertical montage of Evofinder® scans of the 'best' land impression for Shots 1,2,3,4,5 and 30 from Barrel 1. As can be seen, there is no agreement between Shot 1 and 2 and only some similarity between Shots 2,3,4 and 5; none of which rises to the level of an identification. Two measurements of the areas containing striae (0.009-inches and 0.011-inches, 0.23mm-0.28mm) would represent less than 9% of the full width of a land impression had one been produced in these bullets. Shot 5 versus Shot 30 displayed no agreement and the striated area in Shot 30 appears to be narrowing. **Figure 6a** shows a comparison for Shot 29 versus Shot 30 from this same barrel (Barrel 1) in which there is at best, a two-consecutive striae match. **Figure 6b** illustrates a comparison between Shot 29 versus Shot 35, where there is a somewhat improved correspondence rising to at least five consecutive striae- not sufficient if one utilizes the quantitative

INFINITION® DOPPLER RADAR RESULTS

PISTOL	MUZZLE VEL.	100yd VEL.	CALC. G1BC
Hi-Point C9	1067f/s	916.1f/s	0.132
"	1049f/s	897.7f/s	0.123
"	1014f/s	880.8f/s	0.126
"	1036f/s	888.5f/s	0.121
"	1076f/s	915.2f/s	0.126
	1048f/s±25f/s		**0.126±0.004**
Beretta 92FS	1075f/s	933.5f/s	0.149
"	1108f/s	945.4f/s	0.141
"	1093f/s	938.1f/s	0.142
	1092f/s±17f/s		**0.144±0.004**
Glock 17	1127f/s	933.7f/s	0.120
"	1130f/s	942.3f/s	0.126
"	1140f/s	947.2f/s	0.126
	1132f/s±7f/s		**0.124±0.003**
S&W M39	1089f/s	928.0f/s	0.133
"	1085f/s	911.6f/s	0.118
"	1104f/s	945.7f/s	0.144
	1093f/s±10f/s		**0.132±0.013**

Table 1

consecutive matching striae (QCMS) approach to firearms identification. **[2,3]**

Shot 29 displays a much wider area of striae than any of the previous illustrations which is not represented in Shot 35- just another one of the perplexing difficulties with the 3-left C9 pistols. No agreement whatsoever was found in the other two land impressions for these two bullets. These last two examples support the need to fire three, four, or perhaps more bullets through one of these 3-left, C9 pistols to fully appreciate the ease (not likely) or difficulty (likely) in matching test-fired bullets from these pistols to the source firearm. Ammunition brand sensitivity also must not be forgotten with these pistols.

Phase 2 of the Procedure

A second C9 pistol was obtained directly from the manufacturer along with five (5) consecutively rifled barrels stamped 1 through 5 in addition to the one in the pistol. These were previously shown in **Figure 4b**.

At this writer's request, no factory test-firings were carried out with this pistol nor with any of the consecutively numbered barrels. This would allow a definitive assessment of the "settling in" process as a consequence of bullet passage through the bores of these virgin barrels. Likewise, the issue of subclass characteristics and/or carryover of toolmark patterns from the common rifling tool to the fired bullets could be evaluated in this Phase 2 procedure.

This was initially addressed by casting the full-length bores and chambers of the five barrels with the AccuTrans® product. CerroSafe® alloy casts were also taken at the muzzle end of these barrels. The toolmarks produced by the button rifling broach used to rifle these barrels were inter-compared.

Five (5) test-fired Remington 115-grain (7.5g) FMJ-RN bullets were initially collected from each virgin barrel, after which 15 to as many as 30 additional shots were fired to ensure that the "settling-in" process was complete. The exact number of shots was based on the results from the Phase 1 tests, which indicated a minimum of 15 shots effectively completed the "settling-in" process.

Phase 3 of the Procedure

At least one test-fired Remington bullet from each of the five consecutive barrels showing reproducible arrays of striae

Figure 5 : Stacked digital scans for bullets from Barrel 1

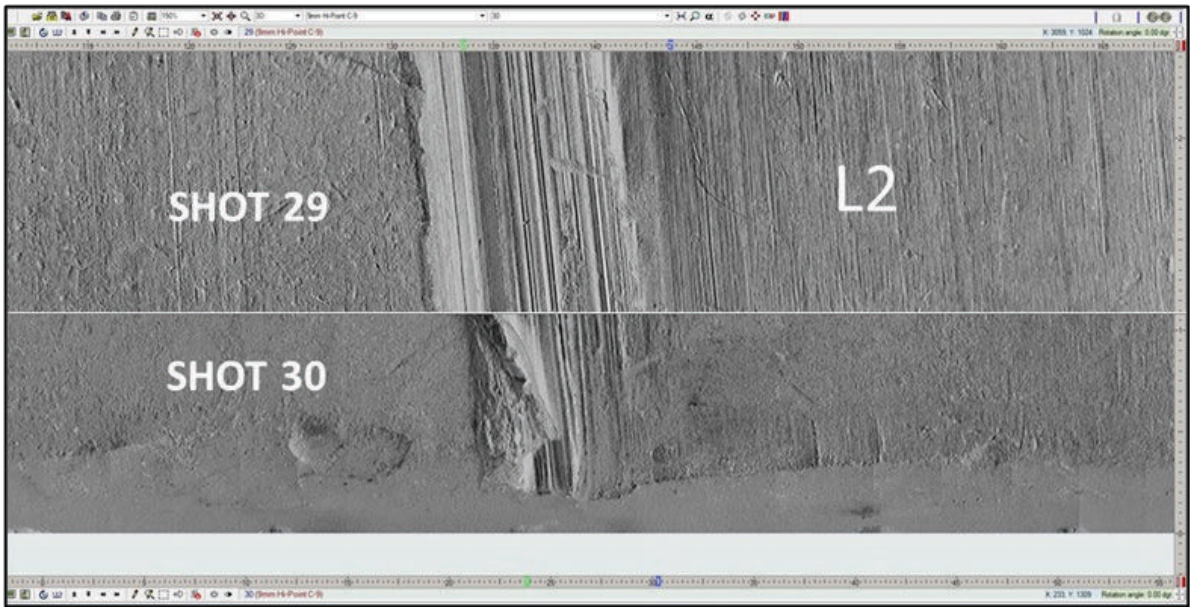

Figure 6a: Digital scans for shots 29 and 30 from Barrel 1

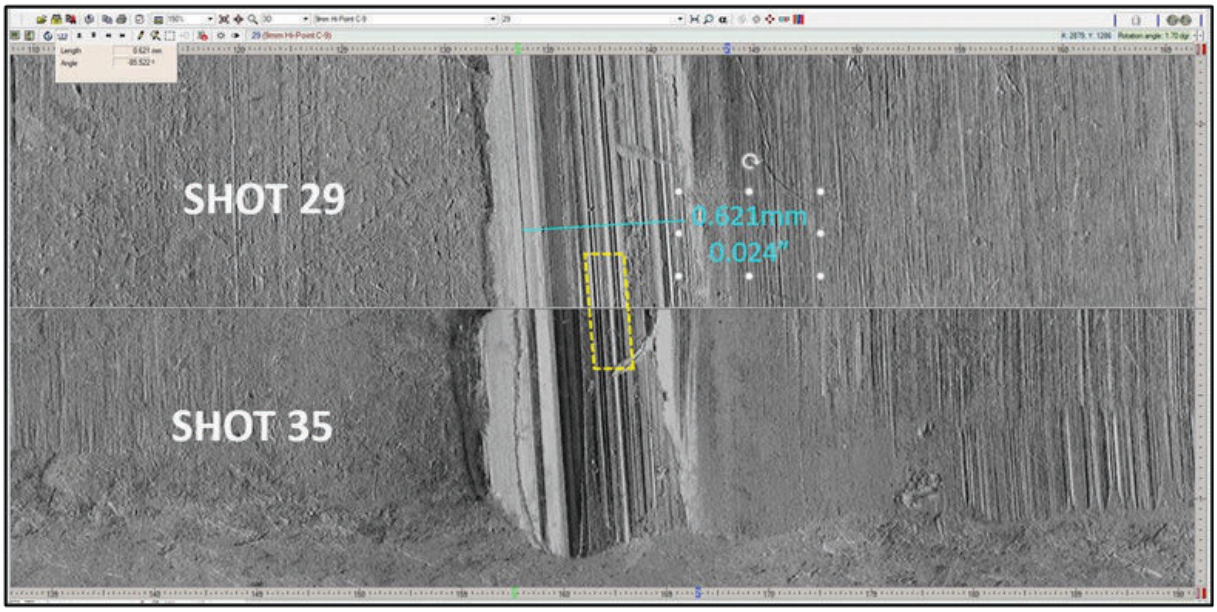

Figure 6b: Digital scans for shots 29 and 35 from Barrel 1

were inter-compared in the following way:

Barrel 1 versus Barrel 2, 3, 4 and 5; Barrel 2 versus Barrel 3, 4 and 5; Barrel 3 versus Barrel 4 and 5; Barrel 4 versus Barrel 5. All these bullets were obtained after 25 to 35 shots through each barrel.

The best "matches" were selected from the numerous comparisons for use as illustrations for Phase 3.

Results-Phase 1

As a side note, cartridge case matching via the manufacturer-induced breechface toolmarks was easy and straightforward whether one used a conventional optical microscope or the imaging capabilities of the Evofinder® device. This came as no surprise given the fact that the Hi-Point company deliberately roughens the beechface of these pistols in an effort to assist forensic firearms examiners in identifying the

specific pistol used in a crime.

No examples are provided here because the focus of this article was on bullets fired from these pistols.

Test-fired bullets from all five of the virgin barrels and the "as received" barrel in the purchased C9 pistol showed minimal to poor engagement of the lands. Only very narrow areas containing striae were present immediately adjacent to the driving edges of the three lands. The trailing edges of the lands seldom registered on these bullets. When there was visible indications of contact and land impression width measurements were subsequently taken, they often differed greatly from the true width of the lands. This was believed to be the consequence of varying amounts of slippage.

It was not possible to set a specific number of shots needed to definitively establish the completion of any "settling-in" process, but 5 to 10 shots seem reasonable. Part of the difficulty in attempting to do so should be apparent when one compares previous **Figure 6a and Figure 6b**. Test-fired bullets which were only 1 shot apart (Shot 29 versus Shot 30) showed, at best, two consecutive matching striae in Figure 6a. However, Shot 29 versus Shot 35 (six shots apart) displayed much better agreement. The take-away from these illustrations and the numerous scans made on test-fired bullets from the other barrels is that even when the brand of ammunition in a case under investigation is known, as many as 5 to 10 test-fired bullets may be needed to adequately assess the reproducibility, if any, by the evidence pistol and whether any patterns of reproducible striae rise to a suitable level to constitute an identification. **Table 2** summarizes the comparisons between the test-fired bullets from Barrel 1.

TABLE 2
RESULTS for VIRGIN BARREL 1

1≠2	
2≈3	
3≈4	
4≈5	KEY
1≠5	≠ No Correspondence
5≠26	
26≈27	≈ Some matching, but insufficient for an identification whether by pattern matching or by QCMS.
27≈28	
28≈29	
29≠30	= Identification by pattern matching and by QCMS.
30≈31	
31≠32	
32≈33	
33≠34	
34≈35	
26≈31	
27≈31	

Table 2

Results-Phase 2

Common 9mm bullets from these 3-left, C9 barrels revealed that only a small area of driving edge of each land marked these bullets. No contact with the grooves occurred with any of the pistols or barrels tested when ammunition with 0.355-inch (9mm) bullets were discharged through them. This was also true for a 3-left, C9 Hi-Point in the author's reference collection and an evidence pistol received in casework. As stated earlier, **Figure 1** provides a typical example of a fired 9mm bullet from a 3-left, C9 barrel.

No doubt many readers have little or no familiarity with the Evofinder® device and how scanned images with this device compare to traditional optical microscopy. **Figure 7a** depicts a traditional comparison between two test-fired bullets from Barrel 2 collected well after the "settling-in" process was complete. **Figure 7b** shows this same approximate area for these two bullets when scanned with the Evofinder® device. The measurement values in this figure quantify the substantial width differences in these striated areas. **Figure 7c** provides a view of the complete bearing surfaces of these two consecutively fired bullets from Barrel 2. A measurement of the apparent land width of 0.159-inches (4.04mm) is included in this figure. This reaffirms the fact that slippage is occurring with 9mm bullets fired through these barrels when one is reminded that the actual land widths measure 0.130 to 0.132-inches (3.30mm-3.35mm). The "1" and "2" entries in these figures do not translate to the first and second shots fired through this barrel. Rather they were collected well after

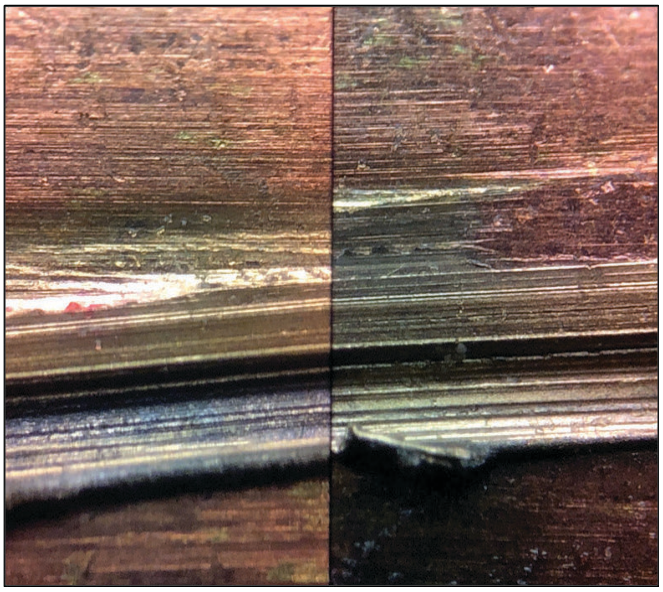

Figure 7a: Best 'match between two test-fired bullets from Barrel 2. Photo-micrograph by Michael Haag – Leica FS C

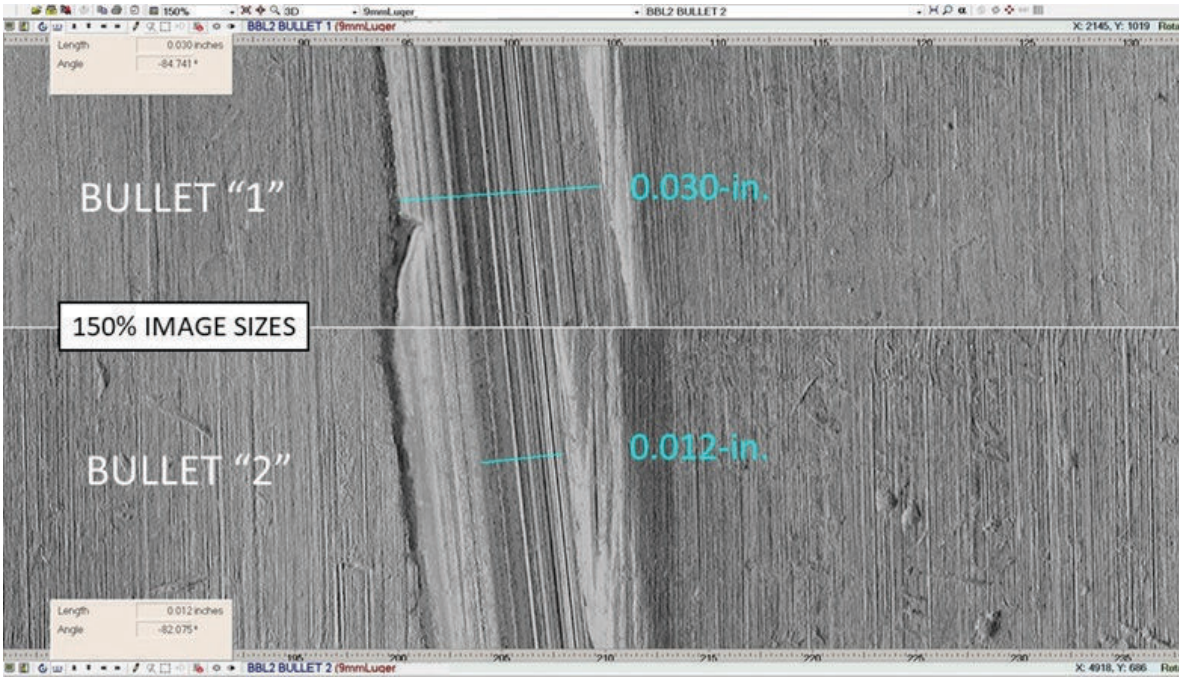

Figure 7b: Best 'match' between two test-fired bullets from barrel 2. Note: These are sequential bullets fired well after the "settling-in" process was complete. They are not the first and second bullets fired through Barrel 2.

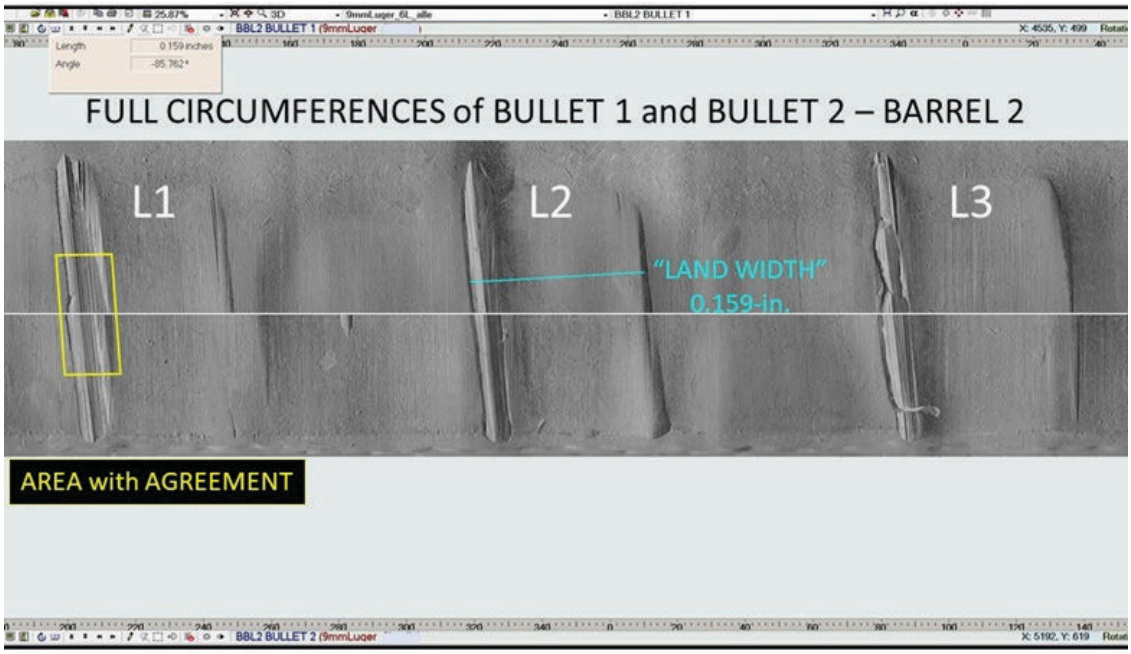

Figure 7c

the "settling-in" process was complete and merely represent consecutiveness.

The pistols and barrels tested here were also found to be ammunition sensitive insofar as the ability or inability to match test-fired bullets. By way of example, **Figure 8** shows a reasonably satisfactory match between two Remington brand 115-grain (7.5g) FMJ-RN bullets fired from the submitted evidence pistol. Note the substantial differences for the measured widths of these striated areas. The matching of these two test-fired bullets was only possible with one of the three land impressions. This has important and serious implications if this land impression becomes obliterated on an evidence bullet as a result of terminal ballistic damage. No suitable match could be found between test-fired Blazer Brass, Fiocchi or Winchester bullets of the same bullet weight, design and nominal muzzle velocity. The 124-grain Winchester bullet fared no better. This brand sensitivity also applied to the five consecutive barrels. If this is to be a recurring phenomenon with other 3-left Hi-Point C9 pistols, it presents an additional difficulty for firearms examiners when the brand of recovered evidence bullets is unknown or uncertain. It also means that in the absence of reliable information regarding the specific brand and loading of ammunition involved in a crime, the forensic firearms examiner in the laboratory may arrive at an inconclusive result when another brand of ammunition is used to prepare test specimens.

Results-Phase 3

Each of these barrels acquired a relatively stable "identity" (reproducible arrays of striae in at least one driving edge land impression) in as few as five shots and clearly after 25 shots.

Just as with the submitted evidence pistol, several of these barrels only produced a single driving edge impression suitable for comparison purposes.

The closest "matches" among these inter-barrel comparisons consisted of two, possibly 3 at the most, consecutive striae. **Figure 9 and Figure 10** represent the best of these, both of which fall far short of a "match" whether by pattern matching or QCMS.

The lack of a clearly defined driving edge for these very limited areas of striae often prevents a reliable registration point for initiating a traditional comparison. This stands to increase the possibility of a mis-identification because the examiner is free

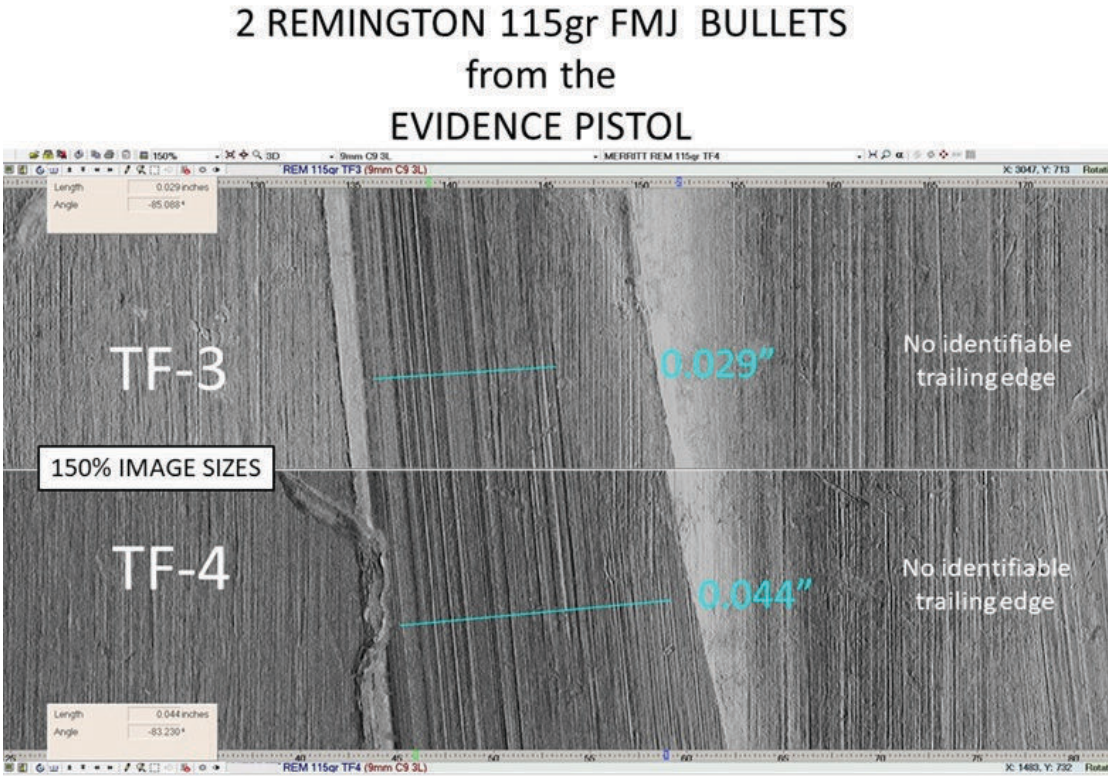

Figure 8

to manipulate the meager striae arrays with little or no means of assuring that any presumed match is actually in register.

Summary

The possibility of subclass carryover was excluded given the results of Scott Owen's previous research and the observations made here. The success of firearm identification

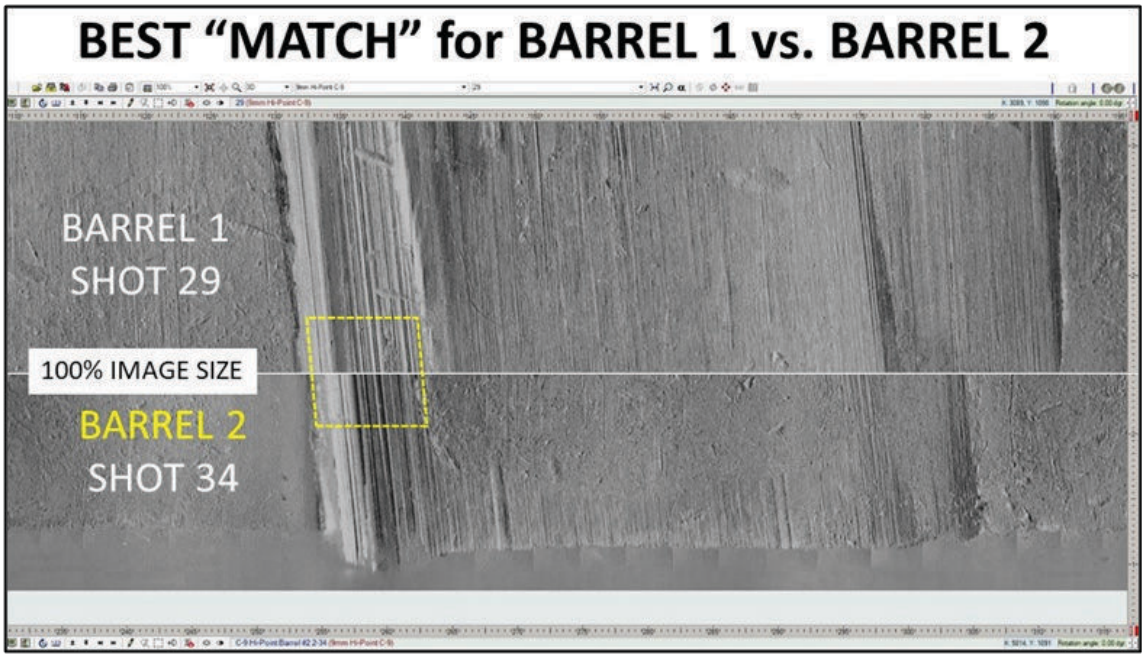

Figure 9

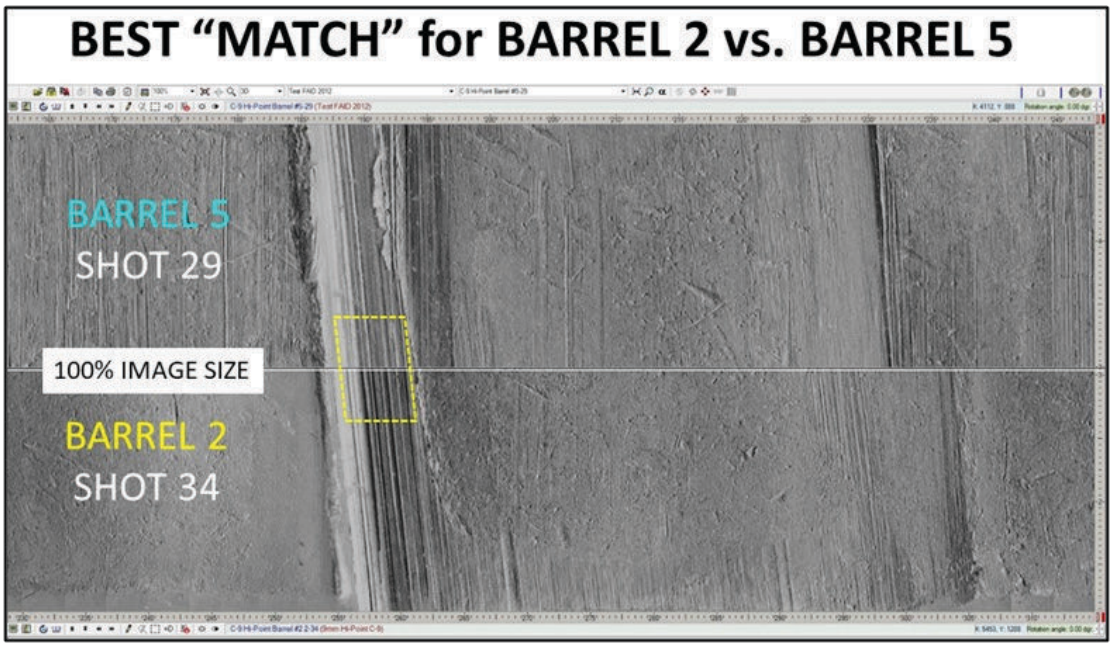

Figure 10

efforts with these pistols is, in large part, dependent on the brand of ammunition. Internal ballistic differences, i.e., firing Remington 115-grain bullets with different propellants (i.e., Red Dot, Bullseye, Unique and several others), generating differences in pressure curves, were excluded as the cause for this ammunition dependency. Suitable matches between test-fired Remington bullets launched by different propellants were obtained. The reason(s) for this brand sensitivity remains unknown. Muzzle velocity differences and/or internal ballistic pressure curve differences did not explain it.

Close examination of the full-length bore casts of the five consecutively button-rifled barrels revealed no evidence of any subclass features. None were observed during the comparisons of test-fired bullets from adjacent barrels.

Inspecting common 9mm bullets fired through these 3-left, C9 Hi-Point barrels revealed that only a small area of driving edge of each land engraved these bullets. These land impressions often represented less than 10% of the full land width. Measurements revealed these striated areas to range from 0.009-inches to 0.024-inches (0.23mm-0.61mm) in width.

No contact with the grooves occurred with any of the pistols or barrels tested when ammunition with 0.355-inch (9mm) bullets were discharged through them. This was also true for a 3-left, C9 Hi-Point in the author's reference collection and an evidence pistol received in casework.

Nonetheless, test-fired bullets from each barrel could be matched, often with difficulty, to the source barrel after the settling-in process. This process required, at the minimum, approximately 5 rounds or more of full metal-jacketed ammunition to achieve. This matching, when it occurred, was limited to striae arrays in the very narrow, and often ill-defined land impressions immediately adjacent to the driving edges of one or more lands.

No matching beyond an occasional pair of fine striae was found between consecutively rifled barrels, i.e., barrel 1≠barrel 2, barrel 2≠barrel 3, and so on through all five barrels.

These results demonstrate that, as currently manufactured, the 3-left, button-rifled C9 Hi-Point barrels are unique, and no evidence of carry-over (subclass) characteristics was present.

In spite of the minimal engagement of the rifling in these 3-left barrels, all brands of fired bullets were adequately spin-stabilized in flight. As a consequence, entry gunshot wounds produced by bullets from a contemporary Hi-Point C9 pistol should have a normal appearance.

Examiners presented with C9 3-left bullets will need to make every effort to determine the brand of ammunition associated with a shooting incident. In the absence of such knowledge, multiple brands of ammunition loaded with the same weight, design and construction as the evidence bullet(s) will need to be employed for any hope of a successful comparison, assuming that the examiner is, in fact, in possession of the responsible pistol.

Comparisons between a minimum of at least five test-fired bullets are recommended to gain insight into the reproducibility, or lack thereof, of any matching arrays of striae in one or more of driving-edge impressions engraved in these bullets.

The lack of clearly defined driving edges and the corresponding absence of a reliable registration point for initiating a traditional comparison stands to increase the possibility of a mis-identification if the examiner relies on too few corresponding striae in these narrow and ill-defined areas of engagement between the bullet and the driving edges of the lands. Examiners confronted with evidence bullets likely fired from a 3-left, C9 Hi-Point should consider elevating his or her criteria for establishing an identity of source between test-fired bullets and evidence bullets.

Acknowledgements

Special appreciation must be recognized for the late Tom Deeb, former Hi-Point president, for his many efforts to aid forensic firearm examiners in their work. Special thanks are extended to the current company president, Mike Strassell, for the historic information provided for this study, the five consecutively rifled barrels, and a new C9 3-left pistol. These items were critical and fundamental to the purposes of this study.

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