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C. A. Grove,[1] *Ph.D.; Gary Judd,*[2] *Ph.D.; and Robert Horn,*[3] *B.S.*

Evaluation of SEM Potential in the Examination of Shotgun and Rifle Firing Pin Impressions

Recently the scanning electron microscope (SEM) was successfully used for an in-depth study of firing pin impressions of semiautomatic pistols [*1*]. The SEM's great depth of field was shown to reveal detail in the impression (far superior to optical microscopy) which could be successfully used for comparison purposes. It was thus the intent of this investigation to extend the work on pistols to shotguns and rifles, in order to see if their firing pin impressions possessed similar class characteristics and identifying features with repeated firings. In addition to this, the effect of preexisting primer marks on the resulting firing pin impression was also studied.

Experimental Procedure

The firing pin impressions from a total of twelve autoejecting shotguns and rifles were examined by SEM. Table 1 lists the manufacturer, model number, serial number, caliber, and number of test rounds fired for each of the weapons examined. The samples were prepared and examined in the same manner as described in the paper on semiautomatic pistols [*1*]. This examination consisted of observing the firing pin impression in an SEM (Materials Analysis Co.—Model 700) at an accelerating potential of 20 kV using 0-deg tilt at an approximate magnification of $\times 50$.

In order to determine the effect, if any, of preexisting primer marks on the subsequent impression, three .25 caliber cartridge casings were viewed in the SEM before and after firing. The cases were first manually unloaded and then the unstruck primers were characterized in the SEM. The cases were next reloaded, with care taken not to place any additional marks on the primer, and fired in a .25 caliber F.I.E. Titan semiautomatic pistol (same weapon as FM in Ref *1*). The exact area viewed in the unfired condition was then reexamined in order to see if the resulting impression were influenced by the pre-existing marks.

Results and Discussion

The criterion for identifying a positive comparison between firing pin impressions from shotguns and rifles was the same as in the previous investigation on pistols [*1*], namely,

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[1] Formerly, postdoctoral associate, Rensselaer Polytechnic Institute, Troy, N.Y.; presently, engineer, materials performance analysis, Knolls Atomic Power Laboratory, Schenectady, N.Y. 12301.

[2] Associate professor, Materials Division, Rensselaer Polytechnic Institute, Troy, N.Y. 12181.

[3] Senior firearms examiner, Firearms Section, New York State Police Scientific Laboratory, Albany, N.Y. 12226.

that the impressions have four or more individual characteristics (identifying features) in addition to similar class characteristics. Since it was necessary to establish a criterion for the samples studied in this investigation to ascertain whether or not a positive comparison between firing pin impressions existed, the number of persisting characteristics needed for positive identification was arbitrarily chosen as four. This arbitrary criterion is not meant to sanction any specific standard of identification. Thus, for this investigation only, a minimum of four identifying features was chosen as the criterion for making a positive comparison.

Figures 1*a*, 1*b*, 1*c*, and 1*d* show the first, second, tenth, and fiftieth, respectively, firing pin impressions from the top barrel of an over-under 20-gage Beretta Silver Snipe shotgun, as seen by the SEM. Because of the SEM's great depth of field, the entire impression is in focus at the same time, allowing many small surface defects to be clearly seen. Some of the characteristics that persist through this series of firing pin impressions have been labeled and can be seen by comparing areas indicated by the appropriate letters. When comparing Fig. 1*a* with 1*b*, 1*a* with 1*c*, and 1*a* with 1*d* using the above criterion, an identification can readily be made between them. The first and fiftieth impressions are match-

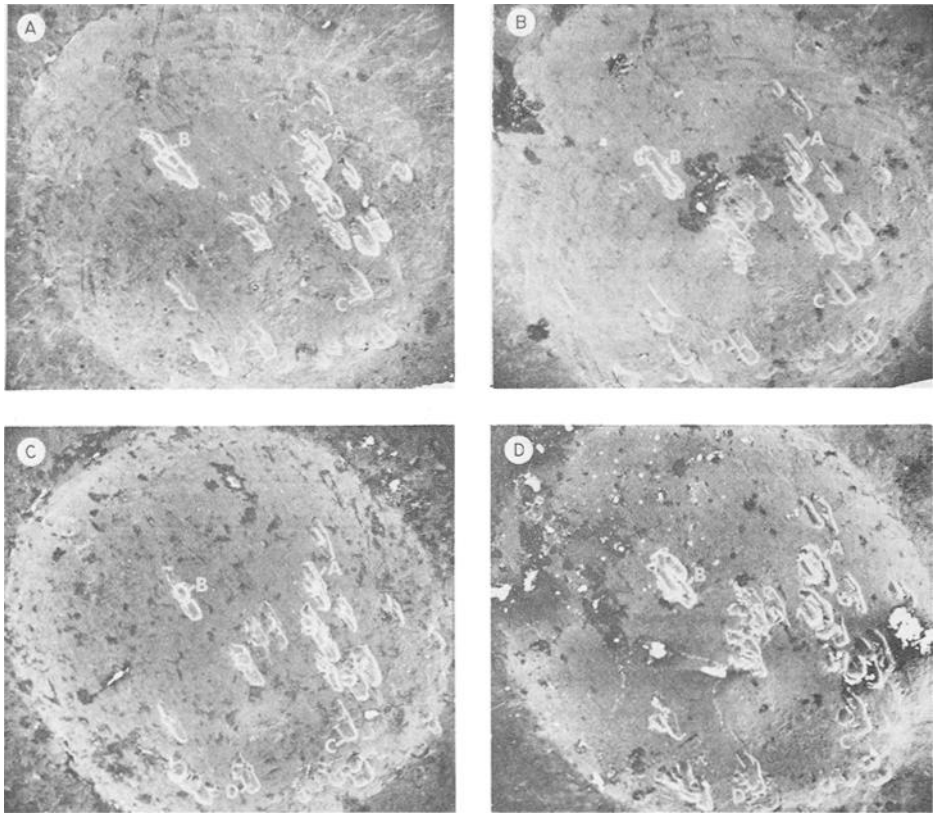

FIG. 1—*SEM image of firing pin impressions from an over-under 20-gage Beretta Silver Snipe shotgun (SG) from* (a) *first cartridge case fired,* (b) *second cartridge case fired,* (c) *tenth cartridge case fired, and* (d) *fiftieth cartridge case fired. Original magnification* ×60.

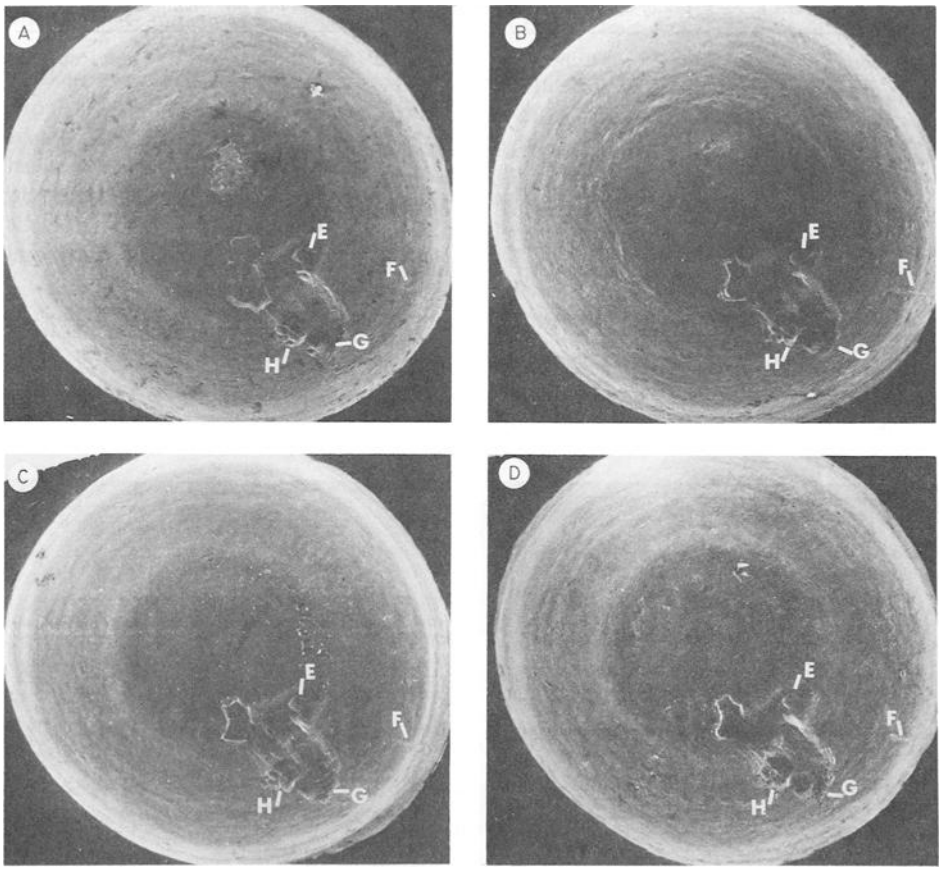

FIG. 2--*SEM image of firing pin impressions from a 5.56-mm Colt AR 15 rifle (RA) from* (a) *first cartridge case fired,* (b) *second cartridge case fired,* (c) *tenth cartridge case fired, and* (d) *fiftieth cartridge case fired. Original magnification* ×*60.*

able, demonstrating the consistence and reproducibility of the firing pin impression over a large number of firings, and the SEM ability to make these identifications feasible.

The firing pin impressions from the first, second, tenth, and fiftieth cartridge cases fired from a 5.56-mm Colt AR 15 (M-16) rifle on full automatic are shown in Figs. 2*a*, 2*b*, 2*c*, and 2*d*, respectively. These impressions all appear very similar in class characteristics with many small persisting details, and are extremely different from those of Figs. 1*a*, 1*b*, 1*c*, and 1*d*. On the basis of class, together with individual characteristics, a positive comparison of Fig. 2*a* with 2*b*, 2*a* with 2*c*, and 2*a* with 2*d* can be made. It might be expected that the first and fiftieth impressions would not match because firing in a fully automatic mode exerts forces on the firing pin, which could lead to rapid alteration of its topographical features. However, this is not the case, since the first and fiftieth impressions compare very well, as can be seen by examining Figs. 2*a* and 2*d*.

The firing pin impressions from another 5.56-mm Colt AR 15 (M-16) rifle can be seen in Fig. 3. Identification details are present between cartridge cases fired from this gun.

TABLE 1—*Types of autoejecting shotguns and rifles used in this investigation.*

Code	Manufacture	Caliber	Model	Serial No.	Test Rounds
SA	Ithaca	12 gage	37	963340	10
SB	Ithaca	12 gage	37	968042	50
SC	Ithaca	12 gage	37	963340	10
SD	Ithaca	12 gage	37	832803	50
SE	Remington	12 gage	870	1274060 V	50
SF	Remington	12 gage	870	376007 M	10
SG	Beretta	20 gage	Silver Snipe	01230 (top barrel)	50
SH	Beretta	20 gage	Silver Snipe	01230 (bottom barrel)	10
RA	Colt	5.56 mm	AR 15 (M-16)	709372	50
RB	Colt	5.56 mm	AR 15 (M-16)	173551	10
RC	Inland	.30 carbine	M 1	51965	50
RD	Winchester	.30 carbine	M 1	5551884	10

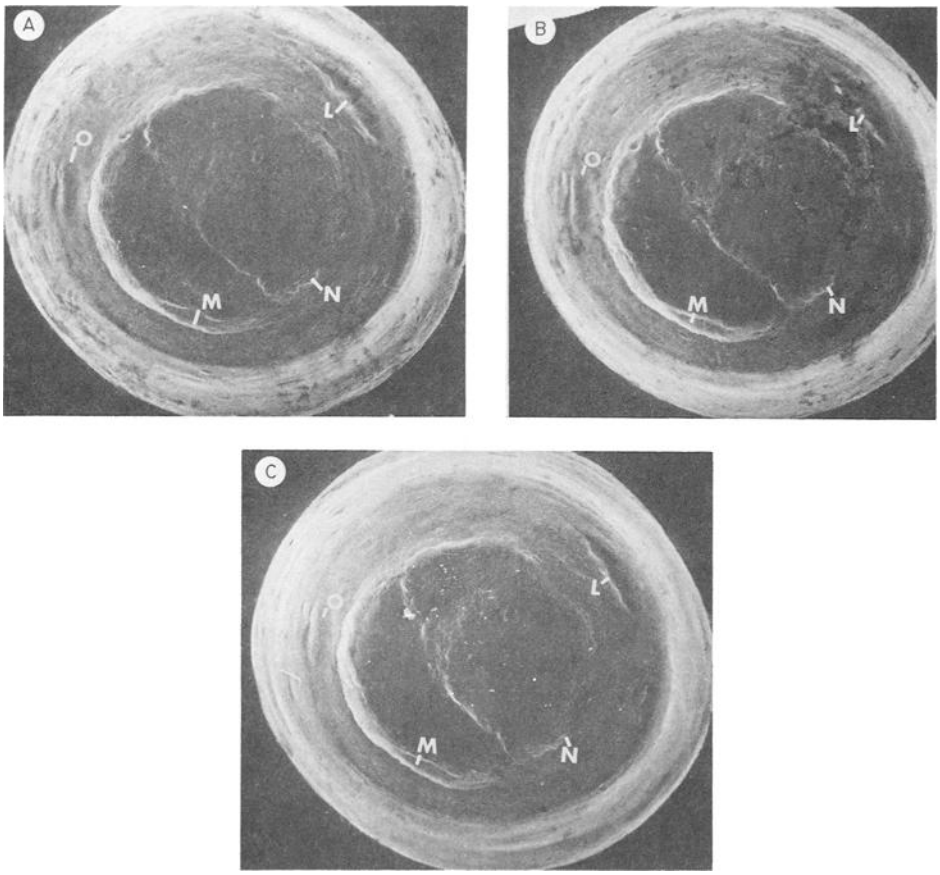

FIG. 3—*SEM image of firing pin impressions from a 5.56-mm Colt AR 15 rifle (RB) from* (a) *first cartridge case fired,* (b) *second cartridge case fired, and* (c) *tenth cartridge case fired. Original magnification* ×60.

In Table 2 the number of readily identifying features is listed for the twelve observed weapons. As indicated in Table 2, 50 percent of the shotgun impressions and 75 percent of the rifle impressions could be matched. Although these results were not as successful as those for the semiautomatic pistols [*1*], they represent an advancement in the current capabilities of firing pin analyses for these types of weapons. This advancement is due to to the extended depth of field and depth of focus capability over a wide magnification range of the SEM, which allows the firing pin impression to be entirely in focus. The firing pin impressions of the weapons that could not be matched generally were void of defects; that is, they were quite smooth, thus making identification based upon a criterion involving persisting details impossible.

TABLE 2—*Results of SEM investigation of shotgun and rifle firing pin impressions.*

Code	Comparison (Number of Identifying Features)		
	1st with 2nd	1st with 10th	1st with 50th
SA	4	4	[a]
SB	0	0	0
SC	2	2	[a]
SD	2	2	2
SE	0	0	0
SF	5	5	[a]
SG	>12	>12	>12
SH	7	5	[a]
RA	9	7	7
RB	11	11	[a]
RC	1	1	1
RD	5	4	[a]

[a] No examination was conducted.

The impressions from one gun had no individual characteristics in common with those from any other weapon. This indicates that the firing pin impression can be used to make an identification when individual characteristics are observed in the SEM.

Figure 4*a* shows the preexisting marks on the primer of a .25 caliber cartridge. Note the large groove, A, in the upper right-hand corner. After firing in an F.I.E. Titan .25 caliber pistol this groove is completely obliterated and replaced by the firing pin impression. The impression as seen in Fig. 4*b* has not been deteriorated by any of the preexisting marks, including the area of the large groove. All of the three primers examined in this manner showed no effect of preexisting primer marks on the resulting impression. Each of these three impressions could be matched to the impressions previously obtained for this pistol [*1*].

Summary

The first, second, tenth, and in some cases the fiftieth firing pin impressions on cartridge cases fired from a total of twelve shotguns and rifles were examined in the scanning electron microscope (SEM). The SEM images of the firing pin impressions proved to clearly reveal all of the surface detail in the impression. Fifty percent of the shotgun impressions and 75 percent of the rifle impressions could be positively identified on the basis of four or more individual characteristics, in addition to the similarity of class characteristics.

The effect of preexisting primer marks on the resulting firing pin impressions was investigated by examining several .25 caliber primers, before and after firing, in the SEM.

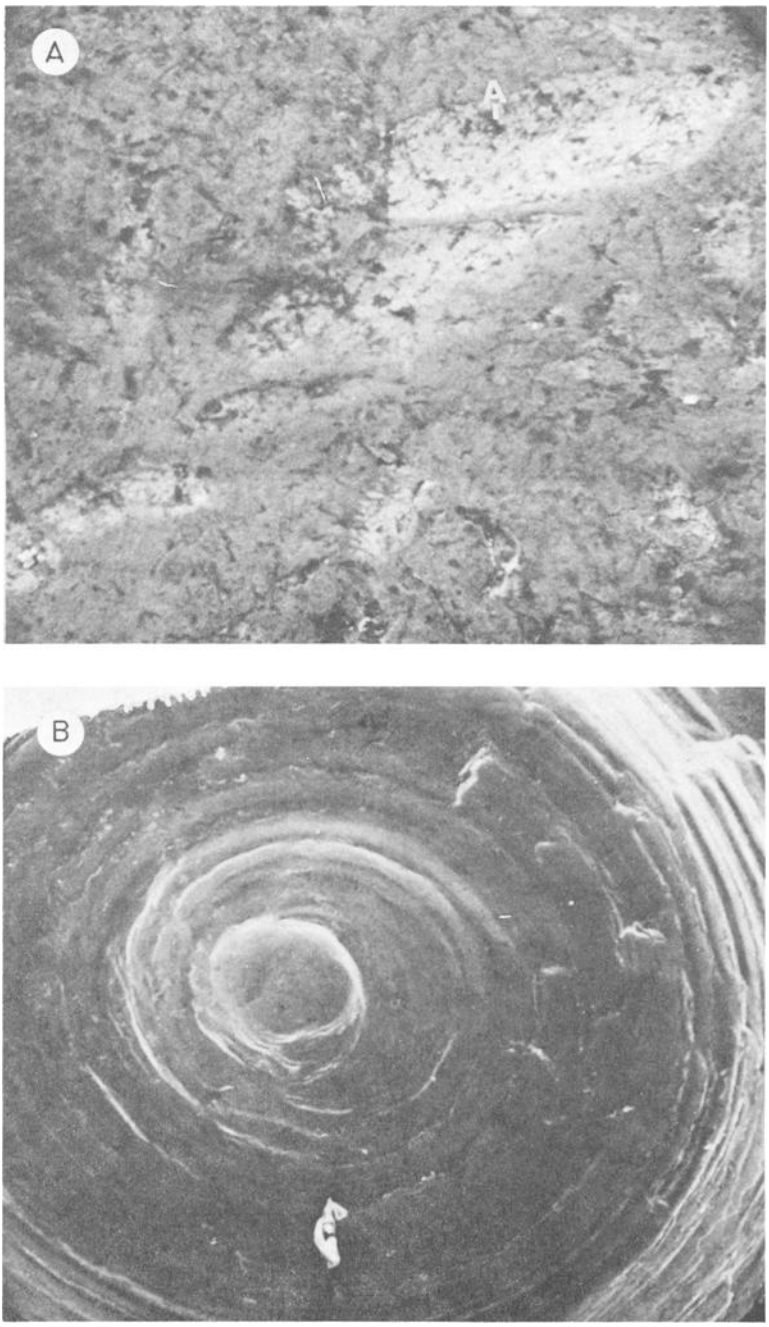

FIG. 4—*SEM image of preexisting primer marks of a .25-caliber cartridge and* (b) *SEM image of the same area, but after firing in a .25-caliber F.I.E. Titan pistol. Original magnification* ×*100.*

It was found that the preexisting marks did not cause artifacts on any of the firing pin impressions.

Acknowledgments

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Reference

[1] Grove, C. A., Judd, G., and Horn, R., "Examination of Firing Pin Impressions by Scanning Electron Microscopy," *Journal of Forensic Sciences*, JFSCA, Vol. 17, 1972, pp. 235–244.

Krolls Atomic Power Laboratory
Schenectady, N.Y. 12301