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Examination of Firing Pin Impressions by Scanning Electron Microscopy

Several investigations [*1–4*] have been conducted in order to show the applicability of the scanning electron microscope (SEM) to the forensic sciences including the examination of firing pin impressions. These studies have shown, for numerous types of physical evidence, the feasibility and potential of SEM. However, as of now, an in-depth examination of one type of physical evidence has not been done. Thus, it is the purpose of this investigation to do an extensive study of firing pin impressions to determine the reproducibility and reliability of SEM using a number of samples and to develop a criterion for comparing firing pin impressions.

Experimental Procedures

The firing pin impressions from a total of 16 semi-automatic pistols were examined. The manufacturer, model number, serial number, and caliber of the weapons examined are listed in Table 1. A series of up to 50 rounds were fired from each of these weapons. The ammunition was first labeled, fired, collected, and then cleaned ultrasonically in trichloroethylene and acetone. A small dab of conducting silver paint was used to electrically connect the primer and the case. The first, second, tenth, and in some cases the fiftieth firing pin impression were examined in an SEM[3] at a magnification of 50 under similar orientation, brightness, and contrast. The resulting images were photographed using Polaroid P/N Type 55 film and the negatives, which were far superior to the prints, were used in the comparison procedure. Several firing pin impressions were also examined optically so that a comparison between the optical and SEM techniques could be made.

Results and Discussion

Figure 1 shows a typical firing pin impression as seen through an optical microscope. A greatly improved photograph of the same impression is shown in Fig. 2. The latter image was obtained by using a diffuser in conjunction with three light sources. Because only a small portion of the impression is in focus even in the improved image, it is difficult to use this for comparison purposes. Figure 3*a* is the firing pin impression from a .32

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TABLE 1—*Types of semi-automatic pistols used in this investigation.*

Code	Manufacture	Caliber	Model	Serial Number
FA	Colt	.32	M	517120
FB	Colt	.32	M	133742
FC	Colt	.32	M	24193
FD	Colt	.32	M	425726
FE	Colt	.32	M	218736
FF	Colt	.32	M	381498
FG	Beretta	.32	1934	805434
FH	Beretta	.32	1934	832020
FI	Walther	.32	PP	318161P
FJ	Walther	.32	PP	383041P
FK	Luger	9 mm	08	6362g1917/DWM
FL	Luger	9 mm	08	1483i1917/DWM
FM	F.I.E. Titan	.25	...	B75859
FN	F.I.E. Titan	.25	...	A47228
FO	Colt	.45	1911A1	765027
FP	Colt	.45	1911A1	862806

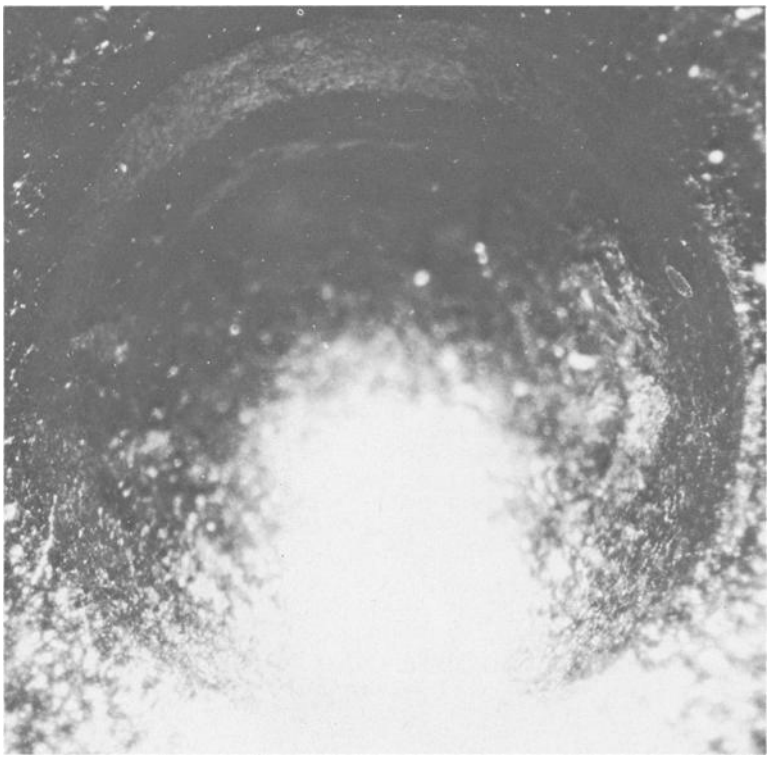


FIG. 1—*Optical microscopy image of a firing pin impression under normal lighting conditions.* ×51.

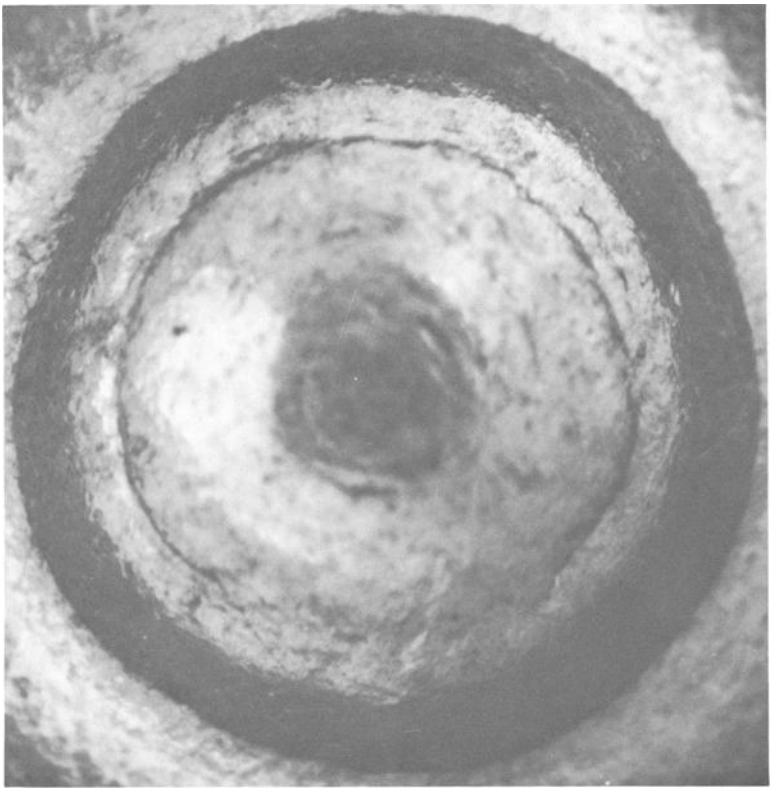


FIG. 2—*Improved optical microscopy image of a firing pin impression under oblique lighting conditions.* ×53.

caliber semi-automatic Beretta as seen by the SEM. The detail in this photograph is quite striking when compared with the optical images. The entire impression is in focus at the same time which allows many small surface defects to be seen.

There are two ways of looking at the SEM images of firing pin impressions when making a comparison between them. First, an overall view of the impression should be obtained and then, secondly, the various defects in the impressions should be compared as to shape and location. The criterion for identifying a positive comparison between firing pin impressions is that within a class of marks, individualizing details consisting of reproducible marks are present on all rounds fired. In this investigation, four or more persisting details (individual characteristics) in addition to the similarity of class characteristics were used as a basis for identification. (Four was the number arbitrarily chosen as a value for the number of persisting characteristics and is not relevant to any standard of identification.) Some of the characteristics that persist through a particular series of firing pin impressions have been labeled and can be seen by comparing areas indicated by appropriate letters. The photomicrographs of the second and tenth firing pin impressions from the same .32 caliber Beretta are shown in Figs. 3*b* and 3*c*. When comparing Fig. 3*a* with 3*b* and 3*a* with 3*c*, using the above criterion, an identification can easily be made between them.

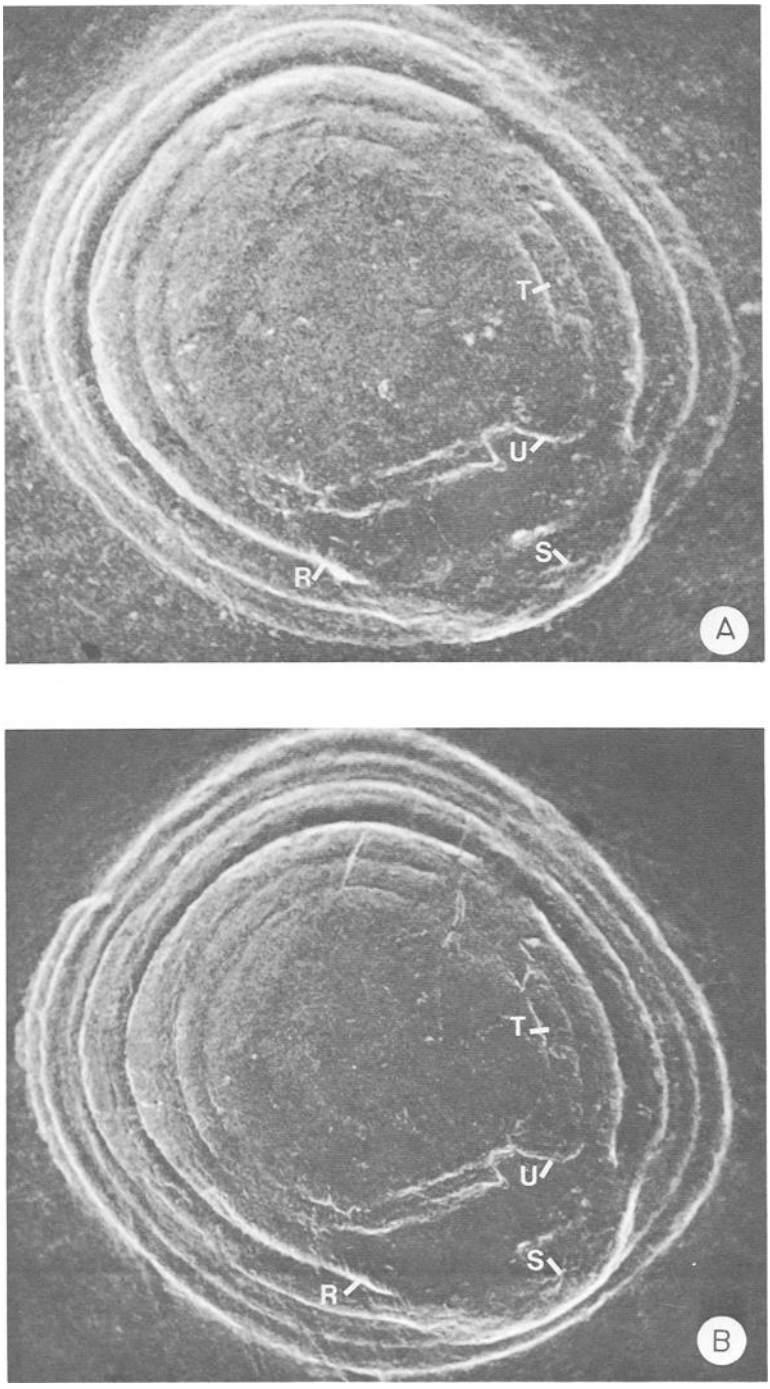


FIG. 3—*Scanning electron microscopy image of firing pin impressions from a .32 caliber Beretta pistol (FH) from* (a) *first cartridge case fired,* (b) *second fired cartridge case, and* (c) *tenth fired cartridge case.* ×48.

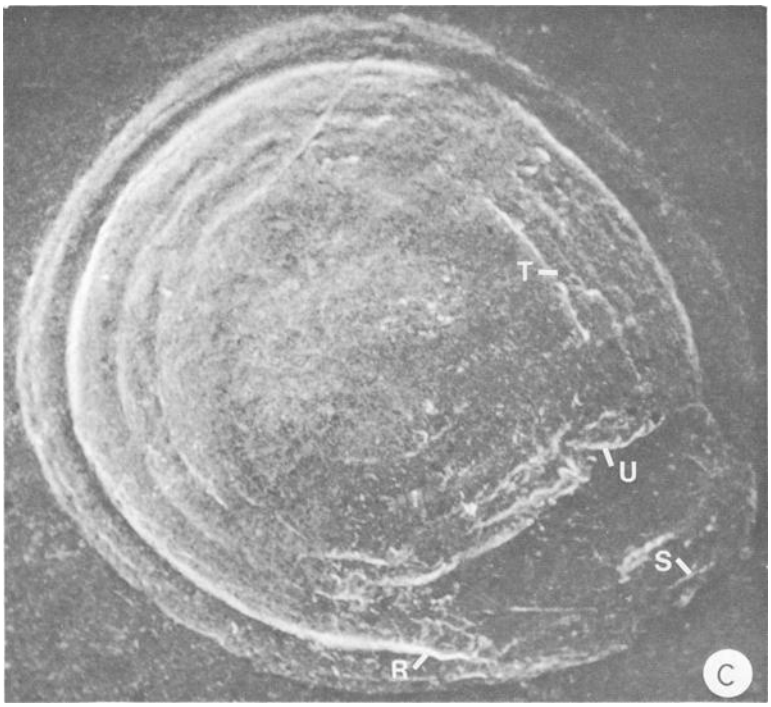


FIG. 3—*Continued.*

The firing pin impressions from the first, second, tenth, and fiftieth shell fired from an F.I.E. Titan .25 caliber semi-automatic pistol are shown in Figs. 4*a*, 4*b*, 4*c*, and 4*d*, respectively. These impressions all appear very similar in class characteristics and are radically different from those of Figs. 3*a*, 3*b*, and 3*c*. In addition, many small persisting details such as the vertical line at R with a depression next to it can be seen in all of these impressions. It is easy to identify Figs. 4*a* with 4*b*, 4*a* with 4*c*, and 4*a* with 4*d* on the basis of class, together with individual characteristics. None of the minutiae in the Fig. 4 series have counterparts with the Fig. 3 series. This method of examination demonstrated consistency and reproducibility in that the first and fiftieth firing pin impressions included the same identifying individuality features.

Figures 5*a*, 5*b*,and 5*c* show the firing pin impressions from the first, second, and tenth cartridge case fired from a .32 caliber semi-automatic Colt Factory Model M pistol. These impressions can be identified with each other on a class basis as well as an individual basis. In identifying the firing pin impressions from one cartridge case with another it is important that the individual characteristics be geometrically related. Thus the identifying features at points R, S, and T are in the same location in each of the Fig. 5 series and form a triangle RST. This triangle RST can not be found in any other series of firing pin impressions examined from other weapons of the same class.

The firing pin impressions from another .25 caliber F.I.E. Titan can be seen in Figs. 6*a*, 6*b*, and 6*c* while the impressions from a 9-mm Luger are shown in Figs. 7*a*, 7*b*, 7*c*, and 7*d*. Identifying details are demonstrated between cartridge cases fired from the same gun.

The results for the total of the 16 weapons tested are given in Table 2 and the number of readily identifying features is listed. All of the firing pin impressions from cases fired

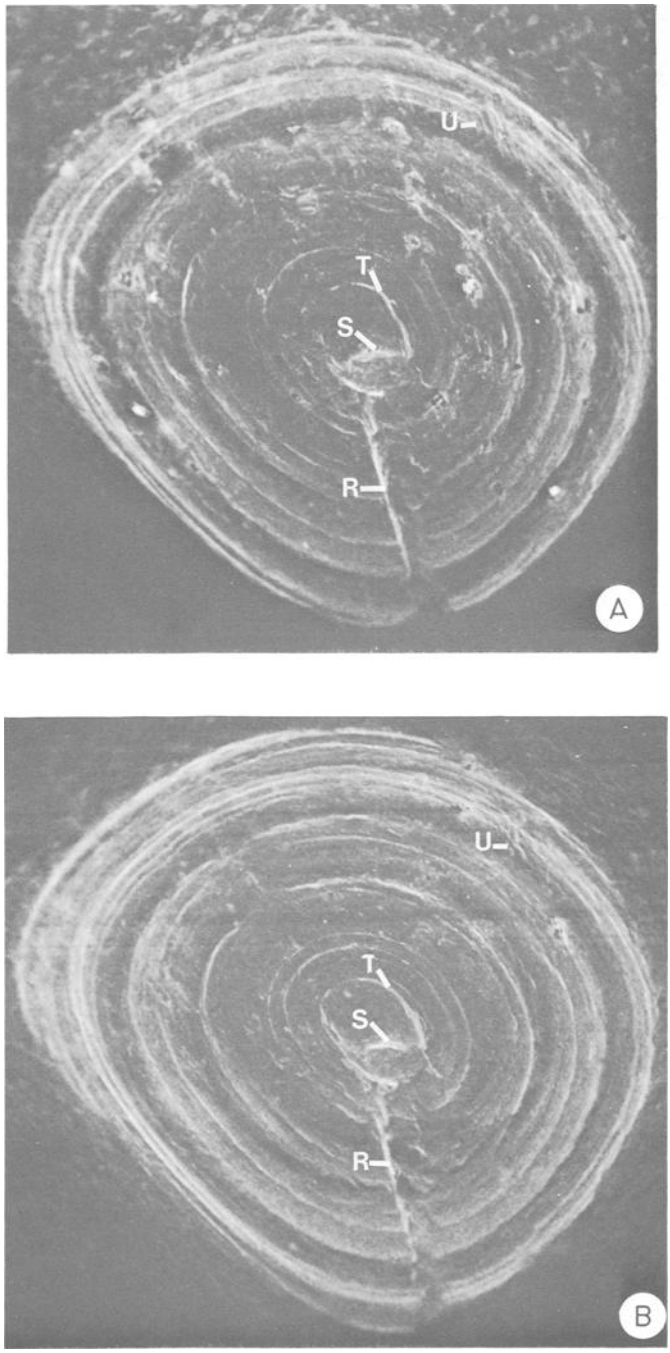


FIG. 4—*SEM image of firing pin impressions from a .25 caliber F.I.E. Titan pistol (FM) from* (a) *first cartridge case fired,* (b) *second cartridge case fired,* (c) *tenth cartridge case fired, and* (d) *fiftieth cartridge case fired.* ×51

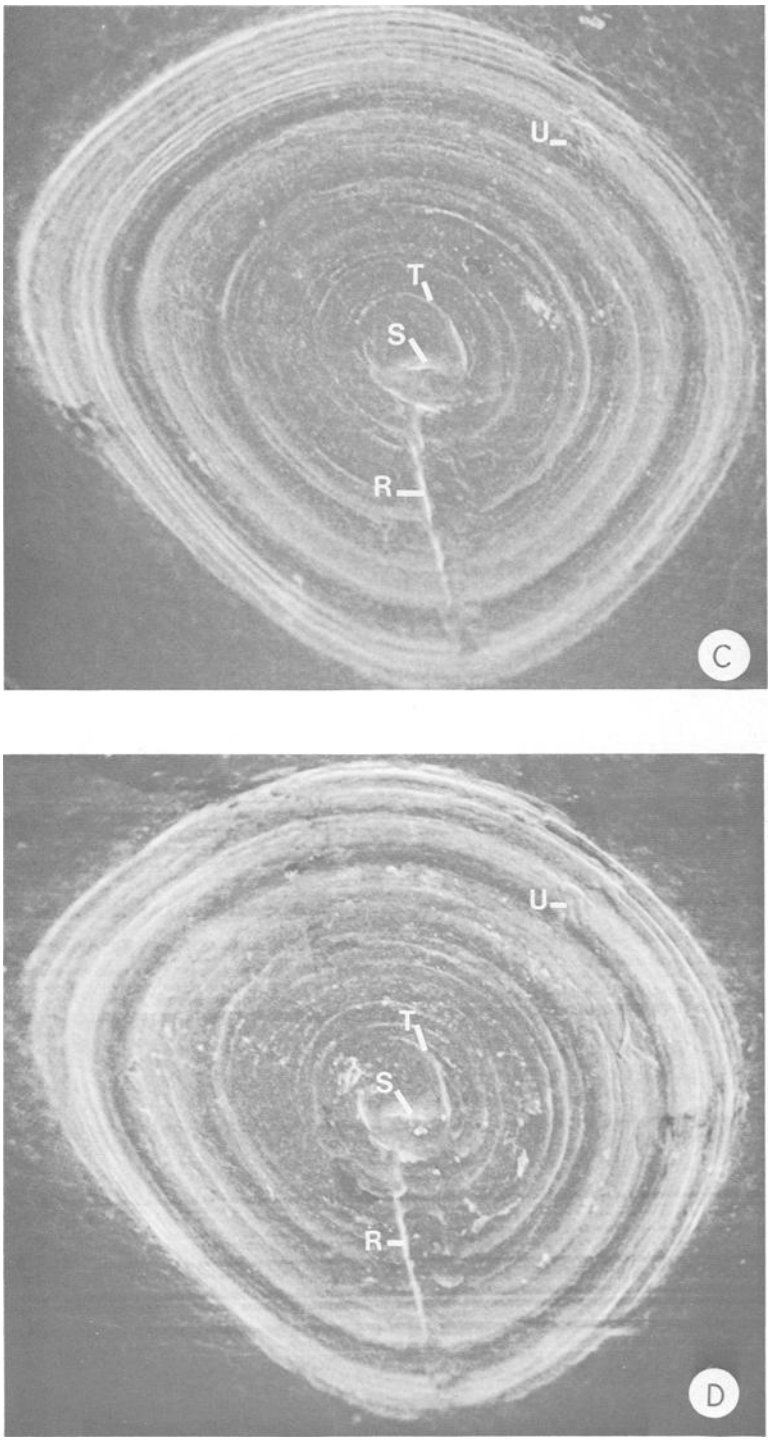


FIG. 4—*Continued*.

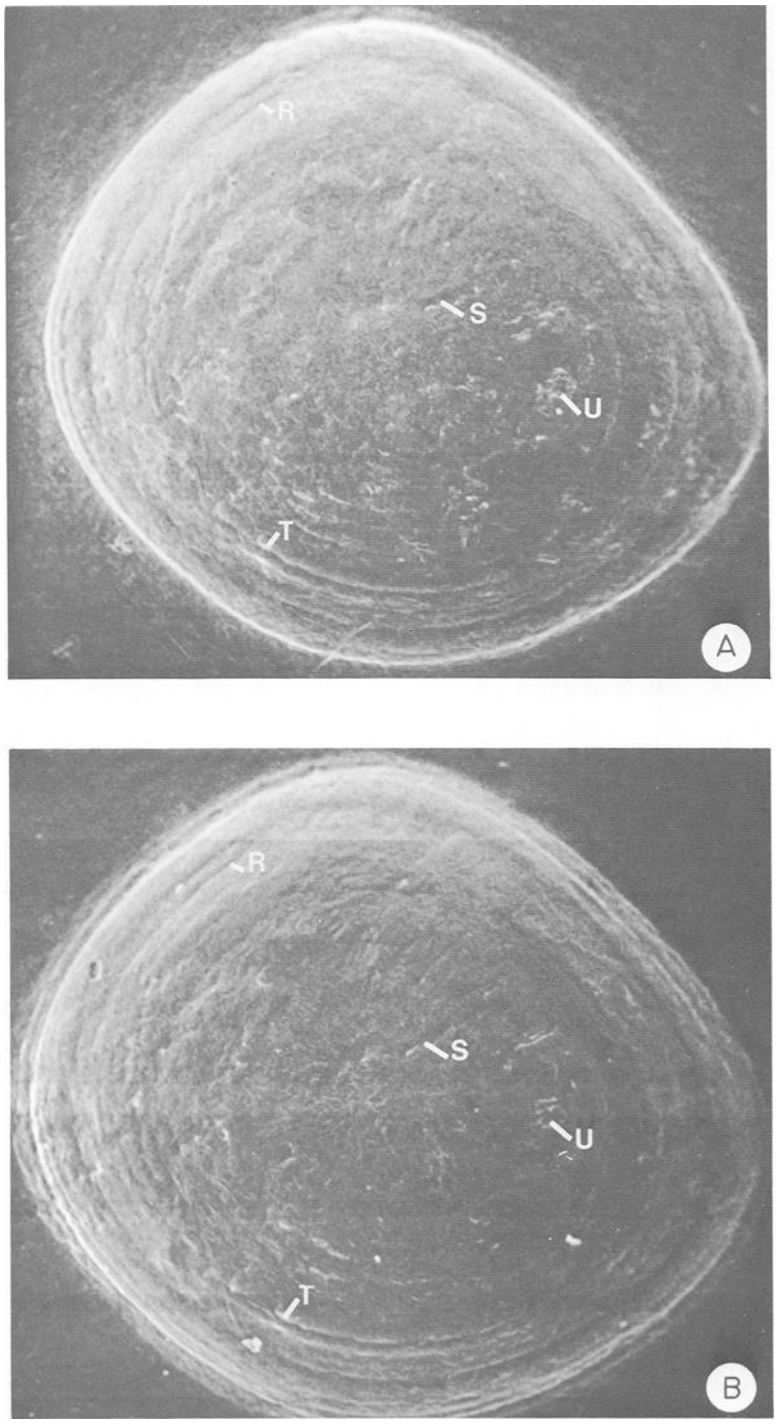


FIG. 5—*SEM image of firing pin impressions from a .32 caliber Colt Factory Model M pistol (FF) from* (a) *first cartridge case fired,* (b) *second cartridge case fired,* and (c) *tenth cartridge case fired.* ×48

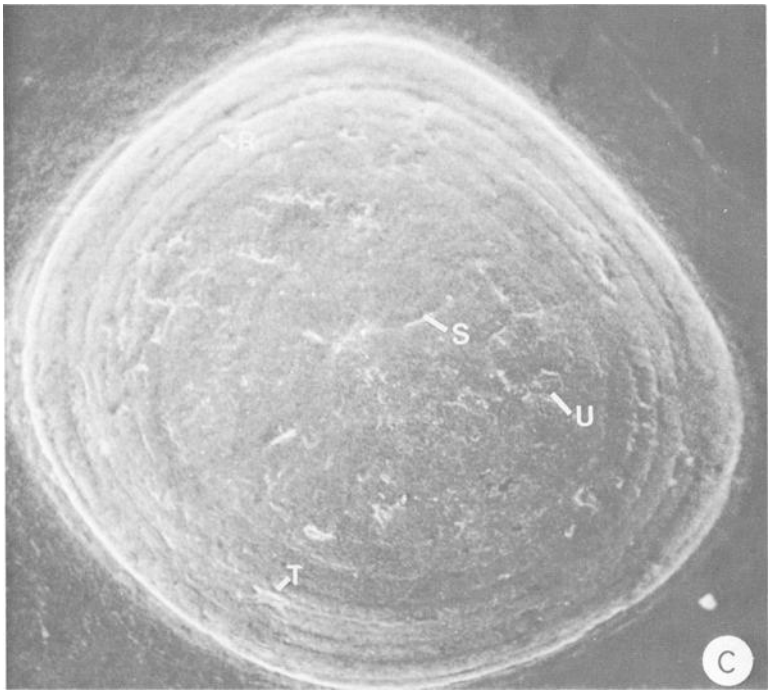


FIG. 5—*Continued.*

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

	Comparison (Number of Identifying Features)		
Code	1st with 2nd	1st with 10th	1st with 50th
FA	6	4	4
FB	5	7	–
FC	12	8	–
FD	7	5	–
FE	5	4	–
FF	5	6	–
FG	4	4	5
FH	> 12	6	–
FI	4	5	4
FJ	7	7	–
FK	7	8	7
FL	9	8	–
FM	7	7	5
FN	8	8	–
FO	0	0	0
FP	6	6	3

NOTE—(–) indicates that no examination was conducted.

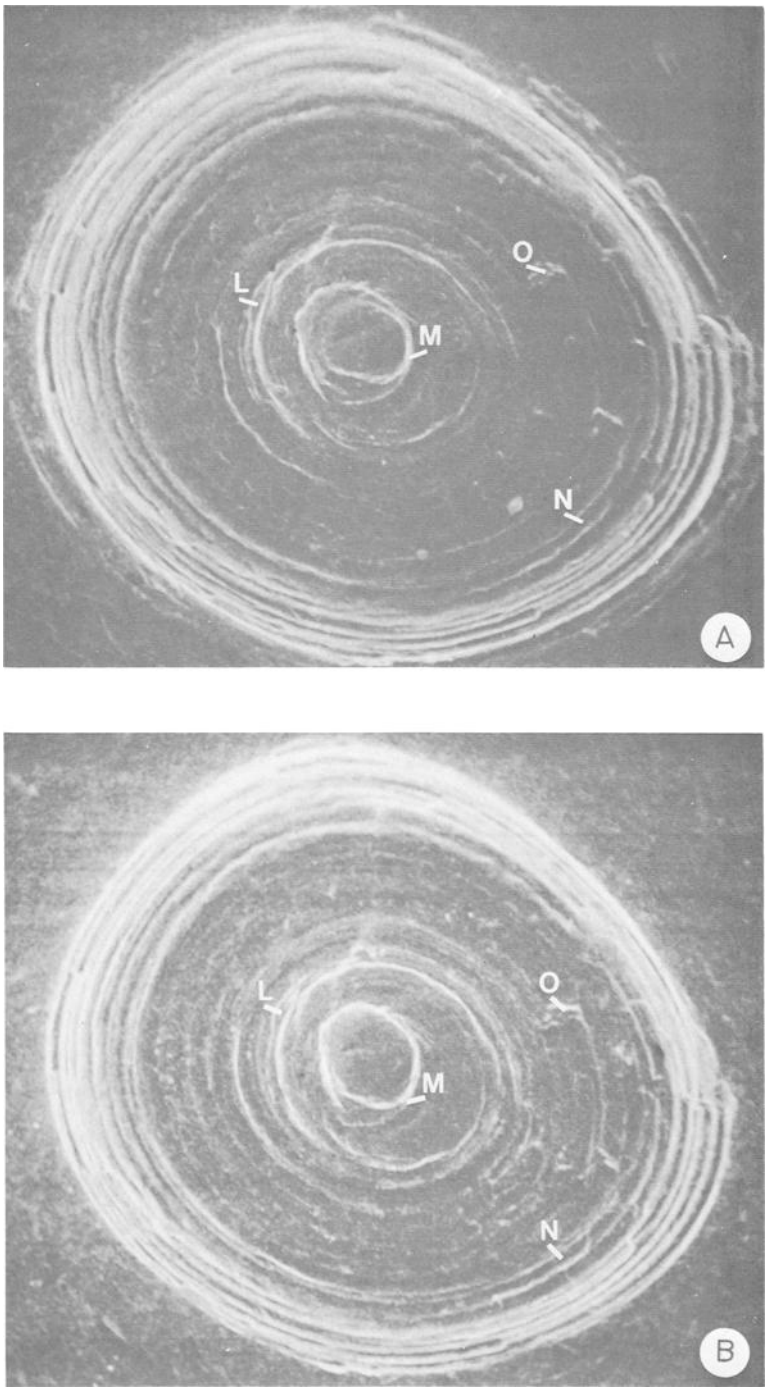


FIG. 6—*SEM image of firing pin impressions from a .25 caliber F.I.E. Titan pistol (FN) from* (a) *first cartridge case fired,* (b) *second cartridge case fired, and* (c) *tenth cartridge case fired.* ×48

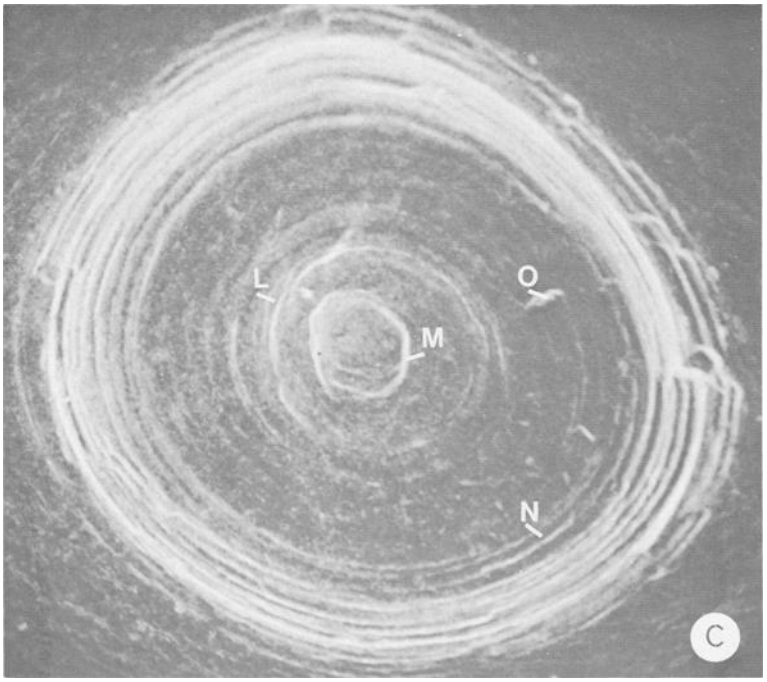


FIG. 6—*Continued.*

from a particular weapon had similar class characteristics, as expected. Fifty of 54 casings examined could be related when using a criterion of four or more individual characteristics within a particular class. The firing pin impressions of cases fired from a .45 caliber Colt Model 1911A1 pistol could not be identified on the basis of four points because no individual characteristics could be found.

Because each series of firing pin impressions had radically different class characteristics from every other series, it is concluded that the firing pin impression is a unique feature of the weapon from which it originates. Consequently this feature can be successfully used for comparison purposes over a relatively large number of firings.

Conclusions

1. The scanning electron microscope has been shown to be a potentially significant tool for firing pin impression comparisons.

2. Detail in the firing pin impression has been clearly revealed in a manner that is far superior to optical microscopy.

3. The method of examining firing pin impressions by SEM demonstrated consistency in that the first and fiftieth impressions from each series of several weapons could be identified.

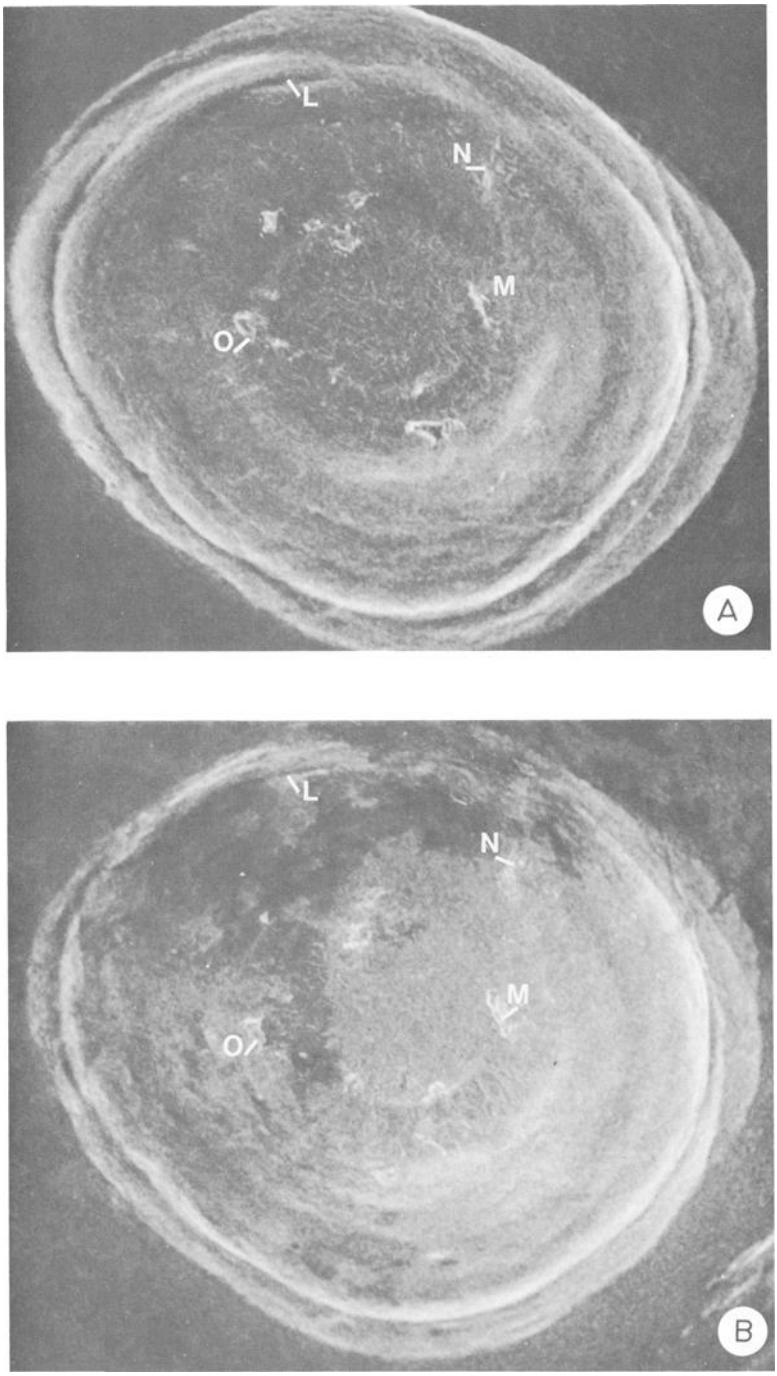
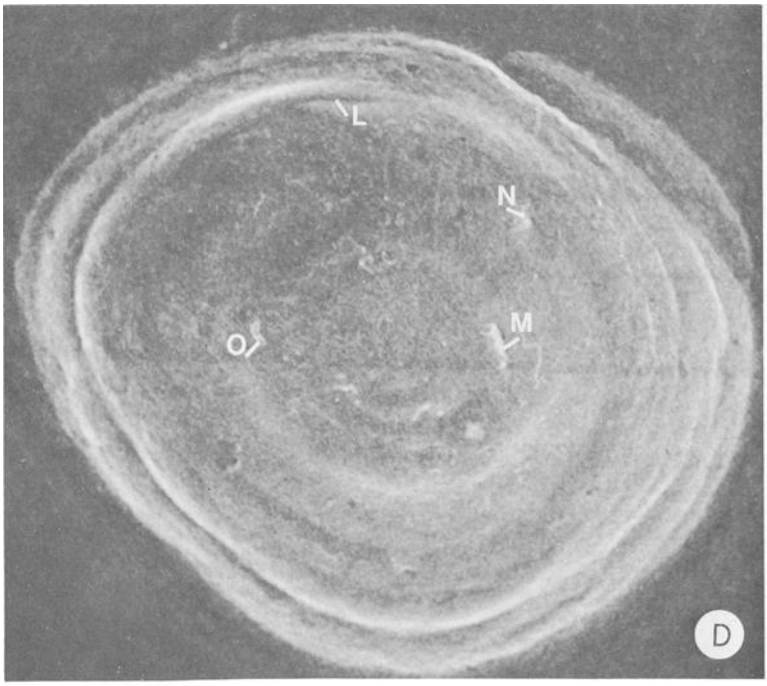


FIG. 7—*SEM image of firing pin impressions from a 9-mm Luger pistol (FK) from* (a) *first cartridge case fired,* (b) *second cartridge case fired,* (c) *tenth cartridge case fired, and* (d) *fiftieth cartridge case fired.* ×48



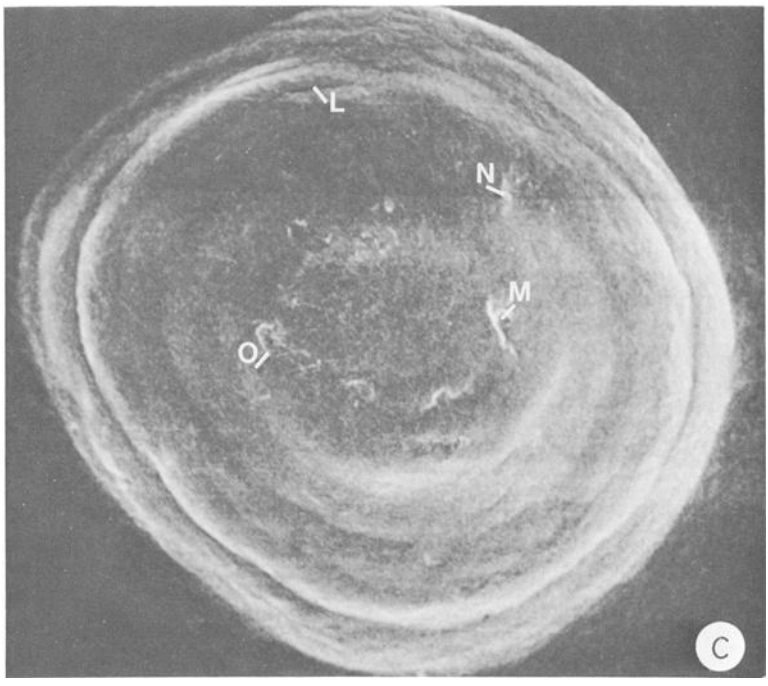


FIG. 7—*Continued.*

Acknowledgments

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[*4*] Bradford, L. W. and Devaney, J. R., "Scanning Electron Microscopy Applications in Criminalistics," *Journal of Forensic Sciences*, Vol. 15, 1970, pp. 110–119.

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