DOI: https:// doi.org/10.34836/pk.2025.322.3

The use of firearms as a factor influencing the appearance of traces left on bullets and cartridge cases from fired cartridges

major Maciej Kuliczkowski
Forensic Laboratory of the Police Headquarters in Wrocław
ORCID 0009-0008-4585-2545
e-mail: maciej.kuliczkowski@wr.policja.gov.pl

Translation: arrant officer Jakub Bosik Central Forensic Laboratory of the Police

Abstract

The article discusses the results of research conducted between 2016 and 2023 at the Firearms and Ballistics Laboratory of the Police in Wrocław on the impact of the use of firearms in accordance with their intended purpose on the image of their parts reproduced on fired bullets and cartridge cases. The research was based on firing tests consisting of firing a specific number of cartridges in a specific time, while following the correct procedures for cleaning and maintaining the weapons and in violation of these procedures, as well as comparative identification studies conducted using a comparative microscope to identify the individual firearm from which the cartridges were fired.

Keywords: 7.62 mm wz. 1930 russian pistol cartridge, spent cartridge cases, fired projectiles, microscopic comparative identification studies.

1. Introduction

The tests used three firearms adapted to 7.62 x 25 mm wz. 30 (Tokarev) pistol cartridges, in the form of: a TT wz. 33 calibre 7.62 pistol manufactured in Poland in 1952, a CZ-52 calibre 7.62 pistol manufactured in Czechoslovakia in 1954 and a PPS wz. 43 submachine pistol calibre 7.62 mm from 1952, manufactured also in Poland. The ammunition used for the tests consisted of 7.62 x 25 mm wz. 30 (Tokarev) pistol cartridges from 1955, manufactured in Poland (from the police stock, intended for firing). These cartridges had full steel jackets plated with tombac, set in brass cases, on the bottoms of which were the manufacturer's markings – Zakłady Metalowe "Pilczyce" in Pilczyce near Wrocław in the form of the code: "343 (inscribed in an oval) 55".

2. Course of the investigation

At the beginning of the research, comparative material for further identification studies was collected from the above-mentioned firearms in the form of three fired bullets and three cartridge cases from each of them. Three cartridges were fired from the TT wz. 33 pistol to obtain initial comparative material on 23 January 2016, followed by a thousand cartridges plus six cartridges for comparative purposes after firing a hundred cartridges and a thousand cartridges

after more than seven years (18 March 2023). From the PPS wz. 43 machine pistol over a period of almost eight months (from 15 March 2023, when the initial comparative material was collected, to 5 November 2023), plus three more rounds for comparative studies of casings and bullets after every hundred shots, i.e. a total of one thousand and thirty shots were fired from the machine pistol. The TT wz. 33 pistol and the PPS wz. 43 machine pistol were cleaned and maintained thoroughly after each firing. The CZ-52 pistol was fired for a month (from 27 May 2023, when the initial comparative material was collected, to 25 June 2023), plus six cartridges for comparative testing, collected after every hundred and two hundred shots, when the firing pin broke and further testing were discontinued for this reason. The CZ-52 pistol was not cleaned or maintained in order to induce corrosion changes in the barrel and other surfaces of the parts that leave marks in the form of marks on the surfaces of the cartridge cases. A total of 2,251 cartridges were fired during the tests from the above-mentioned three firearms.

3. Test results

3.1. Testing of the TT wz. 33 pistol

The casings and comparative bullets from the first three rounds fired (marked "0" for the purposes of this study) were examined using a stereoscopic microscope and found to be suitable for further identification studies. In particular, attention was drawn to the characteristic feature of the firing pin mark on the primer cup in the form of a round bulge in the central part of the bottom of the mark, originating from a defect (indentation) at the tip of the firing pin (Photo No. 1). In addition, characteristic marks were also found in the area of the so-called "slip" of the firing pin and the breech face on the surface of the primer cup, which were suitable for individual firearm identification studies.

a) After firing one hundred shots over a period of more than two months on the cups of the comparison cartridges (marked as "100"), the same individual characteristics were found in the form of a round bulge at the bottom of the firing pin tip mark (Photo 1), linear micro-irregularities forming dynamic traces of the firing pin slipping (Photo 2) and traces of the breech face surface. In addition, the common features of the compared barrel bore traces reproduced on the fired projectiles (marked as "0" and "100") were found to be consistent – Photo 3.
b) After firing a thousand shots over a period of more than seven years The mark left by the firing pin on the cup of the primer has the same rounded bulge in terms of size and shape, while the cup is more convex in the central part, which indicates a deepening of the defect on the top surface of the firing pin (Photo 4). The mark left by the firing pin sliding on the primer cup also has the same characteristic linear scratches, which can be compared (Photo 5). In addition, traces of the breech face with the same characteristics are visible on the surface of the cap cup, although it was found that they are shallower, less visible, with more delicately outlined edges, which is the result of the flattening of the surface of the pistol breech face during its use. However, this does not prevent the positive identification of the weapon and the correct comparison of the characteristics of these marks (Photo 6). Examination of the fired bullets showed that the marks of one field with the most characteristic and deepest features remained unchanged and were suitable for individual identification tests, which, together with the consistency of the features present in the marks of the second field of barrel rifling, allows for a categorical positive identification of the weapon (Photo 7). The marks of the next two fields of barrel rifling were flattened (polished) and, as a result of wear, deprived of the individual features that were present in these places on the starting projectiles (Photo 8.).

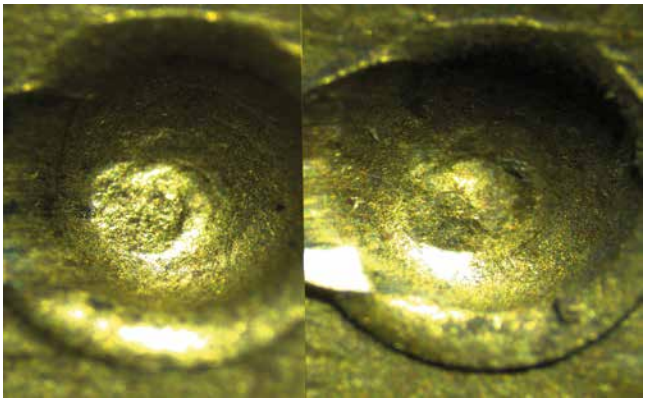


Photo 1. Trace of the firing pin on the primer cup of cartridge "0" (left photo) and cartridge "100" (right photo)

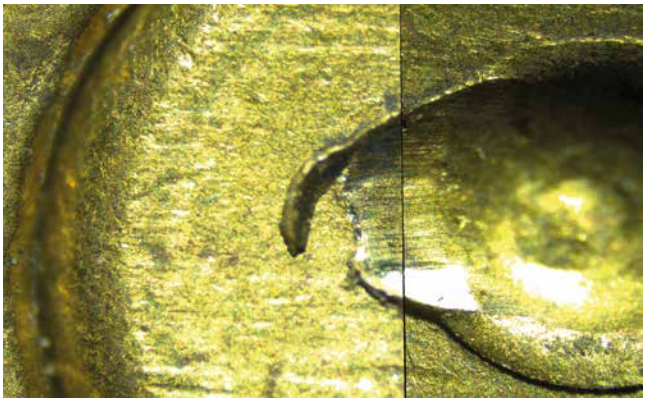


Photo 2. Comparison of common features of the so-called "slip" of the firing pin on the primer cup of the "0" cartridge case (left part of the photo) and the "100" cartridge case

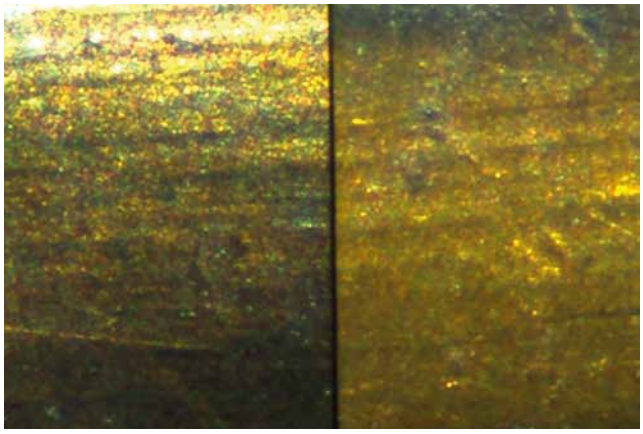


Photo 3. Comparison of common features of the mark left by one of the rifling grooves on the barrel, reproduced on bullet „0" (left part of the photo) and bullet „100"

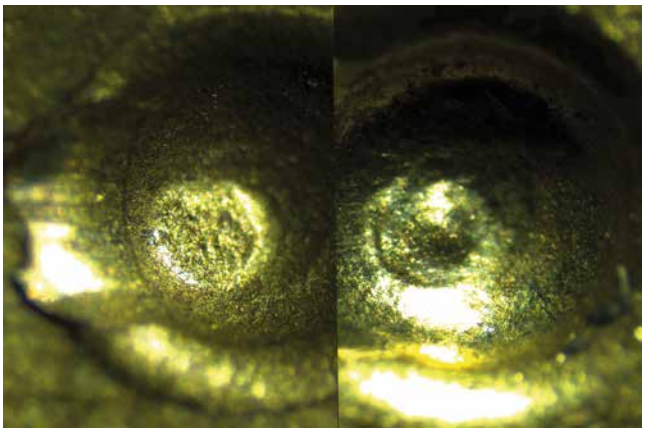


Photo 4. Trace of the firing pin tip on the primer cup "0" (left photo) and cartridge case "1000" (right photo)

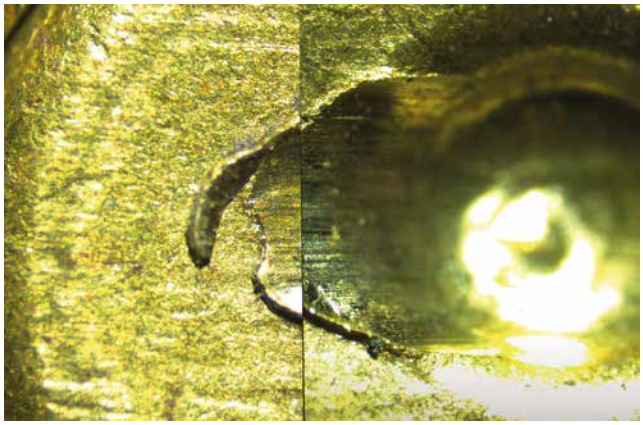


Photo 5. Comparison of common features of the so-called "slip" of the firing pin on the primer cup of the "0" cartridge case (left part of the photo) and the "1000" cartridge case

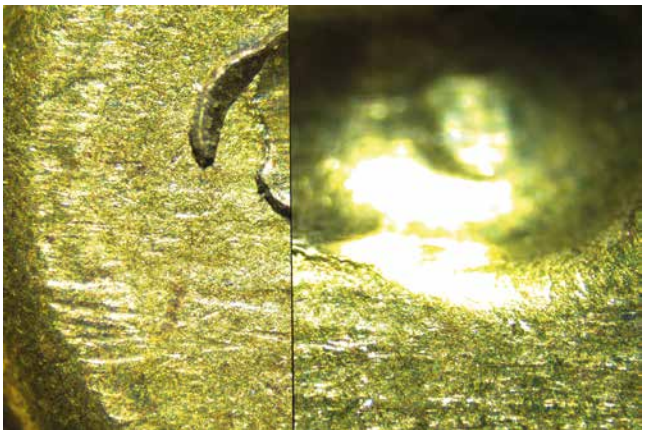


Photo 6. Comparison of common features of the traces of the breech face on the primer cup of the "0" cartridge case (left part of the photo) and the "1000" cartridge case

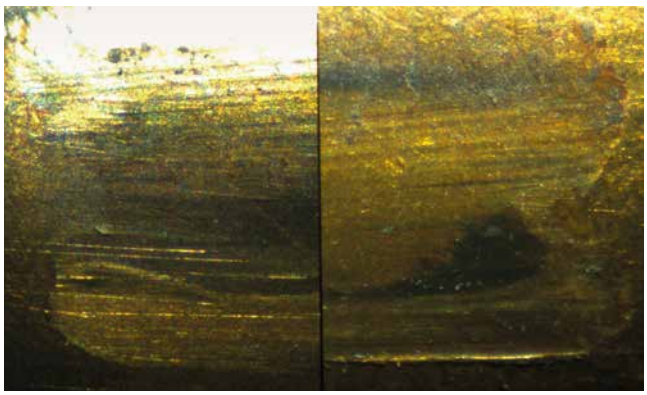


Photo 7. Comparison of common features of the mark left by one of the rifling grooves on the barrel reproduced on the "0" projectile (left side of the photo) and the "1000" projectile

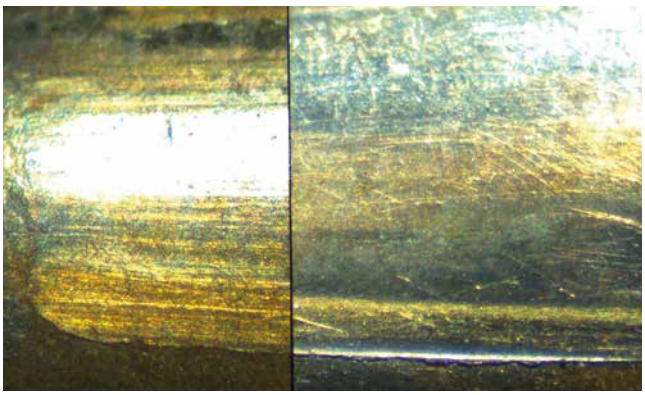


Photo 8. Microscopic comparison of the mark left by the rifling of the barrel on bullet "0" with the image of this mark on bullet "1000" (on which the features have disappeared)

3.2. Examination of the PPS wz. 43 submachine gun

The cartridge cases and comparative bullets from the first three rounds fired (marked "0" for the purposes of this study) were examined using a stereoscopic microscope. It was found that they were suitable for identification testing, with visible perforation of the primer cups by the firing pin in a manner that destroyed the feature (round shape) located at the bottom of the firing pin mark. Other features on the side surface of the firing pin mark, although suitable for identification studies, were difficult to visualize in the photographs. In view of the above, these marks were discarded and it was decided to identify the weapon on the basis of characteristic linear, arched ejector marks. These marks were compared with each other with positive results at 100 (Photo 9), 200 (Photo 10), 300 (Photo 11), 400

(Photo 12), 500 (Photo 13), 600 (Photo 14), 700 (Photo 15), 800 (Photo 16), 900 (Photo 17) and 1,000 shots (Photo 18). During the research, it was found that minor linear features disappeared as the weapon was used, which is undoubtedly the result of the ejector surface becoming flattened. Nevertheless, the main features are clearly visible, run consistently, and can be seen in the photographs.

Additionally, comparative material was collected in the form of cartridge cases fired from thirteen PPS wz. 43 7.62 mm machine pistols manufactured in Poland by three manufacturers marked: "HCP" (1 item), "6" (4 copies), "12" (4 copies), "53" (4 copies) manufactured in the years: 1949 (1 item), 1950 (3 items), 1951 (1 item), 1952 (5 items), 1953 (2 copies), 1954 (1 copy), in order to compare the ejector marks with similar marks on the machine pistol that is the subject of this studies. This was due to the fact that the ejector in weapons of this system is part of the recoil mechanism, taking the form of the round head of the recoil spring rod. The ejector mark on the bottom of the cartridge case is a reproduction of the edge of the round head, made of steel.

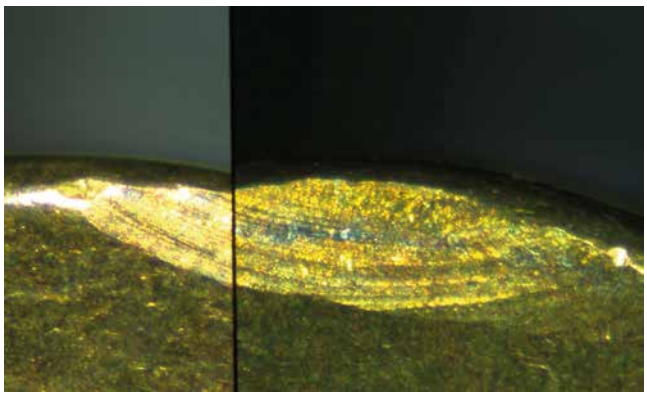


Photo 9. Comparison of common ejector marks reproduced on the "0" cartridge case (left side of the photo) and "100" cartridge cases

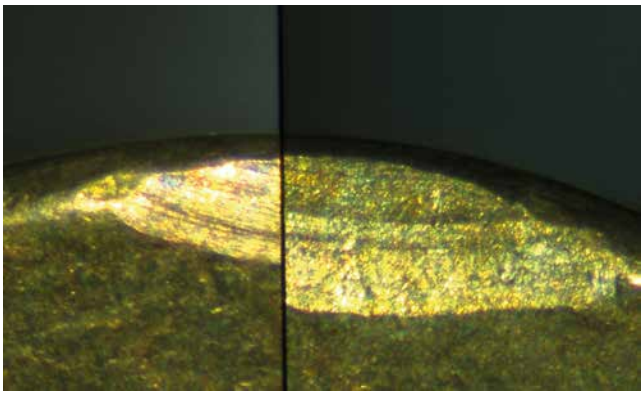


Photo 10. Comparison of common features of ejector marks reproduced on the "0" (left side of the photo) and "200" cartridge cases

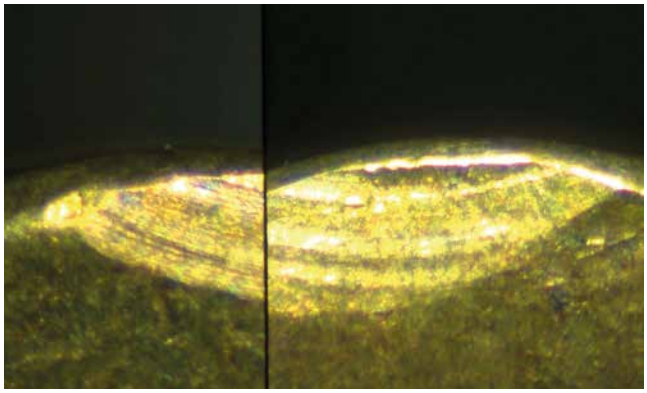


Photo 11. Comparison of common features of ejector marks reproduced on the "0" (left side of the photo) and "300" cartridge cases

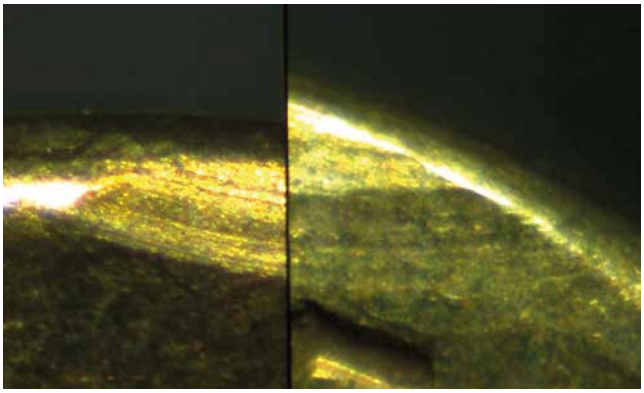


Photo 12. Comparison of common features of ejector marks reproduced on the "0" (left side of the photo) and "400" cartridge cases

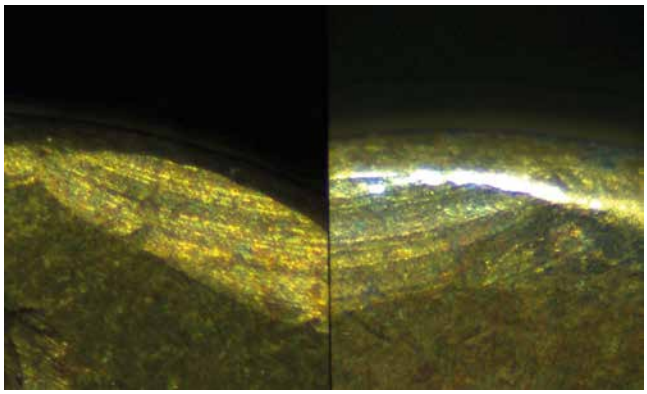


Photo 13. Comparison of common features of ejector marks reproduced on the "0" (left side of the photo) and "500" cartridge cases

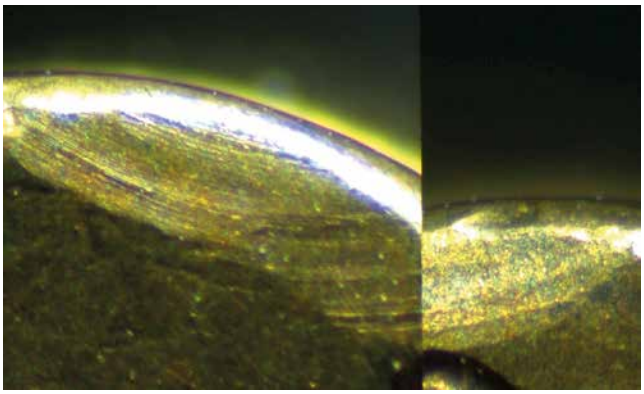


Photo 14. Comparison of common features of ejector marks reproduced on the "0" (left side of the photo) and "600" cartridge cases

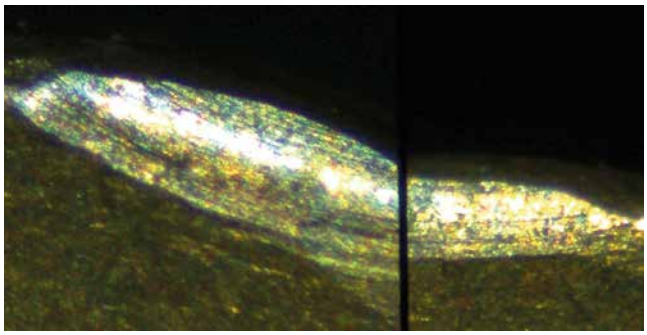


Photo 15. Comparison of common features of ejector marks reproduced on the "0" (left side of the photo) and "700" cartridge cases

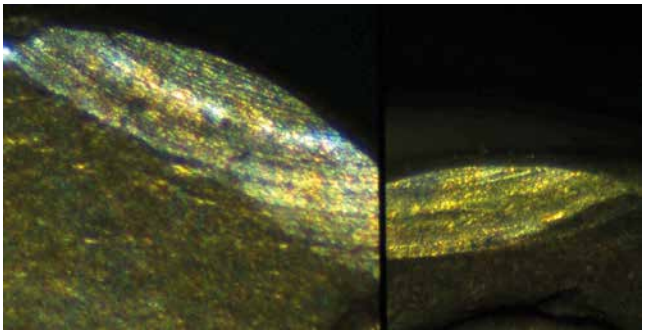


Photo 16. Comparison of common features of ejector marks reproduced on the "0" (left side of the photo) and "800" cartridge cases

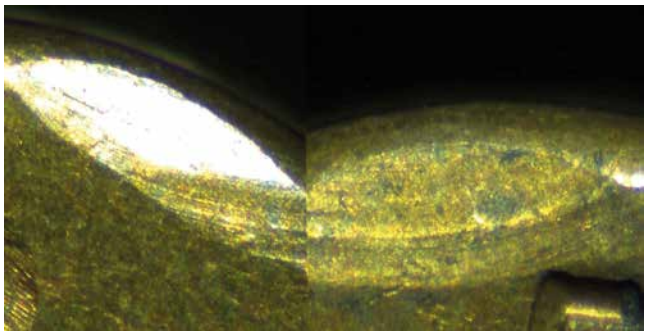


Photo 17. Comparison of common features of ejector marks reproduced on the "0" (left side of the photo) and "900" cartridge cases

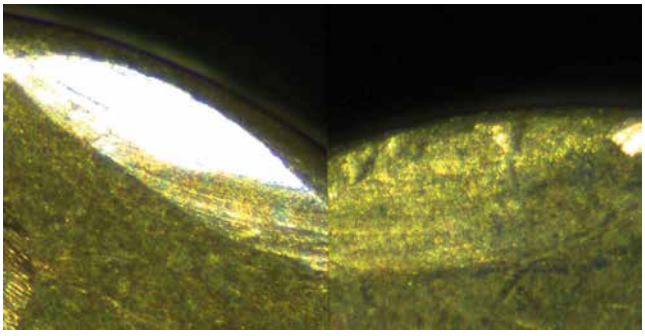
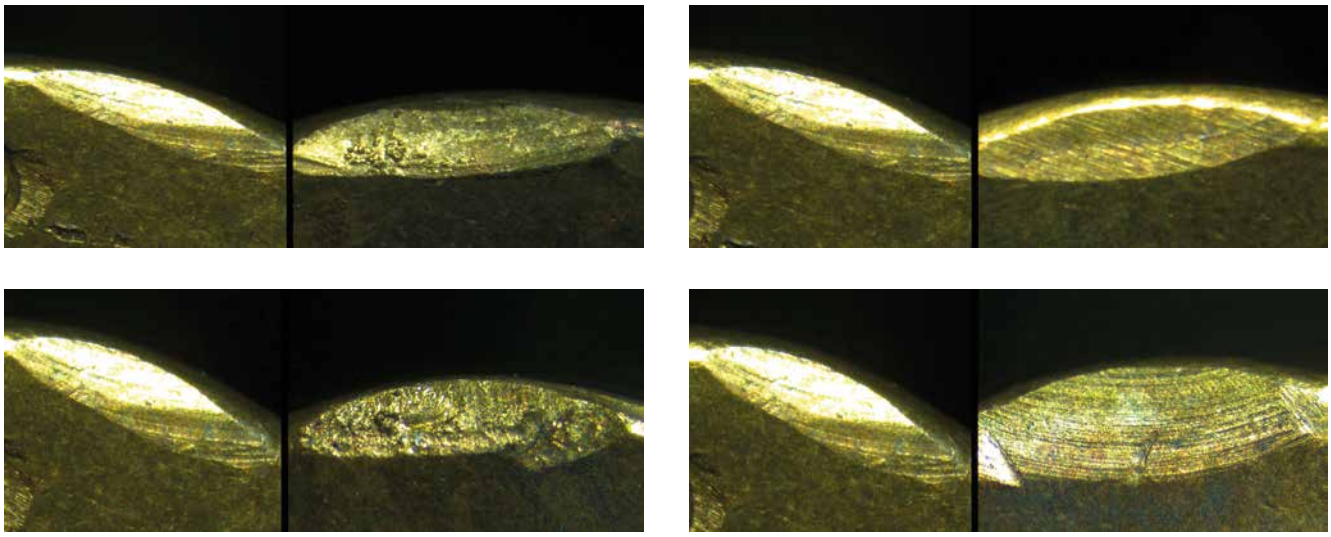


Photo 18. Comparison of common features of ejector marks reproduced on the "0" cartridge case (left side of the photo) and the "1000" cartridge cases

As these parts could have been mass-produced using the same methods and cutting tools, the ejector marks of the above-mentioned submachine guns were compared. Microscopic examination revealed completely different characteristics of the compared ejector marks, which take the form of linear scratches running in different directions and variously shaped indentations. None of the compared ejector marks is similar to the ejector mark of the tested machine pistol, and examples of the compared marks are shown in photos 19, 20, 21, 22, and 23.

The second part of the research involved comparative microscopic identification studies of traces from the barrel of the tested machine pistol left on the leading parts of bullets fired from it after 100, 200, 300, 400, 500, 600, 700, 800, 900 and 1000 shots. It was found that in each case the comparative bullets were suitable for individual identification tests, the results of which were positive. The common features of the compared marks are presented in photographs 24–34, where the comparative mark is on the left side of the photograph.



Photos 19, 20, 21, 22, 23. Comparison of ejector marks from the tested PPS wz. 43 machine pistol with ejector marks from other machine pistols of this model

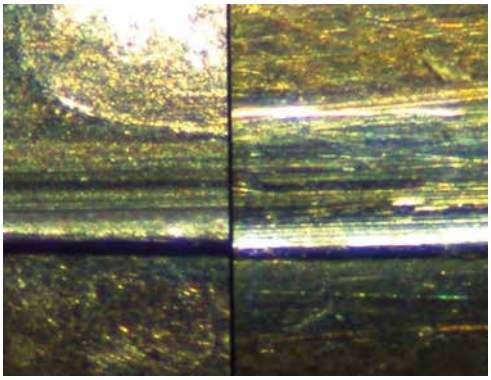


Photo 24. Comparison of common features of the rifling marks reproduced on projectiles “0” and “100”

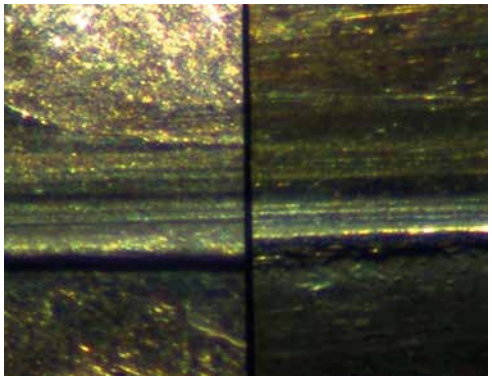


Photo 25. Comparison of common features of the rifling marks reproduced on projectiles „0” and „200”

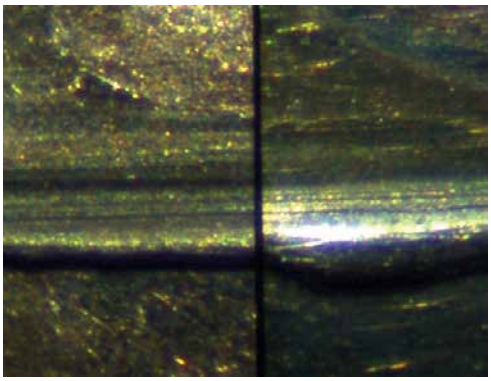


Photo 26. Comparison of common features of barrel rifling marks reproduced on projectiles “0” and “300”

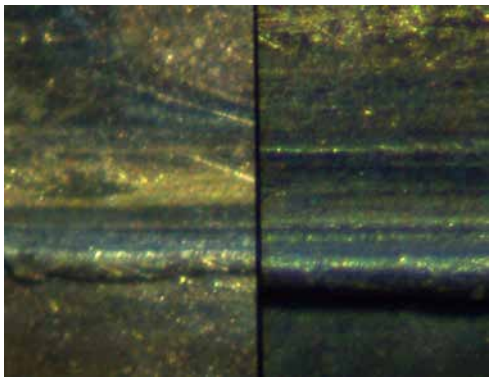


Photo 27. Comparison of common features of barrel rifling marks reproduced on bullets “0” and “400”

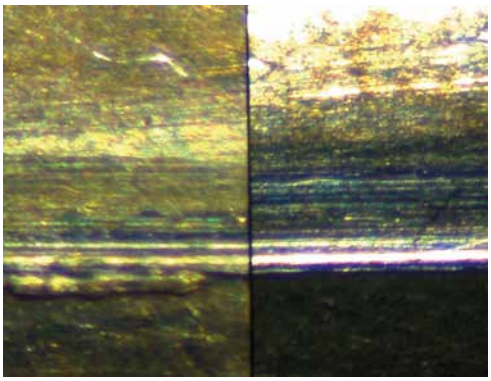


Photo 28. Comparison of common features of barrel rifling marks reproduced on bullets “0” and “500”

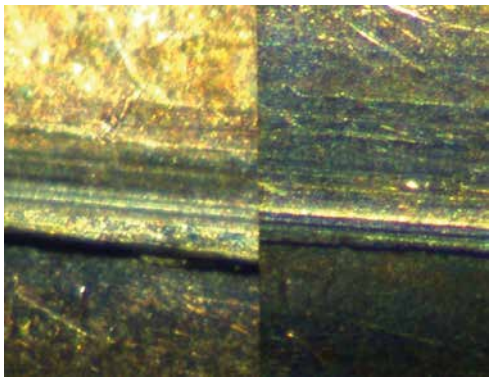


Photo 29. Comparison of common features of barrel rifling marks reproduced on bullets “0” and “600”

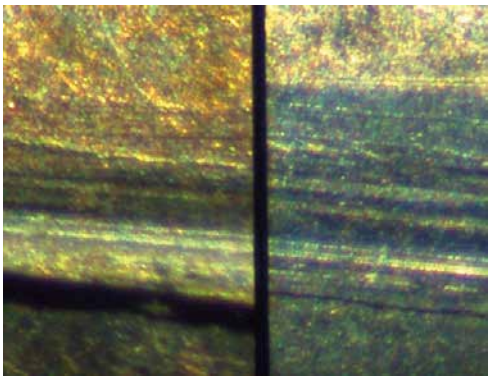


Photo 30. Comparison of common features of barrel rifling marks reproduced on bullets “0” and “700”

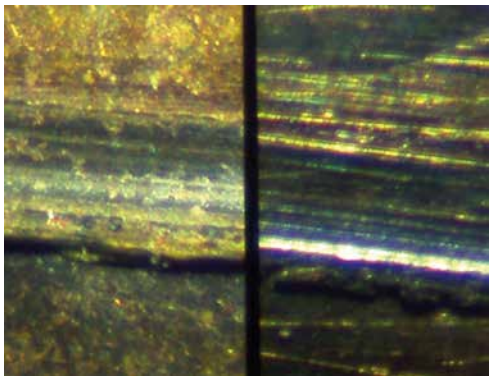


Photo 31. Comparison of common features of barrel rifling marks reproduced on bullets “0” and “800”

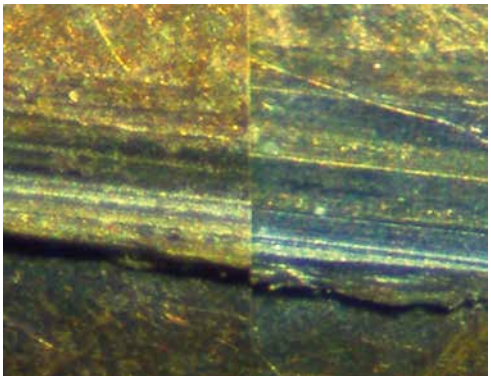
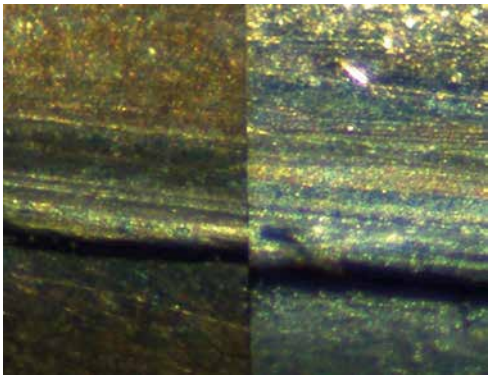
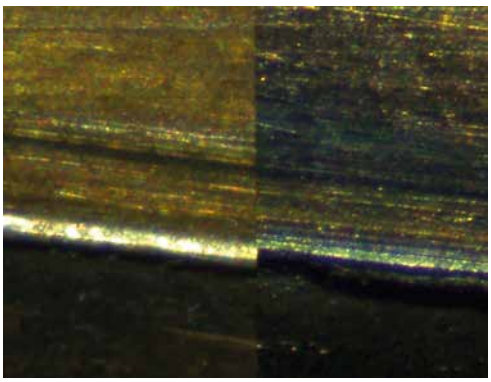


Photo 32. Comparison of common features of barrel rifling marks reproduced on bullets “0” and “900”



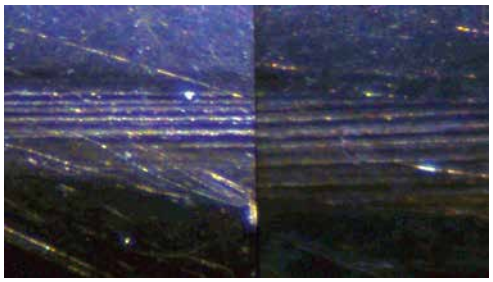


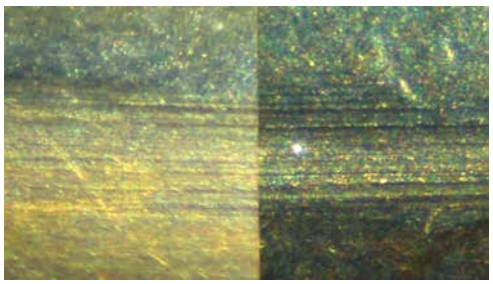
Photos 33, 34. Comparison of common features of two barrel rifling marks reproduced on bullets “0” and “1000”

3.3. Examination of the CZ-52 pistol

The cartridge cases and comparative bullets from the first three rounds fired (marked “0” for the purposes of this study) were examined using a stereoscopic microscope and found to be suitable for further identification testing.

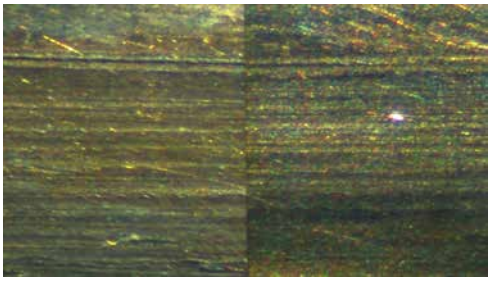
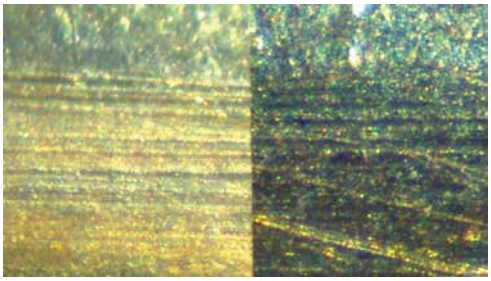
a) After firing one hundred shots, with 50 rounds fired together with three starter rounds and the next 50 rounds fired after seven days, comparative material was collected for identification testing. The pistol was not cleaned and was left at room temperature. The cartridge cases and bullets fired from the tested pistol were subjected to identification tests. During microscopic examination, characteristic features of the rifling of the weapon’s barrel were found on the leading surfaces of the comparative bullets fired after 100 shots, which were compared with similar marks on the starter bullets. The result was positive, with common features found to be consistent (Photos 35, 36). A comparison of the marks left by the pistol’s mechanisms on the surfaces of the cartridge cases from the cartridges fired from it, in particular the firing pin on the primer cups, also yielded a positive result. At the beginning of the next round of tests, the firing pin broke, which meant that the comparative identification studies of the marks on the casings from the fired cartridges had to be abandoned.





Photos 35 and 36. Comparison of common features of the two rifling fields reproduced on bullets “0” (left side of the photo) and “100”

b) After firing two hundred shots, including one hundred rounds shot 29 days after the start of the test and 22 days after the previous test, identification tests were carried out on the bullets fired from the barrel of the tested pistol. Before conducting the performance tests, the tested pistol was subjected to optical tests, including the use of a stereoscopic microscope, revealing minor post-corrosion changes on the surface of the barrel, in its muzzle section. Subsequently, comparative bullets were collected for identification tests, the results of which were positive. The common features of the compared barrel rifling marks of the tested pistol were found to be consistent (Photos 37 and 38).

Photos 37 and 38. Comparison of common features of the two barrel rifling fields reproduced on bullets "0" (left part of the photo) and "200"

4. Conclusions

The use of the three automatic firearms examined did not cause any changes in the image of the weapons mechanisms marks on the surfaces of the casings from the fired cartridges and the fired bullets in a way that would prevent the correct individual identification of the weapons. A thousand cartridges were fired from the TT wz. 33 pistol over a period of seven years, a thousand cartridges were fired from the PPS wz. 43 machine pistol over a period of eight months, and two hundred cartridges were fired from the CZ-52 pistol over a period of one month until the firing pin was damaged, which ended the test. The CZ-52 pistol was not cleaned or maintained in order to cause corrosion changes that could affect the image of the barrel rifling marks on the leading surfaces of the projectiles fired from it. In each case, it was found that the traces of the weapon mechanisms reproduced on the casings of the fired cartridges and the fired projectiles were suitable for further identification tests, which were carried out using a Leica FFM comparative microscope with positive results, including the confirmation of the compatibility of the compared marks reproduced on the casings and projectiles after firing a thousand cartridges from the tested weapon over a period of eight months and seven years. The compatibility of the compared traces of the CZ-52 pistol barrel found on the fired projectiles was confirmed despite the visible minor post-corrosion changes caused by not cleaning and maintaining the barrel after firing.

The image of the compared marks showed operational changes that were not relevant for identification purposes, consisting of:

- deepening of the defect on the surface of the firing pin of the TT wz. 33 pistol, which manifested itself in the form of an increase in the convexity of the round feature at the bottom of the firing pin mark on the surface of the primer cup, while maintaining the characteristic shape and size of this feature,
- smoothing and flattening of the traces of the breech face on the surfaces of the primer cups of cartridges fired from a TT wz. 33 pistol, without affecting the image of individual features enabling the identification of the firearm from which the cartridge was fired. The disappearance of minor ejector marks was also found on the bottoms of cartridges fired from a machine pistol, which also did not affect the preservation of the main individual characteristics of this mark, providing a basis for positive, categorical identification of the firearm,
- smoothing and flattening of the traces of two fields of rifling of the barrel of a TT wz. 33 pistol, which lost their minor individual characteristics as a result of wear. Deeper and more distinctive individual features present in the image of two consecutive rifling grooves remained unchanged, which made it possible to carry out a categorical, positive identification of the firearm from which the bullets were fired after seven years. No changes in the image of the barrel rifling marks were found on the bullets fired from the machine pistol in question over a period of eight months.

Bibliography

1. Bogiel, G. (2021). *Vademecum of forensics weapon examination*. Published by the Central Forensic Laboratory of the Police.
2. Gutekunst, W. (1974). Forensic science. An outline of a systematic lecture. Warsaw.
3. Horoszowski, P. (1952). Firearms and their significance in investigative and judicial practice. Warsaw. Military Legal Review.
4. Poddubny W.N. (1961). Corrosion of weapons and ammunition. Published by the Ministry of National Defence.
5. Skorek, S. (2012). Identification of a pistol based on the examination of cartridge cases and bullets. Prosecution and Law.