Journal of Criminal Law and Criminology

Volume 17
Issue 2 *August*

Article 8

Summer 1926

Scientific Identification of Firearms and Bullets

Calvin H. Goddard

SCIENTIFIC IDENTIFICATION OF FIREARMS AND BULLETS

CALVIN H. GODDARD[1]

FOREWORD

By Charles S. Whitman, President of the American Bar Association, former Governor of New York, and former New York County District Attorney.

The scientific identification of bullets which has been developed by Charles E. Waite and his associates represents a distinct forward step in criminology. My interest in Mr. Waite's work is personal as well as professional. Several years ago, when I was Governor of New York, I designated him to make an investigation in the case referred to by Major Goddard in this article. The situation he uncovered in that case led him to begin a study of bullet evidence which has resulted in discoveries which may well revolutionize this kind of expert testimony. For this service he has earned the thanks of every prosecutor and every attorney for the defense who is sincerely desirous that the truth be told.

(Signed) CHARLES S. WHITMAN.

I. One of the leading daily papers of New York City, in an editorial recently published, has to say anent "Expert Testimony": "The excuse for bringing special experts into court at all is that the case turns to some degree upon technical matters which only those of special training and experience are competent to understand. In theory, the experts explain these matters to the judge or jury. The usual machinery of legal decision can then proceed. This works well enough if the experts are competent and impartial. The facts and opinions of science are seldom complicated. It is not difficult to explain them clearly if one tries hard enough. At present, however, it is too often the aim of the experts to explain only half of the facts, to emphasize the considerations favorable to one side and to suppress those which might benefit the other side. . . . . Too often the judge and jury are left more befuddled than ever, their only recourse being to decide the case on other considerations, without benefit of science at all."

It is bad enough to contemplate the loss of his case by a litigant, with justice on his side, merely because his opponent has secured the

[1]Of the Bureau of Forensic Ballistics, 4 East 28th St., New York.

services of "experts" who succeeded in beclouding, instead of clarifying, the issue. Yet we all know that such "experts" exist—equally ready to adapt their knowledge to the service of whichever side, in a given contest, offers the larger fee. They suffer by comparison with the old Negro man who set forth to vote on election day. Not far from the polls he met the local Democratic satrap, armed with a wallet bulging with dollar bills. "Sam," said he, proffering one of these, "I trust you are going to vote the straight Democratic ticket." "Dat I is, suh, thank you suh," said Sam, who pocketed the note and went his way. A bit farther along the Republican campaign manager barred the road. A second exchange of money and remarks took place, similar in all respects to the first, save that in this instance a two-dollar bill figured. Sam proceeded to the polls, voted and returned to his humble dwelling. His wife, Dinah, met him. "What ticket you vote, Sam?" she said. Sam shook his head, as though overcome by the iniquities of the world. "Dinah," he said, "I votes de Democratic ticket. Dey seems to be de least corrupt!"

But when "expert" testimony, through the ignorance or duplicity of him who offers it, deprives a man of his life, or even puts him in jeopardy of it, we have developed a situation which can only be described as intolerable. Such a situation confronted, some eleven years ago, one Charles E. Waite, then attached to the office of the Attorney-General of the State of New York. An innocent man had been found guilty of murder, by shooting, of two persons. Conviction was based upon the testimony of a firearms "expert" employed by the state. Mr. Waite, detailed to an investigation of the case, developed the innocence of the convicted man, secured his pardon, and effected the apprehension of the actual murderers.

This incident caused him no little concern. The "expert" had testified that the bullets removed from the bodies of the deceased had issued from a revolver owned by the defendant, and could have been fired from none other. Mr. Waite's examination showed conclusively that there was no possibility of the projectiles *having* issued from this particular arm. The fact was patent to any layman, no matter how unacquainted with firearms. The expert had spoken impressively, while on the witness stand, of having testified in scores of murder trials, and qualified as an expert in half a dozen sciences. Had similar testimony of his in the past perchance sent other innocent men to their deaths, or been instrumental in the acquittal of yet more who were guilty? If so, might there not be others like him abroad in the land, to the subversion of law and the despair of justice?

After a serious consideration of the problem, Mr. Waite resolved to devote the remainder of his life to an effort to establish a system of bullet and firearm identification which would stand upon its own bottom, and require no "opinion," lay or expert, for its substantiation. It was to deal with facts, and facts alone, and by facts it should stand or fall.

That was eleven years ago. Ten years of industrious collection of data and specimens, involving personal visits to every manufactory of pistols and revolvers in this country, plus an extended European tour to take in those abroad, put him in a position where he could begin to make his facts available to the world. At this time he joined forces in partnership with the author, who had been working along similar lines for some four years, and as associates there were added Mr. Philip O. Gravelle, a master of all phases of photography, and Mr. John H. Fisher, an expert in micrometrics. Together they formed the Bureau of Forensic Ballistics, of New York City.

II. What is this Bureau, its aims, resources, and what service does it offer?

The Bureau is an organization established for the avowed purpose of banishing "opinion" from any legal question bearing upon small arms, ammunition, and their components. It aims to supplant opinion with facts, and where it is unable to do this, it much prefers to withdraw altogether rather than venture an opinion no matter how certain it may be that this is correct. Its resources include the following:

1. A compilation of the shop standards entering into the manufacture of practically all modern revolvers and automatic pistols, as produced by domestic and foreign makers. These include specifications covering:[2]

   a. Bore diameter.
   b. Number of grooves.
   c. Direction of grooves (right or left).
   d. Groove depth.

[2]Since it so happens that no two makers employ the same specifications throughout (although they may have some features in common), it follows that a bullet fired from a given caliber and make of weapon will exhibit rifling marks peculiar to that caliber and make, and not to be duplicated upon projectiles fired through a weapon of any other type. And it also follows as a corollary, that it is possible to determine, from a study of a fired bullet alone, the make and type of arm from which it issued. This sounds rather simple, but involves the use of numerous delicate instruments of precision in studying and measuring the bullet, plus a comparison of the dimensions so obtained with the lists of shop standards recorded, finally excluding from the list of possibilities, through the application of a process of elimination, every make of arm save the one actually involved.

e. Groove diameter (bore diameter plus twice groove depth).

f. Groove width.

g. Land width. (A land is the elevated surface lying between two grooves.)

h. Rate of pitch. (Number of inches required for the rifling grooves to make one complete revolution.)

2. A number of instruments of precision for measuring the bore and groove diameters of fired bullets as well as groove width and depth, and land width, and for estimating the rate of pitch of the rifling marks, plus a set of gauges for recording the bore diameters of firearms. These need no detailed description. Suffice it to say that they include micrometers, spring gauges, plug gauges, and microscopes with specially designed eyepieces, all graduated to at least one thousandth part of an inch—most of them to a ten-thousandth.

3. A collection of bullets of all calibers, styles, and types, fired through arms of nearly every known make, and available for use as a "reference library." Thus, in the case of many obsolete models and makes of arms, the rifling standards of which are no longer available, we have specimens of the arm itself, and of bullets of various weights and compositions fired through it. When an "unknown"[3] bullet is submitted for examination and yields measurements that do not tally with any we have recorded, we still have recourse to our reference collection, and comparison of the unknown with certain of these will frequently yield the secret of its origin. This test is carried out under the Comparison Microscope.

4. The Comparison Microscope, of which we employ a unique and very satisfactory model, was perfected by Mr. Gravelle. Beneath it are mounted two bullets, unknown and known.[4] By an arrangement of prisms, the images of the two are fused in a single eyepiece. In this way points of similarity common to both may be located (when they have issued from the same barrel) or the absence of such points determined (when they have been fired from different barrels). The fact that they have been projected from arms of the same make and model, but not from the same identical arm, is also readily established, when this happens to be the case.

The usefulness of this apparatus is dependent upon the fact that no two objects, either of God's or man's fabrication, are ever identical in detail. (Try to find two oak leaves that duplicate one another *exactly,* or two blades of grass—or even two match sticks.) Hence,

[3] I. e., the individual arm from which it issued has not been ascertained.
[4] I. e., the individual arm from which it issued is known to us.

every pistol barrel, even when fresh from the factory (and much more so after undergoing wear and tear) contains minute irregularities which are peculiar to it alone, and which will never be reproduced in any other. These irregularities leave their marks, the same ones each time, in the form of fine and coarse linear striations parallel to the deep incisures cut by the groove edges, on every bullet fired from this barrel, and they constitute, to all intents and purposes, a fingerprint of that particular barrel.[5] It can never be exactly reproduced, any more than can the fingerprint of a human being. An explanation of the factors entering into the production of this fingerprint would require more space than is available. The author has discussed them at length in such scientific publications as "Army Ordnance"[6] and "The Military Surgeon,"[7] while they have received popular exposition in the "Saturday Evening Post,"[8] "Police Magazine,"[9] "Literary Digest,"[10] and the daily press. They have been passed upon and certified as scientifically sound and thoroughly practicable by such authorities as Deputy Police Commissioner Joseph A. Faurot of New York, dean of fingerprint experts in the United States, Professor Salvatore Ottolenghi of the University of Rome, Italy, probably the foremost of European criminologists, and Judge Otto A. Rosalsky of the Court of General Sessions in New York City, the jurist before whom human fingerprinting first gained acceptance in America.

5. A collection of several hundred revolvers, single shot pistols, repeating and automatic pistols of all makes, calibers and patterns, from every part of the globe. These are all classified and catalogued, and specimen bullets from each (as above noted) have been fired and preserved. Where a model is missing, a catalog illustrating and describing it is ordinarily on file, so that either the actual arm or its illustration and description is available, for practically every pistol and revolver made from the beginning of the metallic cartridge era up to the present.[11] In addition to the catalogs, quite a library of books on arms, ammunition, and ballistics has been gathered.

6. An instrument, designed by Mr. Fisher, and named by him the "helixometer" (i. e., "pitch-measuring machine"), with which it is possible not only to measure the rate of pitch of the rifling within a

[5]The groove impressions themselves offer a second, and equally valuable, fingerprint.
[6]Issue of Nov.-Dec., 1925.
[7]Issue of Feb., 1926.
[8]Issues of June 13 and 20, 1925.
[9]Issues of July, 1925; Dec., 1925.
[10]Issue of July 17, 1926.
[11]Also, the patent date, and an exfract of the specifications covering every metallic cartridge revolver on record in the U. S. Patent Office, has been secured.

gun barrel, when this is not already known, but to examine visually for abnormalities, fouling deposits, rust spots, etc., the entire interior of the bore of any arm the barrel of which is not over ten inches in length. Thus the origin of any gross abnormality existing upon the surface of a bullet fired from a given gun barrel can be located and studied within that barrel itself. Further, the progressive changes which take place in the fouling deposits left after firing can be studied and recorded. (The author is now carrying out extensive experiments along this line, which should eventually yield data sufficient to answer certain questions bearing upon the time elapsed between the firing of a weapon and its examination, the kind of powder used in the cartridges fired, and the type of bullet employed—lead or metal patched.)

7. A collection of sample bullets, primed shells, and loaded cartridges in every pistol size by every American manufacturer (foreign samples are now being accumulated). Since each maker finishes his product of a given caliber and type slightly differently from that of any other manufacturer, it is possible by comparing an "unknown" fired bullet with the various unfired samples of the same caliber and type on hand, to determine within a few minutes the factory of origin.

8. Samples of all types of powders entering into the manufacture of American pistol ammunition. Since pistol barrels are ordinarily too short to permit complete combustion of the powder charge in cartridges fired from them, unburned grains of the propellant are commonly blown from the muzzle behind the bullet, and may be recovered from the clothing, skin, or wound of the victim if he be shot at close range, or from textiles or other soft objects hanging close to the line of fire and near the muzzle. Further, a few unburned grains are not uncommonly present after firing within the bore of the weapon itself, and a study of these beneath the microscope will reveal the name of the maker, as each type is produced with different physical characteristics.[12]

9. Photographic equipment which makes possible the simultaneous delineation, upon a single plate, of three bullets—a fatal and two "tests" fired from the suspected weapon, so magnified by the lens employed as practically to fill a 10 x 12 print. From these, enlargements may be made to almost any size that can be handled conveniently. These prints are used, as will later be explained, in presenting visual

[12]These studies are especially useful when the bullet has passed entirely through the body of the victim and been lost.

demonstration of the facts brought out by the examination of the fatal bullet under the various instruments of precision. The illumination necessary is naturally of a very intense type, and is furnished by a lamp designed by Mr. Gravelle and developed for him by the General Electric Company.

The apparatus, data, etc., described in the nine paragraphs preceding does not of course constitute by any means the entire armamentarium of the Bureau. It has at its disposal a great many other facilities for attacking the problems presented it, but those enumerated comprise, as it were, its heavy artillery. Further, we have not touched upon the apparatus, methods, etc., employed in the examination of fired shells for the evidence they may offer. Suffice it to say that the shell, as well as the bullet, bears two distinct fingerprints, one impressed into the surface of its primer by the tip of the firing-pin (hammer nose) of the arm exploding it, and one engraved upon its head and primer by the breech face of the firing arm, due to its recoil under tremendous pressure against this surface at the instant of firing. No two firing-pin tips leave exactly the *same* imprint on any two primers, but any *one* will always leave the same print on every primer it strikes. This is also true of the breech face of every firearm. It bears scorings from the file or other tool with which it is finished, in a pattern which is reproduced on the shell head and primer face of every cartridge impinging upon it—but no other breech face carries quite the same pattern. Hence, it is just as easy—again calling upon the comparison microscope—to identify a fired shell to the arm that exploded it, as it is a bullet to the barrel that projected it.

III. What service does the Bureau offer? Its aim, as has already been stated, is to eliminate conjecture from all disputation touching upon firearms in forensic cases, and to substitute therefor—facts. Hence it stands ready to supply service in the form of facts to any person or organization honestly in search of them. It is manifestly difficult to transport microscopes and other similar apparatus conveniently to distant courtrooms. Further, the removal of these instruments from the laboratory cripples the work there until they are returned. Thus it early became apparent that some means must be developed for demonstrating to judge and jury the facts brought out under the comparison microscope without removing this from its usual resting place. The answer was supplied by the development of a triple bullet holder consisting of three small steel shafts set parallel to each other, a half inch apart, and rotated synchronously by a turning handle which operates a worm gear engaging all three. Atop each one is

mounted a bullet—fatal in center and a "test" (fired through the fatal gun) on either side. (The three have of course already been matched under the comparison miscroscope, and their identity of origin verified.) The mounting is so conducted that homologous points on all three bullets will be in the same phase of rotation, i. e., that groove number one of the fatal and both tests will face the observer at once, rather than say number one of the fatal, number three of the first test, and number two of the second, or any other mismatched arrangement. (Of course the grooves and lands of a firearm are not really numbered, but in examining them and bullets fired from them it is convenient to number them arbitrarily to facilitate the work.)

The triple holder is now placed before a camera, the illumination switched on, and the three bullets photographed simultaneously on an 8 x 10 plate, as previously noted. Thus they are all taken under identical conditions as to lighting, focus, etc., an achievement impossible when they are photographed individually.

As many exposures are made as the bullets bear lands and grooves. Thus a five grooved bullet receives ten exposures, the three projectiles being rotated 36° between each. A six grooved bullet requires twelve exposures, and 30° rotation, and so on. With the photographic outfit employed, the image of an ordinary .38 S. & W. bullet measures at least 2x3¾" in the unenlarged, print, i. e., the magnification is about 6 times.

Three sets of prints are made—one to be retained in their original form, one for the Bureau to "cut and match," and one for the jury to treat similarly, if it so choose. By "cutting and matching" we mean cutting across the print of a test bullet, removing a section, and superposing this upon the print of the fatal bullet in the same exposure—or vice versa. Since they have issued from the same barrel, their groove marks, and the fine linear striations left upon the grooves and lands by the various irregularities within the bore, will match into each other quite perfectly—just as though one took two photographs of a man's face in exactly the same position, from precisely the same angle, at the same distance, with the same camera and similar illumination, cut off the top of one, and superposed it upon the other. Naturally, unless some change in facial expression had taken place between the taking of the first and second pictures, the composite would be no different from either of the originals. And even though such a change *had* occurred, there would ordinarily be little difficulty in convincing anyone that the person represented in each half of the composite whole was the same. The same holds true for bullets. The interior of a

gun bore changes with time—just as a man's face changes with the years—and more rapid changes, as by the accumulation of metallic fouling after a series of shots fired in quick succession may also occur. These may be compared with changes in facial expression—which also take place quickly. But just as we can recognize photographs of our friends even though their expressions vary widely from print to print, or periods of years elapse between the sittings, so can we match the photographs of bullets fired through the same barrel, even though the condition of that barrel has changed materially between the firing of the fatal bullet, and the conduction of the subsequent tests. All the fine striations will not match together by any means, but enough will do so to dispel any doubt as to the fact that their arm of origin was identical.

The Bureau's procedure when in court is, then, to describe the methods of rifling a firearm, explain why it is impossible to turn out any two that are exactly alike in their minute details, and bring out the fact that, as a result, each arm leaves its own individual fingerprints on every bullet or shell it fires. The photographs are then exhibited, the points of identity in the three bullets outlined, and the cut and uncut prints offered in evidence, with an additional set for the jury to cut at their convenience. Further, lantern slides portraying the matching of the bullets can be shown in the courtroom under daylight conditions, and with them others illustrating the details of barrel manufacture, etc. In this way it is possible to demonstrate to the satisfaction of any reasonably intelligent person the fact that a given bullet has issued from a given arm. The converse is, of course, much more easily established by the same methods.

The reader must not acquire the idea that perfect results are attainable in every case. The Bureau has not, and will never have, the records of every model of pistol and revolver made since the introduction of metallic ammunition. Even though it could and did, it would occasionally run into cases where muzzle loading arms had been employed, or meet other contingencies that had not been foreseen. Again, bullets become deformed upon impact—with bone in the human body, or with other hard objects after traversing a body. This deformation may be so extensive as to obliterate all marks of identification. Again, these marks, if few in number, may be ruined by a careless surgeon who grasps and grinds the already distorted ball between the jaws of his steel forceps, or scratches elaborate reference marks exactly on top of the few remaining ones which might have served to link it to the projecting weapon.

Nevertheless, Mr. Waite's vision of a decade ago has become a reality. By the Waite method of bullet identification the missile itself has been forced to give up its secrets—to produce evidence which needs no opinion to support it, and which no opinion can controvert. The old-fashioned expert witness, so far as questions of this kind are concerned, is obsolete. A silent witness, one that embodies the two qualities so desirable, but never attainable, is the human witness—inability to tell anything but the truth, and freedom from all personal prejudice —has taken his place.