Journal of Criminal Law and Criminology

Volume 35 | Issue 2 Article 11

1944

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Recommended Citation

J. H. Mathews, Lee K. Henke, The Rifling Meter, 35 J. Crim. L. & Criminology 134 (1944-1945)

THE RIFLING METER

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(Dr. Mathews is Chairman of the Department of Chemistry at the University of Wisconsin. For some years he has been interested in the use of scientific methods in criminal identification and has developed a number of useful instruments—particularly in the field of forensic ballistics, of which the rifling meter described in this article is one. Mr. Henke is Senior Mechanician in the Department of Chemistry at the University of Wisconsin and has devoted many years to the designing and construction of special apparatus for scientific research purposes.—Editor.)

Workers in the field of firearms identification often have need of rifling data not presently available in textbooks or reference works, or obtainable from gun manufacturers. Not infrequently a fired bullet is brought in for examination in connection with some crime. No gun is submitted, nor does a suspect appear at hand. In such a situation the first problem, necessarily, is determination of the make and type of gun from which the bullet was or might have been fired. If the law enforcement officer can be supplied the correct answer as to the identity of the make and calibre of the gun, the field of search for the wanted gun is narrowed and the possibilities of discovery greatly enhanced. For example, if it can be shown that the fatal bullet in the case was fired from a .32 caliber Ortgies automatic pistol and no other, search for all other .32 automatics can be halted at once and the search narrowed to the one wanted model.

It may appear that the rifling specifications data maintained by the different gun manufacturers would be of prime assistance in classifying the make and caliber of the wanted gun. In general it should be said that the various gun manufacturers do have definite rifling specifications and the more reliable ones make a real effort to follow their specifications closely. Now, if each and every manufacturer had *different* specifications and continued at all times to adhere to them, then by making a few accurate measurements on a fired bullet one would know, invariably, from what make and type of gun the bullet had been fired.

But it is not as simple as that, however. In the first place many of the cheap foreign made guns are "'assembled" guns, i.e., the various parts are assembled from parts which have been made in various shops and apparently not from uniform rigid specifications, if indeed from any specifications at all! The identity of the maker of such guns obviously cannot often be determined from measurements made on a fired bullet.

Another difficulty arises from the fact that from time to time a manufacturer may change his specifications. Hence, the fired bullets will present a different set of data corresponding to the change. A similar situation confronts the examiner of typewritten documents. Manufacturers change the font (shape of letters) from time to time. A document dated 1908 allegedly written on a Remington typewriter and having a design of type not manufactured until 1916, is clearly fraudulent. Hence these changes in specifications are very useful. Similarly a change in rifling specifications may "date" a gun from which a fatal bullet was fired. Document examiners have accurate records of all changes made in type design by the different manufacturers and the dates of change. Unfortunately similar data on changes in rifling specifications made by different manufacturers are not available. Often the manufacturers themselves do not have complete data. One of the largest of the world's gun manufacturers, for example, has on three occasions had all its records destroyed, twice by fire and once by flood. American manufacturers have been very cooperative in furnishing such information as they have, and there is considerable information available on a few of the foreign guns. Some of this latter information is, however, none too reliable, and it is very unfortunate that following World War I there were heavy importations of foreign made guns, many of which are found in the hands of the criminal. If such an accumulation of data as is here suggested is ever to be made, it will necessitate a great many measurements on guns of all makes, types and vintages. It is a job which should be done, and it is our intention to make such measurement on all guns which become available to us.

The particular information needed to determine the make and type of gun from an evidence bullet is obtained by noting or measuring the following: (1) Width of grooves on bullet (corresponding to width of lands in the rifled barrel), (2) Width of lands (corresponding to width of grooves in the rifled barrel), (3) Number of lands and grooves, (4) Degree of slope of the rifling, (5) Direction of this slope (indicating a right or left hand turn), and, in some cases, (6) The depth of the grooves. Of these six items the first five are absolutely essential, and the sixth may be helpful. There are available to the identification expert suitable methods for measuring the angle of rifling on the fired bullet and the widths of lands and grooves. If a complete file of information on rifling specifications for all guns were available, the particular make and type of gun which had fired the evidence bullet could be determined, or at least the search could be narrowed down to a very few possibilities. It is true that the specifications for two guns of different make may quite closely approximate each other, but even narrowing down the search to two, three or even four possibilities is very useful.

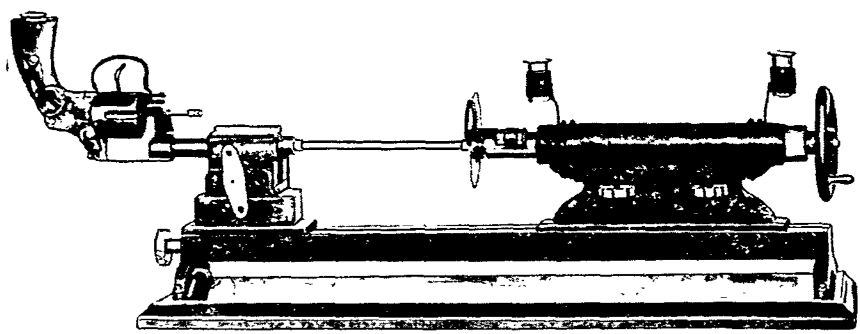
Because of the paucity of information on rifling specifications we have developed in this laboratory an instrument for measuring the pitch of rifling in a gun. This is accomplished by pushing a bullet, or preferably a lead disc through the barrel and at the same time measuring the rotation of the bullet for each inch (or half inch) of travel. After the disc is inserted in the end of the barrel a "zero" reading is taken. Then the disc is pushed forward exactly one inch (for example), and the extent to which the bullet has rotated is measured on a graduated circle provided with a vernier capable of giving readings to 0.05° or 3′ of angle. Suppose the rotation is found to be 22.50°. Then at this rate the distance required for one complete rotation of the bullet will be $\frac{360}{22.50}$ or 16 inches. Naturally several readings are taken and averaged. The accuracy of the driving screw calibration and the readings of angle are such as to give a reproducibility of results to 0.1″ on a turn of 16 inches if the rifling in the barrel is in good condition. Checks on guns of known rifling specifications have been made repeatedly and found to be accurate.

After the disc is pushed through the barrel the width of the grooves and lands on its edge are measured and notations are made as to the number of lands and grooves and the direction of rotation. This information, together with the name of manufacturer, type and model of gun, serial number and name of owner, is recorded on a form card and filed according to the measured class characteristics.

The instrument consists of three essential parts. The head, the vise, and the bench. For ease of description we shall describe each part separately.

The Head:

The head is not unlike the tail stock of a modern lathe. See Fig. I. It consists of a lead screw threaded left hand and actuated by a hand wheel. This lead screw is supported by a bronze bearing. Bronze was used because of the pressure that is necessary to start a disc or bullet down the barrel being tested. The lead screw actuates a steel ram, which has a narrow groove milled its entire length. A short spline in the front of the ram housing engages with this groove, thus preventing axial rotation of the ram when it is moved longitudinally. The threaded bushing in the ram is also of bronze. The steel ram is graduated in sixteenths which are used as a check against the micrometer dial graduations on the sleeve attached to the hand wheel. The lead screw has ten threads to the inch, and the dial is graduated into 100 divisions. Thus every division on the micrometer dial is equal to one one-thousandth of an inch. At the opposite end of the ram is mounted, by means of a thrust bearing ("Nice" number 1001), a five-inch dial divided into 360 divisions, 180° in each direction from zero. Fig. II. A vernier of twenty divisions is matched to this dial



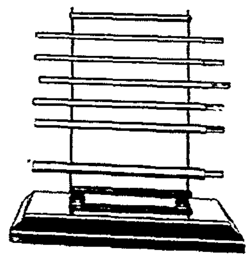


FIGURE I

Rifling meter with rack at right, containing six of the seven rods used for pushing discs through barrel of hand gun being catalogued.

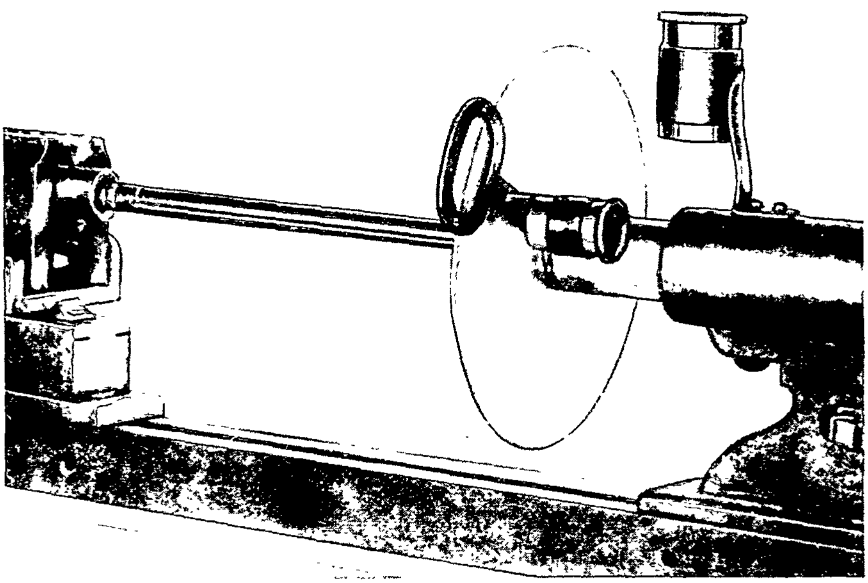


FIGURE II

Closeup of rifling meter showing muzzle of gun without clamp, and the quadrant at the right which permits measurement of angular rotation of lead disc being pushed through barrel being measured.

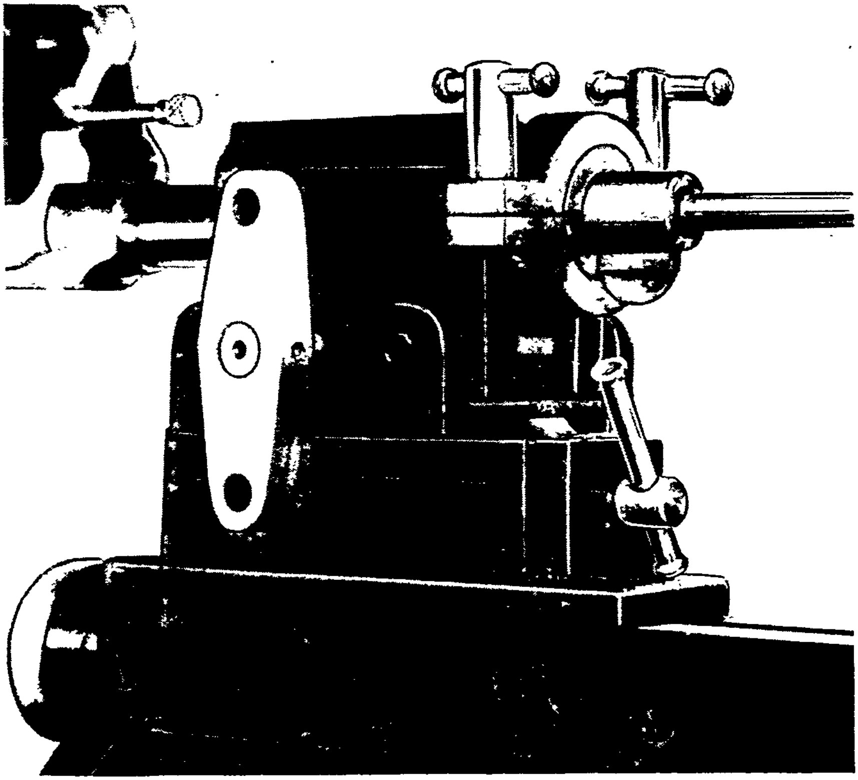


FIGURE III
Rifling meter head stock with barrel in place and supplementary clamp referred to in text.

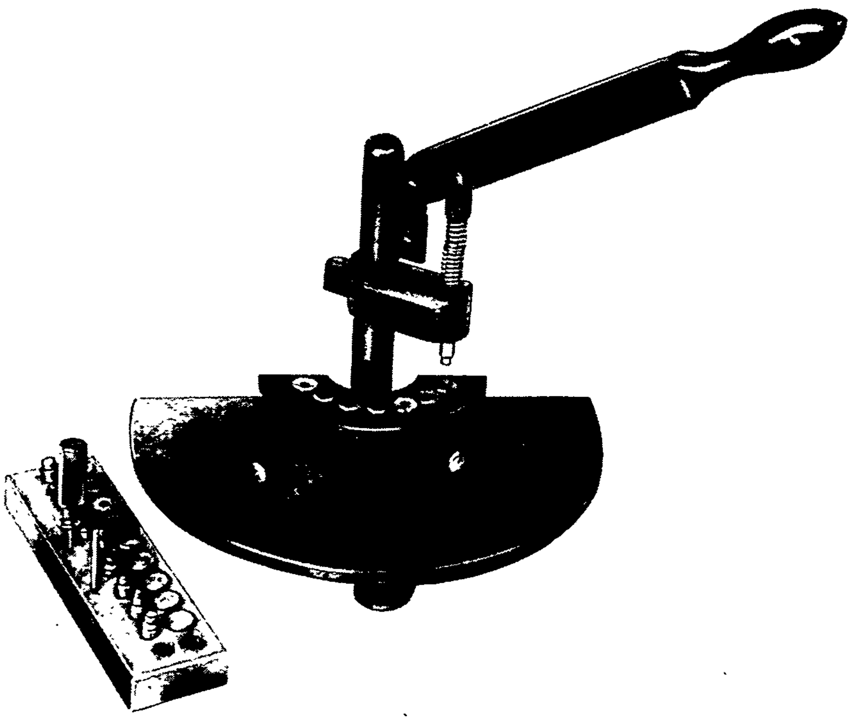


FIGURE IV
Punch and extra dies for cutting 1/16 inch lead discs for rifling meter

giving readings to .05°. Attached to the thrust bearing is a socket into which the several sizes of push rods fit. This socket has a tapered flat key so that when the push rods are inserted there will be a positive fit with no danger of axial rotation of the push rod in its socket. Each push rod is equipped with two diametrically opposite piano wire pins whose ends are ground wedge-shaped to prevent axial rotation between the base of the bullet or disc and the push rod face.

Above the ram housing are mounted two magnifiers, one over each micrometer as can be seen from the photograph. Over the vernier is another magnifier on a swivel mounting, so that the vernier can be read in either direction to take care of both right and left hand riflings. The entire head ensemble is held down by two knurled and slotted nuts, so that by loosening them the entire head can be shifted along the bench to any desired position, and then firmly clamped to the bed of the bench.

The Vise:

The vise consists of a pair of parallel jaws faced with Celeron, to prevent damaging the barrels clamped in it. Two guide rods are used to keep the jaws in alignment. The jaws are given a bi-lateral movement through the use of a lead screw threaded both right and left hand from center. This lead screw terminates in a steel handle having two holes so that a spanner wrench may be used to tighten the barrels in place. Down the center of the "Celeron" facings, whose surfaces are cross hatched, is cut a fairly deep "V" groove to facilitate the centering of the barrel being measured. The vise body is capable of vertical adjustment by means of a dovetailed inclined plane and actuated by a fine lead screw whose shaft terminates in a knurled knob. After an adjustment is made the vise can be locked permanently in position by means of a "V" shaped wedge which is tightened or loosened by means of a thumb screw. The entire vise parts are enclosed in a heavy steel housing which in turn is fastened permanently in position on the end of the bench.

The Bench:

In order to eliminate the time necessary for a good casting to age and become usable as a bench, it was fabricated from two pieces of channel iron selected for straightness and mounted the desired distance apart by means of spacing blocks held in position by heavy machine screws. The feet were then attached and a light cut was taken across the top from end to end. The bench was then checked with a dial indicator and the high spots marked. These were removed by hand scraping until a good surface was presented. Later when the head assembly was placed in position this was also filed and hand scraped until by checking with both the indicator and a good straight edge no tolerance greater than one-half thousandth was observed. Because the channels were facing each other they left a space between them which was utilized to help center the head assembly when being moved longitudinally. A spanner wrench was made to fit the vise and another wrench was made to fit the slotted nuts.

The push rods are about five thousandths of an inch less in diameter than the calibre of the gun with which they are to be used. This diameter is maintained for a distance of about three thirty-seconds of an inch back from the tip of the rod that comes in contact with the base of the bullet or disc, the remainder of the rod has its diameter reduced by about twenty thousandths so that at no time can there be contact between the gun barrel and the push rod.

Because the outside of barrels encountered are tapered and odd shaped, an auxiliary split steel clamp was constructed having split brass inserts which are interchangeable with each other.[1] These inserts have a hole through them closely approximating the barrel diameter. In practice this clamp is placed over the barrel being tested just back of the front sight. The back of this clamp then rests against the front edge of the vise taking most of the pressure exerted. Consequently the vise itself does not have to be clamped with such heavy pressure as would be the case without the auxiliary clamp. This accessory is not shown in Fig. No. I but is shown in Fig. III. Nine sets of inserts for various sizes and types of barrels have been found to accommodate all barrel shapes encountered.

Punch and Die Set:

A very desirable accessory to the rifling meter is a punch and die set, such as the one illustrated in Fig. IV. This is used for cutting the lead discs which are to be pushed through the barrel.

Lead bullets were first used but these became unobtainable because of war restrictions. This turned out to be a fortunate circumstance as the lead discs were found to work much better than lead projectiles. Discs cut by steel dies have accurate, reproducible diameters whereas the diameters of purchased bullets vary considerably. Furthermore, the rifling meter gives the best results when a moderate pressure is required to force the lead object through the barrel. Bullets present a very considerable surface of contact with the walls of the barrel and a slightly over size bullet will require considerable pressure. This is not desirable. Lead discs cut from 1/16" sheet lead present much less, but sufficient, surface and require only a moderate pressure. Measure-

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[1]We are greatly indebted to Mr. Jacob Menn, a student in chemistry at the university for assistance in the construction of the auxiliary clamping device and the press for cutting discs. Mr. Menn has also made a large number of measurements with the rifling meter.

ments obtained by the use of discs have proven to be much more reproducible and more accurate.

Since there are many calibers it is necessary to have a considerable number of pairs of dies and punches. Indeed a number of pairs are necessary for the caliber known as .38 since these vary all the way from about .35″ to .41″. For the other calibers the variation is small and usually one pair will suffice.

The punch and die set illustrated consists of a heavy base plate, semi-circular in shape upon which is mounted a heavy column carrying the punch holder and the operating lever. The dies are set in a secondary heavy steel platform having a series of holes arranged in an arc described by the rotation of the punch holder. The position of each die is such that the punch comes into perfect alignment over each die.

The punches and dies are made in pairs for any given caliber and are readily interchangeable. The dies are locked in place by headless Allen screws. Both dies and punches are fabricated from high speed drill rod, hardened, tempered and ground. Three degrees clearance $\frac{1}{16}$″ below the cutting edge on the dies and 0.005″ relief $\frac{1}{8}$″ back of the cutting edge is used on the punches. All outside diameters of the shanks of the punches are identical and the same is true for the dies, so that there may be interchangeability.

Some of the sizes of the punches found to be most useful are given below:

.2277″	.3576″
.2573″	.3790″
.3055″	.4043″
.3095″	.4398″
.3177″	.4556″

The $\frac{1}{16}$″ sheet lead used for raw stock for the discs is readily obtainable and causes no appreciable wear on the punches or dies. If wear occurred, the punches and dies could be easily sharpened in any shop equipped with a small lathe tool post grinder, a few thousandths face grind being all that would be necessary. Two metal drawers, below the dies, catch the discs. The discs are very perfectly formed and have clean cut edges. They are easily attached to the end of a push rod. After centering the push rod on the disc a light tap with a fiber faced hammer seats the disc on the pins set into the end of the rod.

Such, in brief, is the rifling meter, its structure, use and values. If construction of a rifling meter is contemplated, a set of working drawings can be obtained by writing the Authors.