Rifling Methods of Factory Fitted 9 mm Luger (9 x 19 mm) Pistol Barrels: A Reference Resource

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ABSTRACT

This comprehensive paper aims to act as a collective resource for all those with an interest in firearms manufacturing processes, including firearms examiners, armourers, historians and reference collection managers. The primary focus of this article is 9 x 19 mm semi-automatic (self-loading) pistols.

The content of this paper details the factory fitted barrel manufacturing methods for a wide range of pistol manufacturers and some aftermarket barrels. It also provides information relating to individual contacts within these manufacturing companies and current sources of knowledge for manufacturers who are no longer in business.

Introduction

Barrel manufacturing is an intricate process requiring specialist tools and experience to produce them to a fine tolerance. Many manufacturers keep the 'recipe' of their manufacturing method, and the raw materials used, secret due to the competitive nature of the weapons industry. However, the manufacturing steps usually involve initially drilling a uniform, central core into a bar of steel using a gun drill and then reaming the bore to a more exact diameter. The barrel is then ready to be rifled, if required. Alternatively, barrels may be cast with the rifling built-in or cast and subsequently rifled [1].

The term 'rifling' is used to describe the spiral, internal profile of a barrel. The spiral nature of the bore causes the projectile, in this case a bullet, to spin as it travels towards the muzzle. This is brought about by generating areas of lower (grooves) and higher relief (lands) in the barrel bore; the lands grip into the surface of the bullet as the internal diameter here is less than the maximum diameter of the projectile. **Figure 1** illustrates a typical (conventional) internal barrel profile and depicts the lands, grooves and dimensions.

The purpose of such a rotation about the longitudinal axis of the projectile causes the projectile to be gyroscopically stabilised during flight in air after the projectile leaves the muzzle [2]. This aims to improve the accuracy of the projectile and its maximum range by ensuring that the bullet is aerodynamically stable and does not tumble during flight. Also, it ensures that the projectile arrives at the target in the intended orientation. In the case of a bullet, this is the nose end.

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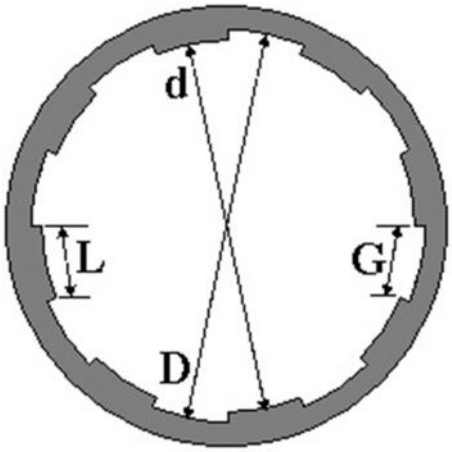

Figure 1: Cross-section of a conventional barrel illustrating the land width (L), groove width (G), groove diameter (D) and internal bore diameter (d).

Rifling was likely to have been invented in the middle of the 15th Century [3], however Lambert claimed it was as late as 1547 [4]; either way, there are a number of ways to generate the spiral profile and many methods have been employed. The methods of rifling have been documented extensively in the literature [3, 5-19] and are separated into three main categories; cut, forged and chemical removal. A new method of rifling was proposed in 2007, called flow forming [20], however, no manufacturers are known to be using this method at present to rifle pistol barrels. Although the individual rifling types are not discussed here in detail, the main principles are summarised. Further detail, including the history of these rifling methods, can be found in the author's PhD thesis [21].

From research done for this article, broach cut, button and cold hammer forged rifling all seem to still be used to a

similar extent by semi-automatic pistol manufacturers (**Table 1**). ECR (ElectroChemical Rifling) however, is not commonly used and from the manufacturers covered during this research, only SIG Sauer and Cugir have used this rifling method in their 9mm pistols.

Cut

Cut rifling involves scraping or cutting away metal from the barrel bore to create the spiralled grooves. The oldest method of rifling is a cut technique called hook or single-point rifling. Also in this category are scrape cut and broach rifling.

Hook and scrape rifling are no longer used by manufacturers that mass produce barrels; however, some custom barrel makers may still use these methods. The most common cut rifling method used in modern handgun barrels is gang broached rifling [7] where all the grooves are cut simultaneously. This generates faster rifling times and therefore higher production rates. The gang broach is much more economical as it may rifle thousands of barrels before needing to be replaced, compared to as few as five when rifled using a hook cutter [9].

Forged

Forged (or swaged) rifling involves the compression and displacement of barrel material instead of material removal, and hammer forging typically causes an elongation of the barrel. Due to the work-hardening nature of the compression process, the forged barrel increases in hardness, becomes wear and corrosion resistant and therefore is more durable. Thousands of barrels can be rifled during the lifespan of one rifling tool and the two main types of forging are hammer forging and button rifling.

Hammer forging is where the outside of the barrel is hammered onto a mandrel at room temperature (cold hammer forging), which possesses the inverse rifling profile. This hammering process will therefore reduce the internal diameter of the barrel bore, reduce the outer barrel diameter and create characteristic peening marks on the external surface [22], which may or may not be removed during subsequent manufacturing processes. The setup cost of this method is initially very expensive; however, is fast and economical in the long term for manufacturers who mass produce barrels.

Button rifling, on the other hand, is where the mandrel is forced and rotated through the barrel bore of a smaller diameter than the button (rifling tool). This compression typically causes the outer dimension of the barrel and internal dimension of the barrel bore to permanently increase during rifling. Button rifling is also a fast and economical method. The equipment is typically less expensive than that used for hammer forging; however, barrels rifled using a button may have a greater potential to warp, thus may increase wastage. Warping and wastage can be reduced by refining the rifling conditions such as progression speed and force applied to the button. Warping may therefore reflect a lower barrel manufacturing quality and less stringent manufacturing tolerances.

Chemical Removal

Electrochemical rifling creates the grooves by chemically stripping metal away from the barrel bore using electrolysis. A similar process can also be used called electron discharge machining (EDM), but this is utilised to a greater extent for manufacturing the dies used in firearm manufacturing [12], rather than the rifling process itself.

Comparison of Rifling Methods used by Manufacturers

This section gives details of the rifling methods used by a large number of 9 x 19 mm handgun manufacturers and, where possible, actual firearms were examined to obtain rifling detail such as the number of lands and grooves (hills or valleys), twist direction and rifling profile (conventional lands and grooves or polygonal hills and valleys; angular or rounded [23]). From the serial number, a date of manufacture has also been established in order to date when a company has used this method of rifling. All this information is collated and compared in Table 1, but any further manufacturing information obtained is written in the main body of text. Other good sources of reference that compile and review the rifling methods of specific manufacturers for a variety of firearm types and calibres include Bonfanti and De Kinder [24] in 1999 and Smith [25] in 2011. This article supports some of the information previously published and provides some supplemental information.

Most of the information provided in this article was acquired through personal communication with current (and occasionally former) employees of these companies in 2010. Such employees were largely members of technical staff and/or senior engineers in the factory. Where sales staff provided the information, they had typically had direct correspondence with appropriate technical staff in order to ensure the information was as accurate as possible at the time. Due to the time that has passed since 2010, it is possible that some of the information in this article may have changed for pistols barrels manufactured after the dates indicated.

The point of contact and correspondence dates for the companies are given in Table 2 rather than being cited as references, as it was felt more information could be detailed

in this manner. Where the individuals' names are either partial or listed as 'unknown', the details were typically acquired through telephone conversations and directed away from the customer service telephone number.

Pistol Manufacturers

Alfa-Proj: This company does not produce their own barrels; they purchase hammered raw barrel blanks for their pistols and revolvers. The barrels for Combat and Defender pistols are purchased from Fratelli Tanfoglio, Italy (www.tanfoglio.it) and the barrels for revolvers are purchased from Metall-Technik-Menges GmbH, Germany (www.metalltechnik-menges.de).

Arcus: For all Arcus models, the barrels are worked and rifled using hammer forging. Pistol barrels are typically bought as barrel blanks with preliminary rifling and have a conventional profile. The rest of the barrel machining and finishing is then done at the factory. Arcus has also developed an in-house barrel blank using a drawing operation; however, it is more economical for them to purchase the blanks.

Armscor (Arms Corporation of the Philippines): Armscor manufactures their barrels at their factory and the 9 mm calibre barrels are button rifled. Such barrels have been made by this method since 1997. Armscor buys the tungsten carbide rifling button and bore reamer/chambering tool from Clymer Tools, U.S.A (http://www.clymertool.com/), which is based on the Sporting Arms and Ammunition Manufacturer's Institute (SAAMI) specifications. The barrel is made from AISI 4140, 1 5/8" (41.2mm) diameter bar stock material and the sequence of barrel manufacturing operations is as follows: pre-cutting, deep hole drilling, reaming, CNC (computer numerical control) turning, milling of lug-slots, chambering and finally, full heat treatment to 44-48 HRC (Rockwell hardness scale). During rifling, the "button" is passed only once through each barrel and one "button" can rifle approximately 1,000 barrels before it is discarded. However, the button is discarded well before it is worn beyond acceptable limits. One manufactured batch contains 40 barrels and Armscor produces approximately 1,000 barrels a month.

Beretta: Beretta rifles all their pistol barrels in-house at the factory in Brescia, Italy using the broach cut method.

Bernardelli: Unfortunately, the new Vincenzo Bernardelli Srl company does not have serial number records for the old Vincenzo Bernardelli SpA company that closed down in 1995. However, technicians at the current factory were able to say that the Bernardelli pistol barrels, such as the PO 18 pistol, were broach cut and the same method is still used to rifle their current firearms.

Briley: Briley makes custom pistols and sells replacement barrels for 1911, Glock, and Tanfoglio pistols; however, they import barrel blanks from different suppliers and do not do the rifling themselves. The rifling method therefore differs depending on which supplier they purchase the barrel blank from and either bar-stock material or forgings are used. The forgings are preferable as they are stamped to be as close as possible to the finished product, which minimises machine time. Briley uses forgings button broached by Bill Jarvis, Montana (http://www.jarvis-custom.com/), broach cut by Bar-Sto Precision Machine [26], California (http://www.barsto.com/) when available, and sometimes button broached blanks (not forgings) by Shilen Rifles, Texas (http://www.shilen.com/); companies all based in the USA. With the supplied rifled forgings, Briley then machines the barrels on the CNC, heat treats them and then prepares them for sale. The barrels are all oversized and need to be fitted to specific guns. Briley also manufactures shotgun chokes that are rifled using electrochemical machining because they are too thin for button or broached rifling.

Colt: All Colt pistols are rifled using broach cut, conventional shaped rifling.

Cugir: Cugir manufactures the barrels for all the weapons their company produces. The 9 mm pistols, for example, the M92, are electrochemically reamed and then electrochemically rifled, but are said to have a polygonal profile.

CZ (Česká zbrojovka a.s.): The CZ factories undertake all the barrel manufacturing for their pistols. The barrels are cold hammer forged onto a mandrel with conventional shaped rifling. Each barrel is hammered individually rather than making multiple barrels from a long piece of hammer forged steel.

Dan Wesson: The rifling in their pistol barrels is gang broached. Although Dan Wesson is affliated with CZ, the CZ factories do not do any manufacturing for the Dan Wesson firearms.

F.B. Radom: Between 1935 and 1939, the VIS 35 barrels were manufactured and rifled at the factory in Poland until the factory was governed by Germans during World War II. The barrels were produced in the following manner: bar material was drop forged and the surfaces were pre-treated; deep hole drilling of bore and cartridge chamber was performed using two-spindle drills (pre-1936) or adapted turret lathe (post-1936); barrels were hardened to 830-850 °C in a crucial salt furnace and cooled in oil; tempered to 450–500 °C and slow

cooled in oil; the bore was enlarged and flattened then enlarged another 2 or 3 times; the barrel was rifled using two-spindle gun rifling machines with brush scrapers (rifling method used between 1925 and 1939); the bore was polished using rotary motion and fine grain powder; the cartridge chamber was enlarged; external surfaces were turned and milled; the barrel was treated by chemical anticorrosive passivation; and then ultimately the barrels were calibrated for quality control and approved for army use.

In 1938, Polish engineers visited one German weapon factory to look at their barrel production technology, which hardened the steel up to 62-64 HRC. As a result, existing F.B. Radom engineers believe that there may have been other rifling trials undertaken at the factory around this time, but they have no definitive information about this.

Post-1939, when the Germans governed the factory, barrels ceased to be made in-house and instead they were produced by Steyr-Daimler-Puch A.G., Austria. F.B. Radom has information that the Germans thought this was a cold forging method on a special mandrel made of sintered wolfram carbides. However, speaking recently with Oliver Bauer at Steyr-Mannlicher, prior to the 1960's Steyr barrels were made using broach cut rifling. It was only in the 1960's when they worked together with GFM that hammer forged rifling machines were developed. The barrels, therefore, could have been button rifled rather than hammer forged, but this is not definitively confirmed.

Glock: The hammer-forged barrel [27] (rifled section and chamber) starts life as a drilled hole, which is honed and polished before cold hammer forging. Once forged, the barrel is heat treated to stress release the material and then hardened, with the final hardening process being Tenifer treatment [28]. The Tenifer coating primarily increases the barrel's corrosion resistance. The finish quality of the hammer forging process is due solely to the bore finish before hammering and the polish on the mandrel. One mandrel will produce a couple of thousand barrels, which have a rounded polygonal profile. In 2016 it became apparent that although Glock barrels are still hammer forged, there is a new rifling profile being used in G42 and G43 model barrels with defined 'rails' in the rifling grooves [29]. Omar Felix toured a US Glock factory and was informed that the 'rails' are already cut into the Austrian made mandrels and these mandrels are now used to rifle 20,000-30,000 barrels. During Felix's research he determined that the 'rails' transferred to fired bullets should not be used for identification, but observed new cross-hatched markings on the barrel surface resulting from the honing process. These honing marks may now survive as Glock seems to have changed the barrel metal composition a few years ago, which potentially increased the material hardness and thus hammer forging no longer removes all the honing marks. Glock intends to incorporate their new rifling profile in the barrels of all models and calibres in due course.

Heckler & Koch (H & K): H & K pistol barrels are cold hammer forged which creates an angular polygonal rifling profile. With regard to the P9S, early barrels had the 6 right-hand polygonal rifling profile; however, this was changed to 4 right. Until 1977, the P9S barrel manufacturing method involved cold hammer forging one long barrel blank, which was then cut into up to 4 barrels and individually chambered. Since then, the pistol barrels were individually formed like the P9 barrels. More information on the manufacturing of the H & K pistols can be obtained from a publication by Haag [30].

Hi-Point: After personal communication with Tom Deeb (owner of Hi-Point Firearms and BeeMiller, Inc. before he passed away earlier in 2016) it was noted that the barrels of both the JS 9mm and C9 pistols are "pressure broached" i.e. button rifled; clarification by the manufacturer is very important in this case as this could be incorrectly interpreted by some as being broach rifled. Thompson [31] also notes that the barrels are button rifled and details an interview with Mr. Deeb. Note - Mike Strassell now heads the Hi-Point company.

High Standard: With respect to the 9mm Backup model, the barrels in this pistol are button rifled, however, the author could not be informed which company supplies these barrels. Depending on the calibre and model, High Standard have outsourced barrels from a number of companies.

Jordan Armament & Weapons Systems (JAWS): King Abdullah Design and Development Bureau (KADDB) in conjunction with Wildey Guns produce the Viper pistol for the Jordanian Armed Forces. With regard to the Viper pistol, at this stage JAWS does not manufacture barrels, but outsources them from an American company called Green Mountain Rifle Barrels (http://www.gmriflebarrel.com/). Green Mountain uses button rifling in their barrels and they also machine the outer diameter of their barrels. In the future, JAWS hopes to do this themselves.

John Slough of London (JSL): At the time of the UK handgun ban, John Slough had the only UK factory that was manufacturing pistols. The Spitfire 9mm Pistol MK II was, at the time of the ban, on trial with the Special Forces in Hereford and the ban forced his factory to close; however, John still restores, repairs and reconstructs artillery weapons. The barrels made by his company used button rifling and exhibited a conventional rifling profile.

Jimenez Arms (formerly Bryco Arms): The J.A. Nine pistol manufacturing process is documented by Welch [32]. In summary, the barrels are rifled in-house using gang broaches. The barrels are bought as blanks that have been machine cut to specific dimensions. Up to 100,000 barrels can be rifled before the broach is sharpened. Chambering of the barrel is undertaken using a chamber reamer with a 'pre-chamber' and this area may still exhibit rifling toolmarks. Blued components are finished in-house, whereas other finishing processes are outsourced.

Kahr: Battles [33] states that the Kahr barrel is a button rifled barrel blank and the following extract is quoted from the Kahr Arms website [34]. "The Kahr barrel begins its transformation from a solid round billet of high tensile strength proprietary steel, 3" (7.62 cm) in diameter and 30" (76.2 cm) long. In the temperature-controlled environment of the Lothar Walther factory, the barrel stock is gun drilled and rifled to match grade tolerances. At the Kahr factory, the barrel stock is precisely cut to length and CNC machined. Nearly 75% of the solid steel billet is machined away to produce a single Kahr barrel. This intensive production method, providing the greatest material integrity and tightest tolerances, was chosen to assure the best quality barrel possible." Kahr pistol barrels have been offered with both conventional (sharp edged lands) and polygonal rifling profiles. It is therefore important for an examiner not to assume that a conventional-looking rifling profile must have been made with a cut rifling method as both forged and cut rifling processes can create conventional rifling profiles. The Kahr Arms website also contains information about the manufacturing processes for their slides and magazines.

Kel-Tec: The Kel-Tec PF-9 is manufactured and rifled at the Kel-Tec CNC Industries' factory and the rifling method used is button rifling. The same can be said for all Kel-Tec pistol models.

Kimber: All Kimber handgun barrels are initially broach cut and then cold button formed. Due to the relatively thin-walled barrel, the rifling is broach cut first to remove most of the material as to not bulge the barrel when cold button forming. The cold button forming is a finishing process that gives a uniform, unidirectional finish to the lands and grooves, which enhances the accuracy of the barrels. The button forming does not apparently alter the 'sharpness' of the lands.

Lorcin: Lorcin pistols were button rifled with a "burnishing broach" at the Lorcin factory [14]. Collins discusses this manufacturing process in more detail, along with the manufacturing process for the frame, breech face and surface finish.

Lothar Walther: Gerd Walther informs us that Lothar Walther produces individual barrels for many firearms companies to their specified dimensions; these include pistol manufacturers Fratelli Tanfoglio and Kahr Arms. All of their barrels are produced from special rifle steel of German origin only, for example from the Krupp steel mills. The company can produce barrels with outer dimensions ranging from a minimum diameter of 9 mm (.36") to 42 mm (1.65"), and maximum length between 930 mm (36") and 1000 mm (39.4"). Their barrels are produced using button rifling, which was introduced by Lothar Walther (son of Carl Walther) in Zella-Mehlis, Germany in 1925.

Para Ordnance (Para USA): Kreso and Coombs [35] document the manufacturing processes for these firearm components. In summary, the barrel rifling method used is broach cutting; however, barrel finishing processes differ pre and post-2004. Pre-2004 barrels are polished and post-2004 are smoothed with glass beads. Chambers for 9 x 19mm barrels are hand reamed in-house and light polishing takes place on the feed ramp and chamber.

Rohrbaugh: Both the 380 (.380" calibre) and R9 (9 x 19 mm calibre) pistols are CNC machined and broach cut rifled in-house at Rohrbaugh Firearms in the United States.

Ruger: Jim Elliot, the Plant Manager at Ruger Firearms informed the author that all models and calibres of Ruger's centerfire semi-auto pistol barrels have been broach cut, in-house, since the first P-85 was released in 1987 (Sweeney [36] also confirms that Ruger pistols were broach cut rifled). However, some of the Ruger long guns are forged rather than broached. The broaching tool used is a round bar approximately 2.5 ft (0.762 m) long with cutting diameters along its length. At the leading end of the bar (gang broach) there is a small diameter pilot, that passes through the unrifled drilled bore. A hydraulic cylinder clamps on to the pilot and pulls the rest of the broach through the barrel, removing barrel material. The leading end cutting surfaces of the broach gradually become larger in diameter until the trailing end is reached. The diameters of the last cutting surfaces are the finished diameter of either the land diameter or groove diameter. For the land and groove diameters, separate gang broaches are used; first, the land broach opens up the gun drilled hole to the land diameter and then the groove broach is used to cut the rifling grooves. During the rifling, it is the barrel that is rotated at a clocked revolution rate relative to the linear pull of the broach to give the rifling the designated twist rate. Using this method, all the machining (reaming) tool marks run longitudinally down the length of the barrel. In addition, it is important for examiners to be aware of the potential existence of subclass characteristics in components of some models of Ruger

firearms. Such components include the barrel and breechface and it has been shown that the level of subclass characteristics exhibited by this manufacturer may vary [37, 38]. Therefore, it is especially important to evaluate the degree of subclass and establish its potential for influencing the reliability of an identification when comparing fired ammunition components

Sarsilmaz: Sarsilmaz informed the author that they use a number of modern rifling techniques in order to make their barrels. These techniques include broach cut, button and hammer forging. The rifling used depends on the requirement from the customer, for example civilian or armed forces use. The ST10 has a 115mm polygonal rifled barrel and uses different rifling than the Kilinc 2000. On the other hand, one model of 9 x 19 mm pistol, such as the P8 L, may use barrels rifled by a number of different methods.

SIG Sauer (Germany): In January 2010 the author was fortunate to visit SIG Sauer Germany where they use two types of rifling to manufacture their pistol barrels; cold hammer forging and ECR. The barrels of the duty pistols, such as P226 pistols, are done using ECR, whereas the rifles and sports pistol barrels are hammer forged. ECR was introduced in 2002, initially with the SP2022 model pistol barrels, to significantly reduce the cost of the pistols sold to law enforcement and military units as ECR is a less expensive manufacturing process. Prior to 2002, all SIG Sauer barrels were cold hammer forged. SIG Sauer only uses steel supplied by Thyssen-Krupp, Germany and the cylindrical raw material has a 45 mm (1.77“) diameter. Bolton-King [22] discusses barrel production and rifling in significantly more detail, and also covers slide and frame manufacturing at the SIG Sauer factory to some extent.

Smith & Wesson: Glass and Gibson [39] published that all of Smith & Wesson pistol barrels are rifled using a broach cut rifling process; however, most of their revolver barrels have been electrochemically rifled since 1993 [13]. Communication with Paul Gazda at Smith & Wesson confirms that this is still the case (January 2010). Further, it is the revolver barrels of .32 cal and above that typically use ECR, which results in a smoother, more tool mark free interior barrel surface. There are some exceptions, such as Power Ported guns and some Performance Center (custom) barrels. Some custom barrels have been out-sourced in the past to premium contract barrel makers, some have been broached in-house, and some have used contract-made polygonal rifled barrels.

Springfield Armory: All Springfield Armory 1911 pistols, including the EMP (Enhanced Micro Pistol) are button rifled; however, the XD model is hammer forged with conventional rifling. The P9C pistol model (discontinued in 1992), was not manufactured by Springfield Armory Inc.; the author was informed that Fratelli Tanfoglio (in Brescia, Italy) supplied all the component parts for this pistol, which were then assembled and assigned serial numbers at the Springfield factory. Prior to 2000, Tanfoglio was broaching their own barrels and therefore, Tanfoglio factory P9C barrels were likely rifled using the broach cut method.

Stallard Arms: To rifle the JS pistol barrels, Stallard Arms used a ‘pressure broach’, i.e. used button rifling. The button was pushed down the barrel as opposed to pulling it through, as pushing is a much faster process. The JS stopped being made in 1994. This information was obtained from Tom Deeb, who set up Hi-Point Firearms after Mr. Stallard passed away and started manufacturing the C series of pistols.

Star: All barrels in Star firearms were made in-house at the Star Bonifacio Echeverria, S.A. factory. Pistol barrels, such as in the Firestar M43 were machined from F127 steel blank and broach cut rifled with a 6 right rifling profile and an advance of 311.73 mm (12.27”) per turn. A total of three successive broaches cut the six rifling grooves simultaneously; each broach cut the rifling slightly deeper. The rifled bore was then finished and polished with a tool called a ‘widia button’. This was to ensure that the rifling was perfectly clean and squared. The final internal bore diameter tolerances between opposing grooves was from 9’01 to 9’06 mm (0.355 to 0.357”) and 8’81 to 8’86 mm (0.347 to 0.349”) between opposing lands. Although Star and Astra went bankrupt in 1997 they formed a new company called Astar and began to manufacture guns again [40]. One facet of the original Star company; however, was allowed to continue as IPAR Guns (http://www.iparguns.com/cas/ index.htm) and this company is where many former Star engineers are still working.

Steyr: The barrels for all firearms (pistols, rifles, assault rifles etc.) from Steyr Mannlicher are cold hammer forged and have been since the mid 1960’s.

STI International: Barrels in STI firearms are made from 416 rifle grade, stainless steel billet forgings. The steel billet is gun drilled and then the bore is button rifled. The barrel is then air gauged to ensure the dimensions of the barrel are within defined tolerances and that the barrels are consistent. The barrels are vacuum heat treated and vacuum tempered to 40 Rc (Rockwell C. hardness scale), and then machined to their defined specifications. When manufactured, the barrels are short chambered to allow the gunsmith to finish chambering to the firearm’s application; however, STI would not comment on whether barrels were manufactured in-house or out-sourced. The GP6 pistol model is made to STI specifications by Grand Power in Slovakia [41] and has a chromium-vanadium

(CrV) steel barrel that is treated with Tenifer QPQ treatment [42]. The internal geometry of the GP6 has been tested for durability and after more than 110,000 shots the dimensions had not changed [43]. The Spartan model is built by the STI division of Armscor in the Philippines, but all other models are made in Georgetown, USA.

Tanfoglio: Prior to 2000, Tanfoglio used to broach cut the rifling in their pistol barrels in-house; however, now they buy the barrel blanks already rifled from Lothar Walther GmbH, Germany (http://www.lothar-walther.de/3.php). As previously stated, Lothar Walther barrels are all button rifled. Once the rifled barrel blanks are purchased, Tanfoglio carries out all other machining and contouring at its factory in Brescia, Italy.

Taurus: The vast majority of Taurus pistols are manufactured in Brazil; however, Taurus USA does manufacture the PT22 model. Forjas Taurus S.A. uses button rifling to create the rifling in their 9 x 19 mm calibre pistol barrels.

Vektor: The Vektor pistol series began with the Z-88, which was reverse engineered in 1986 and went into production in 1988. The SP-1 series was produced in 1992 and the CP-1 series in 1993. Vektor barrels are manufactured and rifled using the cold hammer forged process, but the Z-88 has a conventional profiled barrel and the SP-1 and CP-1 pistols have a polygonal profiled barrel. From Monturo's [44] observation and the author's discussion with Derik Synman at Denel Land Systems, the class characteristics of the 9 x 19 mm calibre CP-1 and SP-1 are 4 right and polygonal, whereas the Z-88 is 6 right and conventional.

Walther: The author was fortunate enough to be invited to visit the Carl Walther factory in Germany (January 2010) and be given a tour of the factory by Peter Dallhammer. From this, much information was gathered about the manufacturing processes of all Walther pistol barrels. However, unfortunately, they do not typically disclose details of their barrel production information and all the author is able to publish is that the rifling in the barrels of all modern Walther pistols is done by button rifling. Prior to this, Walther used cut rifling; however, the exact method of cut rifling could not be ascertained. Button rifling was introduced by Lothar Walther in 1925, so it is possible that button rifling was also introduced at Carl Walther at a similar time (possibly with the PP series of pistols in 1929). However, it is also possible, that button rifling was not used in Carl Walther pistols until 1957 when the P38 began to be re-made after World War II. Unfortunately, no-one at the factory has details of the rifling methods used that far back.

Zastava Arms (formerly Crvena Zastava): The barrels used in the M88, CZ99 and their other pistols are cold hammer forged; however, the CZ model also has a chromium plating on the barrel surface in order to protect against corrosion and rusting.

Some After-Market Pistol Barrel Manufacturers

Bar-Sto Precision Machine: Milam [26] states that Bar-Sto uses broach cut rifling in all of their barrels.

EFK Fire Dragon: The EFK homepage [45] states that all their products are manufactured from 416 stainless steel, machined using CNC equipment and heat treated to a consistent hardness between 40 and 43 Rc using a vacuum furnace. Also, their barrels are bored and rifled using EDM (electrical discharge machining) to produce greater accuracy (+/-50 millionths of an inch), a superior finish and less stress in the material compared to button or broach cut barrels.

KKM Precision: The KKM website [46] indicates that they use button rifling in all of their pistol barrels using a titanium carbide coated button that is made in-house. They also indicate that the button is pulled through the barrel, as opposed to being pushed through, to displace the metal and produce "a more accurate bore diameter, surface finish, surface hardness as well as a more uniform rate of twist" compared to other rifling methods.

Storm Lake: Laskowski [47] explains that Storm Lake Barrels are manufactured by Genesis Mill Works, Inc. and all of their barrels are manufactured from 416 grade stainless steel and rifled using the broach cut method.

Conclusions and Further Work

The information provided in this article was acquired between 2009 and 2010 as background research to support the author's PhD in forensic firearm identification and imaging. This article aims to be a valuable source of information to firearms examiners and other firearms professionals who need to understand or are interested in the pistol barrel manufacturing processes, which ultimately supports the comparison science of firearm and toolmark identification.

There are a number of modern rifling methods being utilised in 9 x 19 mm pistols; namely hammer forged, button and broach cut rifling. Electrochemical rifling is also utilised in pistol barrels, although less frequently than the other approaches. Barrels can sometimes be rifled in-house by the manufacturer, or the rifled barrel blanks can be bought from another company. Either way, it is notable that each of the methods can produce different rifling profiles. For example, the hammer forged method can generate both conventional

(sharp-edged) and polygonal (more rounded) barrel profiles, whereas, to the author's knowledge, broach cut rifling has only been used to produce conventionally shaped rifling. To further expand on this statement, Hocherman, Giverts and Shosani [23] documented differences in land-to-groove transition profiles for manufacturers of polygonal barrels; Glock pistols having a different profile (rounded polygonal) than that of the Israeli Military Industries Jericho 941 barrel and the Heckler & Koch pistol barrel (angular polygonal), for example. Bolton-King [22] also illustrates that the rifling method of conventional profile SIG Sauer barrels can be differentiated through the cross-sectional examination of land-to-groove transition profiles for their ECR and hammer forged pistol barrels.

The information in this article was subsequently used to investigate whether pistol manufacturers can be classified and differentiated by observing only the barrel transition profile. The successful outcome of this PhD research was published by the author in 2012 [21]. The method of transition profile comparison [48] could now be utilised to examine the barrels of clandestinely manufactured firearms to identify the manufacturing methods and establish a common source of the weapons. Further research has since been initiated to evaluate the degree and reproducibility of transfer for the transition profile on to the surface of fired bullets, which could potentially lead to a new class characteristic for barrel and pistol manufacturer identification.

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References

[1] Thompson, E., "Aluminum Barreled 380 Caliber Derringer," AFTE Journal, Vol. 32, No. 1, Winter 2000, p. 48.
[2] Warlow, T., Firearms, the Law, and Forensic Ballistics, CRC Press, Boca Raton, USA, 2011.
[3] Heard, B.J., Handbook of Firearms and Ballistics: Examining and Interpreting Forensic Evidence, John Wiley & Sons Ltd, Chichester, UK, 2008.
[4] Lambert, R., "Footnotes," AFTE Newsletter, Vol. 9, No. NL09-2, August 15, 1970, p. 37.
[5] Lansing, J.F., "Electrochemical Machining - A New Barrel Making Process - Part 2: Testing of the Coonan Arms Model B Pistol and the Reproducibility of Rifling Striae," AFTE Journal, Vol. 20, No. 4, October 1988, pp. 396-403.
[6] Kolbe, G. 2000 July. "Making of a Rifled Barrel". <www.firearmsid.com/Feature%20Articles/RifledBarrelManuf/BarrelManufacture.htm>. Accessed 2009 06/11.
[7] Petty, C.E. "A Short Treatise on Barrel Making". Guns Magazine. 2001 December. <http://findarticles.com/p/articles/mi_m0BQY/is_12_47/ai_79586229/>. Accessed 23/06/2009.
[8] Sundra, J.R., 24 July 2003. "All about Barrels". Petersen's RifleShooter. <http://www.rifleshootermag.com/gunsmithing/RSgunsmith1/#cont>. Accessed 2009 June 24.
[9] Biasotti, A.A., "Rifling Methods – A Review & Assessment of the Individual Characteristics Produced," AFTE Journal, Vol. 13, No. 3, Summer 1981, pp. 34-61.
[10] Murdock, J.E., "A General Discussion of Gun Barrel Individuality and an Empirical Assessment of the Individuality of Consecutively Button Rifled .22 Caliber Rifle Barrels," AFTE Journal, Vol. 13, No. 3, July 1981, pp. 84-111.
[11] Bonfanti, M.S., "Revue Des Procédés De Fabrication De Certaines Parties D'Armes À Feu," Revue Internationale De Criminologie Et De Police Technique, Vol. 50, No. 4, 1997, pp. 460-468.
[12] National Institute of Justice. Firearm Examiner Training Website. <http://www.ojp.usdoj.gov/nij/training/firearms-training/index.htm>. Accessed 2009 April 29.
[13] DeFrance, C.S., Van Arsdale, M.D., "Validation Study of Electrochemical Rifling," AFTE Journal, Vol. 35, No. 1, Winter 2003, pp. 35-37. Accessed via: <http://www.firearmsid.com/Feature%20Articles/ecr/electrochemicalrifling.htm-37>.
[14] Collins, J.M., "Manufacturing the Lorcin L380 and Corresponding Characteristics," AFTE Journal, Vol. 29, No. 4, Fall 1997, pp. 498-502.
[15] Extrude Hone Corporation. 2004 February. "Electrolytic Rifling Solutions". <http://www.extrudehone.com/media/files/ECRifling_001sc.pdf>. Accessed 2009 06/22.
[16] Mahdavinejad, R., Hatami, M., "On the Application of Electrochemical Machining for Inner Surface Polishing of Gun Barrel Chamber", Journal of Materials Processing Technology, Vol. 202, No. 1-3, 20 June 2008, pp. 307-315.
[17] Papke, R.E., "Electrochemical Machining: A New Barrel Making Process," AFTE Journal, Vol. 20, No. 1, Winter. 1988, pp. 48-52.
[18] Knox, G., 2006 September. HGR Firearms Website. "Barrels and the Rifling Within Them". <http://www.hgrfirearms.com/resources/Barrels_and_Rifling.htm>. Accessed 2009 June 15.
[19] Lilja, D., 2002. "The Making of a Rifle Barrel". <www.riflebarrels.com/articles/barrel_making/making_rifle_barrel.htm>. Accessed 2009 June 12.

[20] GÜN, B., GÜVEL, I., 2007 October. "Rifling by Flow Forming". <http://www.firearmsid.com/Feature%20Articles/FlowForming/riflingbyflowforming.htm>. Accessed 2009 06/22.
[21] Bolton-King, R.S., "Classification of Barrel Rifling Transitions for the Identification of Firearms", PhD, Nottingham Trent University, Nottingham, England, 2012.
[22] Bolton-King, R.S., Evans, J.P.O., Smith, C.L., Painter, J.D., Allsop, D.F., Cranton, W.M., "Manufacturing of SIG Sauer 9 X 19 mm Pistols," AFTE Journal, Vol. 44, No. 1 (Winter), 2012, pp. 19-28.
[23] Hocherman, G., Giverts, P., Shosani, E., "Identification of Polygonal Barrel Sub-Family Characteristics," AFTE Journal, Vol. 35, No. 2, Spring. 2003, pp. 197-200.
[24] Bonfanti, M.S, De Kinder, J., "The Influence of Manufacturing Processes on the Identification of Bullets and Cartridge Cases – a Review of the Literature," Science & Justice, Vol. 39, No. 1, 1. 1999, pp. 3-10.
[25] Smith, J., "Letter to Editor: Method of Rifling by Manufacturer," AFTE Journal, Vol. 43, No. 2, Spring. 2011, pp. 104.
[26] Milam, A., "After-Market Barrels for Glock Pistols," AFTE Journal, Vol. 39, No. 1, Winter. 2007, pp. 64-65.
[27] Garland, P.V., "The Glock 17 Pistol," AFTE Journal, Vol. 19, No. 2, April. 1987, pp. 178-180.
[28] Northcutt, A., "Glock Barrel Modification: A Feasible Method to Facilitate the Identification of Fired Bullets?" AFTE Journal, Vol. 42, No. 2, Spring. 2010, pp. 108-119.
[29] Felix, O., "Glock Marking Barrel - An Evaluation of Individual and Subclass Characteristics" Presented at the 47th AFTE Training Seminar, New Orleans, LA, June, 2016. Access via <https://youtu.be/aBlOpVGJkHc>. Accessed 2016 10/03.
[30] Haag, L.C., "Heckler & Koch Polygonal Rifling," AFTE Journal, Vol. 9, No. 2, Spring. 1977, pp. 45-47.
[31] Thompson, E., "9mm Hi-Point an Interview with the Owner," AFTE Journal, Vol. 25, No. 4, October. 1993, pp. 308-317.
[32] Welch, A.K., "History and Manufacturing Process of the Jennings / Bryco / Jimenez Arms Pistols," AFTE Journal, Vol. 45, No. 3, 2013, pp. 260-266.
[33] Battles, B., "... Inside Kahr Arms", On Target 2009 Special Tactical Issue, Accessed [25/07/2011] Via <http://www.Kahrauction.Com/PA-1B/review_ot09.Html> 2009, pp. 42-45.
[34] Kahr Arms, 2007. "Kahr Barrels". <http://www.kahr.com/KA-2A.html>. Accessed 2010 02/03.
[35] Kreso, J.J., Coombs, J., "Para-Ordnance (Para USA) Company and Manufacturing Information," AFTE Journal, Vol. 42, No. 3, 2010, pp. 291-292.
[36] Sweeney, P., The Gun Digest Book of Ruger Pistols and Revolvers, Gun Digest Books, Iola, Wisconsin, 2007.
[37] Norris, S., "Subclass Characteristics in Recent Ruger Handguns", AFTE, Dallas, Texas, 27 May, 2015.
[38] Hamby, J.E., Brundage, D.J., Thorpe, J.W., "The Identification of Bullets Fired from 10 Consecutively Rifled 9mm Ruger Pistol Barrels: A Research Project Involving 507 Participants from 20 Countries," AFTE Journal, Vol. 41, No. 2, Spring. 2009, pp. 99-110.
[39] Glass, S.A., Gibson, W.M., "Firearms Factory Tours," AFTE Journal, Vol. 29, No. 4, Fall. 1997, pp. 487-493.
[40] Hoober, S., 2009 August 13. "Star Bonifacio Echeverria, S.A". <http://star-firearms.com/index.html>. Accessed 2010 01/19.
[41] STI International, 2009. "STI Guns FAQ". <http://www.stiguns.com/FAQ.php>. Accessed 2010 01/19.
[42] Poole, E.R., "STI GP6 9mm", Combat Handguns, Accessed <http://Media.Stiguns.Com/USPress/CombatHandguns/May2009/CombatHandgunsMay09-GP6.Pdf>May. 2009, pp. 11-16.
[43] STI International, 2009. "STI International GP6". <http://stiguns.com/guns/GP6/GP6.php#fourth>. Accessed 2010 01/19.
[44] Monturo, C., "Rifling Characteristics of the VEKTOR Semi-Automatic Pistol," AFTE Journal, Vol. 32, No. 4, Fall. 2000, pp. 363.
[45] EFK Fire Dragon, 2010. "EFK Homepage". <http://www.efkfiredragon.com/index.php>. Accessed 2010 01/20.
[46] KKM Precision, 2010. "KKM Precision Homepage". <http://www.kkmprecision.com/custom_pistol_barrels/pages.php?pageid=3>. Accessed 2010 01/20.
[47] Laskowski, G.E., "Storm Lake After Market Barrels for Glock Pistols," AFTE Journal, Vol. 40, No. 2, Spring. 2008, pp. 216-218.
[48] Bolton-King, R.S., Bencsik, M., Evans, J.P.O., et al., "Numerical Classification of Curvilinear Structures for the Identification of Pistol Barrels," Forensic Science International, Vol. 220, No. 1–3, 7/10. 2012, pp. 197-209.

(Tables continued on next page)

Manufacturer	9 x 19 mm Calibre Model	Serial Number	Date of Manufacture	No. Lands & Twist Direction	Rifling Profile	Method of Rifling
ALFA-PROJ s.r.o.	Combat & Defender					Hammer forged
AMT	On Duty	A00778		6L	Conventional	Broach cut (Gun World, April 1991)
ARCUS Co. (Imperial Defence Services Ltd.)	Ranger (Model 94)	00GU 00002	9th Nov 2000	6R	Conventional	Hammer forged
ArmaLite Inc.	AR-24			6R	Conventional	Broach cut
Arms Corporation of the Philippines	Government Model 1911					Button
Bersa S.A.	Thunder 9				Polygonal	Hammer forged
Bond Arms, Inc.	Texas Defender				Conventional	Button
Bryco Arms (now Jimenez Arms)	Jennings Nine (J.A. Nine)			6R	Conventional	Broach cut
	Model 59			6R	Conventional	Broach cut
Carl Walther	P5	170023	32478	6R	Conventional	Button
	P99 DAO	FAH 4733	39814	6R	Conventional	Button and Tenifer treated
Ceska Zbrojovka (CZ)	75	42332	1981	6R	Conventional	Cold hammer forged
Colt's Manufacturing Co.	All American Model 2000	PF12281	1992	6L	Conventional	Cut rifling, possibly broach, def. not button
Dan Wesson	Pointman Nine (PM 9)					Broach cut
Fabbrica d'Armi Pietro Beretta	92SB	B76622Z	6th Jul 1982	6R	Conventional	Broach cut
Fabrique Nationale (FN) Browning	Hi-Power Mark I	BL79A19877	Early 1979	6R	Conventional	Hammer forged
Fabryka Broni Lucznik (F.B. Radom)	Vis Model 35 (German)	C1052	1939 (after 8th Sep)	6R	Conventional	Broach cut (by Steyr-Daimler-Pugh post 8th Sept 1939)
Glock	19	ASA170	1993	6R	Polygonal (rounded)	Hammer forged and Tenifer treated
	17	BKC687	1995	6R	Polygonal (rounded)	
Heckler & Koch	P9S	108 603	12th Mar 1976	4R	Polygonal (angular)	Cold hammer forged - 1 long barrel rifled then cut into sections and chambered (prior to 1977)
		106151	1975			
	P7	37481	1982	6R	Polygonal (angular)	Cold hammer forged - individually rifled
	USP	24-12385	1995	6R	Polygonal (rounded) - H&K call 'conventional'	

Table 1: A comparison of rifling methods used in certain pistol models by manufacturer

Manufacturer	9 x 19 mm Calibre Model	Serial Number	Date of Manufacture	No. Lands & Twist Direction	Rifling Profile	Method of Rifling
High Standard	Backup					Button
Hi-Point Firearms	C9			9L	Conventional	Button
Indústria de Material Bélico do Brasil (IMBEL)	M973	30450	4th Sep 1991	6R	Conventional	Hammer forged
Israeli Military Industries (IMI)	Jericho 941FB (Frame Baby)	122714	1993	6R	Polygonal (angular)	Hammer forged
John Slough of London (JSL)	Spitfire Mark II	1385	1993	6R	Conventional	Button
Kahr Arms	K-9			6R	Polygonal	?
	CW9			6R	Conventional	Button (by Lothar Walther)
Kel-Tec CNC Industries	PF-9					Button
Kimber Manufacturing	Aegis II and Target II					Broach cut and cold button formed
Lyttelton Engineering Work (Vektor)	CP1	BBF135	34851	4R	Polygonal (angular)	Cold hammer forged
	SP1	G001014	35704	4R	Polygonal (angular)	
	Z-88	TQ 114162	34759	6R	Conventional	
Para USA, Inc. (Para Ordnance)	All					Button
Rohrbaugh Firearms	R9					Broach cut
S.C. Uzina Mecanica Cugir S.A.	M92				Polygonal	Electrochemical
SIG Sauer	P226	U 101 042	8th Mar 1983	6R	Conventional	Cold hammer forged
	P250	EA 004 051		6R	Conventional	Electrochemical (post 2002)
Smith & Wesson	6904	TCE2929	32478	5R	Conventional	Broach cut
Springfield Armory (Tanfoglio parts)	P9C	AM13781	30th Aug 1991	6R	Conventional	Broach cut (P9 parts were obtained from Tanfoglio and assembled at Springfield)
Stallard Arms	JS	42081	29th Nov 1990	6R	Conventional	Button
Star Bonifacio Echeverria S.A.	Firestar	1917391	1989	6R	Conventional	Broach cut
Steyr Mannlicher	GB (Gas Brake)	P 03586	1982	3R	Conventional	Cold hammer forged
	M9	13723	22nd Mar 2001	6R	Conventional	
STI International, Inc.	All, but GP6					Button

Table 1 - cont'd: A comparison of rifling methods used in certain pistol models by manufacturer

Manufacturer	9 x 19 mm Calibre Model	Serial Number	Date of Manufacture	No. Lands & Twist Direction	Rifling Profile	Method of Rifling
Sturm, Ruger & Co	KP89	304-22919	33725	6R	Conventional	Broach cut
	KP85 Mark II	302-62186	33270	6R	Conventional	Broach cut
Tanfoglio	TA90 Baby	Z00004	31564	6R	Conventional	Broach cut (prior to 1999); Button (by Lothar Walther since 1999)
Taurus	PT99AFS	TOB 41378	34731	6R	Conventional	Button
Vincenzo Bernardelli	PO 18	300307	Unknown	6R	Conventional	Broach cut
Wilson Combat & Scattergun Technologies	All					Button
Zastava Arms (formerly Crvena Zastava)	M88A	6448	1990	6R	Conventional	Hammer forged
	CZ99	88444	1995	6R	Conventional	Hammer forged and chromium plated

Table 1 - cont'd: A comparison of rifling methods used in certain pistol models by manufacturer

(Tables continued on next page)

Firearm Manufacturer	Contact	Company	Date of Contact
Alfa-Proj	Jaroslav Tabery	ALFA-PROJ s.r.o.	3-Jun-09
ARCUS	Maria Petrova (Marketing Co-ordinator)	ARCUS Co.	8-Jul-09
ArmaLite	Glenn Minton	ArmaLite Inc.	6-Jul-09
Armscor	Wenifredo Borlagdan (Chief of Firearms Manufacturing Division)	Arms Corporation of the Philippines	5-Jun-09
	Gene de los Reyes (Chief Quality Officer/ Chief Information Officer)	Arms Corporation of the Philippines	7-Jun-09
Beretta	Wanda Porta	Fabbrica d'Armi Pietro Beretta	3-Nov-09
Bersa	Unknown	Bersa Firearms USA	2-Jul-09
Bond Arms	Unknown	Bond Arms, Inc.	2-Jul-09
Briley	Claudio Salassa	Briley Manufacturing Company	16-Jun-09
Colt	Unknown	Colt's Manufacturing Co.	12-Sep-09
Cugir	Serafim Bota (Chief of Technical Department)	Mechanical Factory Cugir	9-Dec-09
CZ	Scott (CZ-USA Warranty)	Ceska Zbrojovka USA	27-Oct-09
Dan Wesson	Keith Lawton (Dan Wesson Service)	Dan Wesson	24-Dec-09
F.B. Radom	Ewa Gralewska	Fabryka Broni "Łucznik" - Radom Ltd.	26-Jan-10
FN Browning	Rob Semonis	Browning International	12-Oct-09
Glock	Chris Price (Proprietor)	Helston Gunsmiths	19-Oct-09
Heckler & Koch	Mike Thornton (Managing Director)	NASF Ltd (trading as H&K Great Britain)	24-Oct-09
High Standard	June	High Standard	25-Jan-10
Hi-Point	Tom Deeb (Proprietor)	Beemiller, Inc./Hi-Point Firearms	22-Dec-09
IMBEL	Paulo Dias	Indústria de Material Bélico do Brasil	11-Feb-10
IMI/IWI	Karina Eidelman (Export Control Manager)	Israel Weapon Industries Ltd.	14-Dec-09
JAWS	Sameer Rahhal	Jordan Armament & Weapons Systems	3-Jun-09
JSL	John Slough (Master Gun Maker)	John Slough of London	15-Dec-09
Kahr Arms	Website (www.kahr.com)	Kahr Arms	21-Dec-09
Kel-Tec	Pill	Kel-Tec CNC Industries	25-Jan-10
Kimber	Ron Dudzic	Kimber Law Enforcement	21-Dec-09
Lothar Walther	Gerd Walther (Managing Director)	Lothar Walther	5-Jun-09
Mauser	Rupert Haynes (Proprietor)	Open Season Ltd.	27-Oct-09
Para Ordnance	Unknown	Para USA, Inc.	2-Jul-09
Rohrbaugh Firearms	Maria	Rohrbaugh Firearms	21-Dec-09
Ruger	Jim Elliott (Plant Manager)	Ruger Firearms	12-Nov-09
Sarsilmaz	Ahmet Ozbek (Regional Sales Manager)	Sarsilmaz	13-Jul-09

Table 2: Point of contact for specific pistol manufacturers

Firearm Manufacturer	Contact	Company	Date of Contact
SIG Sauer	Harald Wagner (Sales & Customer Support)	SIG Sauer (Germany)	3-Nov-09
Smith & Wesson	Paul Gazda (S&W Support)	Smith & Wesson	13-Oct-09
Springfield	Unknown	Springfield Armory Inc.	27-Oct-09
Stallard Arms	Tom Deeb	Beemiller, Inc./Hi-Point Firearms	10-Feb-10
Star	Jorge (former Star Engineer/ Designer)	IPARGuns Manufactura De Armes S.L	10-Dec-09
Steyr	Oliver Bauer (Sales Manager)	Steyr Mannlicher GmbH	16-Dec-09
STI International	Jay Dunlap (Sales Accounts Supervisor)	STI International, Inc.	2-Jul-09
Tanfoglio	Unknown (Customer Service)	Fratelli Tanfoglio S.N.C.	4-Jun-09
Taurus	Leonardo Sperry	Forjas Taurus S.A.	10-Feb-10
Vektor	Derik Snyman (Product Support)	Denel Land Systems, Division of Denel Ltd.	10-Jun-09
Vincenzo Bernardelli	Nicole Ghirardini	Vincenzo Bernardelli Srl	10-Feb-10
Walther	Peter Dallhammer (Product Management Law Enforcement)	Carl Walther GmbH	5-Nov-09
Wilson Combat	Unknown	Wilson Combat & Scattergun Technologies	2-Jul-09
Zastava Arms/ Crvena Zastava	Aleksandar Maladenovi (R&D Manager)	Zastava Arms	21-Feb-10

Table 2 - cont'd: Point of contactfor specific pistol manufacturers