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When You Care Enough to Hone the Very Best

Providing the U.S. military with .50 caliber machine gun barrels means more than simple gun drilling, Sabre Defence Industries hones its products to better than military specifications

Sabre Defence Industries U.S. shop was about to launch its entry into quality consumer firearms when the conflicts in Iraq and Afghanistan arose, and increased military orders for .50 caliber machine gun barrels. With former production methods, Sabre produced about a barrel an hour. By incorporating a honing machine, it increased production more than tenfold.

"Ask the man who owns one" is a 1950s' advertising slogan that still rings true if America's combat troops are to be believed. They can attest that the .50 caliber machine gun barrels made by U.K.-based Sabre Defence Industries' Nashville shop, are the best in the business. Part of the reason for that preference, according to the Sabre staff, is the accuracy and ease of cleaning that result from the bore geometry and surface finish imparted by a Sunnen HTB tube hone. Since installing the hone, test groups from Sabre's barrels have exceeded the Army's requirements by almost 100 percent.

"We have been making military .50 caliber barrels and guns since 1979, as well as commercial rifle barrels for various companies over the years," Charles Shearon, the Nashville general manager said. "The Sabre owner, Guy Savage, planned to reposition our operation to be about 50 percent military and 50 percent commercial."

Commercial Work Set Aside

The operation was to be the launching pad for U.S. production of Savage's XR15/16 rifles – a premium variant of the AR15/M16 – for the civilian and police markets. The start of the second Iraq war changed that.

"We received military orders for our .50 caliber machine-gun barrels,



The ultra-round hole produced by the Sunnen Products' HTB-2000 tube hone system helps prevent high and low spots in the rifling and keeps the grooves concentric with bore, all of which aid accuracy

7.62mm M60 machine gun barrels, M134 minigun barrels, M6 weapons mounts, and various components," Shearon said.

The demand for .50 caliber barrels grew from about 100 per month to 1,200 per month, and employment at the plant ramped up from 15 to 85 people.

Sabre makes two variations of the .50 caliber barrel: the heavy barrel for the M2 Browning gun, and a lighter, shorter version for the M3 aircraft machine gun. Both have a Stellite liner for the chamber throat and first few inches of rifling. The liner and a retainer for attaching the barrel to the receiver are both shrink fit. The Stellite liner – 75 percent cobalt and 25 percent chrome

– withstands the intense heat and gas erosion of the initial discharge better than ordnance steel.

The heavy barrel starts as a 45" piece of bar stock, 2.625" in diameter, weighing about 73 lb.

"For the heavy barrel we use MIL-S-46047, a special alloy with extra vanadium to increase life," Shearon said. "The aircraft barrel is MIL-S-11595, which we also use in our commercial guns and pass the quality advantage on to our customers. We have to buy these steels by mill run."

The heavy-barrel material is cut by the mill and heat-treated before Sabre receives it. It does some preliminary operations to prepare it, then gun-drills

the chamber end with a 0.75" hole about 11" deep.

A temporary liner is installed and the rest of the barrel is gun-drilled with a 0.490" hole. Sabre reams after drilling and has a hole-size tolerance of ± 0.001 " at that point.



The honing tool emerging from the barrel blank at the end of its stroke

The next step is stress relief that often changes the bore.

"Honing allows us to control the bore's final geometry and hole size to a fraction of the allowable Mil-Spec," Shearon said, "which helps because of the small variations introduced later with button rifling and chrome plating."

Sabre was using a manual lapping machine to finish bores, but the increase in military orders resulted in a bottleneck.

Ron Williams, the senior field engineer in Sabre's area for Sunnen Products, Co., St. Louis, offered Sabre assistance.

"We consulted with him on how current technology could improve our processes and output," Shearon said.



The hone's size-control probe checks the barrel bore size

More Than a Tenfold Increase

The result was installation of a Sunnen HTB-2000 tube hone system. Equipped with Borazon CBN stones, a traveling steady rest, and whip-guide

bushings, the PLC-controlled machine provides an output of 10 to 12 barrels an hour, compared to about one per hour with the old process.

"The load sensing system on the machine automatically adjusts the stone feed for optimum stock removal with-

out tool crashes," Garry Hogan, Sabre's plant manager, said. "That reduced our labor and helped improve output."

More important was the automatic gaging system. The machine gages the bore after every stroke, allowing

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Sabre to control hole size, roundness, and straightness to 0.0005" without operator intervention.

"Even after button rifling and plating, we are able to stay well below the Mil-Spec of ± 0.004 " on bore dimensions," Hogan said. "That's quite a

feat on a bore length of 33". Tool life for the process varies with the amount of stock removal, which typically runs 0.002" to 0.004"."

Hogan says the crosshatch pattern that honing leaves on the bore surface aids in rifling the barrel by maintaining

a consistent lubricant film. To create the rifling, a 0.517" carbide button is pushed through the bore, which is 0.503" at that stage. The button has the rifling form in high relief on it, and is rotated at the correct twist rate. The lands on the button engrave the grooves in the bore.

"The very round hole we get with the hone helps prevent high and low spots in the rifling, and keeps the grooves concentric with the bore, all of which aid accuracy," Hogan said. "We're unique in the business in that we make our own buttons, too, which gives better control of our quality."

Surface finish of the bore coming off the hone is approximately $20\mu" R_a$ and drops into the low teens after button rifling, significantly exceeding the Mil-Spec of $63\mu"$. This helps maximize muzzle velocity and makes it harder for metal and powder fouling to accumulate, so cleaning is easier.

"In the precision rifle shooting community, the sweet spot for surface finish is considered $10\mu"$ to $20\mu"$," Hogan said. "Though it seems contradictory, a smoother surface actually increases surface contact and friction with the bullet jacket, causing increased copper fouling."

After contouring the exterior of the barrel, the bore is chrome plated to a thickness of 0.0013" to 0.0020".

"One of the reasons we run such tight tolerances off the hone is because we lose some tolerance in the plating process," Hogan said. "The platers are excellent and seldom vary more than 0.0005", but if they do, we already have some margin for error to work with."

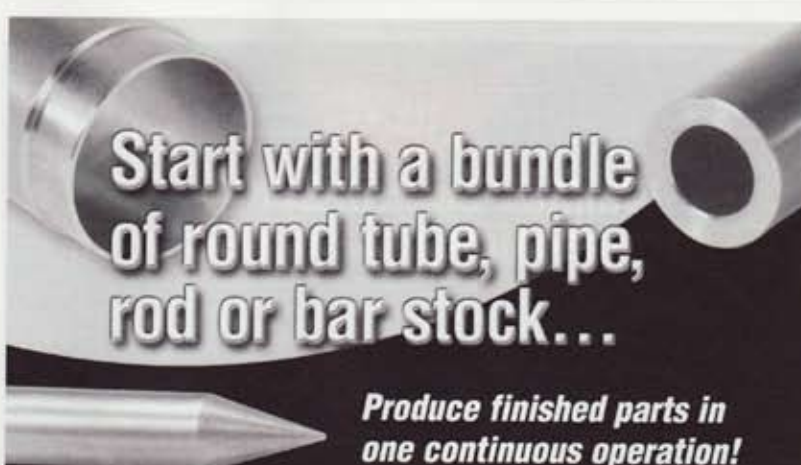
Every Gun Has a "Silver" Lining

The Stellite liner starts as a casting, which Sabre gun drills and reams, then sends to a third party for honing.

"This supplier has never scrapped a part, so it's a good system that we're not going to 'fix,'" Hogan said.

With the barrel induction heated and an alignment gage in place, the Stellite liner is pressed into the barrel's chamber so that its lands and grooves align with those of the barrel.

Every barrel is then fired with a high-pressure test round and exam-



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ined with a Sunnen magnetic particle inspection system.

"We're required to test fire a certain number of barrels from each lot for accuracy," Shearon said. "The Army's spec calls for a 10-round burst to hit within an 8" circle at 100'. We've always been able to hit a 7" circle, but since we started honing we're hitting a 4"."

"Sabre's experience is not unusual. Honing is earning respect from barrel makers, whether it's pistol, rifle, shotgun or even paintball," Ron Williams,

of Sunnen, said. "One leading maker of special-purpose rifle barrels both rough hones and finish hones. It is a perfectionist that holds ± 0.00005 " roundness the entire length of the barrel."

"We're lucky to be able to interact with users of our products," Shearon said. "At a recent armor combat symposium at Ft. Knox, KY, we had several tank gunners tell us they knew as soon as they shot a fifty whether it was a Sabre barrel or not. If it wasn't, they found one of ours and installed it.

We're sure our commercial rifles will earn the same loyalty, too, as we ramp up production and get the word out."

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A FORCE TO BE RECKONED WITH

Few weapons on the battlefield are feared more than the M2HB .50 caliber machine gun. Designed almost 90 years ago by John M. Browning and affectionately called "Ma Deuce" by troops on the trigger end of the gun because of its "M2" designation by the Army, the weapon and its variants are widely used by all of the branches of the U.S. military.

It fires a 0.510" dia. slug, weighing about 1.71 oz to 750



The heavy-duty Ma Deuce – M2HB – uses MIL-S-46047, a special alloy with extra vanadium to increase life of the barrel



The shorter, lighter, aircraft-mounted M3 .50 caliber machine gun uses the MIL-S-11595 alloy for its barrel

grains – at more than 3,000 fps [more than 2,000 mph], delivering 10,000 to 13,000 ft-lb of energy on a target. By comparison, that's equivalent to 12 .223 M16 bullets. The M2 has an operational range of up to 1.25 miles. It is effective against lightly-armored vehicles, personnel, hardened fortifications, aircraft, and light naval craft. The M2 is usually vehicle-mounted or in a fixed position, though it is portable by infantry, too.