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# MACHINE DESIGN

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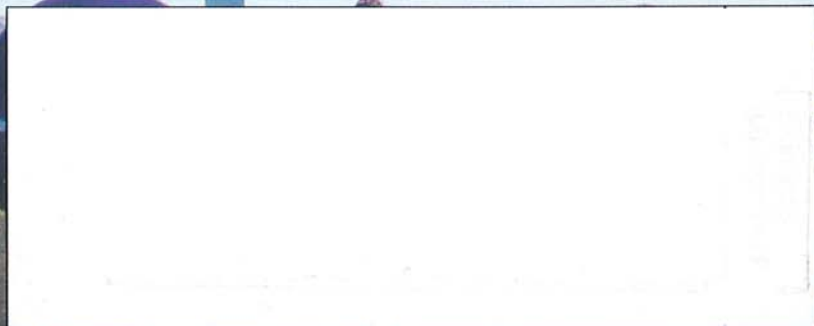
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# Straighter shooter

**Automatic hone helps machine gunners hit their mark.**

**Lawrence Kren  
Senior Editor**

HTB-2000 tube hones from **Sunnen Products Co.**, St. Louis, let a maker of .50-caliber machine gun barrels beat MIL-Spec accuracy by a factor of two and meet demanding production schedules. U.K.-based **Sabre Defence Industries** switched to the HTB-2000 when a manual-lapping machine created a production bottleneck as orders leapt from about 100 to 1,200 barrels/month in the wake of the Iraq War. The upgrade has the added benefit of turning out barrels able to shoot straighter than the company's manually lapped barrels.

From its U.S. plant in Nashville, Sabre produces two 50-caliber barrel models: a heavy barrel for the M2 Browning machine gun; and a lighter, shorter version for the Browning M3 aircraft machine gun. A heavy barrel starts as a 73-lb piece of MIL-S-46047 bar stock 45-in. long and 2.625 in. in diameter. MIL-S-46047 is a special alloy with extra vanadium for long life. Aircraft and commercial barrels are of MIL-S-11595. Sabre purchases these steels by mill run. In the case of the heavy barrel, the mill cuts the material to length and heat treats it.

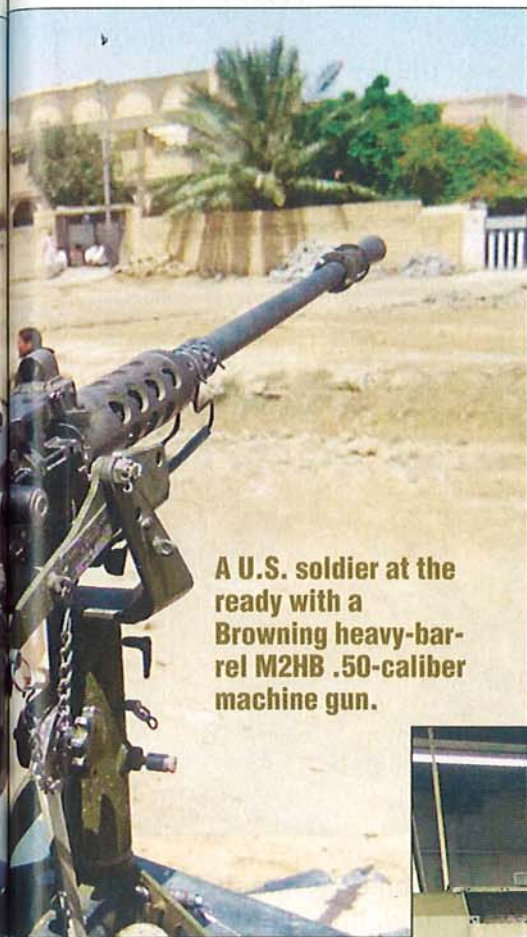


After preliminary prep, a Sabre machinist gun-drills the chamber end with a 0.75-in. hole about 11-in. deep. A temporary liner goes in the drilled hole, and the remainder of the barrel is gun-drilled with a 0.490-in. hole. Reaming slightly enlarges the hole and brings bore tolerances to  $\pm 0.001$  in., though a subsequent stress-relief operation can change bore diameter. Honing is the next step.

The HTB-2000 uses Borazon CBN stones, a traveling steady rest, and whip-guide bushings. Whip-guide bushings, as the name implies, support the long

hone tool and prevent it from whipping around as it enters a barrel. An automatic-gaging system checks the bore after every stroke, giving operators hands-off control of hole size, roundness, and straightness to  $\pm 0.0005$  in.

"Such high accuracy at the honing stage helps us stay well below the MIL-Spec of  $\pm 0.004$  in. on bore dimensions over a length of 33 in.," explains Sabre Plant Manager Garry Hogan. "It also offsets small variations introduced by later button-rifling and chrome-plating operations." Sabre's experience isn't unusual,



**A U.S. soldier at the ready with a Browning heavy-barrel M2HB .50-caliber machine gun.**

according to Sunnen Senior Field Engineer Ron Williams. "A maker of special-purpose rifle barrels uses the hone to hold  $\pm 0.00005$ -in. roundness and  $\pm 0.0001$  in. or better size over barrel length."

A load-sensing system in the HTB-2000 eliminates costly tool crashes by automatically adjusting stone feed for optimum stock removal. Tool life for the process scales with the amount of stock removed, which is typically about 0.002 to 0.004 in. The crosshatch pattern left on the bore from honing helps maintain a consistent lubricant film that aids in rifling, the next step.

A 0.517-in. carbide button pushed through the bore — which is 0.503 in. at this stage — creates the rifling. The button has the rifling form in high relief and rotates at the correct twist rate. The lands on the button engrave the grooves in the bore. "The extremely round hole imparted by the hone helps prevent

high and low spots in the rifling, and keeps the grooves concentric with the bore, all of which boost accuracy," Hogan says. Sabre also makes its own buttons to better control quality.

Surface finish of the bore coming off the hone is about  $20 \mu\text{in. } R_A$ , and drops into the low teens after button rifling, exceeding the  $63\text{-}\mu\text{in. MIL-Spec}$  by a wide margin. This maximizes muzzle velocity and discourages metal and powder fouling for easier cleaning. "The precision-rifle shooting community considers 10 to  $20 \mu\text{in.}$  the sweet spot for surface finish," Hogan explains. "Surfaces smoother than that actually raise surface contact and friction with the bullet jacket and increase copper fouling."

After contouring the barrel exterior, the bore is chrome plated to a thickness of 0.0013 to 0.0020 in. Both the aircraft and heavy barrels receive a Stellite liner that covers the chamber



**A machinist loads a .50-caliber barrel into the Sunnen HTB-2000 hone at Sabre Defence Industries, Nashville.**

**The PLC-controlled machine can hone 10 to 12 barrels/hr, compared to about one an hour with the old manual-lapping process.**



**Stellite liners are individually OD ground to size, measured with a micrometer, and pressed into their mating, induction-heated barrels. A liner sticks out of a barrel awaiting press fitting.**

throat and the first few inches of rifling. Stellite (75% cobalt and 25% chrome) withstands the intense heat and gas erosion of the initial discharge better than any ordnance steel. Sabre gun drills and reams the liner casting, then sends it to a third party for honing. The liner and a retainer for attaching the barrel to the receiver both are shrink-fitted. With the barrel induction heated and an alignment gage in place, a

machinist presses the liner into the barrel chamber so that its lands and grooves align perfectly with those of the barrel.

Finally, every barrel is fired with a high-pressure test round and examined by a Sunnen magnetic particle inspection system. Sabre also test fires a certain number of barrels from each lot for accuracy. "Army spec calls for a 10-round burst to hit within an 8-in. circle at 100 ft," says

## Ma Deuce

Few weapons on the battlefield strike fear into those on the receiving end more than the heavy-barrel 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, the M2 and its variants are widely used by all branches of the U.S. military.

The M2HB launches a 0.510-in.-diameter, 750-grain (1.71-oz) slug at over 3,000 fps. The slug delivers 10,000 to 13,000 ft-lb of energy on a target, equivalent to that of twelve .223-caliber M16 bullets. Users revere the M2 for its effective range



of up to 2,000 m and capability against lightly armored vehicles, personnel, hardened fortifications, aircraft, and light naval craft. The M2 is typically vehicle mounted or in a fixed position, though infantry can hustle it around, as well.

Sabre's Charles Shearon. "We've always been able to hit within 7 in. But barrels honed with the HTB-2000 hit within 4 in."

All this attention to detail pays off in customer loyalty. "At a recent armor war fighting symposium at Ft. Knox, we had several U.S. tank gunners tell us they knew as soon as they shot a 'fifty' if it was a Sabre barrel or not," Shearon says. "If it wasn't, they found one and installed it." **MD**