

# Repeat Performance

The art of machining classic shotguns.

Ithaca Gun Co. has reintroduced a classic shotgun: the National Wild Turkey Federation Limited Edition, Millennium Commemorative, Ithaca Model 37. The pump-action, repeating shotgun is a reproduction of an original 1911 John Browning design, which was marketed by Remington Arms as the Model 17. This particular design allows loading and ejecting shells through the same hole in the bottom of the receiver.

again. This action empties and feeds the shells into the breech.

For the Model 37, the pump-activated slide pushes the breechblock to the rear, cocking the hammer while the breechblock extracts a spent shell. As the breechblock travels toward the back of the receiver, the shell ejector on the breechblock directs the spent shell through the hole in the floor of the receiver. While this is occurring, another shell is indexed from the spring-loaded tube magazine and is positioned to be chambered. As the slide reverses direction and moves the breechblock forward in the pump cycle, the new shell is fed into the chamber as the breechblock moves forward and locks in place.

The receiver—the section of the shotgun housing the trigger, breechblock, shell carrier and feed-ejector slide assemblies—is made from a 7-lb. block of 1137 steel measuring 7"×4"×1.35". It's a resulfurized, free-machining alloy that yields small, curly chips when machined. The 1137 has a hardness of 197 HB, machinability rating of 70 and requires moderate power for machining. It can be finished to a smooth, satin finish, which

is important for obtaining a lustrous, deep-blue finish.

## Machining

A fair amount of the machining Ithaca Gun does is performed on specially designed, single-function machines. The production sequence begins on a machine for deep-hole drilling. It produces a hole straight through the square block on the long axis, where the barrel and magazine tube mount on the front of the receiver. This hole cre-



All photographs: Ithaca Gun Co.

The Ithaca Gun National Wild Turkey Federation Model 37 shotgun illustrates the artistry, quality and craftsmanship of today's high-end gunmakers.

Though developed 90 years ago, the piece illustrates the timeless appeal of an elegant design. Today, Ithaca Gun, Kings Ferry, N.Y., can barely keep up with demand for the shotgun. The company manufactures the shotgun in 20, 16 and 12 gauges.

## The Action

Operating a pump shotgun involves sliding back a wooden handle, which encloses the tube magazine to the rear, then pushing it forward

*See related story, last page*



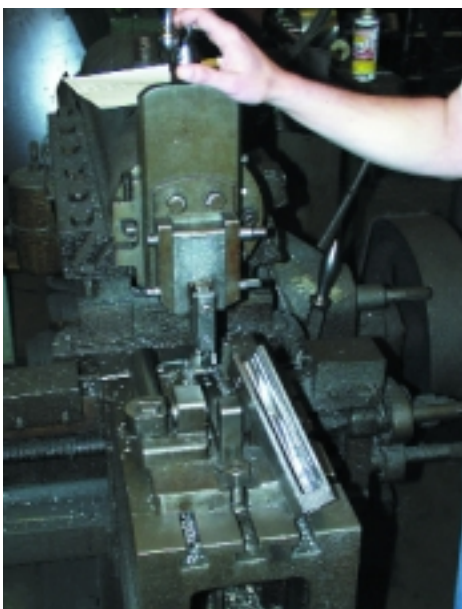
Internal cuts, such as the slide way, are milled on a vertical machining center.

ates the clearance for the other machining operations and the radius on which the circular breechblock rides when the receiver is finished.

The hole is drilled using a special carbide-tipped, through-coolant tool manufactured by Niagara Cutter, Amherst, N.Y., and standard cutting oil.

The diameter of the holes vary, depending on the gauge. For example, a 12-gauge has a 0.729" ID and a 16-gauge has a 0.662" ID.

According to Terry Whiffen, plant manager, "the machining processes



Shown is one of a series of special, single-purpose machines Ithaca Gun uses to produce the Model 37's receiver.

must hold between 0.001" and 0.0015" tolerance from end to end in the receiver."

For the next machining operation, the receivers are fixtured vertically in standard jaw vises on a vertical machining center, the Monarch VMC 75. In this position, a bottom plate—with a point on the front end—locates the two receivers for machining. The front face of the receiver is milled and squared using a 3"-dia. facing mill with eight diamond-shaped inserts turning at 16 rpm. Then a hole for the magazine tube is drilled next to the barrel hole and milled to the finished size. Again, this hole can be set for one of three sizes, depending on the specified gauge.

Next, the receiver's interior is roughed and holes are drilled for the carrier screws, carrier locking screws and trigger-plate screws. These locking screws retain the carrier screws in the sides of the receiver. A shallow, counter-sunk hole is drilled and tapped next to an existing screw. The countersink cuts a radius into the circumference of the head of the existing carrier screw. When the locking screw is installed, it prevents the original screw head from rotating. Tapping is performed with special 6-48 taps.

After these operations, the receiver blocks are transferred to a second Monarch 75 for milling of the internal surfaces. At this machining station, six receivers are mounted in horizontal vises for milling. In this orientation, the cutting tools machine the bottom, inside and back of the receivers.

Initially, the slide-way cut is for the slide mechanism that extracts, ejects and loads shells and cocks the hammer in one smooth action—typical of a Browning design. Then the trigger way is cut for a subassembly that includes the trigger guard, trigger, trigger spring, safety button and hammer with the sear on the back. The trigger subassembly slides into the receiver from the back on two machined side rails and comes to rest on the trigger-assembly stop, where it is retained by a screw.

Next, there are seven machining operations, each involving a special cut to accommodate the moving

parts that make up the operating components for the pump action. For shell stops, a T-slot cutter—specific to the particular shotgun—is used to create a 0.880"-wide T-slot for the slide.

The receivers then return to the single-function machines. A bolt-notch cut is made by a machine that can get inside the receiver; it's equipped with a special head that cuts the bolt notch on an angle. Making the bolt-notch cut is a critical operation since it sets the head spacing for the gun.

Then the receiver moves to a special shaper, which is a vertical-motion machine having a single-point cutting tool that shears off the metal from the part's interior. The shaping tool is set for a 0.11" DOC and a 0.700" to 0.800"



The gunmaker uses special cutters in the manufacturing process.

WOC per pass. Another machine makes the stock cut. This operation cuts the stock tang, which protrudes from the back of the trigger plate. This is for mounting the wooden stock.

Next, the receiver is faced off on an angle for the cant of the stock. At the next machining station, the top and bottom of the receiver are shaped with a spiral-type form cutter, which creates the top and bottom radii.

### Tooling

A lot of the equipment and tooling at Ithaca is highly specialized and manufactured specifically for making shotguns. "Although we use some standard 0.750"-dia. endmills, much of the tooling is specific to Ithaca's products and machining processes," said Whiffen.



Hand fitting (left) and hand finishing are two of the critical tasks in the manufacture of the Model 37.

On a 12-gauge gun, for instance, the barrel threads call for 1.125" angular grooves, which are cut with a special form tool from Niagara Cutter. The titanium-coated, HSS groove cutter is sent back to the factory for resharpening and recoating, which extends tool life to 4,000 parts.

Machining that configuration makes it possible to remove the barrel. With the angular grooves, the free-floating barrel drops inside the receiver and locks into position on rotation. It's similar to an interrupted-step screw. The thread configuration ensures the barrel is always in the same position. The

locking thread is 0.065" and the grooves are 0.150". Additionally, there is a lug on the barrel that helps hold it in place so it won't move, even if it's not tightened.

### Finishing

After a receiver is milled completely, it's finished by hand. The inside, top and external edges are hand filed and deburred, as are the barrel threads and trigger-plate components. When deburring is completed, the receiver goes to a Blanchard grinder to be sized to a thickness of 1.335" and then to the polishing department for finishing.

Ithaca uses belt and wheel machines for finishing. Polishing jacks elevate the receivers into the belts for roughing and truing the radii. The sides and tops receive a fine polishing.

At that point, machinists roll various scenes into the receiver sides. As the engraving-machine roll transverses the side of the receiver, it displaces metal, leaving an imprint of the desired scene. (One scene, for instance, depicts Annie Oakley.) Like burnishing or thread rolling, the process increases material strength, leaving the surface harder and with increased fatigue strength.

Afterwards, the receiver goes for final buffing to give it a nice appearance. After stamping the serial number into the receiver, a final polishing takes place followed by a superfine blasting on the top of the receiver, resulting in a matte finish that reduces glare.

Usually, Ithaca Gun strives to streamline its production processes. But that isn't the main concern when producing the Model 37. The company's goal is to produce the highest-quality firearm possible. It's a time-consuming process, which makes the guns very expensive. Prices start at \$2,750.

In a world where everyone attempts to eliminate labor input, each Model 37 still requires 6 man-hours. That is substantial, considering much of the machining is done on CNC machines. But when a company focuses on high quality, high value and customer service, it's appropriate. △

## John M. Browning's enduring influence

You may be familiar with the name Browning, which is synonymous with high-quality sporting goods—especially over-and-under shotguns. But you may not know the influence John M. Browning had on the design and manufacture of firearms.

Browning's patented rifle, shotgun and pistol designs were manufactured by his own company, Browning Arms, as well as Colt, Ithaca, Remington, Stevens, Winchester and Fabrique National. In 1900, Colt produced the first semi-automatic pistol in the U.S., basing it on a Browning design. In 1906, Remington received manufacturing and sales rights for the Model 8, the first successful autoloading, high-power rifle. Then, in 1910, Remington acquired the rights to produce the Model 17 pump shotgun. The design would later become the Ithaca Model 37.

Stevens Firearms used Browning's design for one of its shotguns when it manufactured and marketed its Model 520 pump in 1902. Winchester used Browning's designs when it produced the 45-70, 1886 lever-action repeater and the famous 30-30, lever-action

Model 94. (The Winchester 94 is the saddle gun often seen in Western movies.) And, the Belgian company Fabrique National produced many Browning-designed firearms.

With over 25 firearm patents, Browning had an equally strong influence on military small arms. He designed the 50-caliber and 30-caliber machine guns and the Browning Automatic Rifle, which was used in World War II, the Korean War and Vietnam. Browning also designed the 45-caliber, 1911-A1 automatic pistol, which was the U.S. military's standard-issue sidearm for nearly 75 years.

Now, Ithaca Gun Co. is producing the original Browning design in its National Wild Turkey Federation (NWTf) Limited Edition, Model 37, using many of the original machines and manufacturing processes. The Model 37 was originally patented by Browning in 1911 and manufactured and marketed by Remington Arms as its Model 1917 pump-action, repeating shotgun.

Some of the NWTf Model 37s have gold in their engraved portions.

—C. Boyles

For more information about Ithaca Gun Co., visit [www.ithacagun.com](http://www.ithacagun.com).

# Classic Side-By-Sides

BY TECHNICAL EDITOR CHARLES M. BOYLES, CPE

Another approach to manufacturing classic firearms.

Ithaca Classic Doubles, Victor, N.Y., takes a different approach to manufacturing high-end sporting arms than Ithaca Gun Co., profiled on page 44. (The two companies aren't affiliated.) Ithaca Classic makes the Model NID side-by-side shotgun, which was discontinued in 1946.

Ithaca Classic President Steve Lamboy described how he came to recreate the classic, hand-fitted piece, which, except for the final finish work, is machined entirely on a Mikron gear-driven, 5-axis, CNC vertical mill. Before production began, Ithaca Classic converted the last revision of the original manufacturing process sheets and drawings to CAD drawings with AutoCAD 2000. Then, based on the CAD drawings, the company CNC-machined 25 part-sets of prototype pieces.

Using the prototype parts, Ithaca made the finished guns and polished everything exactly as it should be. In the hand filing and polishing processes, the gunmakers removed a lot of metal. Then the hand-finished frames and parts were digitized with a Mitutoyo coordinate measuring machine. When digitizing, Ithaca Classic scanned the parts to identify and quantify the changes made during the hand-fitting process.

Next, the company perfected the CNC programs to reflect the changes and the tighter tolerances. The CNC machining produced the absolute finest surface finish possible without hand polishing and generated the tightest dimensions.

As a benefit, CNC machining eliminated much of the hand preparation of metal parts. The manual work that re-

mained involved removing the burrs and machining marks. In one critical operation, for example, the final finish for the barrel jointing—where the barrels join the receiver with a lug—is extremely important, because the barrels and the frame must contain the explosion when firing. Fitting must be exact, because when a shell explodes in a gun, parts tend to move under pressures in the 20,000-psi range.

Fitting used to be an arduous process. Generally, the tolerances on the action are  $\pm 0.001$ ", and on some dimensions, such as the rotary bolt, locking surface and locking mechanism, they are  $\pm 0.0005$ ". This process makes higher-quality guns with better metal-to-metal and surface fits, which are extremely important for durability.

During the pilot run with rough-machined prototype parts, Ithaca Classic could barely joint two guns in 5 working days. Thanks to the CNCs, gunmakers were able joint 17 guns in 10 days. And, after final process tuning of the CNC program for production runs, Ithaca expects to see that number rise to 10 per week.

A gun frame acts like a spring and flexes during firing. If a frame doesn't flex, it gives. Also, gun frames need a core hardness of 26 to 29 HRC and a surface hardness of 55 HRC 0.008" to 0.012" deep. The traditional bone-and-charcoal carburizing process generates this required case-hardness. Carbon is added to the steel in varying amounts and generates the color variations—a charcoal and deep-rust bluing—to impart a beautiful appearance.




Master engraver Giacomo Fausti turns Ithaca Classic shotguns into pieces of art.

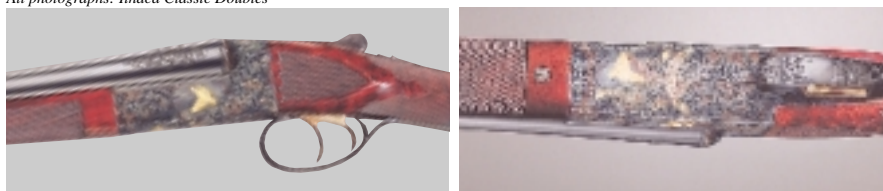
Ithaca Classic is tooling up to bring all work in-house except for the barrels, which will continue to be hammer-forged in Germany. The production rate should double when the tooling is completed. With the new processes, the company expects to produce 1,000 to 1,200 guns per year, while maintaining superior quality—similar to a fine Swiss watch.

Basically, Ithaca is applying general practices used in Switzerland. This amounts to determining the final net shape accurately and programming that into the process. The frame forgings are made of a high-quality nickel-chrome-moly alloy steel. Every part is fine-forged, which reduces machining and provides better wall angles and references. The frame slot for the barrel lug, for example, is within  $\pm 0.008$ " of net size.

The romance of an exquisite fowling piece is enhanced by hand fitting. And though Ithaca employs precision CNC machining, the shotgun must, like a fine Swiss watch, be hand-fitted to achieve perfection—the true art of gunmaking. That takes superior materials and machining, coupled with craftsman capable of hand fitting to exacting standards. Ithaca's highly talented gunmakers do what they do best, which is fine finishing, fitting and hand checkering.

Engraving and final finishing are the last steps. The engraver, Giacomo Fausti, gives Ithaca's side-by-sides their character and turns them into works of art.

Ithaca Classic Double's side-by-sides are available in .410 through 12-gauge and start at \$3,465. 



Classic design, close tolerances, hand fitting and hand engraving come together in this side-by-side shotgun from Ithaca Classic Doubles.

For more information about Ithaca Classic Doubles, visit [www.gunshop.com/ithaca\\_classic](http://www.gunshop.com/ithaca_classic).