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Edited by Lawrence Kren

# Banging out balls

## *Modern servocontrols help finishing machines produce golf balls faster than ever before.*

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All golf balls today are made through some kind of molding process. That goes for the cheapest range balls to the most exotic models used on pro tours. But no matter what process was used to make it, a ball after molding has up to 20 small tubular projections sticking out up to 0.04 in. from the ball equator in all directions along with a thin parting line. Obviously, you can't sell golf balls in this condition. The imperfections have to come off. The first buffing machine for this purpose manually loaded and could finish about 30 balls/min. Current pure-mechanical machines produce about 40 balls/min and were, until recently, considered state of the art.

Enter Gil Barfield, an engineer with more than 30 years experience designing golf-ball-making equipment at his Big Bend Machine & Tool Co. in Carrabelle, Fla. The company builds thousands of golf-ball molds annually for every major ball manufacturer and recently designed and built a new servomotor-driven ball finisher. Big Bend's CNC Seam Prep Machine is said to run at 60 balls/min and could go faster with some tweaking. And it lasts longer than machines that rely solely on pure mechanical systems for motion.

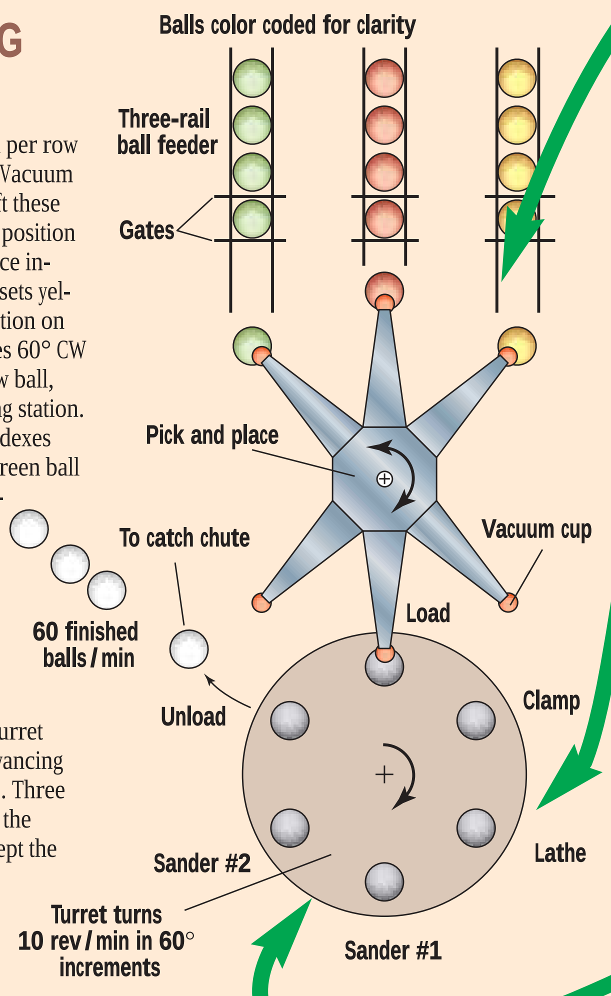
Here's how it works:

### OPERATING SEQUENCE

Gates admit one ball per row to orientation cups. Vacuum cups on arm ends lift these balls. Starting in the position shown, pick and place indexes 135° CW and sets yellow ball in load location on turret. Turret indexes 60° CW after receiving yellow ball, moving it to clamping station.

Pick and place indexes 90° CW and drops green ball in load location; turret indexes 60° CW advancing yellow ball to the lathe and the green ball to clamping.

Pick and place indexes 45° CCW and loads red ball; turret indexes 60° CW, advancing balls to next stations. Three more balls load and the process repeats except the pick-and-place motions reverse (135° CCW → 90° CCW → 45 ° CW).

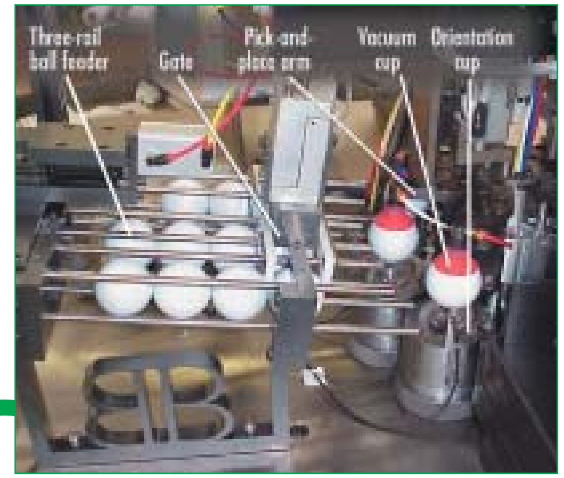



### BE THE BALL

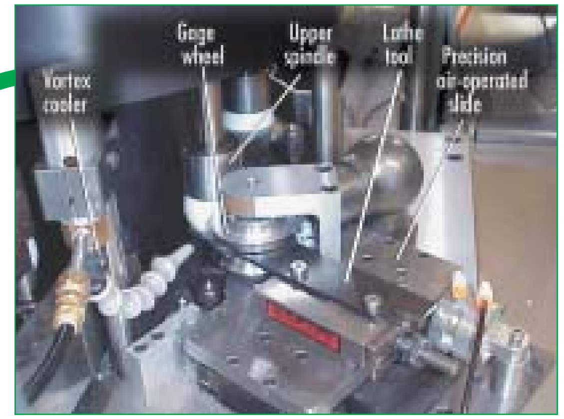
Balls feed into the machine on a track and split into three rows. A pair of air-operated gates capture three balls, one in each row. When the front gate rises, the balls roll into three orientation cups. A rotating plate in the bottom of each orientation cup spins the balls. Around the inside perimeter of a cup is a ramp. As a ball spins the mold runner protrusions catch on this ramp and ride up it, bringing the ball equator to horizontal.

An improperly oriented ball sits on the runners so it is tall, equal to the protrusion length, or about 0.040 in. This triggers fiber-optic photocells mounted to posts on either side of the orientation cup which, in turn, signals the machine to dump the errant ball into a recycling chute. Competing machines are said to correctly orient ball-parting lines about 92% of the time. The Seam Prep machine boasts a 98% rate. This additional 6% translates into an extra 10 dozen balls/hr, or nearly three quarters of a million more balls annually.

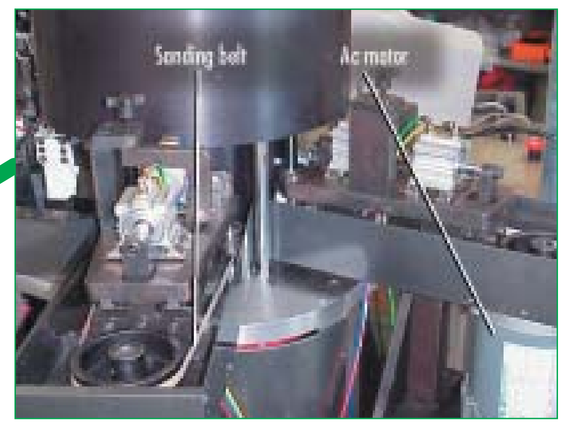





**Gates on the three-rail feeder deliver balls, one from each rail, to the orientation cups. Vacuum cups on the ends of pick-and-place arms lift balls from the orientation cups and shuttle them to the polishing turret.**




**A ball spins between an upper and lower spindle as a precision, air-operated slide moves the lathe tool (cuts off runners) to a depth controlled by the gage wheels. A vortex cooler delivers chilled air to the area and clears away debris.**




**A pair of belt sanders removes runner residue left behind by the lathe. Either one or both of the sanders are used, depending on ball design.**

### IT'S IN THE HOLE

Once oriented, balls are lifted by one of two sets of three vacuum cups attached to a rotating, servocontrolled pick-and-place system. A 100-W servomotor, run by a DeltaPro Single Axis Positioning Controller from Industrial Indexing Systems (*www.iis-servo.com*), rotates the pick-and-place mechanism, guided by MotionPro software for Windows, also from IIS.

The mechanism rotates 135° CW and drops the first ball into one of six orientation gaging plates on the indexing polishing turret. Plates each contain a hole sized to exactly match the golf-ball diameter. The ball equatorial runner catches on the hole edge preventing the ball from falling through while precisely aligning the runner with the horizontal. The pick and place then rotates 90° CW, drops the second ball into the next hole as the turret indexes 60° into position, then rotates 45° CCW and drops the third ball, again preceded by a 60° CW turret move. A 600-W servomotor and an IIS DeltaPro Single Axis Positioner indexes the turret. When the third ball drops from what is now the rear set of three vacuum cups, the front set picks up three more balls and the process repeats but instead in the opposite direction beginning with a 135° CCW move. This indirect sequence of loading gives balls time to locate properly in the orientation cups or to be sent to the recycling chute if necessary.

**An as-molded ball sitting in the mold lower half shows the small (0.040-in. tall) protrusions about its equator. The protrusions are purposely put there for alignment in ball polishing machines.**

The polishing turret's six stations each have three moving elements; the gaging plate described earlier and a lower and upper cup for ball clamping. A cam raises the gaging plate and upper cup to accept a ball as it drops from the pick and place arm. The cam then lowers the ball onto the lower cup at the clamping station and for subsequent operations. The lower cup locates below the gaging plate and is positioned such that when the upper cup and gauging plate come down, it (the lower cup) supports the ball as the gaging plate drops below grade.

### MAKING THE CUT

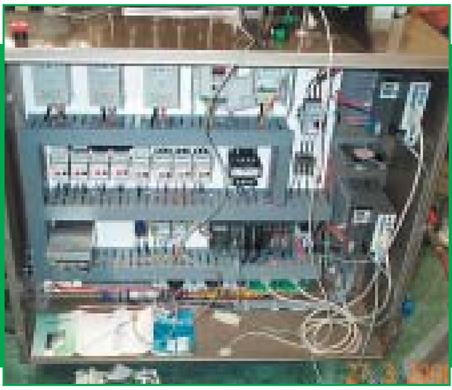
As the turret indexes 60° to bring balls to their next station, a spindle attached to a lower cup engages a serpentine belt below the table and begins spinning at programmable speeds to 3,500 rpm. The belt is positioned to engage only certain spindles while others free wheel.

A lathe is the next stop. Some machines use a single, custom-machined tool to remove most of the parting-line residue. But the tools tend to be expensive and difficult to replace resulting in costly set-up and maintenance. The Seam Prep lathe instead swings out to accept relatively inexpensive tool bits that automatically position correctly when replaced.

The lathe tool and holder ride on a precision spring-loaded, air-operated slide. Tool depth is controlled by a pair of gaging wheels that touch the golf ball surface. Tool bits contact balls for about a 230 msec duration controlled by a dwell in the turret servo indexer. Work time is kept short so friction doesn't melt the ball cover. (Covers are typically made of DuPont Surlyn which begins to flow at about 155°F). A vortex-cooling nozzle helps remove some of the heat from the operation.

At the next two stations a pair of belt sanders finishes the job. Either one or both of the sanders are used depending on ball design. The sanders are run by ac motors and variable-frequency drives and touch a ball for about as long as the lathe tool. When the ball exits the second sander, the serpentine belt loses contact with the turret's lower spindle. At this point, the ball is still spinning rapidly as the turret accelerates to its next station. The upper spindle raises up and the ball is literally thrown from the machine into a catch chute. An air jet, and what is best described as a miniature truck mud flap, help with unloading and clean the cup for the next ball. The empty spindles and cups index under the vacuum cups, three more balls drops in, and the process repeats. ■


**The CNC Seam Prep Machine from Big Bend Machine & Tool makes extensive use of modern servocontrol technology to finish one golf ball / sec. Balls in the three-row, multilevel track feed to orientation cups where a servomotor-driven pick-and-place mechanism shuttles them to finishing operations located about an indexing turret, also servomotor driven.**



**The system uses a touchscreen for routine machine control and programming. Switching from one ball type to another takes only a few seconds. The IIS DeltaPro Single Axis Positioning Controllers are located in the right side of the cabinet.**

## A "SLICE" OF GOLF BALL HISTORY

The first golf balls were probably wood, but by the early 1600s, they were made from pieces of horsehide stuffed with feathers and fashioned into a ball when wet. As it dried the stitched leather shrank and the feathers expanded to create a hardened ball. These "featheries" were used for more than two centuries. By the mid-1800s the rubberlike sap of the tropical Gutta tree was formed into balls. And by the late 1800s this same material was being machine molded into balls with raised spherical bumps. Over the next few decades materials and manufacturing processes gradually improved and in 1932 the U.S. Golf Association standardized the weight and diameter of the ball at 1.620 oz maximum and 1.680 in. minimum.

Currently, some 100 million dozen golf balls are produced each year in one, two, and three-piece varieties. Single-piece balls are generally for driving ranges. Their biggest attraction is low cost. Most average golfers prefer a two-piece ball, as it combines good durability and distance with moderate price. Ball cores are typically high-energy acrylate covered by Surlyn plastic from DuPont. Many pros and better amateurs prefer a three-piece ball, a more-expensive combination of a solid rubber or liquid-center core covered by elastic windings or a solid mantle and finished with a Surlyn or urethane cover. These balls are softer than the two-piece variety and take more spin, which lets a skillful golfer better control the ball's flight.

The number, size, and location of the dimples are a subject of continuing interest by players and manufacturers alike. The dimples give the ball its lift and reduce air resistance, which result in longer distances and greater trajectory stability. Modern balls generally have between 350 and 500 dimples. Ball materials and production techniques are a closely guarded secret at most ball manufacturers, and many players are religious in their choices.