# Spring Thing

## Putting The "Spring" Back In Your Corvette's Step

BY JOHN HINCKLEY

PHOTOS JOHN HINCKLEY

**One of the hallmarks of a good restoration (or just good maintenance) is having your Corvette at the proper ride height – not just for appearance, but to restore the correct suspension jounce and rebound travel so your shock absorbers can do their job. It also re-establishes correct alignment geometry, and avoids tires rubbing on the frame or bodywork. As leaf springs age, they lose load capacity and "sag," especially if they've lost material due to corrosion and eventually you face the decision of whether to rebuild or replace them.**

**THE OBJECTIVE** of this article is to show you the "right" way to rebuild/re-arch Corvette leaf springs, and to share some knowledge about how leaf springs were designed and manufactured, and how they can be "brought back to life," assuming they're basically serviceable.

While researching this article, *CE* visited Eaton-Detroit Spring (1555 Michigan Avenue, Detroit, Michigan 48216, 313-963-3839, www.eatonsprings.com), and learned a lot about the manufacture of leaf springs from President Mike Eaton, General Manager Gary Gassman and their staff of experienced specialists on the plant floor. Eaton-Detroit Spring was founded by Mike's grandfather 65 years ago, and holds a unique niche in the spring business. They have more than 23,000 original leaf spring blueprints dating back to the early 1900s, and they have all the facilities, tooling, and expertise necessary to deal properly with the metallurgy and heat-treating involved in custom leaf spring manufacture. Eaton is not an OEM manufacturer; they are more of a custom service center, and can supply virtually any spring a restorer would ever need. More than 75 percent of Eaton's business comes from individuals who need long-since-discontinued springs for restoration of old cars and trucks, with the balance from commercial customers like truck repair shops and dealers who can no longer get the replacement springs they need from the original manufacturers' parts systems. Eaton can also custom design springs that will provide increased or decreased ride height from stock specifications on request.

There are some limitations in terms of creating exact duplicates of original Corvette springs.

**1** This shear cuts the alloy steel to the length specified for each leaf.

**2** The cut lengths of 5160 alloy steel are placed in the 1800-degree furnace to heat them prior to forming, rolling, and trimming operations. Then, Ronnie forms the end shape and tapers the thickness with this cam-and-roller machine, then puts the leaf back in the furnace.

**3** This press finish-trims the end of the leaf to the desired shape – square, tapered, or radiused.

**4** If a "dimple" is required for an insulator puck, this press creates it in the still-hot leaf. One stroke of the press, and the "dimple" is formed. This spring shows a radiused end trim.

**5** The main leaf, fresh from the furnace, gets its eyes formed in this machine; the size of the mandrel determines the diameter of the eye. The still-hot spring eye is checked with a gauge to ensure that the correct diameter for the bushing has been formed.

**6** A finished bushing eye, after forming and gauging; it may not be red, but it's still HOT!

**7** With all cutting, initial forming and trimming operations complete, the springs go to the next step in the process, another 1800-degree furnace. While the springs are heating, Chris selects the specified shape of steel form and positions it in the fixture; pins lock it in place at each end.

For C1s, steelmakers no longer produce the grooved raw material originally used, so C1 owners should focus on having their original springs re-arched. For C2/C3s, the SAE 5160 alloy steel (premium leaf spring steel used by Eaton for ALL of their springs) is no longer produced in the original .214" and .194" thicknesses, so the next-closest thicknesses are used, with the spring camber adjusted to maintain original ride height.

A word about "re-arching" leaf springs – there are lots of "spring shops" that offer this service, but just doing it mechanically doesn't restore the spring's load capacity or service life, and mechanically re-arched springs will soon deflect back to their "sagged" state; cold-setting a spring doesn't erase a spring's "memory." There are significant metallurgical properties involved in leaf springs, and they have to be dealt with to restore the spring back to its original load capability and to provide long-term durability. Most "spring shops" don't have the equipment required to deal properly with spring metallurgy or required heat-treating processes.

The accompanying photos show the manufacture of leaf springs from scratch. A customer's spring to be re-arched goes through the same process (except for the raw material stage) as a new spring, and looks like new when it's complete. Springs to be re-arched are disassembled and must pass a detailed physical inspection for signs of fatigue, and a Brinell hardness test before they're deemed metallurgically sound and capable of further processing. With that background, let's follow the process from raw material to finished spring.

**RAW MATERIAL, CUTTING, END-FORMING, EYE-ROLLING, AND TRIMMING:** The work order, with the original spring blueprint attached, is sent from the office to the raw material area, where Ronnie selects a strip of the specified width and thickness of SAE 5160 alloy steel from inventory, measures and marks the length of each leaf on the strip, cuts them to length, and punches the hole for the center bolt.

Each strip that requires special end treatment is placed in a furnace and the ends are heated to cherry-red (1800° F). Once at temperature, the strip is removed and placed in a machine whose jaws form the top-view tapered shape,

**8** Chris pulls a leaf out of the 1800-degree forming furnace and prepares to place it in the forming fixture. With the spring loaded and clamped in the fixture, locking clamps are applied to shape the ends of the leaf to the steel form.

**9** With the spring still clamped to the form, it's cooled from the red state before being removed from the fixture for quenching.

**10** The still very hot spring is removed from the form fixture and submerged in a quenching tank filled with oil for controlled cooling prior to the trip to the draw furnace for annealing.

**11** After cooling from the annealing furnace, Tom performs a Brinell hardness test on each leaf.

**12** Tom uses a special optical device to measure the size of the indentation from the Brinell test machine. This verifies proper spring metallurgy.

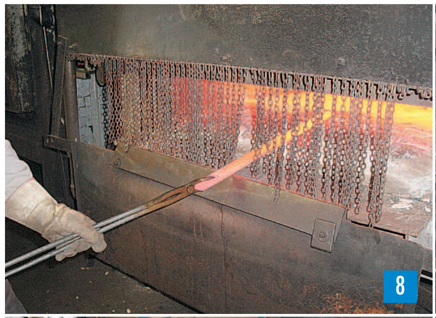
**13** The leaves are placed in the shot-peening machine. The weights hold the leaves in position during the "steel hailstorm" to come. When the door opens, it reveals spring leaves that are not only clean and shiny, but whose long service life is assured due to reduction of internal stresses.

**14** A close-up of the steel balls in the shot-peening machine. The largest ones are freshly added, and the very tiny ones will soon disappear into the machine's vacuum extraction system for disposal.

**15** Spring elements are then laid out on the assembly table with their blueprints and work orders, ready to add the detail parts and be completed. This fixture clamps the "stacked" spring elements together for installation of the center bolt and clips. The finished spring now moves on to shipping.

**16** The rollers on this machine move down and form U-bolts or clips over the die placed on the center anvil. They have all the dies needed to form any size or type of U-bolt or spring clip.

**17** Pairs of custom-made springs, each ready for shipping to an individual customer. This type of work is 75 percent of Eaton-Detroit Spring's business.



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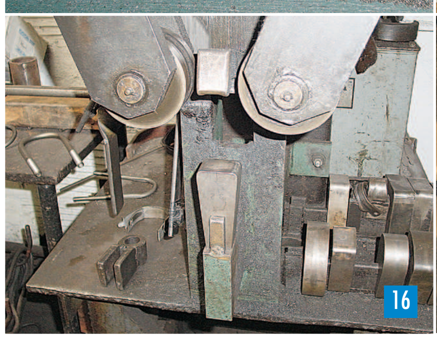

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then the end is run through a cam-and-roller device that thins the end of the leaf and "curls" it up if required. The leaf then goes back into the furnace to reheat it for further end processing.

The reheated leaf is removed from the furnace again and a press is used to finish-trim the end (square-cut, tapered, radiused, etc.), and to form the "dimple" or to pierce holes for insulator pucks if required.

The ends of each main leaf are left square-cut from the first cutting operation and heated in the 1800° furnace. Then the ends of the leaf are placed in an eye-rolling machine, which rolls the red-hot steel leaf around a mandrel. This process creates a perfectly round eye of the correct diameter for the specified bushing, and each eye is checked with a gauge while still red hot to ensure proper sizing. Mandrels are available next to the machine to create any size eye required.

At this point, the raw material stage is complete, and the prepared leaves for each spring are allowed to cool, then stacked on a cart with their blueprint and work order and are transferred to the forming area.

**FORMING, QUENCHING, AND ANNEALING:** The forming operation is where each leaf gets its specified curved shape, or camber. Eaton has literally hundreds of steel forms to match the design camber of virtually any spring.

Chris loads the prepared leaves into another 1800° furnace, and while they're heating, he selects the specified form from his collection, loads it into the forming fixture, and pins it in position over the water tank. When the leaf is up to temperature, it's removed from the furnace and placed on the form (fixtured in place by the pin through the center-bolt hole); the fixture clamps the main portion of the hot leaf in position, and locking clamps are applied to each end of the leaf, clamping the red-hot leaf to the exact shape of the form.

While still clamped to the form, the leaf is then sprayed with water to cool it. The locking clamps are removed, the fixture opens, and the leaf is removed and placed in a tank filled with quenching oil for a ten-minute controlled cooling to room temperature.

The leaf is then removed from the quenching tank and placed in a 1000° draw furnace, where it remains for 30 minutes or so while it anneals, to reduce its hardness and to relieve internal stresses from the previous forming operation. When the annealing cycle is complete, the leaf is removed from the draw furnace, allowed to cool, and moves on to the shot-peening area.

**HARDNESS TESTING AND SHOT-PEENING:** After cooling from the draw furnace, Tom tests each leaf for Brinell hardness to ensure proper metallurgy has been achieved during the annealing cycle, then he runs them through his shot-peening process.

The shot-peening operation accomplishes two things – it cleans the scaly surface resulting from the previous processes and, more importantly, reduces residual stresses in the surface of the steel, which doubles or triples the service life of the spring compared to "bargain" springs that aren't shot-peened. Long-term durability of a spring is essential, and this process ensures it. When the two-ton steel door of the shot-peening machine closes, the parts inside are bombarded under incredible velocity and pressure with hundreds of thousands of tiny steel balls for several minutes. The balls are replaced continuously, as they are rapidly reduced to steel dust by the process. When the shot-peening process is complete, the leaves are removed and passed on to the assembly area.

**SPRING ASSEMBLY:** Ray handles the assembly area, and stages all the leaves of each spring set on his assembly table along with their blueprint and work order, which describes all the unique components required for each spring – liners, insulators, bushings, clips, and center bolts. The spring is "stacked," main leaf first, and each component is added progressively, then the "stacked" spring is placed in a fixture which aligns, clamps and compresses the spring for installation of the center bolt. Any clips or shipping clamps are added, and the completed spring is ready for shipping. Ray also has a special machine with many sets of interchangeable dies that forms whatever size U-bolts are required (from many lengths and diameters of pre-threaded straight stock) if the customer requires them. The same machine also makes spring clips and clamps in many sizes and styles.

From here, the completed springs, blueprint, and work order move back to the office, and the springs are prepared for shipment to the '56 Cadillac, Max Wedge Mopar, Pierce-Arrow, or Corvette owner who ordered them to complete his restoration project with either new or like-new rear leaf springs.

**BOTTOM LINE:** As you can see, there's more to "simple leaf springs" than meets the eye, and we've avoided any discussion about spring design, rate, spring load, load rate, load height, measurement, stepping, and all the other fine points of leaf-spring design and technology. That's well beyond our scope, and the basics of those issues are explained in the Technical Information section of the Eaton Web site, www.eatonsprings.com. Springs are a difficult system to "de-mystify" but it's hard to argue with a 65-year history and 23,000 blueprints on file! ■