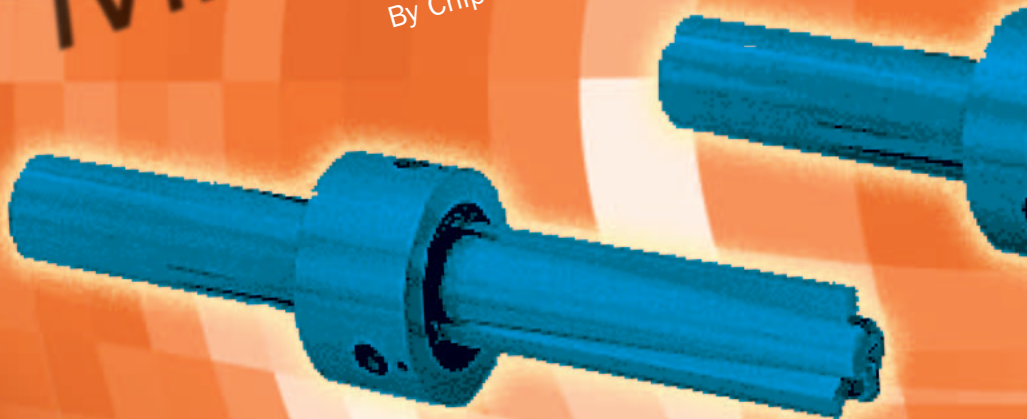
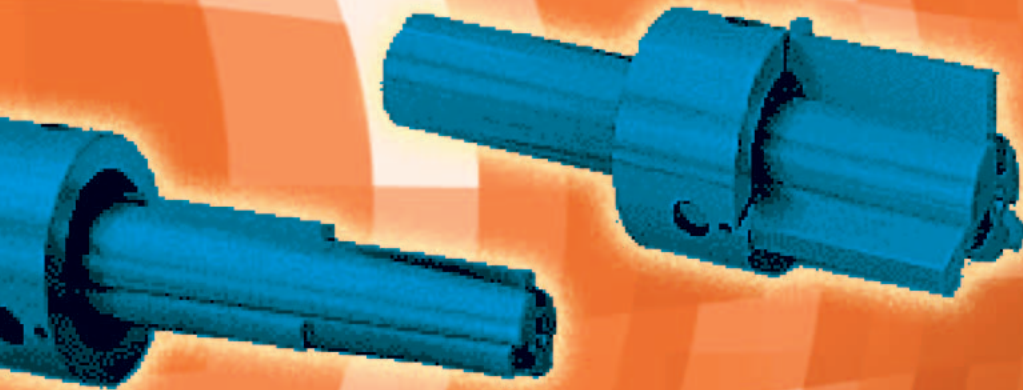


EXPERT  
ADVICE  
on  
**EXPANDING  
MANDRELS**

By Chip Brettell



## The original expanding mandrel was patented by William J. LeCount in 1847, so who better to offer advice on their usage than the president of LeCount, Inc.?



**B**race yourself, because your workday is about to undergo a significant change. As hard as it may be to believe, after reading this article, you will never again have to stress out over selecting the proper expanding mandrel for a particular job.

Gears come in all shapes and sizes, and they come with all sorts of requirements for precision and geometrical relationships. Manufacturing drawings define what is to be inspected, and what makes a gear "good" or "bad." But it's the gear inspection process that determines whether or not the gear meets the drawing's specifications, and it also determines whether or not the manufacturing process is properly controlled.

An old rule of thumb says that your gauging should be 10 times more precise than the parts to be inspected. In the world of gears, this means that you will often have a need for mandrels with the capability of holding your parts within one or two ten-thousandths of an inch total indicator reading (TIR). As your tooling gets more precise it will tend to get more expensive. But it can also get expensive if you ship bad gears to your customers, or if you have to scrap good gears because the mandrel being used lacked the necessary precision. Choosing the wrong mandrel for the job can be costly.

This article is intended to shed a little light on several types of mandrels that are used in the gear inspection process. More specifically, it deals with the types of mandrels that are used for holding gears between centers for inspection. Five of the most common types of mandrels that I have seen in gear inspection departments include LeCount's 3-Jaw Expanding Mandrels, hydraulic mandrels, slotted sleeve mandrels, tapered mandrels, and nut arbors. Each type has its strengths, as well as its weaknesses.

The LeCount 3-Jaw Expanding mandrels combine high precision with lots of expansion range. A total of 12 mandrels will cover all bore diameters from 0.25" to 7". These expanding mandrels will hold gears within

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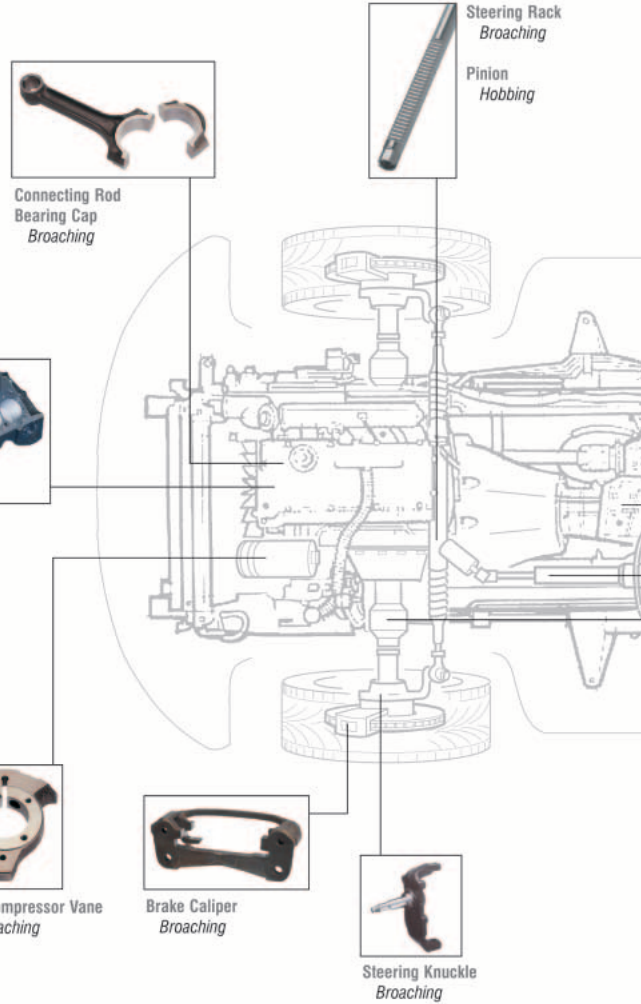
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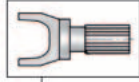
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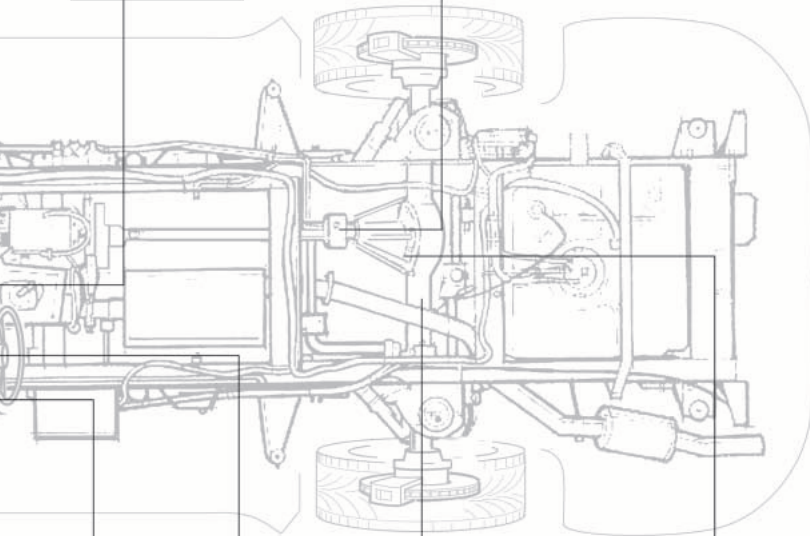
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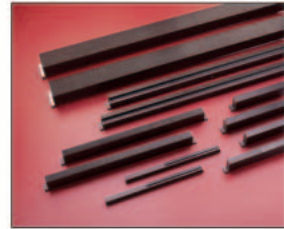
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Axle Shaft  
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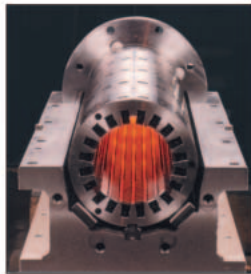
Pinion & Side Gear  
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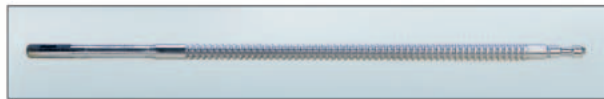
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Pot Broach Tools



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0.0001" TIR throughout the expansion range. No tools are needed for loading and unloading parts. Simply place the gear over the jaws, draw back the sleeve until it makes contact on the bore of the gear, and then lightly tap the end of the mandrel on a firm surface, such as an anvil or a workbench. A light tap on the opposite end will release the part. There are no part-stops on these tools, so the axial position of the gears will vary from load to load.

These expanding mandrels cost in the neighborhood of \$1,000 to \$2,000 each, and even though the cost may frighten you away initially, the investment pays off quickly if you have lots of different sized parts, high volumes, or tight tolerances. Special variations to this mandrel include the ability to hold gears with internal splines. Armed with the internal spline data, these mandrels can be designed to contact the gear on its pitch diameter, minor diameter, or major diameter. These mandrels are not recommended for machining operations.

Hydraulic mandrels—or "grease arbors," as they are sometimes called—have the ability to expand about 0.003" per inch in diameter. The outer shell of the mandrel is forced to expand as hydraulic fluid is pressurized by means of an actuator, typically a turn of a screw. They can be very precise, with TIR down to 0.00005", although 0.0001" TIR seems to be the advertised norm. Some companies provide off-the-shelf hydraulic mandrels for common sizes, but most of the time they are custom-designed for a specific part. Expect the lead time for custom grease arbors to be in the range of 10 to 15 weeks.

The cost of these tools range from several hundreds of dollars for an off-the-shelf item to several thousands of dollars for high-precision, custom-designed tools. It is a tough job to make hydraulic mandrels for small bores, so don't expect to use them on gears with less than a half-inch ID. Should your gears have internal splines, these mandrels can be made with a splined outer shell that is designed to contact the pitch diameter or major diameter (no modifications are needed to contact the minor diameter). Hydraulic mandrels can be used for machining, as long as they are designed with machining in mind.

Slotted sleeve mandrels consist of two main components: a tapered shaft, and a slotted sleeve. The slots in the sleeve allow it to grow in diameter as it is driven up the tapered mandrel by a nut or an arbor press, and they have an expansion range of around 0.015", with some upwards of 0.125". If you can live with the 0.0005" TIR typical of these tools, the expansion range—combined with low cost (often less than \$100)—makes this a very popular item. To keep the price even lower you can often find sets that have one tapered arbor with several interchangeable slotted sleeves of varying diameters. Slotted sleeve mandrels can be used for machining as well as for inspection. Some styles offer repeatable axial location of the gears, while other styles do not. It is often the case that the customer will need to grind the slotted sleeve to the appropriate diameter for the gear.

Tapered mandrels are the least-expensive and most-simple of the expanding mandrels, and they are often made in-house. These mandrels are ground with a slight taper from one end to

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the other. The taper can be as little as 0.0002" per inch and up to 0.0005" per inch. A gear is placed on the small end of the mandrel and slid along the axis until it contacts the mandrel. A slight tap on the large end of the mandrel will seat the gear. These tools are especially popular for small-diameter bores, where it is difficult to manufacture a mechanical expanding mandrel.


The biggest drawback to this type of tool is that the gear is being held on only one end of the bore (the opposite end will have clearance), which makes it likely that it will not be held squarely. Depending on the tolerances, this may or may not be an issue. Also, if the tolerance of the bore diameter is larger than the taper, you will need to have more than one mandrel for the job. It can be time consuming finding the mandrel with the right fit as you process gear after gear, and if you have a lot of different part sizes you can end up with quite a large number of mandrels. In fact, I received a letter from a customer that said he was able to discard 500 tapered mandrels and replace them with one 3-Jaw Expanding Mandrel. That's 499 fewer mandrels that have to be inventoried and calibrated periodically!

If an arbor press is used, tapered mandrels can be used for machining purposes. The tapered mandrel offers the worst case for repeatability of axial location; a ten-thousandths of

an inch change in diameter may change the axial location by an inch. Tapered splines can be ground into these mandrels, making them suitable for use on gears with internal splines.

Nut arbors are another common tool for holding gears. This tool has a clearance fit to the bore of the gear. A nut is used to clamp the gear against a part-stop on the mandrel. In this case, the primary datum is a face on the gear, not the bore. This mandrel needs to have enough clearance to accommodate the tolerance of the bore, or you may need more than one mandrel. In either case, the repeatability of radial runout will be no better than one half of the diametral clearance between the bore and the mandrel.

A benefit of the nut arbor is that the part is always located in the same axial position, regardless of bore size variation within the lot, and the cost is relatively low; a few hundred dollars will get you a custom tool for the job. It is also not uncommon to have these tools made in-house if your facility has a toolroom, as they are fairly simple to build. Nut arbors are quite common in machining processes as well.

Now, armed with this knowledge, you are prepared to tackle a job—*any job*—with the peace of mind that only using the proper expanding mandrel can bring. 

#### ABOUT THE AUTHOR:

Chip Brettell is president and owner of LeCount, Inc., of White River Junction, Vermont. He can be reached at (802) 296-2200 or chip@lecount.com. The company's Web site is [www.lecount.com].

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