

TECHNICAL TOPICS

Service/Parts Updates

Choosing my Solution

CHOOSING A REMANUFACTURED STEERING GEAR

By Doug Leno

In TDR Issue 79 (February 2013) on page 16, I described two steering box replacement options for Third Generation Turbo Diesels. I also touched on an interesting detail in the history of replacement steering gears. Issue 79 gives you the data:

“The new factory replacement steering box for 2003-2008 trucks, introduced in November 2011, appears to be a very robust (and heavy!) alternative, especially for Turbo Diesel owners who prefer factory parts.

Based on its size and weight, we can expect this beast to perform well, especially compared to the undersized steering box that was originally supplied on new 2003-2008 trucks.”



On the left is the original steering gear supplied on new 2003-2008 trucks. The 50% heavier Mopar replacement gear (right), part number 68170214AA, was introduced in 2011.

Steering Boxes (Gears) are boring – Why Do We Care?

I admit that I sometimes tackle subjects that aren't very popular. Need an example? TDR issue 91 (page 16), the title was, “Ball joints are boring: Why do we care?” Yet, in that article I showed how individual component tolerances can impact long term vehicle serviceability. Only a truck enthusiast (like us TDR-types) could appreciate the level of detail in the ball joint article. This go-round we'll get an education on steering boxes. However, to get us started, let's use the correct nomenclature, “steering gears.”

Here goes...

I have tested four different steering gears on my Turbo Diesel, three of which have been new. This time, having already invested in the larger gear shown on the right-hand side of Figure 1, I decided to have my Mopar steering gear remanufactured. I chose RedHead Steering Gears in Auburn, Washington. On their website there is the following description of what the RedHead folks do to their steering gears: “Custom fitting each worm and piston assembly with special ordered, precise over-sized ball bearings...”

Figure 2 is a photograph of RedHead part #2879U, which is based on the same 46-pound Mopar 68170214A core which had been giving me the steering problems. I reached out to Tyler Hanks, marketing and sales manager at RedHead, who was kind enough to send me a completely torn down gear so that I could photograph the areas of interest, learn more about how these things work, and discover the root cause of my steering problems.



Figure 2. The Redhead Steering gear, part #2879U, which is based on Mopar part #68170214AA

I should point out that the photographs and descriptions that follow are from the standard Mopar core shown on the left-hand side of Figure 1. After remanufacturing, this becomes RedHead part #2879. However, the steps and remanufacturing principles of the 2879 are identical to that of the bigger 2879U.

Overview of Steering Gear Operation

When you take the steering gear apart you'll find a recirculating ball screw (also called a "worm and piston assembly") which translates the rotational motion of the steering wheel into the linear motion of the piston, all of which can be assisted with the application of high pressure fluid. It is all but impossible to illustrate the mechanical action of the ball screw in this article, but there are several YouTube animations that do so, which I highly recommend. One such animation is found at <https://www.youtube.com/watch?v=zjXnv5Uzarw>. As you view it, note how the ball bearings recirculate so that they stay with the piston as it moves back and forth along the ball screw. This is exactly what happens in our steering gears.

Figure 3 shows actual components of the Mopar steering gear, without the housing that holds everything together: The steering wheel rotates the input shaft, which turns the ball screw, which moves the piston back and forth while recirculating the ball bearings through an external tube (see Figure 4). Assisted by high pressure fluid on one side or the other, the linear motion of the piston rotates the sector shaft, which turns the pitman arm, ultimately turning the wheels. Got it?



Figure 3. Essential steering gear components, shown without the housing that holds everything together: The input shaft (far left) rotates the ball screw (center), which moves the piston (far right) which rotates the sector shaft (top).

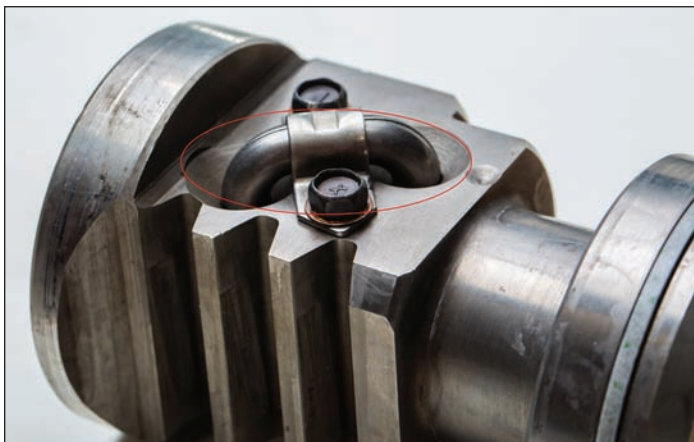


Figure 4. The ball bearings "stay in the piston" while it moves back and forth along the ball screw by passing through the recirculation tube (circled).

Eliminating Steering Slop

The ball screw assembly arguably has the most influence upon steering slop of any subsystem in the gear. Consider the set of ball bearings (shown in Figure 5) which ride inside of the screw's helical raceway: If the bearings are too small, then the screw will rotate before the bearings engage the piston, which will cause steering slop or play at the steering wheel. On the other hand, if the bearings are too large, the assembly will bind. There is a direct connection between the steering wheel and the ball screw so the driver feels any of the ball screw slop. This is magnified by the diameter of the steering wheel! According to RedHead, undersized bearings are the most common problem in mass produced gears, accounting for about 70% of my steering slop. This slop cannot be adjusted out—it is the natural consequence of mismatched parts.

I was pleased to discover that RedHead replaces the entire set of factory-supplied ball bearings with their own proprietary bearings, custom sized for each gear they build. While mass produced steering gears rely on a "one bearing size fits all" assembly, RedHead chooses the bearing that best fits the raceway. This is the only way to eliminate ball screw slop.

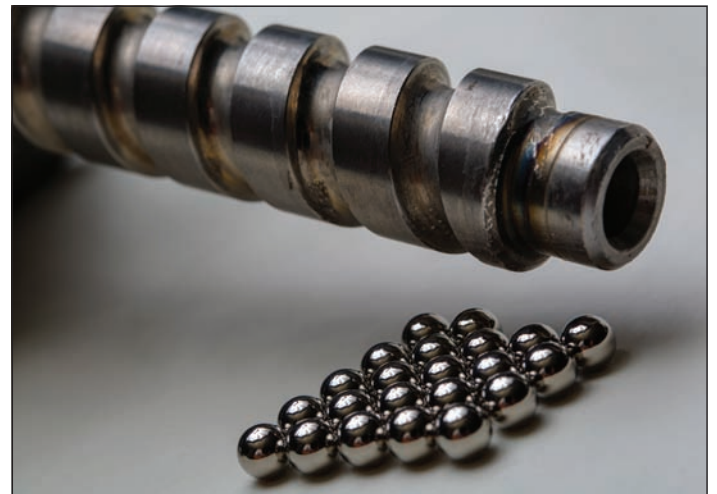


Figure 5. RedHead replaces the entire set of recirculating ball bearings with custom-fit bearings to eliminate slop. The standard steering gear, part #2879 (shown here), utilizes 22 bearings. The 46-pound "Mopar Upgrade", part #2879U, utilizes 27 bearings.

RedHead chooses the bearing that best fits the raceway. This is the only way to eliminate ball screw slop.

Sector Shaft Play

The second big contributor to steering slop is the gear lash between the sector shaft teeth and the piston teeth. In a properly manufactured steering gear, this lash is adjusted out as illustrated in Figure 6.

A high volume production process or a careless adjustment will result in excessive lash simply because it is easier, quicker, and cheaper to ship a gear with some lash than to adjust out as much as possible without binding.

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During the remanufacturing process, RedHead found that my gear's "hard parts" were in essentially new condition, but that the gear lash adjustment had been incorrectly performed, accounting for the remaining 30% of my reported steering slop.

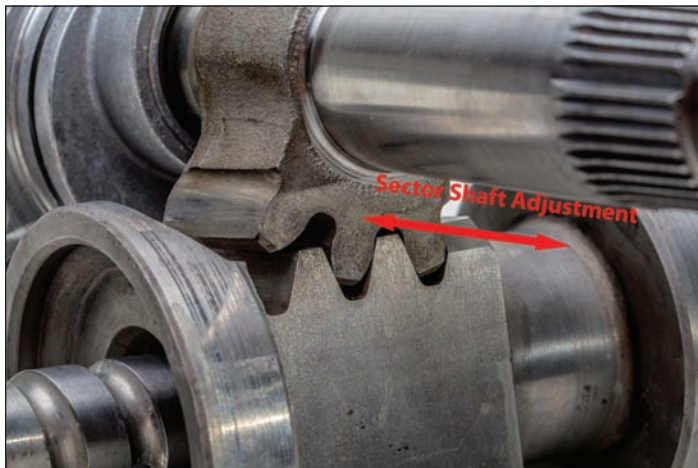


Figure 6. The Sector shaft is adjusted with respect to the piston for minimum gear lash without binding.

To illustrate the tedious nature of proper lash adjustment, I photographed the standard (original) Mopar gear as it might appear during the lash adjustment process: Consider Figure 7, where you can see the sector shaft teeth located just inside of the black housing (bottom right, in the photograph). Notice that the end cap has been screwed onto the threaded adjustment end of the sector shaft—the number of turns precisely locates the sector shaft with respect to the piston inside the housing. To adjust gear lash, a technician will give the end cap one turn, install the assembly onto the housing, test the gear, and then repeat the process until achieving that magic point of minimum lash before binding.

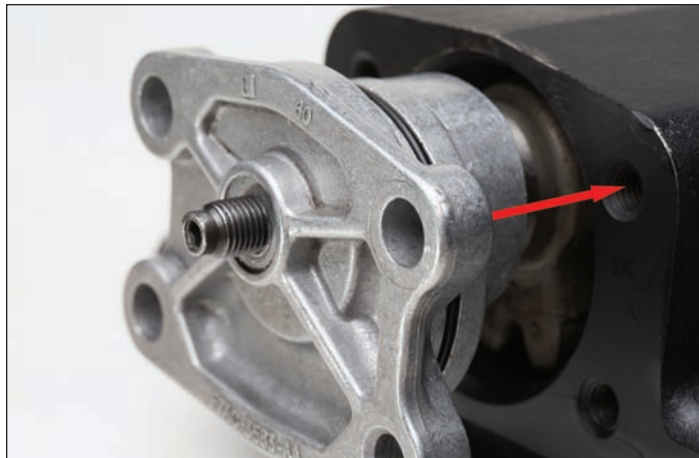


Figure 7. Gear lash on the original Mopar gear, RedHead part #2879, is adjusted one turn at a time. The same adjustment for RedHead part #2879U (Figure 2) is made with an external adjustment screw.

The Power Assist Valve

The flow of power steering fluid is controlled by a rather complex set of seals, parts, and passageways within and surrounding the input shaft and the mating surfaces of the housing (see Figure 8). This is where the "magic" happens—rotation of the input shaft also rotates the valve assembly which directs high pressure fluid where it is needed to assist piston movement. RedHead replaces all the seals and accompanying parts as required to guarantee new valve performance. They bench test every gear to verify correct power assist behavior.



Figure 8. The magic of power steering assist is accomplished by a set of seals, parts, and passageways on the input shaft and mating surfaces of the housing.

Other Remanufacturing Details

When you are in the remanufacturing business you see all kinds of interesting failure points of the steering gear. One example is shown in Figure 9. Notice the uneven wear on the housing that encloses the piston. This type of wear is common in the standard gear, and greatly accelerated by oversized tires and lifted suspensions with dropped pitman arms. Sloppy internal tolerances are also a factor. Tyler informed me that the housing shown in Figure 9 will be scrapped, along with the piston, which showed corresponding wear as well.

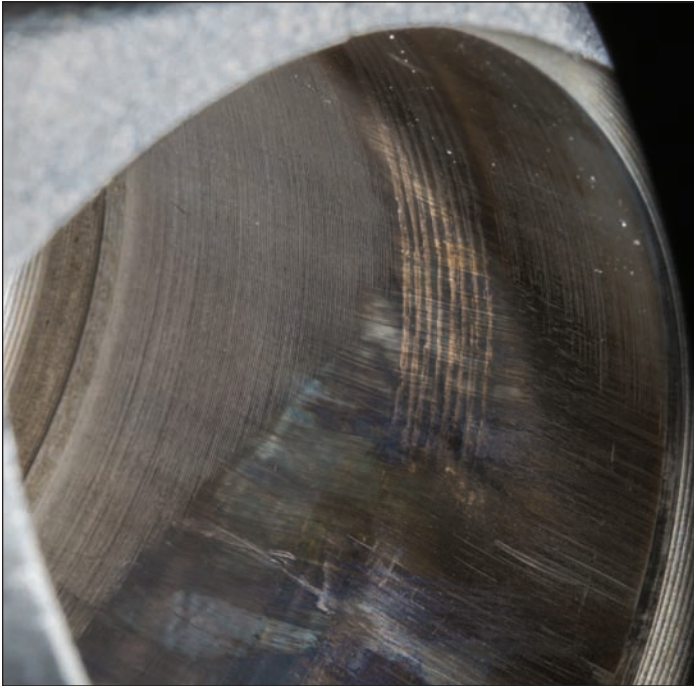


Figure 9. This housing will be replaced, due to uneven wear.

Another failure point is the piston and sector shaft teeth themselves. As astute Turbo Diesel owners, we might notice the heat generated by the power steering gear and pump, but we rarely stop to appreciate the tremendous forces present inside of the steering gear itself. Consider the sector shaft teeth, for example, which endure all the forces required to hold and turn the wheels. Properly lubricated and adjusted, these teeth can take it; otherwise they end up like the photo in Figure 10.

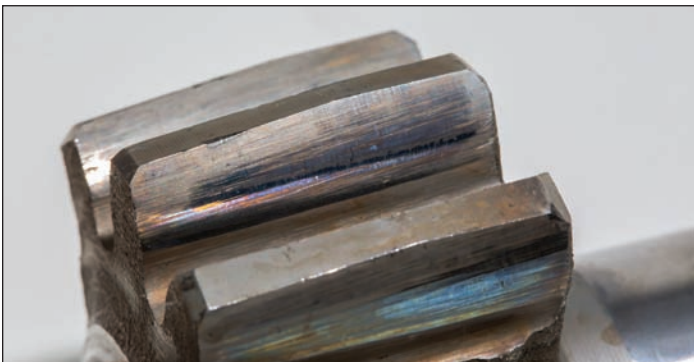


Figure 10. Excessive wear on the sector shaft teeth: this one is headed for the scrap bin.

After inspecting and photographing several failure points, I asked Tyler to comment on their internal scrap rate, so I could get a better feel for RedHead's quality control and the nature of failures in the field. Since that information is proprietary, he simply noted, "We even scrap a lot of the new parts we purchase." That was enough for me.

Conclusions

Having tested a number of different steering gears on my 2004 Turbo Diesel, I now prefer a custom remanufactured gear instead of a new gear. This preference is due to the issues of ball screw slop and gear lash, which have apparently not been well controlled in high volume manufacturing processes.

Without a highly controlled process to custom size the bearing to the ball screw raceway, the gear will have inherent and permanent slop, and be susceptible to premature wear and additional slop as it ages. Similarly, a high volume production process is not as capable of adjusting sector shaft gear lash, which is an inherently tedious effort when performed correctly.

While the solution is more expensive, I favor the larger (and heavier) Mopar Upgrade when it can be custom built as described in this article. This gear matches up well with my "T-type" steering upgrade (TDR Issue 91, page 10), and provides a small advantage in power assist, which I like. The steering gear as supplied by RedHead delivers on the claim printed on the tag shown way back in Figure 1: "There is no play in this steering gear."

Turbo Diesel owners who wish to extend the steering gear service life should consider the addition of a steering brace, such as the BD Steering Stabilizer, available from a variety of sources, including Geno's Garage and RedHead. Be sure to order the right one, as the different steering gears described here require different braces.

For more information regarding RedHead's remanufactured steering gears, contact RedHead directly.

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