



# Doing The Diff, Part 2

**By Mike Weinberg  
Contributing Editor**

**W**hen we left off last month we had diagnosed and disassembled a GM 10-bolt rear. We looked at identifying the ring and pinion and discussed how to get the right parts the first time. This month, we are going to set up the rear correctly.

For those shops that are not into ring-and-pinion work now, following the simple procedures

here and understanding the theory involved will help you add a profitable service for your customers. Those of you who are old hands at differential work may find a few new ideas to make the job easier.

In all forms of transmission repair, cleanliness is next to godliness, and this applies to ring and pinions also. Thoroughly clean the rear-end housing. This includes the axle tubes, since the oil will circulate into the tubes and wash back any debris into the housing and contaminate the bearings and geartrain. With a good bearing puller, CAREFULLY remove the old

inner-pinion bearing from the old pinion gear. Take care not to damage the bearing, as we will make it into a tool for setting pinion depth and adjusting backlash on the gear set.

In the bad old days, many pinion gears bore a head stamp that gave you the distance from the end of the pinion to the centerline of the ring gear. When you removed the inner pinion bearing, you measured the shim underneath and added or subtracted shim thickness according to the difference in the pinion depth, marking from old gear to new. Frequently, using a

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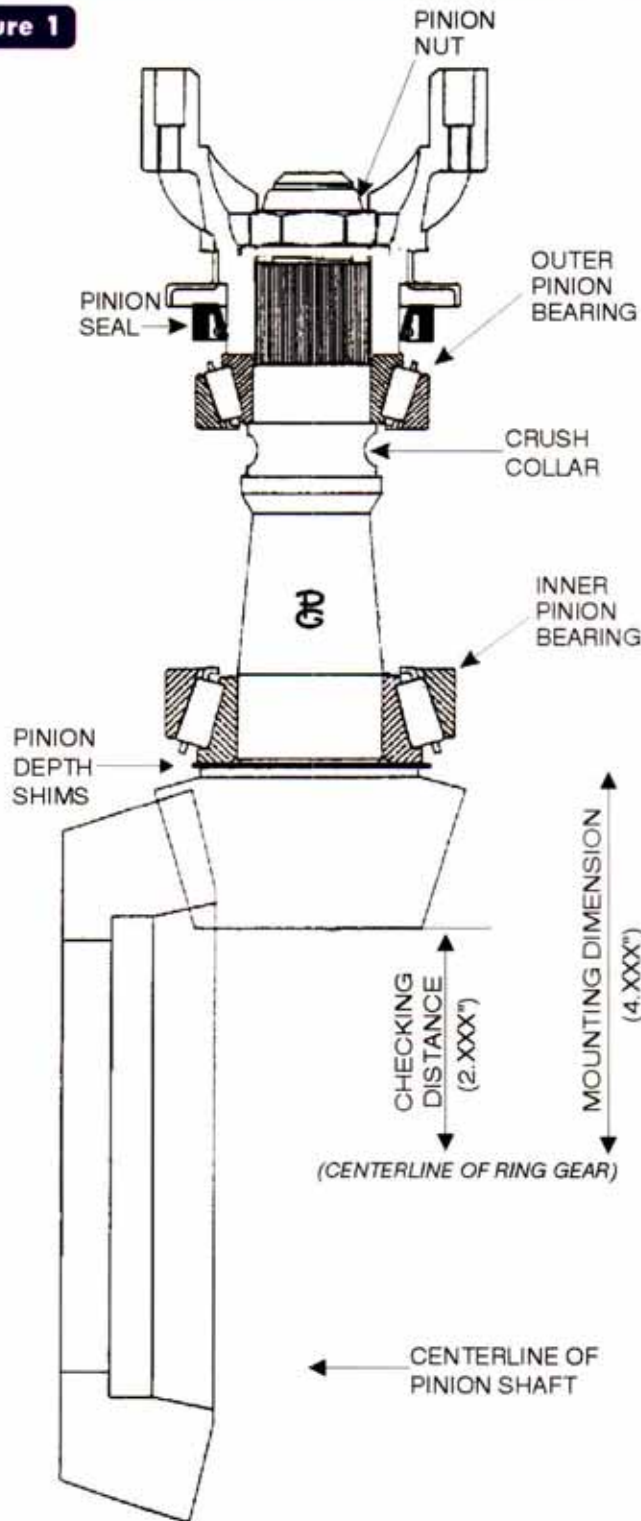
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**Figure 1**



pinion-depth gauge was critical, a fact that many technicians seemed not to understand.

In the good current days, CAD/CAM design and modern

manufacturing techniques have made tolerances on quality ring-and-pinion sets so good that pinion-depth gauges rarely are needed. Quality gear makers

such as Precision Gear, which provided the pictures for this article, keep tolerances so tight that I always start my setup using the original shims found on the old pinion gear (See Figure 1)

Now spend a few minutes with the old inner-pinion bearing you removed before. With a die grinder, ream the inner bore of the old inner-pinion bearings enough to remove a few thousandths of material (that created the interference fit) so that the bearing will slide on and off the new pinion by hand. Now we can install the pinion gear in the housing using our modified inner bearing and the old outer bearing. Without installing the crush collar, install the yoke and the old pinion nut. Tighten the yoke nut just enough to give the pinion a little drag when you turn it by hand. Now if we have to adjust pinion depth we don't have to worry about ruining a new pinion bearing should the puller slip while we're trying to remove it. Our setup bearing will just slide off, and we won't use the crush collar either.

Carefully install the ring gear onto the diff carrier, making sure that the gear sits flat on the carrier flange. Snug up the ring-gear bolts in a star pattern to bed the gear to the carrier flange without deflection or distortion.

**Figure 2**



**Adjustable Shims**

If you bought a quality installation kit (See Figure 2) from *continues page 44*

## Up To Standards

your gear vendor, it came with all the bearings and a set of adjustable shims. This makes adding or subtracting shim thickness to position the carrier for correct backlash a snap.

Using new carrier bearings and the original thickness of left and right shims, place the carrier into the housing and snug up the bearing caps. We are working on a GM 10-bolt rear that has a backlash spec of 0.008-0.10 in. Backlash is defined as the measure of free movement of the ring gear when the pinion is held in place. Measure backlash with a dial indicator mounted to the housing and the plunger set on the edge of a ring-gear tooth (See Figure 3). Take measurements at three places around the ring gear and come up with an average. Subtract or add shim thickness to move the ring gear closer to or farther from the pinion until the backlash is correct. The chart in Figure 3 shows about how much shim to change to move the backlash the correct amount. Bear in mind that shims subtracted from one side of the carrier must be added to the other side to maintain correct preload of the carrier bearings.

Now that we have established the correct backlash it is time to mark the gears and run a test pattern. Included in your gear set will be some marking compound. Brush-coat five or six teeth of the ring gear lightly with the compound and turn the pinion several times in each direction (drive and coast), then read the contact pattern. Compare it with the chart of contact patterns that is included in Figure 4. Illustration A in Figure 4 is the ideal contact pattern. A high or low contact point will require you

**Figure 3**

### Checking Backlash

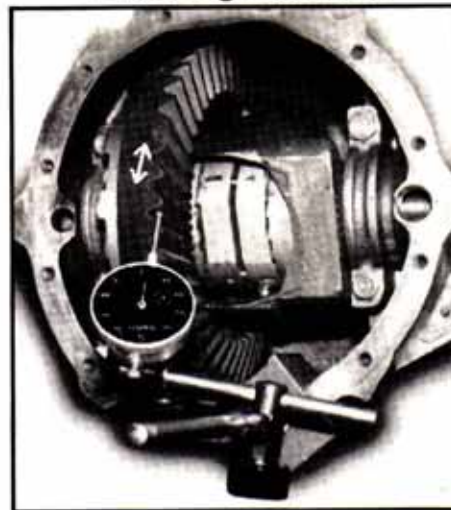


ILLUSTRATION C

BACKLASH IS THE FREE MOVEMENT OF THE RING GEAR WITH THE PINION HELD FIXED IN PLACE.

#### BACKLASH SPECIFICATION .008" — .010"







BACKLASH CHANGE REQUIRED (INCH)	SIDE TO SIDE CHANGE REQUIRED (INCH)	BACKLASH CHANGE REQUIRED (INCH)	SIDE TO SIDE CHANGE REQUIRED (INCH)
.001	.002	.009	.012
.002	.003	.010	.014
.003	.004	.011	.014
.004	.005	.012	.016
.005	.006	.013	.018
.006	.008	.014	.018
.007	.010	.015	.020
.008	.010		

to add or subtract pinion-depth shims. Heel or toe contact will require moving the ring gear closer to or farther from the pinion. Now you can see why using the modified inner-pinion bearing makes changing pinion depth an easy job. Once the contact pattern and the backlash are correct you can remove the modified bearing, save it for the next job, and put on the new inner- and outer-pinion bearings and new crush collar. Never, repeat never, reuse a crush collar.

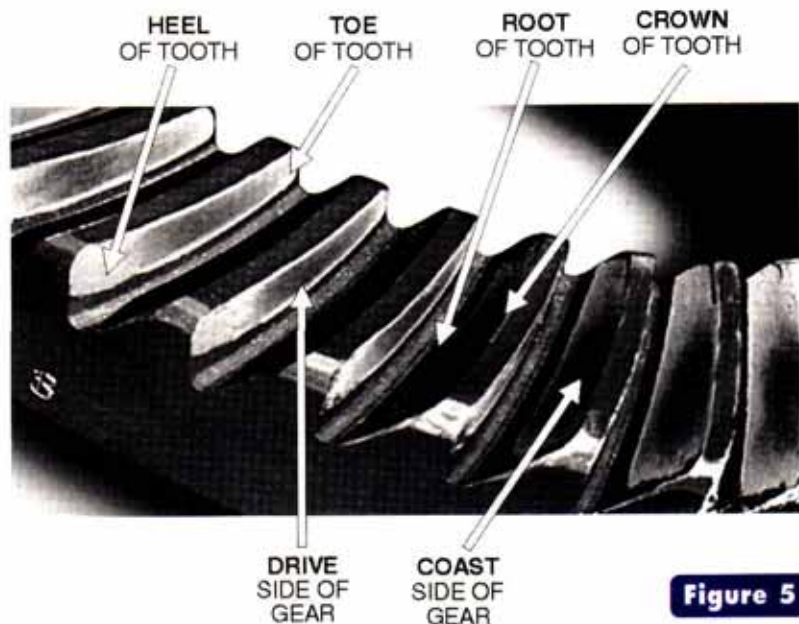
Tighten the pinion nut to preload the pinion bearings properly. Use a bar or a spanner

to hold the yoke steady, and tighten the yoke nut with a torque wrench. It will take about 180 ft.-lbs. of torque to begin to collapse the crush collar. Using an air gun makes it too easy to overtighten the crush collar, and then you would have to disassemble everything and replace the crush collar. Tighten the pinion nut enough to preload the pinion bearings until it takes 15-20 in.-lbs. to turn the pinion shaft alone (using new bearings). Now you can install the carrier and torque the bearing caps to spec. Double-check your backlash

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TOOTH CONTACT PATTERNS - (Drive Side of R/G)		
Tooth Contact	Condition	Remedy
A 	IDEAL CONTACT Pattern is spread evenly over tooth's profile with concentration nearer toe than heel.	
B 	COMPETITION CONTACT Pattern concentrated just up from the toe covering 1/3 to 1/2 of the tooth.	
C 	HIGH CONTACT Pattern is concentrated at the crown of the drive gear tooth.	Move the pinion deeper in towards the differential carrier (add pinion shim).
D 	LOW CONTACT Pattern is concentrated in the root of the drive gear tooth.	Move the pinion out away from the differential carrier (subtract pinion shim).
E 	HEEL CONTACT Pattern is concentrated off the heel end of the drive gear tooth.	Move the ring gear closer to the pinion (decrease backlash) while maintaining minimum backlash.
F 	TOE CONTACT Pattern is concentrated off the toe end of the drive gear tooth.	Move the ring gear away from the pinion (increase backlash) while maintaining minimum backlash.

**Figure 4**



**Figure 5**

to make sure nothing moved; install the axles, c-clips and rear cover, and add a good-quality gear lube (GL5 or better).

Good to go for the initial road test. Breaking in the gear set properly is very important for longevity and silent operation. An easy road test for 15 or 20 miles will heat-cycle the gears. Don't get heavy with the throttle, as anything that shocks or heavily loads the gears will shorten their life span. Park the car and let the rear cool to ambient temperature. Leak-check your work, and send your customer on his way with instructions not to hammer the vehicle or load it up heavily (such as towing) for at least the first 200 miles.

Differential work is much simpler than rebuilding a transmission and in most cases more profitable. If you become an all-around gear specialist, you attract more business, and by offering a variety of services you never have to send a customer to another shop. Example: A shop specializes in automatic transmissions but does not work on standards or rears. Many families in this country own two or three cars. If you turn away a job on a stick trans or a rear, the shop that gets that job also will compete with you to get the rest of that customer's work, including the automatics. To survive in the new century you will have to be an all-around service provider. **TD**

### THE BOTTOM LINE:

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