GEARS TO GO

Swap Your Ring and Pinion on Saturday, Run Quicker on Sunday

BY CHRIS RITTER

PHOTOGRAPHY BY THE AUTHOR, LEAD PHOTO BY BRENT VAUGHAN

The smallest part can often be the source of biggest gain regarding Pontiac power. Evidence can be found in the ring-and-pinion gear swap. Pound for pound, dollar for dollar, this change can provide you with more usable performance than many more expensive and complex modifications.

When considering a rear-gear swap, start with an overall view of the intended use for your Pontiac. For instance, your daily driver is not going to make you happy if you stuff in a set of 4.10:1 gears and hit the freeway. You're also going to be disheartened if all you do is drag race, and your car leaves the line like it's mired in molasses because of 2.56:1 cogs that were intended for highway and economy use.

Selecting our gear set was done via a mathematical formula and tempered with a good dose of common sense. The formula for the rear-gear ratio is (rpm times tire diameter)/(mph times 336) equals the rear-gear ratio. For example, (3,000 rpm times 26 inches)/(65 mph times 336) equals 3.57 for the rear-gear ratio. This calculation allowed us to select an rpm range we thought we could live with on the highway and still run the tallest gear that was practical for a street/strip setup.

The subject of our gear change is a '74 462ci Trans Am. It was originally equipped with air conditioning, which mandated a 3.08 gear set from the factory. The closest applicable gear offering for the 8.5-inch, 10-bolt rear is the 3.42 ratio.

After some discussion with Bryan Blocker of Blocker's Performance and Restoration in Vilonia, Arkansas, we decided to replace the carrier bearings and pinion bearings while doing the swap. His reasoning was that the OEM bearings had more than 30 years of wear. Even if they passed a visual inspection, it would be foolish to disassemble the rearend without replacing the bearings. The axle bearings had been replaced a few months before.

A call was made to the Precision Gear tech line, and the company agreed that our math was correct. The tech also recommended we stick with a regular gear set since the intended use was primarily street. Their Ultra-Lite series of racing gears would have been overkill in this application. We ordered the 3.42:1 gear for a GM 10-bolt differential (PN GM 10/342, $155.95)

A second call to Summit Racing netted a Ratech (PN RAT-310K, $89.99) installation kit that included all the needed bearings, shims, marking compound, seals, and gaskets. A local parts store provided the requisite gear oil and limited-slip additive for our upgraded rearend.

With the gear set selected, we wondered what kind of performance gain we might expect from changing to the deeper gears. Data for the T/A's performance in the eighth-mile was available. It had run a previous best of 8.13 at Centerville Dragway in Russelville, Arkansas. Would we see any additional performance by simply swapping gears?

Follow along as we perform the install in a day's time and return to the track for follow-up testing.

The parts for our swap included the GM 10/342 ring-and-pinion gear set from Precision Gear and the Ratech RAT-301K installation kit. After examining the Ratech kit, we opted to buy a Fel-Pro RDS-55028-1 differential cover gasket rather than use the paper-style one supplied.

Bryan Blocker began the disassembly by unbolting the rear stabilizer bar from the down links and swinging it out of the way. Then we unbolted the differential cover and drained the case. While removing the 5/16 pinion-shaft retaining bolt, we used caution since it's easy to round off the head if it's lodged in place.

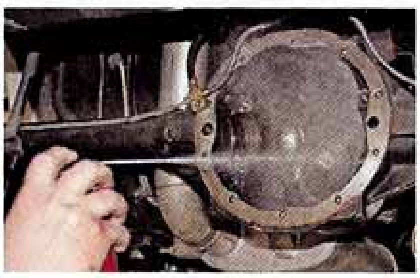
We positioned the differential for access to remove the bolt, pinion shaft, and C-clips without disturbing the unit. If we were to rotate the differential without the pinion shaft in place, the spider gears could walk and make reassembling the unit a nightmare. With the bolt removed, our pinion shaft slid out easily. If yours doesn't, a few gentle taps with a hammer should dislodge it.

▶ We checked for any obvious cracks or wear marks, and Bryan examined the bottom of the case for any debris. After passing the visual inspection, we cleaned up the housing, washing out the case and wiping it down with a clean rag.

Then we pushed each axle inward with the hope the C-clips would simply fall into the differential case. They didn't, so we used long-nosed pliers (a magnet will work, too) to remove them.

We used a punch to mark both carrier-bearing caps for side and alignment so they could be returned to their original position on reassembly. We made one punch mark on the top-left bearing cap and two punch marks on the bottom-right cap.

Next, we pulled the entire differential from the housing. This is where another set of hands is helpful as it can be pretty tight and quite heavy. We kept the left and right shim packs away from one another to measure the total thickness of each to ease reinstallation. If you intend to reuse your carrier bearings and races, note which side they came from, and be sure to return them to their respective sides upon reassembly.



Bryan employed an impact gun to remove the pinion nut. We used a rag wrapped around the pinion gear to keep it from freewheeling while he applied the power to break it loose and remove the old cog.

Since we were replacing all the old bearings, we employed a hammer and a long drift to drive the inner and outer pinion-bearing races out of the case, taking care not to let the drift slip and gouge the bearing seats.

With all the parts removed, we were off to the parts washer. Even parts that weren't going to be reused were cleaned and thoroughly inspected to determine any problems. Our old parts passed with flying colors.

After the seats for the pinion-bearing races were wiped with clean rags and solvents, we applied a light coat of silicon spray, and Bryan drove the new races into place with a brass drift.

We used a bearing press to remove the old inner pinion bearing. Why bother when we'll be installing a new bearing on the new pinion? We needed to see how many shims were behind the bearing and measure their thickness. This will be the starting point for the shim pack to set the pinion depth and our final backlash setting.

The original shims were in good enough shape to be reused after a trip through the parts washer. If they hadn't passed inspection, our Ratech kit came with new replacement shims that we could have substituted.

With the shims under it, we pressed the new inner pinion bearing into place. Bryan then mocked up the remaining parts to show the final installation order of the inner bearing, crush collar, and outer bearing. Not pictured are the new pinion seal, yoke, washer, and pinion nut that will secure the assembly.

Sans the crush collar, we installed the pinion with the shims, lightly oiled inner bearing and outer bearing, and the nut. Next, we tightened the nut in small increments to achieve the required bearing preload of 14-19 in-lb of drag. This step would normally be followed by measuring the pinion depth, but Bryan only does that when an unknown shim pack is used. When reusing an existing pinion-shim pack, he prefers to install the pinion, carrier, and ring gear, and run a pattern to determine if the depth is already correct. (Editor's Note: For a general description of how to check pinion depth, see "Maximum-Effort Fourth-Gen 10-Bolt," Oct. '06.)

We then turned our attention to the carrier and ring gear. Bryan headed back to the press to remove and install the carrier bearings on each end. We used a liberal dose of silicone spray prior to pressing on the new bearings.

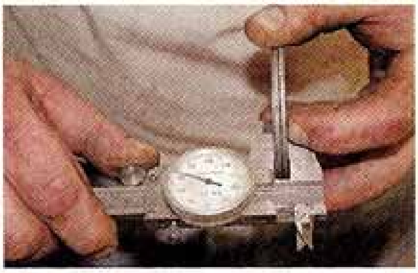
Since the new ring gear is a tight fit on the carrier, Bryan put the carrier in the freezer for a few hours and then placed the ring gear in the oven at 200 degrees to heat it. The combination of hot and cold allowed the ring gear to easily drop into place. We used red Loctite on every ring-gear bolt. The bolts were then brought to the proper torque in three steps to the final torque setting of 65 ft-lb using a criss-cross pattern to pull the gear down evenly against the carrier.

After prelubing all the bearings, Bryan installed the carrier with the new ring gear, carrier bearings, and races on the differential case. We reinstalled the shim amounts that were in place when we disassembled the unit between the carrier race and housing as a starting point for setting the backlash.

◀ Next, we removed the old ring gear, keeping in mind that on the GM 8.5-inch, 10-bolt differential, the bolts are reverse-threaded (left-hand). Bryan has seen more than one ring gear ruined by having the impact set incorrectly and stripping out threads.

Bryan torqued the carrier caps to 60 ft-lb. Some instructions say snugging the caps is adequate, but he believes it's better to measure with the caps at full load.

We then took the critical backlash measurement at a few different places on the ring gear. A dial indicator was set on a tooth of the ring gear each time, and the amount of play in the gears was measured. The instructions said to look for a backlash of 0.006-0.010. Ours measured 0.014 so additional shims were needed.



Since our backlash was loose, we needed to move the ring gear closer to the pinion gear. Bryan removed the shims, then measured and added 0.010 to the driver-side shim pack while removing an equal amount from the passenger side. He hoped to subtract roughly 0.007 from the backlash. When checked, it was exactly 0.007. He expected the gear set to loosen up after break in, so being on the tight end of the specification didn't alarm him.

We generously applied gear-marking compound (supplied with the Ratech kit), mixed with a few drops of oil to thin it, onto the ring-gear teeth evenly so that contact patterns could be easily read.

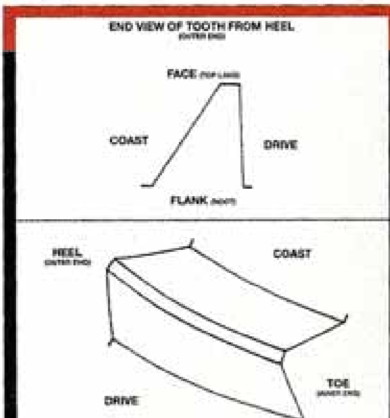
Then Bryan turned the gear set in the direction of the drive rotation until a clear pattern was established in the marking compound. He paid particular attention to the face (toward the top of the tooth, above the pitch line) to flank (toward the bottom of the tooth, below the pitch line) pattern. A centered contact pattern from face to flank indicates correct pinion depth. A pinion that is too close to the ring will show a pattern toward the flank of the tooth; too far away will favor the face. If either of the latter had occurred, a tear down and adjustment would have been made to the pinion shim thickness. We compared the markings to acceptable patterns specified in the instructions, and this pattern on the drive side and coast side were deemed acceptable.

CONCLUSION

We removed the carrier once again to facilitate the final assembly of the rearend. To install the crush collar, Bryan had to—of course—take out the pinion. He then reinstalled it with the outer pinion bearing, pinion seal, yoke, washer, and nut, torqueing the latter to 300-400 ft-lb in order to place the proper preload on the pinion bearings. Lastly, Bryan checked the backlash and contact pattern once again before bolting on the cover with its gasket and refilling the unit with fluid and limited-slip additive.

It should be noted that any new gear set requires a break-in procedure. Consult your installation instructions for the exact methods recommended by the manufacturer of your gears. Most require the car to be driven 15–20 miles, and then allowing the new gears to cool completely before driving it again. Many also caution against towing or spirited use during the first 500 miles. Improper break-in can lead to overheated and damaged gears.

See the "Drag Testing" sidebar to learn how the small detail of swapping 3.42s in place of 3.08s paid dividends on the strip after proper break-in.



READING PATTERNS AND GEAR TERMS

TOE: Inner end of the gear
HEEL: Outer end of the gear
PITCH LINE: Halfway across the tooth
ROOT: Bottom of the tooth
FACE: Area above the pitch line
FLANK: Area below the pitch line
CONVEX: Drive side of tooth
CONCAVE: Coast side of tooth

The pattern should be in the middle of the tooth (pitch line), splitting the face and the flank. In theory, it should be even on the drive side and coast side, and even in width and diameter across the tooth with feathered edges.

Pinion depth affects the pattern. While it will change toe and heel a bit, it mostly moves the pattern up or down relative to the pitch line. Increasing pinion depth moves the pattern up toward the face, while decreasing it moves it down toward the flank. The coast and drive sides move opposite each other with changes in pinion depth.

Backlash affects the pattern. A decrease moves the pattern from heel toward toe; an increase does just the opposite. The drive and coast sides move evenly in both cases. A pattern toward the heel is quieter than one toward the toe. —Tom DeMauro

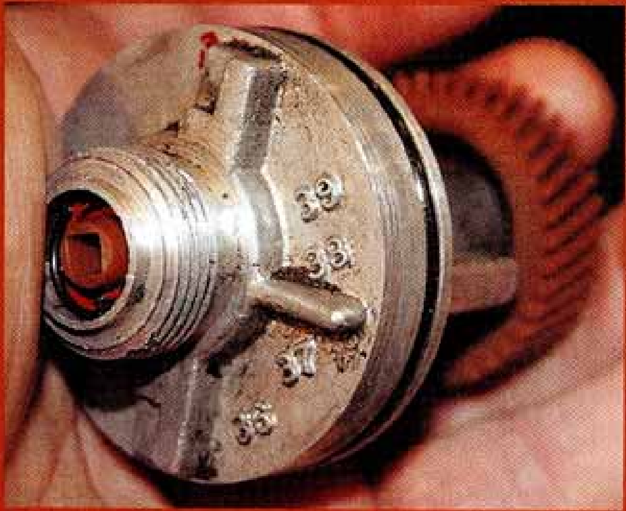
TRANSMISSION SPEEDO GEAR

Changing the rear-gear ratio requires a recalibration of the speedometer. This can involve changing the speedometer drive gear, driven gear, or both.

In this case, we determined that our speedometer was turning 5-mph faster than it should be because 50 mph on our speedometer showed an actual speed of 55 when tested. If we divide 55 by 50, we get 1.1 for our correction factor. That means the driven gear in the transmission is moving 0.1 faster than it should for our gear set. This can be corrected by adding teeth to the driven gear or by subtracting teeth from the drive gear.

There are two types of carriers for the driven gear. The first will hold driven gears that have 34-39 teeth, while the other can run driven gears with 40-45 teeth. The carrier in this Turbo 400 was for 34-39 teeth.

Driven gears are color-coded to help determine the number of teeth they have. These colors can fade and be hard to identify. We confirmed our tooth count by marking a tooth with an indelible marker and counting the teeth. We did this more than once to be certain of the count. The driven gear that was matched to the original 3.08 ring-and-pinion gear set had 36 teeth, according to our factory service manual.



The old gear assembly has the numbers of the driven gears it will accept cast into the case. This assembly is held in place with one bolt and a Y-shaped retainer.

Our previously calculated correction factor of 1.1 can be used to determine how many teeth are needed to correct the speedometer. The existing driven-gear tooth count can be multiplied by the correction factor (36 times 1.1 equals 39.6).

The original driven gear (left) is a natural color, while the replacement gear (right, GM PN 1359273) is brown. The color can be hard to determine unless seen side by side.

We have two choices based on the results—either round up or down. Since our existing driven-gear carrier is capable of holding the 39-tooth gear but not the 40-tooth gear, we elected to go that route to avoid disassembly of the transmission to change the driven gear. If our speedometer is off, it will be minimal. The proper 39-tooth driven gear was purchased at a local GM dealer, and the speedometer correction was complete. TCI has a great chart on driven gears, colors, applications, and more on its Web site, www.tciauto.com.

DRAG TESTING

As with any track testing, it's virtually impossible to duplicate every factor. The biggest variable can often be the weather. For this reason, we attempted to return to Centerville Dragway with similar weather conditions.

The '74 Trans Am test car features a 462 engine, unported SD heads milled for 9.2:1 compression, Crower 247/252-degrees duration at 0.50 solid cam with 0.505/0.517-inch lift., a port-matched Performer RPM intake, a Speed Demon 850 carb, Hooker Super Comp 2-inch primary headers with 3.5-inch collectors, a 3-inch Torque Tech exhaust system, a Dr. Gas X-crossover, and Dynomax Super Turbo mufflers. The tires are M/T 275/60-15 drag radials pumped up to 17 psi on widened 15x8 Rally IIs.

Our initial runs were made on a crisp spring morning with temperatures in the upper 60s to lower 70s. The humidity was virtually nonexistent. In short, it was one of those perfect days at the track. The result was new personal bests for the T/A with the old 3.08 gears. Our follow-up testing was on a day that was an average of 10 degrees cooler but with similar humidity levels.

The first number to notice when comparing our runs from before and after the gear swap is the improved 60-foot time, which dropped an average of 0.14 seconds. This tells us the deeper gear ratio is getting the heavy car off the line quicker. That improvement was amplified at the 330-foot mark with an average drop of 0.19 in elapsed time. The averages kept getting better as the e.t.'s dropped by 0.23 seconds at the end of the eighth-mile track with a mile-per-hour increase of 1.49.

RESULTS

	3.08:1 GEARS				3.42:1 GEARS			
	Run 1	Run 2	Run 3	AVG	Run 1	Run 2	Run 3	AVG
60-FT	1.92	1.95	1.96	1.94	1.83	1.80	1.79	1.80
330-FT	5.31	5.33	5.37	5.33	5.17	5.14	5.11	5.14
⅛-MILE	8.13	8.14	8.20	8.15	7.96	7.93	7.87	7.92
MPH	87.78	87.75	87.50	87.67	88.41	88.64	90.45	89.16

SOURCES

Precision Gear Inc.
Dept. HPP
12351 Universal Dr.
Taylor, MI 48180
(800) 524-0804
www.precisiongear.com

Summit Racing Equipment
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