

# Differential Overhaul June 20, 2019 (SL)

by Tom Endy

This rear axle assembly arrived in the back of a modern SUV after being removed from a 1931 roadster. The owner complaint was that the ring & pinion were jammed up. The unit had a Borg Warner overdrive installed that the owner removed before bringing it over. The overhaul will include a new 378:1 ratio ring & pinion gear set and a new Mitchell 26% overdrive will also be installed.



Note there is no Borg Warner stub shaft seen sticking out of the banjo. The owner said that when he pulled the Borg Warner overdrive unit off the banjo the stub shaft came out with it. This does not seem possible as there should be a nut on the end of the stub shaft inside the banjo that would have prevented that from happening.



**A close-up photo showing where the Borg Warner stub shaft should be protruding from.**



**The owner supplied this photo of the Borg Warner stub shaft that came out of the rear axle assembly when he pulled the Borg Warner overdrive off. It is still attached to the overdrive. Note how torn up is the threaded end where the nut was supposed to be.**



**The two axle housings have been removed. The grease seals and the carrier bearing races have been removed and the housings are ready for clean-up.**



**Shown here are the two grease seals removed from the two axle housings. Note these are the original leather seals Henry Ford installed at the factory. The leather disappeared years ago and there was no sealing going on. This was evidenced by large amounts of grease found inside the axle housings. The seals are there for the purpose of directing grease pumped in through the grease fitting at the end of the axle housing to go toward the rear wheel bearing. Without the seal the grease just flows into the void on the inside of the axle housing.**

**The CR stamped on the seals stands for Chicago Rawhide, the original manufacturer of the seals.**



**Both axle housings have been cleaned up, new races and seals have been installed.**



**This photo shows after the two axle housings were removed: The banjo with the pinion gear still installed and the carrier assembly with the two axle shafts still installed. Note the metal debris in the bottom of the banjo.**



**This photo shows the pinion gear with the nut missing from where the threaded end of the stub shaft would have protruded and secured with a nut and cotter pin. Note the broken teeth from the pinion gear in the bottom of the banjo.**





**Close up of broken teeth from the pinion gear in the bottom of the banjo.**



Shown here is metal debris from the pinion gear scattered on the carrier assembly. The teeth on the ring gear are also battered.



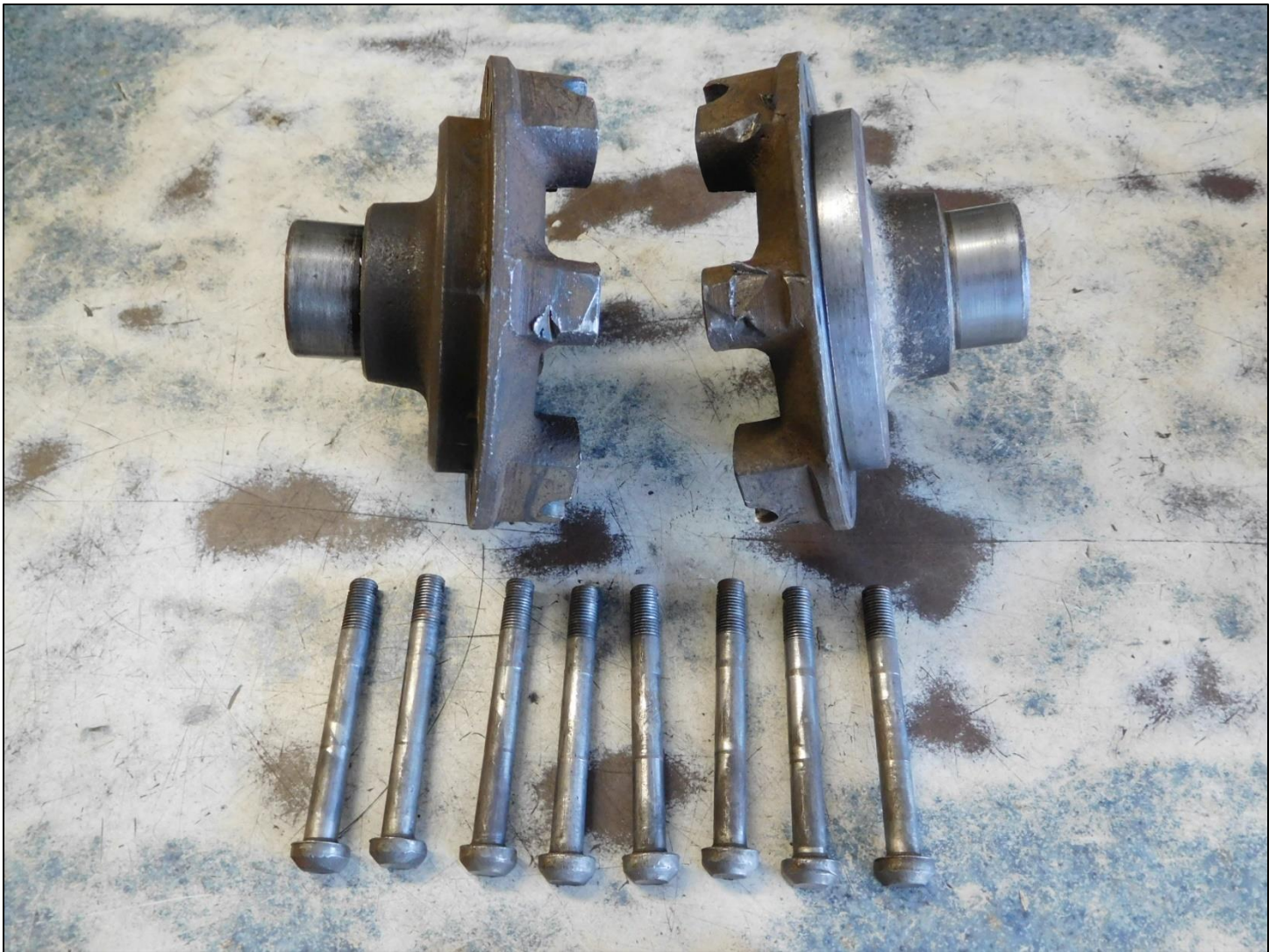
**Shown here is the damaged pinion gear. Note the many teeth missing from the gear.**



Shown here is some of the debris removed from the banjo. On the left is the remnants of the nut that was on the end of the stub shaft, it appears to have been cut in two. To the right are three teeth broken off the pinion gear.

**Suspected cause of failure:**

I suspect that when the Borg Warner overdrive was installed, the nut on the end of the stub shaft was not sufficiently tightened and a cotter pin was not installed. Eventually the nut backed off the threaded end of the stub shaft and hit the rotating carrier, which cut it in half and the pieces became jammed in the ring & pinion gears. I was not able to find any pieces of a cotter pin among the debris.



**Shown here is the carrier that was removed. It is the early version used in the 28-29 cars. The two halves are identical part numbers. The ring gear can mount on either side. The area where they join together is not notched as are the later carriers. The bolts used were different, they have a half dome head that locks into the ridge on the opposite side of the ring gear.**

**The carrier has the bearing mount hub spun on the side the ring gear was on. It also suffered some exterior damage due to all the broken parts adrift in the banjo. The carrier will be replaced with a serviceable later version that has had both hubs knurled. A set of later style bolts will also be used.**



**Shown here is the damaged ring & pinion that was removed. It is an original 378:1 gear ratio. It is definitely not serviceable.**

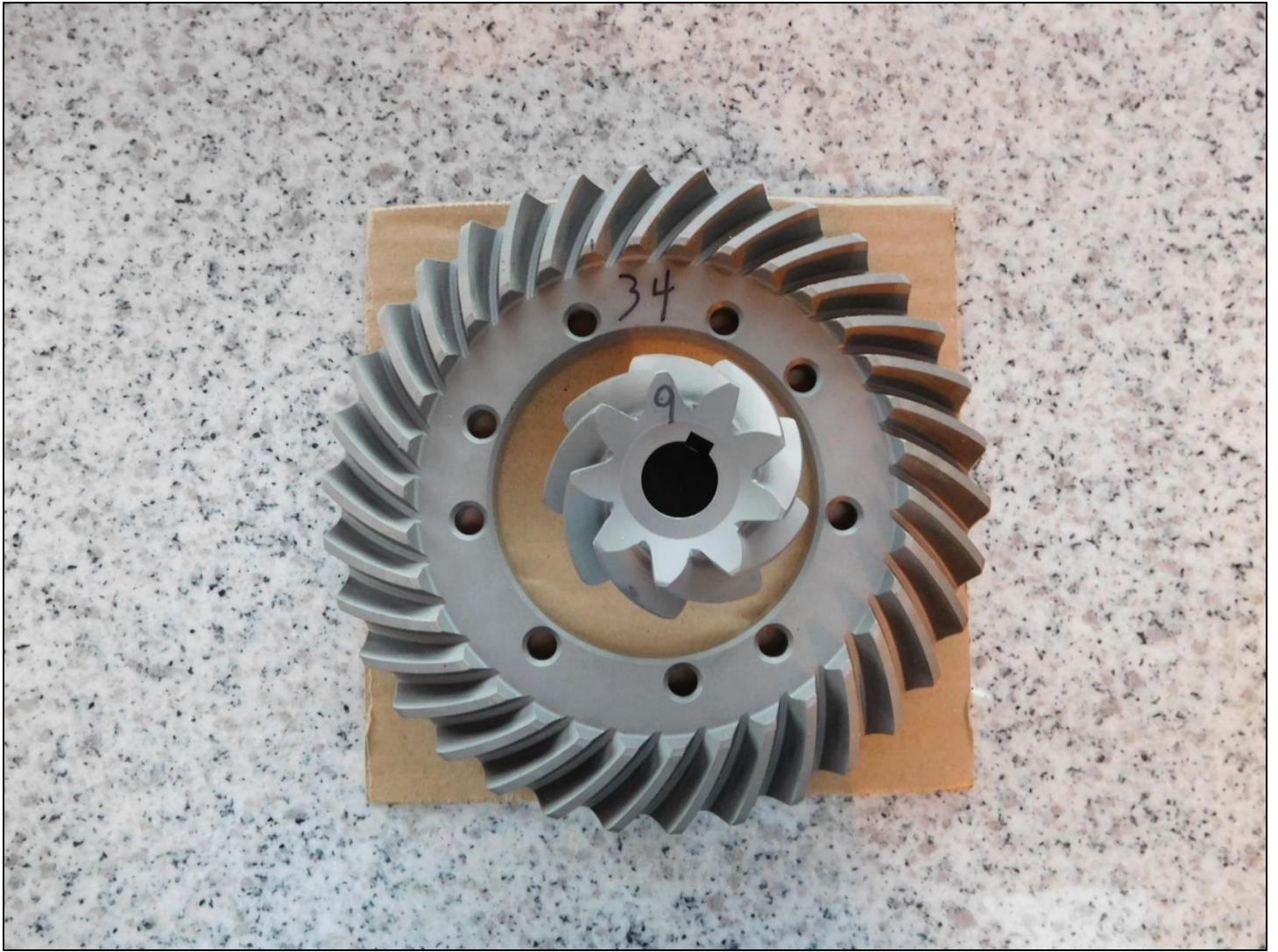


**The banjo on the left is the one removed. It is a 1929 to mid-1930 with the drain hole and the fill hole in line in the center of the banjo. The banjo on the right is a mid-1930 through 1931 with the fill hole off the center line to the left. Since the car is a 1931 roadster, the 1931 banjo on the right will be exchanged and installed.**

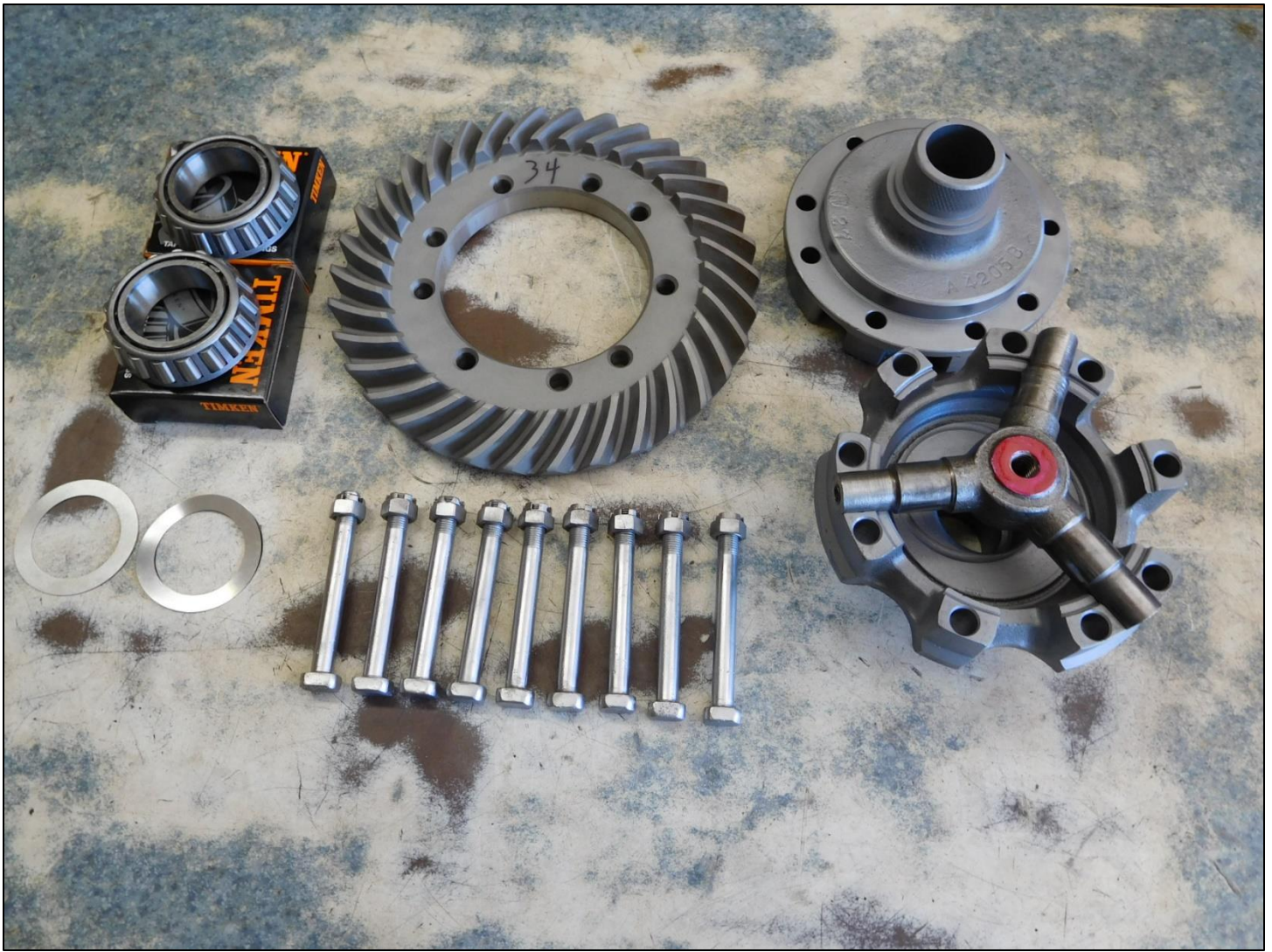


**Shown here is a new double pinion bearing race being pressed into the 1931 banjo. Note how the banjo is positioned on the press. The banjo should never be set with the banjo bottom sitting on the base of the press as the force of the press will distort it into the shape of a football. A support should be placed directly under the banjo flange to absorb the pressure of the press.**

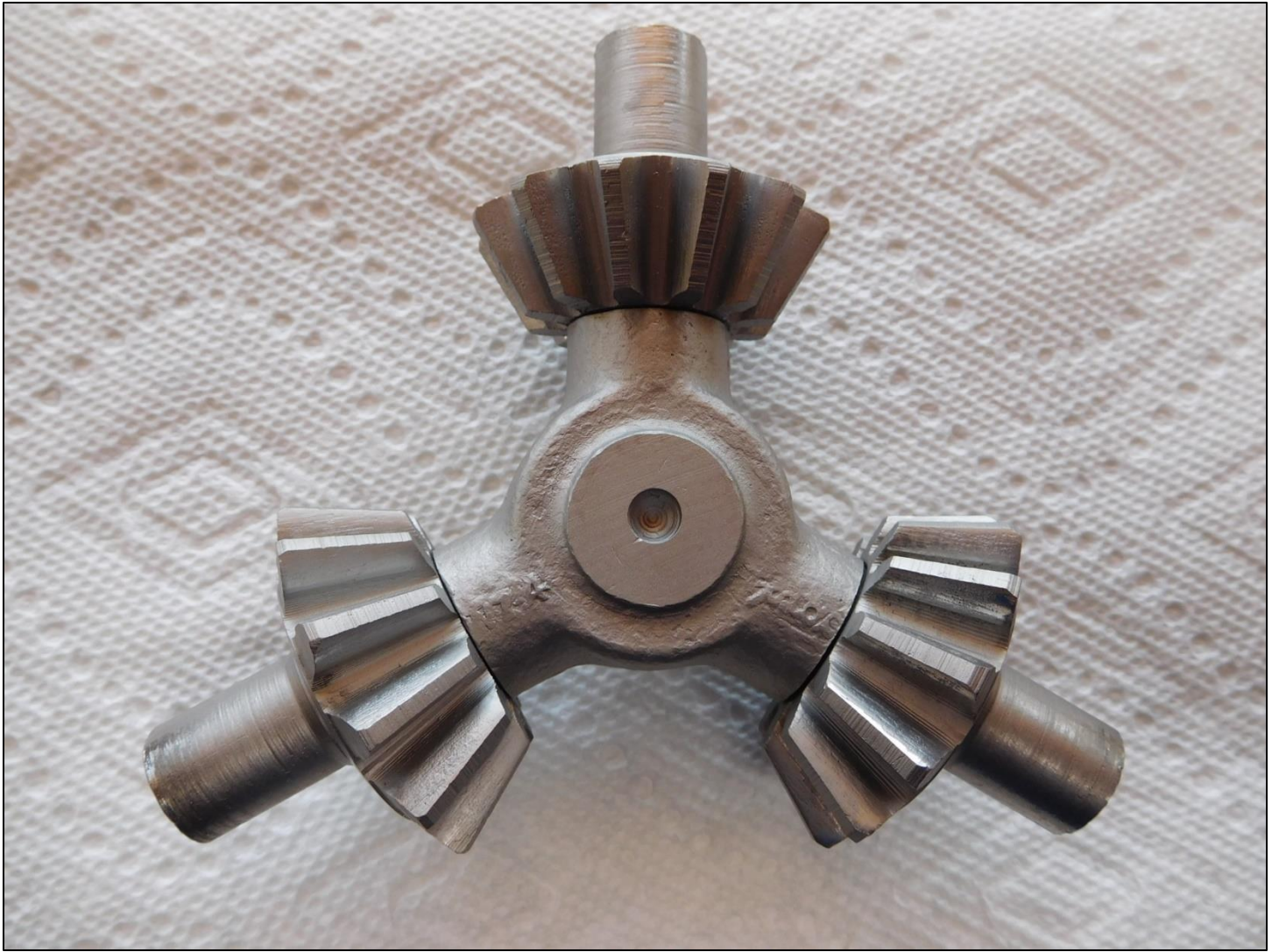




**The new 378:1 gear ratio ring & pinion gear set showed up from the supplier. Nine teeth on the pinion, 34 teeth on the ring gear.**



**The new ring gear is about to be installed on the replacement carrier that has had both bearing hubs knurled. Inside the two carrier halves is part of the pre-load tool (red paint). Nine carrier bolts and nuts hold the carrier assembly together. The two bearings will be pressed onto the hubs with a .005 bearing shim under each bearing. The shims are to compensate for material that was machined off the bearing stops to clean them up when the knurling was done.**



**Shown here is the spider gear assembly that survived the devastation inside the banjo after it was cleaned up and bead blasted. It is in excellent condition.**



**Shown here is the carrier assembled. The spider gear assembly and the two axle shafts are not installed until final assembly. Inside the carrier is the tool used to set the pre-load on the carrier bearings.**

**The two red dots are markers placed there when the carrier was first disassembled. This is to allow it to go back together the way it came apart. The inside the carrier usually has wear marks from the back side of the three spider gears. They are not always equal and it is a good idea to have the carrier go back together with the wear marks lined up.**

**This particular carrier has virtually no internal wear marks.**



**Shown here is the new pinion gear. It was not machined correctly as is the case with most reproductions. The sleeve where the two bearings mount should be of two different dimensions. The bearing shown installed must press on with an interference press fit, and it does. The second bearing which installs to the right of the first bearing after it is inserted into the double bearing race in the banjo must be able to slide with a snug fit in order to achieve the pre-load setting and it did not. The difference in the two dimensions should be .0015. In this case the sleeve was all one dimension and was a .002 interference press fit along the entire length. In order to be able to install this pinion correctly I had to have the right end of the sleeve machined to remove metal to create a snug sliding fit.**



**Both axle shafts have been cleaned up and inspected. They were found to be in excellent condition. There are no cracks around the keys and the threads are in good condition.**



**Shown here is the pinion assembly and a Mitchell stub shaft installed in the banjo. The pre-load on the pinion bearings has been adjusted to a nominal 20-inch lbs. by adjusting the two large hex nuts on the other side of the banjo flange.**



**The nut on the end of the stub shaft is torqued to a nominal 100 ft. lbs. A cotter pin is inserted and the legs are bent over the sides of the nut. The legs should never be bent over the end of the shaft as they could contact the rotating carrier.**

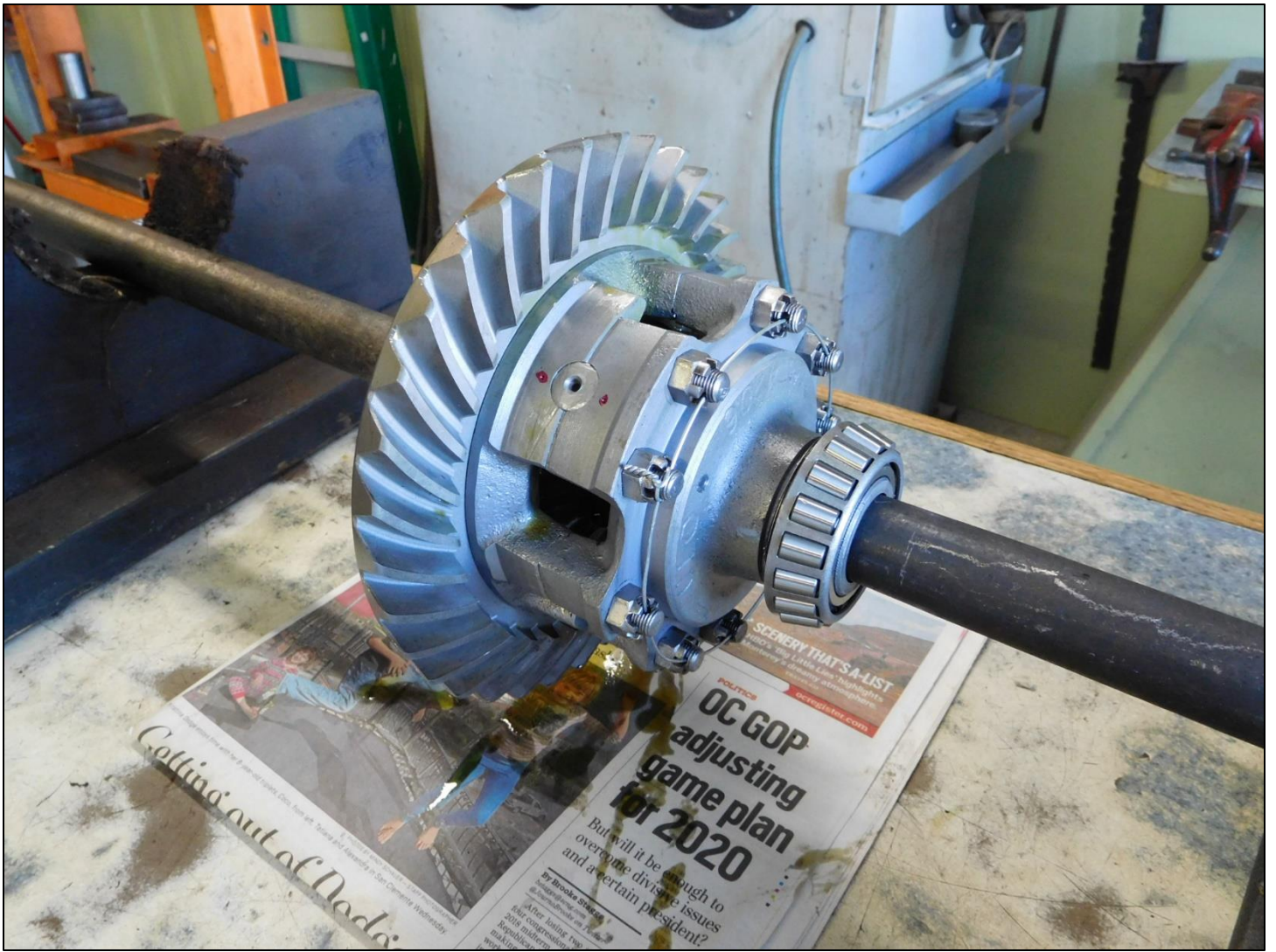




**The two axles along with the spider gears are shown here being assembled into the carrier.**



The nine carrier bolts and nuts are torqued to 35 ft. lbs. A large screwdriver is used to prevent the carrier from turning while the nut is being tightened.



The nine carrier bolts are safety wired.



**Shown here is the final assembly. The carrier pre-load had previously been determined by the number of shims under the carrier bearings and the number of banjo gaskets used and was adjusted to a nominal 20-inch lbs. Alignment studs are used to align the gasket and Indian Head gasket sealer is applied to the gaskets.**



**The 20 banjo bolts are torqued to 35 ft. lbs.**



**The rear axle assembly is complete and the housings have been sanded. The next step is to paint it.**



**Painted!**



**The Mitchell overdrive arrived and is shown here being installed onto the overhauled rear axle assembly.**





**The six mounting bolts are installed and safety wired.**



**Done! Ready for installation in the car.**

**Don't forget to put oil in the banjo and the overdrive!**