Rear Axle Assembly Overhaul Pictorial
July 2018 by Tom Endy

This is a pictorial of a typical rear axle assembly that has been received for overhaul. It is long and tedious. However, for those who have taken on the task of overhauling a rear axle assembly themselves, the photos and captions may be of help.

The job arrived in the back of a modern pick-up truck. It came out of a running Model A. The owner said the car had been stored in a shed for about 50 years. He was able to get it running and drove it around the neighborhood. However, an inspection revealed a section of the end of the right rear axle shaft was broken away at the key, and was the reason for the decision to have the entire rear axle assembly overhauled.

The exterior was extremely cruddy, one of the worst.

The bottom side was not as cruddy as the top side.

The bottom side of the torque tube flange is almost hidden in crud.

The top side of the torque tube flange is hidden in crud.

The speedo housing at the front of the torque tube is partially hidden in crud.

Easily 50% of the effort in a rear axle assembly overhaul is the cleanup. De-greasing, bead blasting, and orbital sanding take up a lot of the time. The housings have to be cleaned inside and out. Quite often the assembly has suffered a bust up. There will be metal particles imbedded in the crud on the inside of the housings; this all has to be cleaned out. A solvent cleaning tank is a necessity.

The end of the right axle shaft has a section broken off at the key and is the reason for the overhaul.

The rear axle assembly is sitting in a roll around cradle. The threaded end of the axle shaft has a thread protector screwed on.

The inside of the rear axle assembly was surprisingly clean compared to the outside. The pinion gear seen here appears to be in very good condition. The cotter pin in the nut at the end of the drive shaft was installed properly with the legs bent down along the side of the nut.

The ring gear also appears to be in very good condition

The two axle housings have been removed and both grease seals have been driven out. All three of the grease seals associated with the rear axle assembly were found to be the originals installed at the factory. The seals are made of leather, have the Ford logo on them, and the letters CR (Chicago Rawhide) stamped on them.

Both rear axle housings will have to be thoroughly cleaned and both carrier bearing races removed. New races and grease seals will then be installed.

Both shackle bushings will be replaced.

These two axle housing are somewhat rare. Note they have the weld seams at the bottom. They were only used on some cars in 1929.

The original grease seals installed in a Model A at the Ford factory were made of leather. The letter CR stamped on the side next to the Ford logo stands for Chicago Rawhide.

The leather found on these particular seals was largely deteriorated, which is usually the case when original seals are discovered to still be installed in a rear axle assembly.

The three seals used in a Model A rear axle assembly are grease seals, not oil seals. There is a belief by some that the purpose of the seals is to keep the differential oil from traveling to the brake shoes and to the U-joint at the front of the torque tube. Their purpose is to direct the flow of grease to the rear wheel bearings and to the roller bearing in the front of the torque tube.

Quite often I have found completely deteriorate original seals in an overhaul job with no sign of differential oil having reached the brake shoes. What I do find is a large amount of grease that has centrifuged around the axle shafts and traveled toward the differential.

A closer look at the damaged right axle shaft:

The old bearing is being pressed off the carrier half opposite the ring gear.

The ring gear half of the carrier was found spun. The bearing just fell off. If only one side of a carrier is found spun, it is always the ring gear side. My theory is that the ring gear side receives the initial torque from the pinion gear. The opposite carrier half was not spun.

Note the punch marks on the hub. This was done many years ago by a previous mechanic because he also found the ring gear side spun and the punch marks are his attempt at knurling.

The carrier will be replaced (exchanged) with one that has had the hubs knurled.

The reason carrier bearings are often found spun is because people who have previously worked on the assembly did not understand the pre-load requirement. They simply put a single gasket on each side of the banjo and in most cases locked the carrier up. Henry's 40 horses broke it loose once the car was back on the road, and the result is the bearings are spun on their mounts. Setting the pre-load usually requires multiple banjo gaskets.

The ring & pinion is an original installed at the Ford factory. Note the end of the pinion gear has the number 37 stamped on it at the factory. This number is then written on the flat side of the ring gear by a worker with an etching tool at the time they are installed in a rear axle assembly.

Note the number 37 can be seen etched on the flat side of the ring gear. This matches the number stamped on the end of the pinion gear.

I have seen this phenomenon many times and I am convinced the procedure at the factory was to pull the ring gear and the pinion gear from two different stock bins. They do not become a mated pair until installation when a worker etches the pinion number on the flat side of the ring gear. They don't become "matched" until they have run together for a number of miles.

This contradicts the belief some have that a ring & pinion were somehow run in and matched at the factory prior to installation.

The ring & pinion gears were found to be in excellent condition. They are shown here after they were de-greased and bead blasted. The gear ratio is 378:1. There are 9 teeth on the pinion gear, and 34 on the ring gear.

This photo shows the minimum replacement parts that are installed in every rear axle assembly overhaul that I do.

On the left are the four tapered bearings, two for the pinion gear, and two for the carrier. Both pairs will be adjusted such that they will have a nominal 20 inch pound of pre-load against their mating races. The Timken part number is 28156.

Next are the two races that are associated with the two carrier bearings. Each is pressed into the two axle housings. The Timken part number is 28317.

Next is the double cone shaped race that is associated with the two pinion bearings. It is pressed into the banjo housing. The Timken part number is 38314XD.

Also shown are the three replacement grease seals and the two replacement axle housing shackle bushings.

Miscellaneous parts have been de-greased and most bead blasted. It is important that the nine carrier bolts be wire wheeled after bead blasting and any nicks or burrs removed. They fit into the carrier and ring gear tightly.

When the nine carrier bolts were removed care was taken to not hammer aggressively on the ends of the bolts to drive them out; this will damage the threads. Those that would not come out with gentle tapping were pressed out using a shop press.

Shown here are the twenty banjo housing bolts (top two rows). It is important that original bolts be used. Note the thick hex head and the space between the threads and the head of the bolt. It is also important that the bolts be clean and the threads in good condition. These have been de-greased, bead blasted, and wire wheeled.

The bottom row is the six bolts that attached the torque tube to the banjo flange. These are also original bolts. The hole in each head is for safety wire. These bolts have also been de-greased, bead blasted, and wire wheeled.

The next series of photos show how the banjo double pinion race is removed. The tool used here can also be used to remove an entire pinion gear assembly from a banjo with the drive shaft still attached, or as shown here to remove just the race. For this task a cut off drive shaft with a scrap pinion gear and bearing attached is used with the puller tool.

The banjo is placed in a wood vice. The cut off drive shaft with the pinion gear attached is placed inside the banjo.

The bottom plate of the puller tool with two locating pins on the bottom side is placed over the flange of the banjo. The locating pins insert in the top and bottom bolt holes.

The second plate with the four threaded holes is placed over the bottom plate and lined up on the red markers.

Next the “grabber” part of the tool is installed over the shaft. This part of the tool “grabs” the drive shaft tightly such that it does not slip after the four bolts and nuts are tightened. Note the chalk mark on the shaft just above the grabber. This is monitored during the pulling process to make sure the grabber is not slipping on the shaft.

The four puller bolts are installed and evenly tightened such that they will pull the race out of the banjo. An impact wrench works well and speeds up the process.

The tool has pulled the double race out; it can be seen on the left side of the upper plate of the tool and the scrap bearing.

The banjo has been de-greased and bead blasted and is ready to have a new double race pressed into place.

Another view of the cleaned up banjo: It is important that all 20 axle housing bolts are in good condition. After bead blasting, I clean the threads with a gun barrel cleaner attached to a drill motor. A 45 caliber works best.

When a new double race is pressed in, the banjo housing must be placed on a press so that it hangs down from a cross member. Never place the base of the banjo on the press platform as the force of the press will surely distort the banjo into the shape of a football.

Note the small steel plate and an old banjo race sitting in front of the banjo. They will be placed directly under the area below where the new race is to be pressed in.

The small plate and an old race have been placed directly under the area where the new race is to be pressed in. The new race has been set into place. It is a good idea to put a light coat of Vaseline on the mating surfaces.

Another old race has been set on top of the new race to be used to press the new race into place.

A new double race is shown having been pressed into place. Check the backside to make sure the race has been pressed in against the stop all the way around.

A replacement carrier that has had both hubs knurled and has been bead blasted is ready to accept the ring gear and the two new bearings.

The tool part that is used in conjunction with the pre-load tool is set into place in the half of the carrier opposite the ring gear half.

The second half of the carrier has been attached to the first half of the carrier. The ring gear has been set on top and the nine bolts set into place to properly align the ring gear to the carrier.

It is a good idea to coat all mating surfaces with a light coat of Vaseline. The bolts fit very tightly into the holes. Some of the bolts will have to be driven into place with a hammer.

The heads of the bolts should be lined up so that the rectangle is parallel to the circumference of the carrier. This will correctly line up the safety wire holes in the other end of the bolts. The heads of the bolts can be held in place with a 5\8” open end wrench while the nuts are being tightened.

It should be noted that the configuration of this carrier assembly is the later version. The earlier carriers have different shaped bolt heads and the carrier itself is different.

A part of the pre-load tool can be seen inside the axle shaft opening at the top of the carrier.

The nine nuts must be tightened to 35 ft. lbs. It is very easily done if the carrier assembly is held tight in the shop press.

Once the nuts are torqued the bearings are pressed on. When this carrier was knurled the machinist took a .005” cut on the bearing stop to clean it up. Therefore a .005” shim must be installed to take up the space. The shim is shown in place.

The new bearing is then set in place and pressed onto the hub. This photo shows the carrier half opposite from the ring gear. The device used to press the bearing on is hollow inside.

The ring gear carrier half also requires a .005” shim. It is shown in place.

A new bearing is pressed onto the ring gear half of the carrier.

The replacement carrier assembly is shown assembled with the ring gear and a new set of carrier bearings. Part of the pre-load tool is inside. The axles and the spider gears will be installed once the carrier bearing pre-load has been established.

A new bearing is being pressed onto the pinion gear sleeve. An original pinion gear and a reproduction that is correctly made will have two dimensions on the sleeve. The area closest to the gear will be .0015 larger is diameter. This will allow for an interference fit of the bearing. The area where the second bearing will install is .0015 smaller in diameter that will allow for a snug fit of the bearing, but will not be an interference fit. This will allow the bearing to be adjusted for the pinion bearing pre-load.

This is an important factor to be considered when overhauling a rear axle assembly. If a new reproduction ring & pinion gear set is being installed it is prudent to determine if there are two different dimensions on the pinion sleeve. If there are not, you need to have the sleeve machined so that the second bearing is not an interference press fit. If both bearings are an interference press fit, you will have great difficulty setting the pinion bearing pre-load.

Many reproduction ring & pinion gear sets on the market are incorrect in this manner.

The new bearing is shown installed. Once the pinion gear is installed in the banjo race the second bearing will be added.

The old axle housing races have to be removed. The old race is shown in place on one of the axle housings.

The tool shown is a K.R. Wilson axle housing race removal tool.

A K. R. Wilson axle housing race removal tool is shown in place to remove the old race. An impact wrench is used to speed up the process.

An alternate method of removing the race is to place the axle housing on the floor with the wheel bearing hub up. With about a three foot length of 1\2" steel pipe insert it down through the axle housing and catch the edge of the race to be able to drive it out with a hammer. Move the pipe around the circumference of the race and drive it out evenly. Take care to not damage the race stop.

The old race has been removed and the axle housing must be cleaned up before a new race is installed.

This photo shows the back side of the old race removed from one of the axle housings. Note it has the word Bower stamped on it. Bower was the original bearing supplier to Ford during the manufacture of the Model A. Note also the part number A-4222 is the original ford part number. This is a clear indication that the race is the original that was installed at the factory.

The bearings that were removed were made by Timken and had the later Timken part number indicated.

This is often found to be the case. Over the years people have been overhauling rear axle assemblies with half measures. People will change the bearing, but not the race.

The old shackle bushing is being pressed out with a pusher-outer tool.

The pusher-outer tool is shown here. It is made from an old pedal shaft. The same tool is used to press the new shackle bushing into place. The first dimension on the left fits inside the shackle bushing. The second dimension is the same as the outside diameter of the shackle bushing.

A new shackle bushing is pressed into place.

A new shackle bushing has been installed.

The axle housing has been cleaned up. The gasket surface has been wire wheeled to remove any crud and any residual gasket material. A flat file has been run over the gasket surface to remove any burrs. The race stop has been cleaned and inspected for any burs. It is important that both surfaces be clean and flat.

A new race had been set into place and is ready to be pressed in.

A K.R. Wilson axle housing race presser-inner tool is shown here. It will be used to install the race.

The tool is placed down into the axle housing and over the race that is to be installed. The new race is directly under the tool.

At the opposite end of the axle housing the hand crank part of the tool is shown. Tightening the crank handle will seat the race.

A new race is shown installed.

An alternate method of installing an axle housing race is to use the banjo as a platform sitting on the rails of a shop press. The axle housing is slid inside and is resting on the gasket surface of the banjo. This provides a stable platform.

A new axle housing race is set into place.

An old banjo race is used to press the new axle housing race into place.

It is important to check the seating of the axle housing race with a dental mirror. The race must be seated against the stop all the way around its circumference.

A new grease seal must be installed in the outboard end of the axle housing. The new seal is shown on the end of the insertion tool. Apply a liberal coating of grease on the seal before installing it.

The grease seal on the end of the tool is set in place and will be driven into place with the hammer. It usually takes four or five heavy hammer blows to seat the seal. With the axle housing sitting on a concrete floor the hammer blows will have a dull thud sound with each hammer blow. When the seal seats the hammer blows will change to a ringing sound.

By running your finger into the opposite end of the housing you can check that the seal is up against the stop.

The carrier bearing pre-load adjustment procedure is begun by bolting the right axle housing to the right side of the banjo housing without any gaskets. Torque the banjo bolts to 35 ft. lbs. Place two .010 banjo gaskets on the left gasket flange of the banjo. Insert ten alignment studs in the bolt holes.

Remove one alignment stud at a time and replace it with a banjo bolt. Torque all ten bolts to 35 ft. lbs.

Note the left-right markers on the housing elements. It is prudent to place alignment markers as the housing elements are assembled and disassembled several times during the overhaul process and it is easy to get things out of the proper orientation.

The other half of the carrier bearing pre-load measuring tool is seen here. It will insert down through the left axle housing and screw into the tool portion that was previously placed inside the carrier assembly.

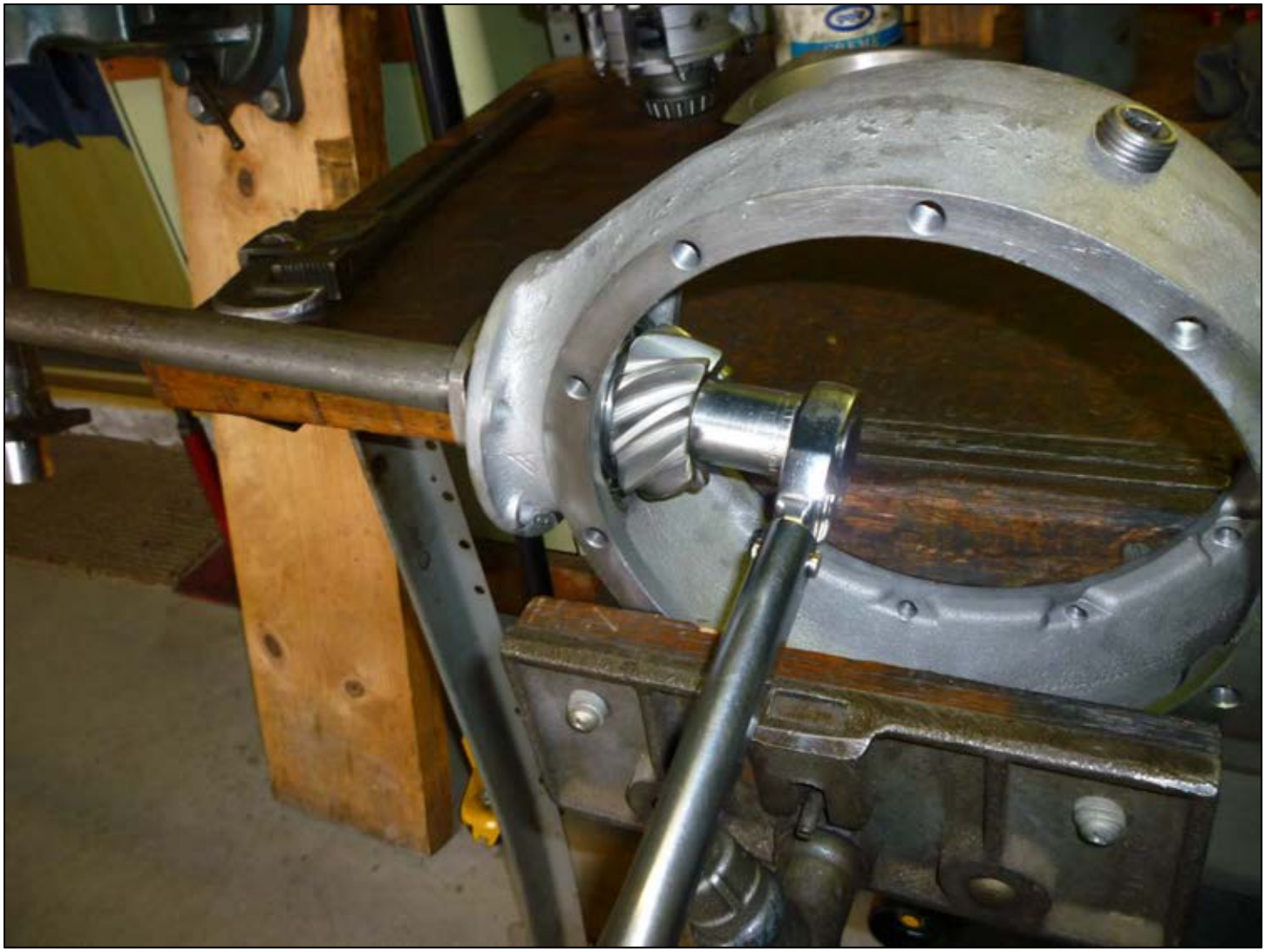
Shown here is the inch pound torque wrench being used to measure the carrier bearing torque value.

The carrier bearing pre-load is measured on an inch-pound dial indicator torque wrench. The nominal desired value is 20 in. lbs.; anything between 14 in. lbs. and 22 in. lbs. is acceptable. The pre-load value is adjusted by adding or subtracting banjo gaskets to the left side. Banjo gaskets are usually .006 and .010 in thickness.

Once the carrier pre-load has been established, disassemble both axle housings from the banjo and set the quantity of gaskets aside. This gasket quantity will be dispersed to the two sides of the banjo on final assembly to establish the back lash.

It is important to have a minimum of at least two .010 banjo gaskets, one for each side, for oil control purposes. If this cannot be achieved, additional shims must be placed under one or both carrier bearings. This will allow for additional gaskets to be added.

The pinion gear assembly is installed into the banjo. The second pinion bearing has been added. The pinion bearing pre-load will be adjusted after the drive shaft has been installed and the nut on the end of the drive shaft torqued to a nominal 100 ft. lbs.



The nut on the end of the drive shaft is being torqued. My method is to initially set my torque wrench to 90 ft. lbs. Then check to see where the cotter pin hole is located. Torque more if necessary to line the hole up. The drive shaft needs to be held with a pipe wrench during the torqueing procedure.

After the nut is torqued, a cotter pin is installed. The legs of the cotter pin are bent down along the side, not over the end; reason being if bent over the end they could contact the rotating carrier.

Ford factory pinion wrenches are used to adjust the pinion bearing pre-load and to tighten the two large nuts on the pinion gear assembly.

When adjusting the pinion bearing pre-load, the first nut is tightened to make the adjustment, the second nut is tightened to lock the first in place. Easily said, but difficult to do: When tightening the second nut it will affect the setting of the first nut. For this reason I set the pre-load at about 10 in. lbs. with the first nut, and then tighten the second nut.

Note the inboard nut is being held by a wrench that is braced against the work bench. The drive shaft is also held with a pipe wrench to prevent it from turning.

It is important that the two nuts be locked tightly together after the pre-load is set. The Ford factory service bulletin recommends hammering the wrench holding the outer nut.

The pre-load is set at a nominal 20 in. lbs. A setting between 14 and 22 is acceptable.

The pre-load can be read from a dial indicator torque wrench placed on the end of the drive shaft. A 1&1\16” six point deep socket will fit the six splines on the end of the drive shaft.

The pre-load is read off the dial while gently rotating the drive shaft.

Once the pre-load is set and the two nuts are tight two of the ears of the locking washer are bent over in opposite directions.

Beware of reproduction locking washers. Some have the ears too long and will scrape on the inside of the torque tube. In this case all the ears have to be bent over.

The carrier, still without the spider gears and the two axles is once more assembled with a trial and error placement of the number of banjo gaskets on each side that was selected during the carrier pre-load adjustment.

In this case the number determined were two .010 gaskets. One was placed on either side and the backlash was determined to be only a few thousands. This is determined by very carefully rotating the drive shaft back and forth and feeling where the teeth on the ring and pinion contact. There should be a slight backlash around the full circumference of the ring gear. There should be no binding.

The next task is to prepare the carrier assembly with the two axles and the spider gears. Shown here is the right axle being held in a vice. The pre-load tool was removed and replaced with the spider gear assembly. The two axles were inserted and the nine carrier bolts torqued to 35 ft. lbs.

The damaged right axle shaft was replaced with serviceable original.

The nuts on the end of the nine carrier bolts are safety wired after torqueing. The nuts are torqued to 35 ft. lbs., then tightened slightly more in order to line up the safety wire holes parallel to the circumference to the carrier.

The completed carrier assembly is installed in the axle housings. The gaskets on both sides are coated with Indian Head sealer. All twenty of the banjo bolts are then torqued to 35 ft. lbs.

The completely assembled rear axle assembly is shown here still sitting in the assembly jig. The torque tube will be installed once the assembly has been removed from the jig and placed back into the rolling cradle.

The next task is to clean up the torque tube and install it onto the rear axle assembly. It is important that the front end of the torque tube where the seal and the roller bearing race (sleeve) installs be thoroughly clean and free of debris. The seal must be installed first. The stop for the seal can be seen inside the front of the torque tube at the bottom. Right above it is the dimple that secures the bearing sleeve.

It is extremely important to remember to install the <u>seal first</u>. If you forget and install the sleeve first, you will have difficulty getting it back out, and will likely destroy it.

The original seal and the sleeve were removed together. I have a seal insertion tool on a long shaft that has the flange turned down to 1& 1\16". By placing the torque tube on a concrete floor (on a newspaper) and with the front end down the shaft is inserted in the other end of the torque tube and the seal and the sleeve are driven out together with a hammer.

An alternate method is to use the drive shaft. Place a 1& 1\16" six point, deep socket over the spline end and use it to drive the seal and the sleeve out.

The new seal is seen on the end of an insertion tool. Grease it liberally. The seal is driven into place with a hammer with the torque tube standing vertical on a concrete floor. It will take about 10 hammer blows to seat it. Each hammer blow will have a dull thud. When the seal seats the hammer blow will have a ringing sound.

The race is installed next. The roller bearing race (sleeve) is split and the material property will cause it to expand. Squeeze it in a vice and put a wrap of safety wire around it. Note the dimple. The dimple will snap into a dimple recess inside the torque tube when properly installed.

The sleeve has been set into place in the top of the torque tube. The torque tube is standing vertical on a concrete floor. Note a slight chalk mark has been placed on the top edge of the sleeve right above the dimple. A chalk mark has also been put on the torque tube right above the dimple recess. Line the two chalk marks up.

Using a large socket (36mm) up-side-down, drive the sleeve into place. The safety wire will exit at the top. It is important that the dimple snaps into the recess. If it does not install properly you will never be able to install the roller bearing. Take a punch and insert it into the dimple through the speedo housing opening and tap it with a hammer to make sure it is seated.

Check that the sleeve is flush against the inner circumference of the torque tube and there are no gaps. The split will also have opened. It is seen located at about the seven o’clock position.

Install the torque tube with a gasket coated on both sides with sealer. Torque the bolts and safety wire them. The torque value is 35 ft. lbs. However, it is difficult to use a torque wrench on this task.

Tighten the bolts tightly with a box wrench. Check to see where the safety wire holes are. Tighten them more to align them parallel to the circumference of the torque tube. If you cannot achieve this, swap the bolts around. I have a box full of original torque tube bolts, so the effort is easier for me.

The assembly is complete; the next task is to paint it. Machined surfaces will be masked of before painting.

After painting the speedo housing is installed. Care must be taken to makes certain the gears are in mesh before installing the bolts; otherwise it can easily crack the speedo housing. The 1&1\16” six point deep socket is used to crank the drive shaft over before the bolts are installed and tightened to make certain the gears are in mesh.

The two grease fittings have also been installed in each end of the axle housings.

Note the threaded stock in the radius rod bolt hole. This is used so the front of the torque tube can be raised up out of the cradle and set on a jack stand for painting.

The rear axle assembly can be rotated 180 degrees and the threaded stock set in the other jack stand at the opposite end. This way the top and the bottom of the assembly can be painted.

The rear axle assembly overhaul is complete and is painted and ready for the customer to pick it up.

The final touch: Don’t forget to put oil in the banjo. Leave the tag in place until you do.