Rear Axle Assembly Rebuild Pictorial 2015

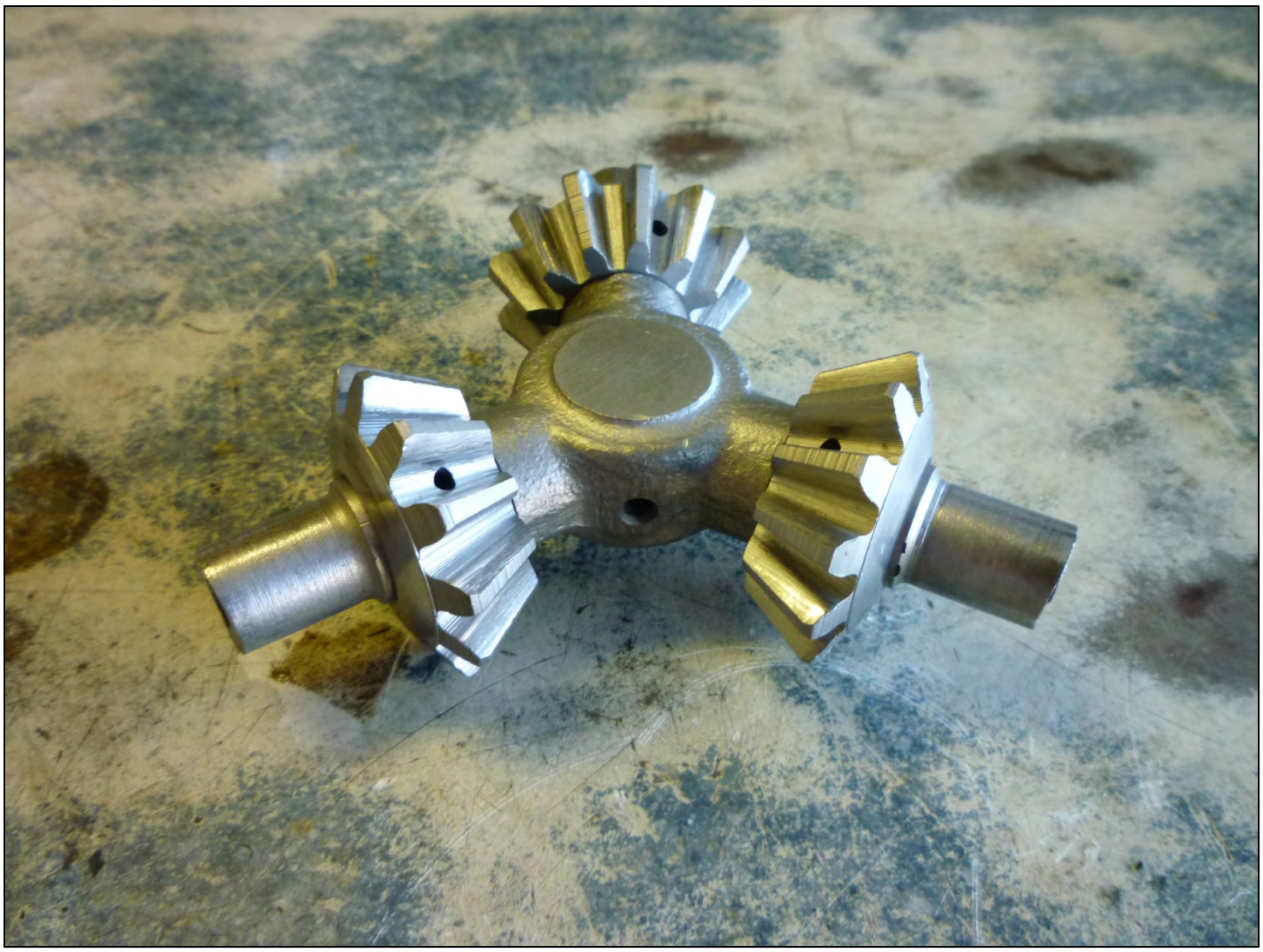
by Tom Endy

The following series of photos were taken during the rebuild of a Model A rear axle assembly.

Bearings, races, seals, gaskets and new shackle bushings are ready for installation in a rear axle assembly rebuild.

The carrier has been cleaned and bead blasted and inspected for any signs of wear. A 411 ring and pinion gear set will be part of this rebuild. The two carrier halves along with the ring gear have been bolted together with a modified spider gear yoke inside to facilitate the pre-load adjustment of the carrier bearings. Two new bearings have been pressed onto the carrier. The two bearings must press on with an interference press fit. The pinion gear has a new rear bearing pressed on.

Another view of the 411 ring and pinion gear set. This is an original Henry Ford gear set. The first pinion bearing should seat with an interference press fit just behind the gear. The second bearing when installed should press on snugly, but not overly tight. On an original pinion gear sleeve there is a difference in diameter of .0015 where the two bearings mount. The reason is to allow the second bearing to be moved fore and aft to achieve the pinion bearing pre-load adjustment.



The spider gear assembly has been cleaned, inspected, and bead blasted. This particular set is a 1931 gear assembly with oil holes drilled into the three spider gears. The three spider gears normally turn loosely on the shafts. This spider gear assembly will be set aside until final assembly when it will be installed.

The modified spider yoke that was installed in the carrier to measure the pre-load has a hole bored through the center and is threaded to accept a long threaded rod. By turning the rod with a dial indicator torque wrench the pre-load vale (nominal 20 in. lbs.) can be read from the dial. The three spider gears are left off for this procedure.

The miscellaneous hardware for the front of the torque tube has been cleaned and bead blasted along with the hardware for the pinion gear sleeve.

Note the flat thrust washer on the right with the holes around the circumference. This washer is positioned between the roller bearing and the speedo drive gear. The purpose is to allow grease pumped into the U-joint housing to reach the roller bearing.

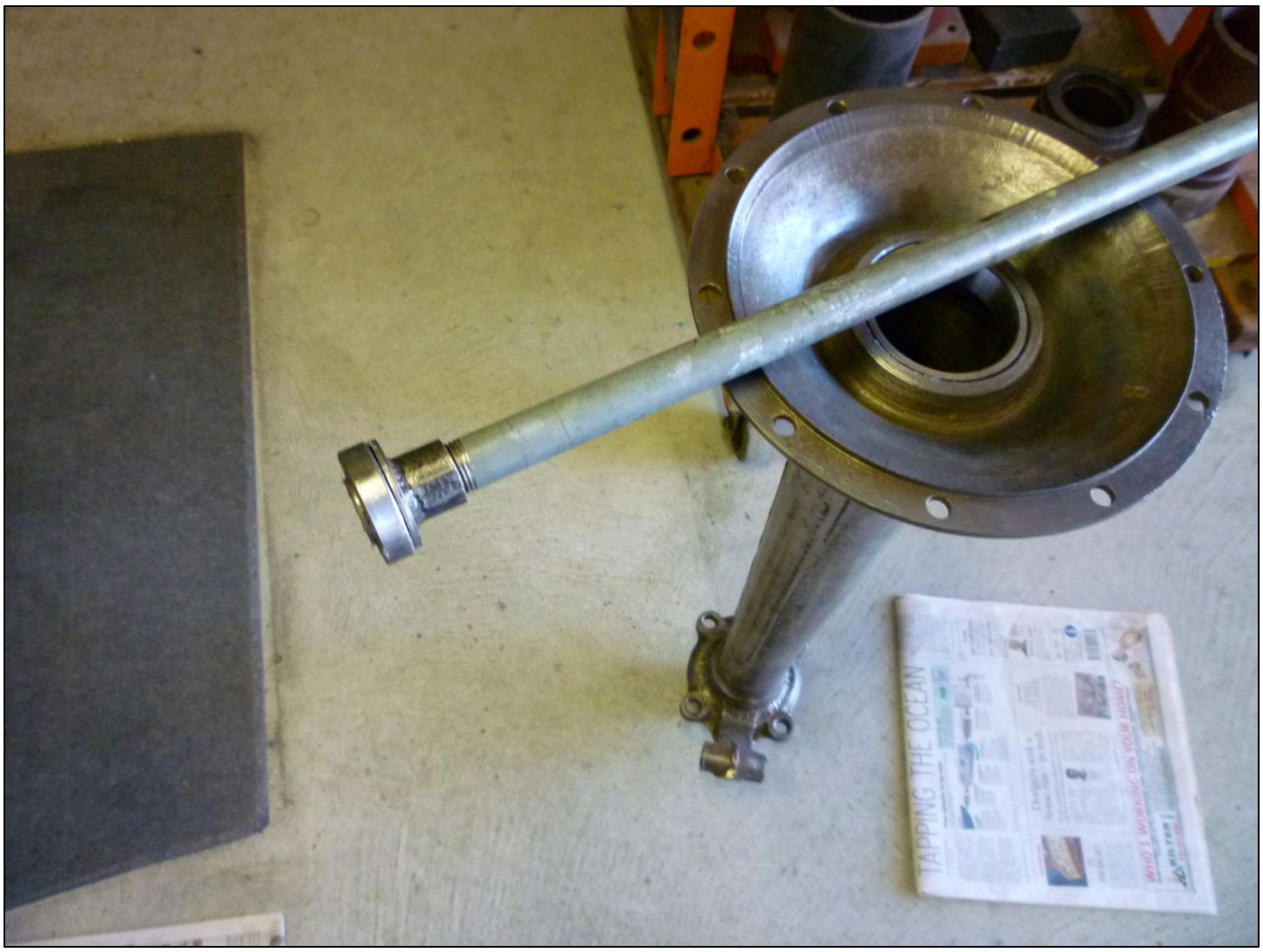
A new grease seal will be installed in the neck of the torque tube just behind the roller bearing and race sleeve to prevent grease from migrating down the drive shaft.

The banjo has been cleaned, bead blasted, inspected, and painted. All the thread holes have been inspected and cleaned with a small wire brush mounted in a drill motor. A new double bearing race has been pressed into place.

Care should be taken when installing this race. Do not set the back side of the banjo on a press platform as it will likely distort the shape of the banjo as the race is pressed in. Support the inside of the banjo where the race stop is by hanging it over a rail on the press platform and placing the old removed race under for support.

Both axle housings have been cleaned, wire wheeled, and the exterior sanded. The old bearing race has been removed and is ready for the installation of a new race.

A new bearing race has been pressed into place. It is important that the race is seated properly. A small mirror should be used to determine that the race is firmly seated against the stop all the way around. The new race may be installed using a shop press or a K. R. Wilson tool.



A new grease seal is hammered into place using a long insertion tool. The area where the seal will seat must be thoroughly cleaned before the seal is hammered into place. The seal is shown positioned onto the end of the insertion tool.

The grease seal is hammered into place by standing the axle housing upright and using a long insertion tool. It takes about 4 to 5 hammer blows to seat the seal into place. When the seal seats the hammer blow sound will change from a dull thud to a ringing sound. Check that the seal is fully seated by running your finger around the circumference at the other end of the housing.

This photo shows the two axle housings, the banjo, the pinion gear, and the carrier ready for assembly for a trial and error effort to determine the carrier pre-load. Both axle housings have new races and seals installed. The carrier assembly has new bearings installed and the modified spider yoke tool installed. The axle housings have been wire wheeled and sanded down. New shackle bushings have also been installed.

Before beginning assembly it is suggested that the two axle housings and the banjo have left-right markers placed to indicate the proper mating. Since the assembly will be taken apart several times it is easy to assemble the housings to the wrong orientation.

Note that this assembly is a hybrid, in that the banjo is from a 1931 vintage car that has offset fill and drain holes. The two axle housings are from a 1928 vintage car that has the axle weld seams oriented along the length and face forward on the car. All Model A rear axle housings are functionally interchangeable, the only consideration being the Judging Standards for a show car.

The right axle housing is shown mounted into the vertical work stand. The banjo has been bolted to the right axle housing with the ten banjo bolts and torqued to 35 ft. lbs. There are no gaskets between the banjo and the right axle housing. The carrier assembly, minus spider gears and the two axles is set down into the right axle housing with the flat side of the ring gear facing up.

When the left axle housing is bolted into place, also without any gaskets, the ability to lock up the ring gear should be noted. As the ten banjo bolts are pulled down on the left axle housing reach in through the opening where the pinion assembly installs and turn the ring gear with your fingers. The ring gear should lock up before the 35 ft. lbs. of torque is reached.

If the ring gear does not lock up the assembly will have to be taken apart, one or more of the carrier bearings removed, and shims placed under either or both of the bearings. This will increase the width of the carrier assembly and provide the means to lock up the ring gear. There must be an ability to lock up the ring gear with no gaskets installed before proceeding with the preload adjustment, which will be accomplished by adding banjo gaskets.

The left axle housing is installed and the ten banjo bolts were pulled down snug while turning the ring gear by finger until the ring gear locked up. On this particular rebuild the ring gear did lock up when all the bolts were torqued down.

The next step was to install two paper .010 paper gaskets to the left side of the banjo. Short threaded studs are used to properly align the holes in the gaskets with the holes in the banjo. Two .010 gaskets are the minimum that should be used to create a good oil seal.

The left axle housing is re-installed and the threaded studs are replaces with banjo bolts one at a time. When the ten bolts were installed and torqued down the ring gear could be freely turned through the pinion assembly opening. This is an indication that a pre-load adjustment cannot be achieved. The left axle housing had to once again be removed and both bearings on the carrier had to be removed and shims installed under each.

The left carrier bearing is being removed from the carrier hub using a specially made tool that will grip the underside of the bearing and remove it without damaging the skirt.

The carrier assembly is placed on a press with a .005 metal shim installed on the bearing hub on the left side of the carrier. Shims can be purchased from Bratton's. Each is .005 thick. Shims can be stacked if additional shimming is needed.

The carrier bearing for the left side is pressed back onto the hub with a .005 metal shim under it.

The carrier bearing on the right side is removed using the same special bearing removal tool.

The carrier is placed back on the press and a .005 metal shim installed under the bearing.

The carrier bearing for the right side is pressed back on with a .005 metal shim under it. The carrier is then installed back into the banjo and the right axle housing as before. The left axle housing is reinstalled with the same two .010 paper banjo gaskets.

When all was back together the ring gears was again rotated by finger and it was found that the ring gear by feel was hard to rotate which indicated it had too much pre-load on it.

The left axle housing was once again removed and a .006 paper banjo gasket was added to the two .010 paper banjo gaskets.

The left axle housing was once again reinstalled and torqued down. The ring gear was rotated by finger and this time the pre-load by feel seemed to be reasonably close to the desired 20 in. lbs.

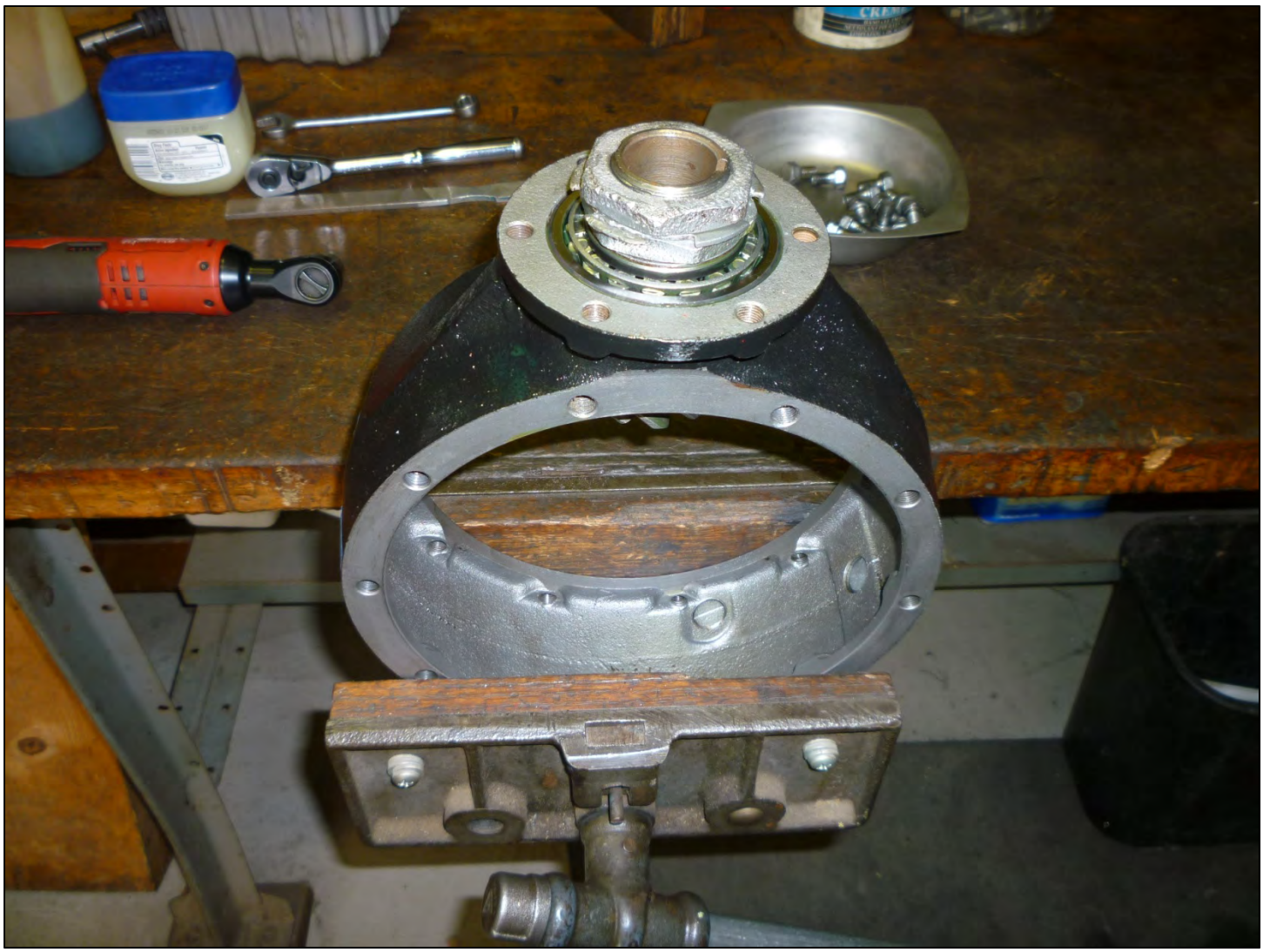
The pre-load measuring tool was installed and the pre-load was checked with a dial indicator inch-pound torque wrench.

The reading was almost dead on 20 in. lbs. The reading should be taken as the wrench is slowly rotated. When the rotation is first initiated the bearings have to overcome inertia so the reading will be initially high. As the wrench is slowly rotated the reading will drop and settle and indicate the true pre-load. There will be some amount of slight fluxuation. A reading from 16 to 22 in lbs. is acceptable.

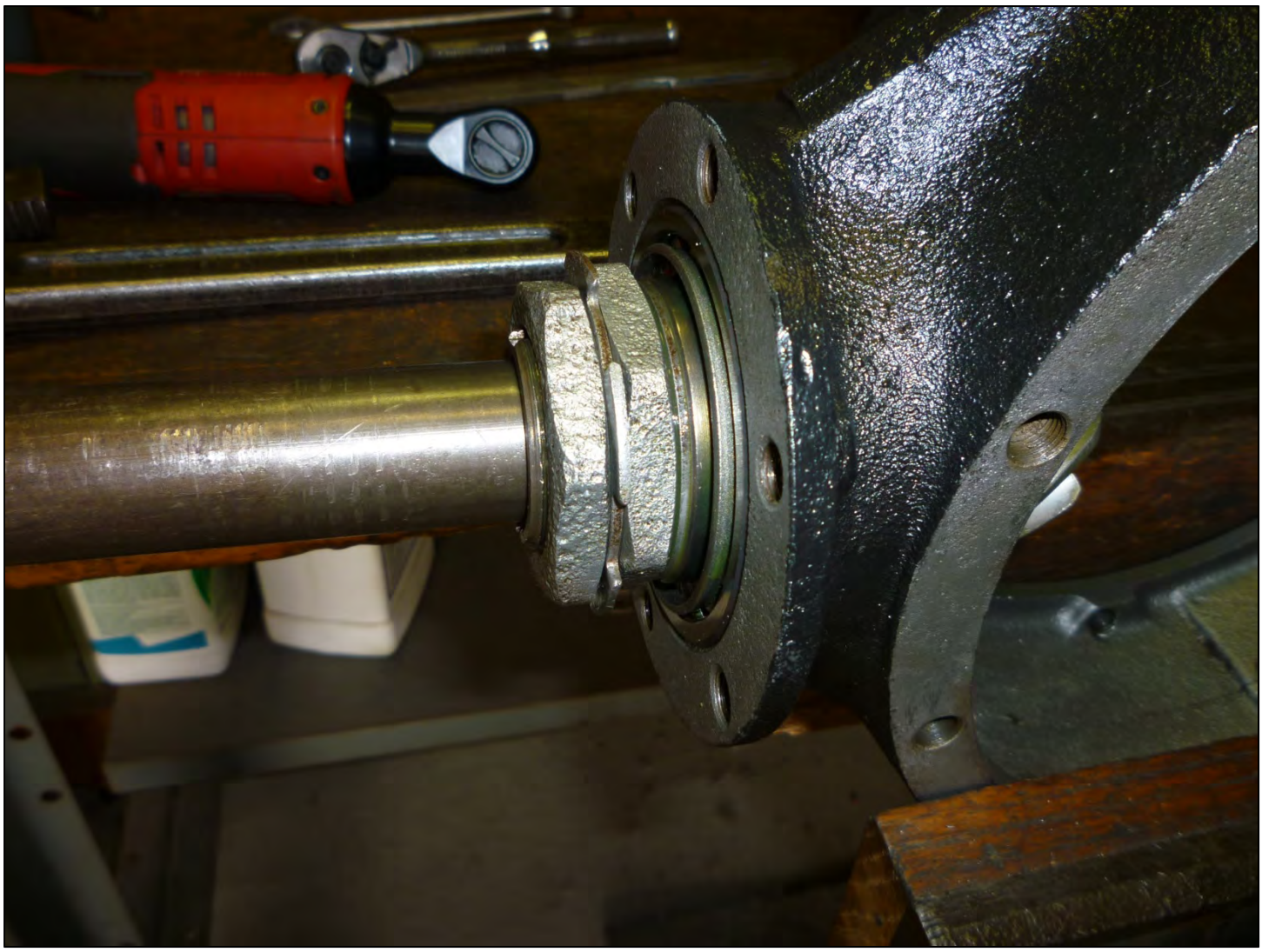
With an acceptable pre-load established the assembly is disassemble. Both axle housings are removed from the banjo and the carrier is set aside. The three banjo gaskets are also set aside. These gaskets will eventually be installed to both sides of the banjo during final assemble. The back lash on the ring and pinion gears will be determined by the number of gaskets on either side of the banjo. In this case only the .006 banjo gasket can me moved in order to maintain an oil seal. If the back lash cannot be established with the movement of this single gasket, the two shims under the carrier bearings may have to be moved to either side.

The next effort is to install the pinion gear assembly in the banjo and set the pre-load on the two pinion bearings.

In the photo the pinion gear assembly is ready to install in the banjo. It is best to use an original locking washer as some of the reproductions are made incorrectly and they will rub the inside of the torque tube and create noise unless all the ears are bent over. Flatten it out under a press and reuse it.



The pinion assembly has been installed. The second pinion bearing installed with ease and has the ability to move back and forth with little effort to facilitate the pre-load adjustment. The next step will be to rotate the banjo in the vice to a horizontal position for the installation of the drive shaft and torqueing of the shaft nut down to a nominal 100 ft. lbs. before attempting to set the pre-load on the pinion bearings.



With the banjo in a horizontal position in a wood vice the drive shaft with locking key is inserted into the pinion gear sleeve. I always coat the taper on the drive shaft with anti-seize compound. Note that the two pinion nuts show signs of severe pitting from rust. This is acceptable as long as the flat mating surfaces are smooth. They should also be lubricated during assembly. Quite often you find chisel marks on these nuts where a mechanic of yester year adjusted the pinion bearing pre-load with a hammer and a chisel instead of using the proper wrenches. Both of these nuts have been bead blasted to remove all the rust.

The nut on the end of the drive shaft is torqued to a nominal 100 ft. lbs. My procedure is to set the torque wrench to 90 ft. lbs., tighten and then look to see where the cotter pin hole is. I then tighten more until the hole is in a window of the castle nut. The end torque value will be between 90 and 120 ft. lbs.

The cotter pin is installed as shown with the two cotter legs bent down alongside the nut. Do not bend it over the end of the drive shaft as it may contact the rotating carrier. Care should be taken when installing a cotter pin so that it has a low profile and does not interfere with the gears.

Quite often the cotter pin cannot be inserted through the hole in the drive shaft because a mechanic of yester year hammered on the end of the dive shaft in an attempt to remove it and made the hole oblong. When encountering this situation I carefully run a drill bit of the proper size through the hole.

The next step is to adjust the proper pre-load on the two pinion bearings. The pre-load should be set to the same value as the carrier bearings, a nominal 20 ft. lbs. The photos show Ford factory wrenches being used to turn the two nuts. The wrench on the left is locked against the bottom of the work bench. The wrench on right is turned by hand to tighten. The other hand is used to hold the drive shaft stationary with a pipe wrench.

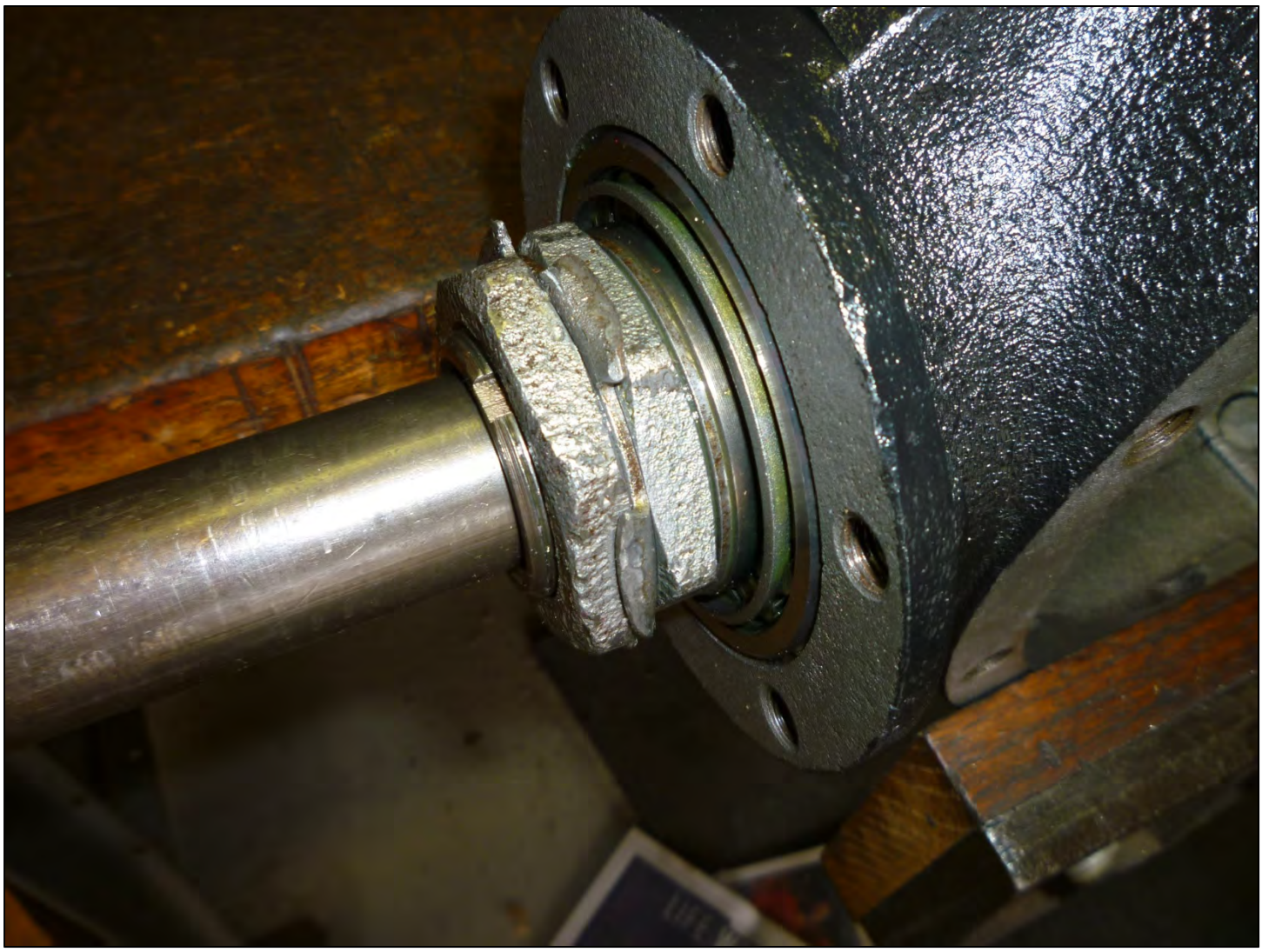
Most literature instructs to tighten the first nut such to obtain the 20 in. lbs. of pre-load and then tighten the second nut down to lock the first in place.

It does not work quite like that. If you tighten the first nut down to the full pre-load, when the second nut is tightened it will increase the pre-load past the desired value. My method is to adjust to about half the pre-load, then tighten the second nut down.

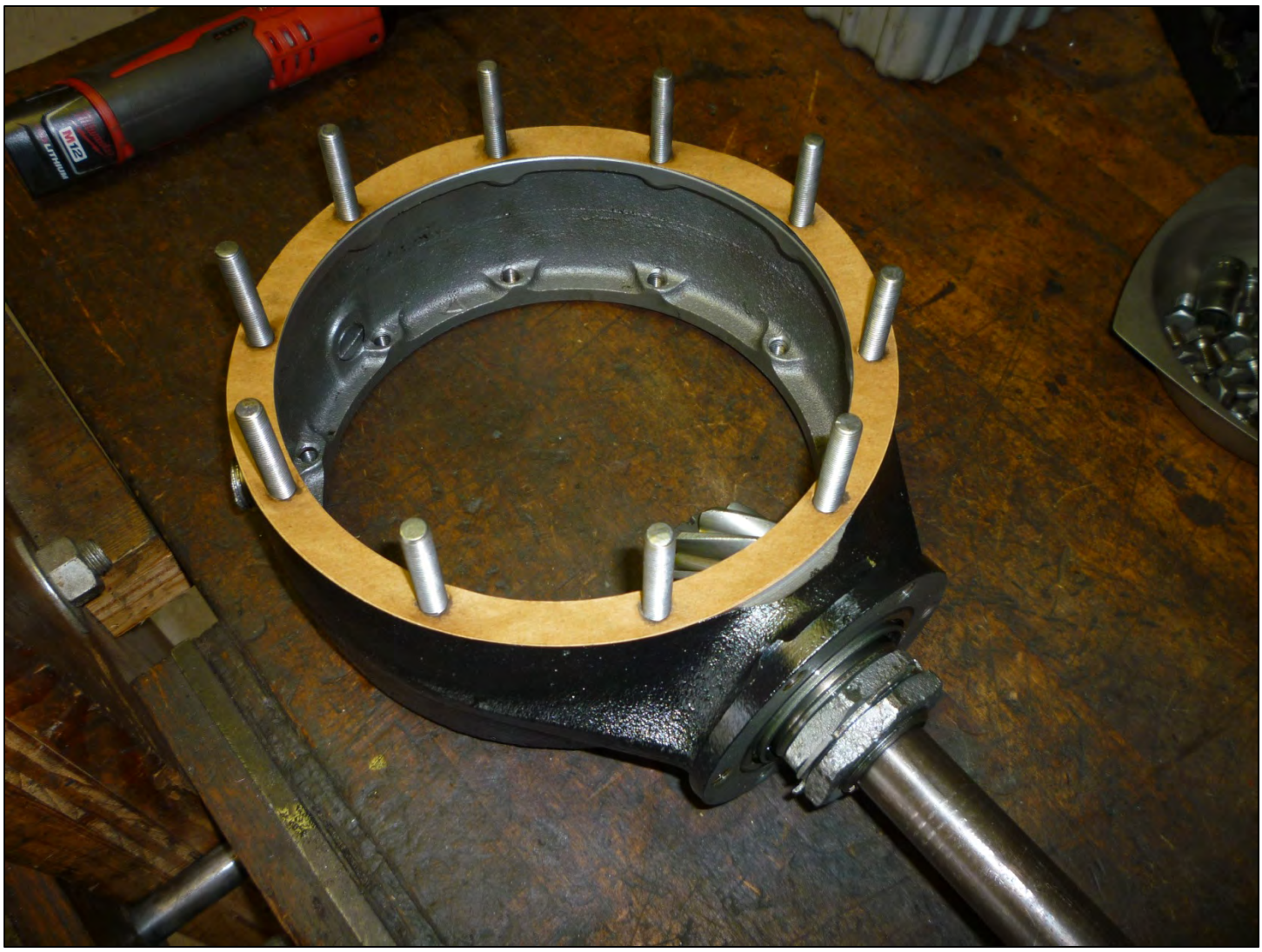
The end result is you want the pre-load set to the proper value and both nuts extremely tight. Ford recommends you actually hammer on the Ford factory wrenches to get them extremely tight. This is a tedious and time consuming task, but it must be done correctly.

The pinion pre-load is read from a dial indicator inch pound torque wrench. A one and a sixteenth inch six point deep socket will fit directly onto the spline end of a Model A drive shaft. The photo shows the socket in place and being turned with the dial indicator torque wrench.

When making the pinion pre-load adjustment it is often necessary to loosen the two nuts and start over again. For this reason the back, or second pinion bearing, must have the ability to be repositioned with little effort. If it is on with a press fit it makes the task difficult if not impossible. This is the reason original pinion gear sleeves have two dimensions on the sleeve with a difference of .0015. Not all reproduction pinion gears sleeves are machined correctly. Some have the sleeve machined to one dimension (a press fit for both). These will definitely cause you grief.



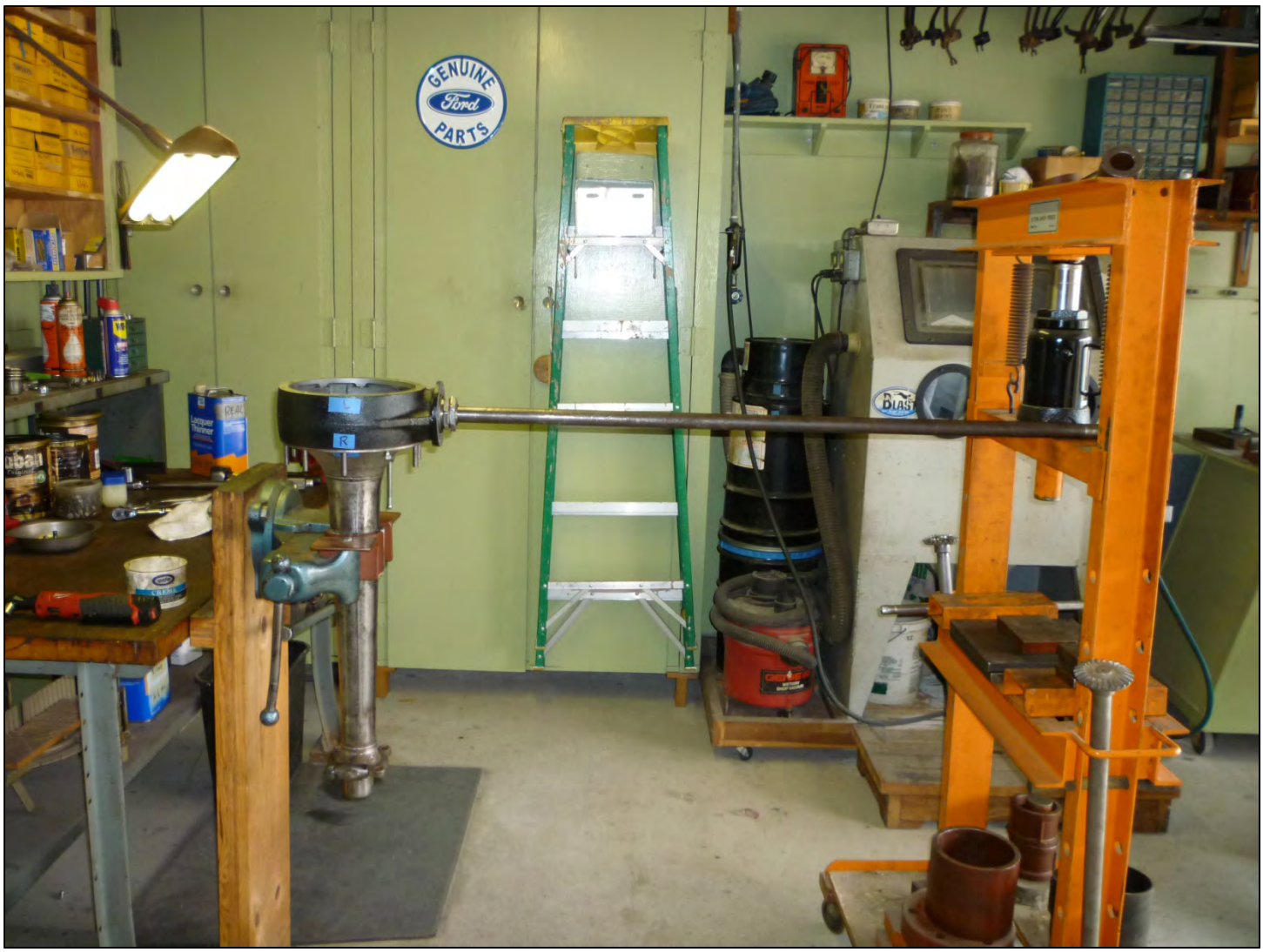
Once the pre-load adjustment has been achieved and both nuts are tight against each other two of the locking washer ears are bent over to lock the nuts in place. One is bent forward, the other is bent aft. The photo shows the two ears bend over.



The next step is to establish the backlash by reassembling both axle housings onto the banjo with an educated guess as to which side to install the previously selected banjo gaskets.

In this particular rebuild it was determined that carrier pre-load was established by installing a .005 metal shim under each carrier bearing and adding two .010 gaskets and one .006 gasket to the left side of the banjo.

The photo shows gaskets being installed on the right side of the banjo using the threaded studs. One .010 and one .006 gasket was installed. Since in this case the only choice was which side of the banjo the .006 gasket would be installed on, the choice was to install it on the right side to minimize the backlash.



The banjo with the drive shaft and pinion gear assembly installed it set on top of the right axle housing with the front end supported by a shop press.

The banjo is set down onto the right axle housing. A banjo bolt is installed as each threaded stud is removed. When all the bolts are installed they are torqued down to 35 ft. lbs. The two gaskets (.010 and .006) are also installed.

The carrier assembly is set down into the right axle housing and the banjo with the flat side of the ring gear up as before. The other .010 banjo gasket is installed onto the left side of the banjo using the threaded studs.

The left axle housing is set down onto the left side of the banjo with the single .010 gasket installed. A banjo bolt is installed as each threaded stud is removed. When all the bolts are installed they are torqued down to 35 ft. lbs.

With the quantity of the selected gaskets installed on both sides of the banjo for a trial and error effort, and all 20 banjo bolts torqued down to 35 ft. lbs., the backlash can be detected. Grasp the drive shaft by hand and very slowly rotate it in both directions to feel the distance where a pinion tooth contacts one side of a ring gear tooth and then the other side. It should be very small, only a few thousandths. It is important to have some amount of backlash, but not too much. How much is too much? I don't know, it depends on who is telling the story. I would think more than .010 may be too much.

In the case of this rebuild, if there was too little backlash, the .006 gasket would be moved from the right side of the banjo to the left side, which would increase the backlash. However, in this case the backlash was very little, only a few thousandths.

The next step it to rotate the drive shaft to accomplish the 360 degree rotation of the ring gear, stopping periodically to check and ensure the backlash is consistent throughout the rotation and there is not binding. If there is any binding it has to be investigated.

This completes all three adjustments. The next step is final assembly.

With both the carrier and pinion pre-loads determined and the backlash determined, the next effort is to prepare for the final assembly. The axle housings are once more disassembled.

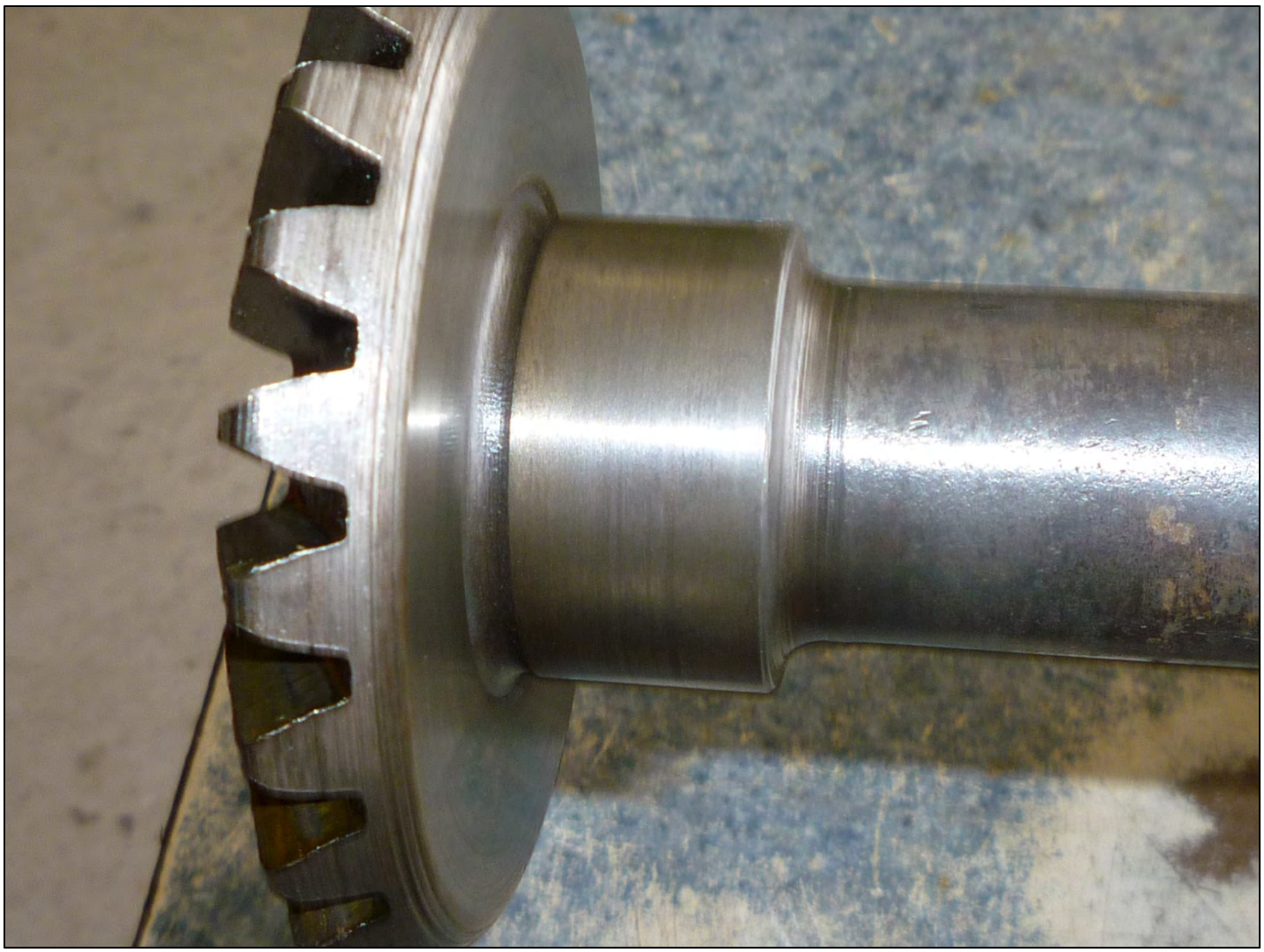
The two axle shafts are cleaned and inspected. Particular attention should be paid to the key slot and the threads. The gear end is not critical as long as teeth are not broken off or hopelessly pitted by heavy rust.

The gear on the end of the axle shaft mates with the three spider gears and sees little wear as there is minimal rotation of the gears.

When a Model A is rolling straight down the road there is no movement of the gears. They are stationary as the axles and the carrier rotate. When the car is turned to the left or to the right there is then rotation of the gears. That is why it is called a differential.

The key slot should be inspected for a crack at the inboard end. A crack will usually start in this area and eventually work its way around the circumference of the axle shaft, and then break off. The key slot should also be inspected for wallowing. This is caused when the axle nut was not torqued down to a nominal 100 ft. lbs. This allows movement of the brake drum against the locking key and in time will wallow out the slot. Some repair can be made by placing the axle on an anvil and with a heavy hammer pound the edges of the key slot back. An axle shaft with an excessively wallowed key slot should be discarded in favor of a better one.

Check the threads carefully. If they appear somewhat compromised a dye can be run over them. However, excessively damaged threads are cause for rejection of the axle shaft.



The axle shaft should be wire wheeled or bead blasted if rusted. The gear end of the axle shaft should be in good shape where it rides inside the carrier.

With the two axle shafts ready for installation, the carrier is taken apart and the spider gear yoke modified as a tool removed and replaced with the complete spider gear assembly that was previously cleaned up.

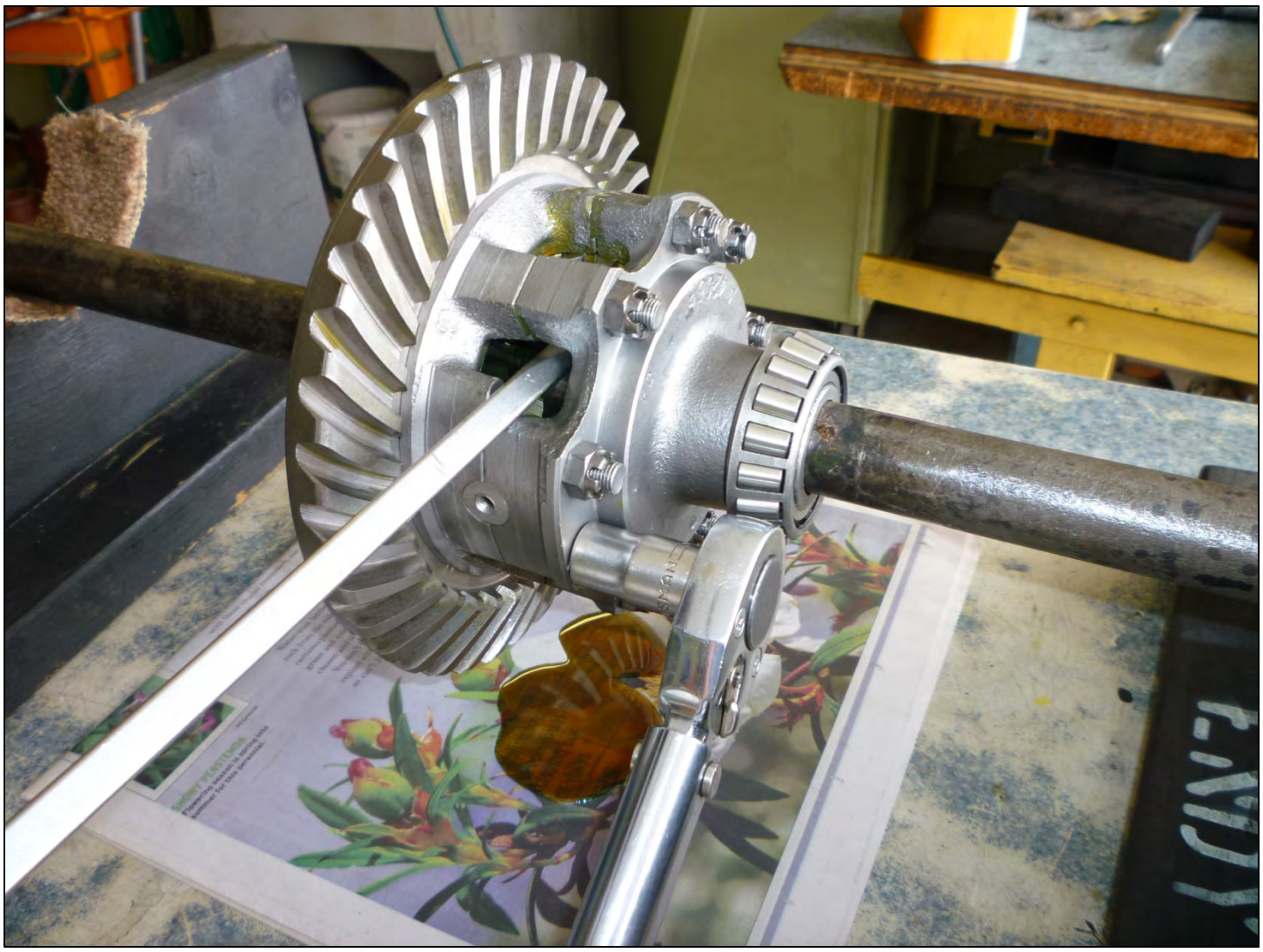
In the photo the left axle shaft is shown inserted into the ring gear side of the carrier. The spider gear assembly is placed on top. The right axle shaft will be inserted into the right carrier halve shown sitting on the workbench. The hardware is liberally coated with 600W oil during the assembly.

Axle shafts are interchangeable so either axle shaft can be a left or a right.

The right carrier half has been installed and the castle nuts installed and snugged down enough to hold the assembly together. Note the two carrier half assembly marks in red. These were placed thee before disassembly. The back side of the three spider gears rides against the inside of the carrier and cause three wear patterns. It is best to line up the wear patterns as before. In some instances the wear patterns are severe and the carrier should be discarded in favor of a better one.

The assembly is them removed from the bench vice and moved to a horizontal cradle.

With the axle assembly in the horizontal cradle the nine carrier bolt and nuts will be torqued to 35 ft. lbs. before doing that rotate each of the bolts so that the wide part of the rectangular bolt head is perpendicular to the carrier hub. This will align the safety wire holes in the bolt with the carrier. Use a 5\8” open end wrench to hold the head in place while the nut is tightened.



A long screwdriver inserted into the openings of the carrier is used to hold the carrier from rotating while the nuts are torqued down.

After each nut is torqued note where the safety wire hole is located in each castle nut. If the hole is not in a window, tighten the nut more to bring it into a window.

Before applying the safety wire grasp each axle up close to the bearings and rotate the axles by hand in opposite directions. There should be no binding.

Some reproduction axle shafts are not made correctly and will bind the inside of the carrier. These should not be used.

With all the nuts torqued down and each hole in a window safety wire the assembly. My technique is to form the safety wire in a perfect circle, overlap the wire by passing it through a bolt hole in opposite direction and twisting it as shown. It may not be according to Henry, but it looks very neat and is my Hallmark.

This completes the assembly of the axle and carrier assembly and it is ready to be installed in a final assembly into the axle housings.

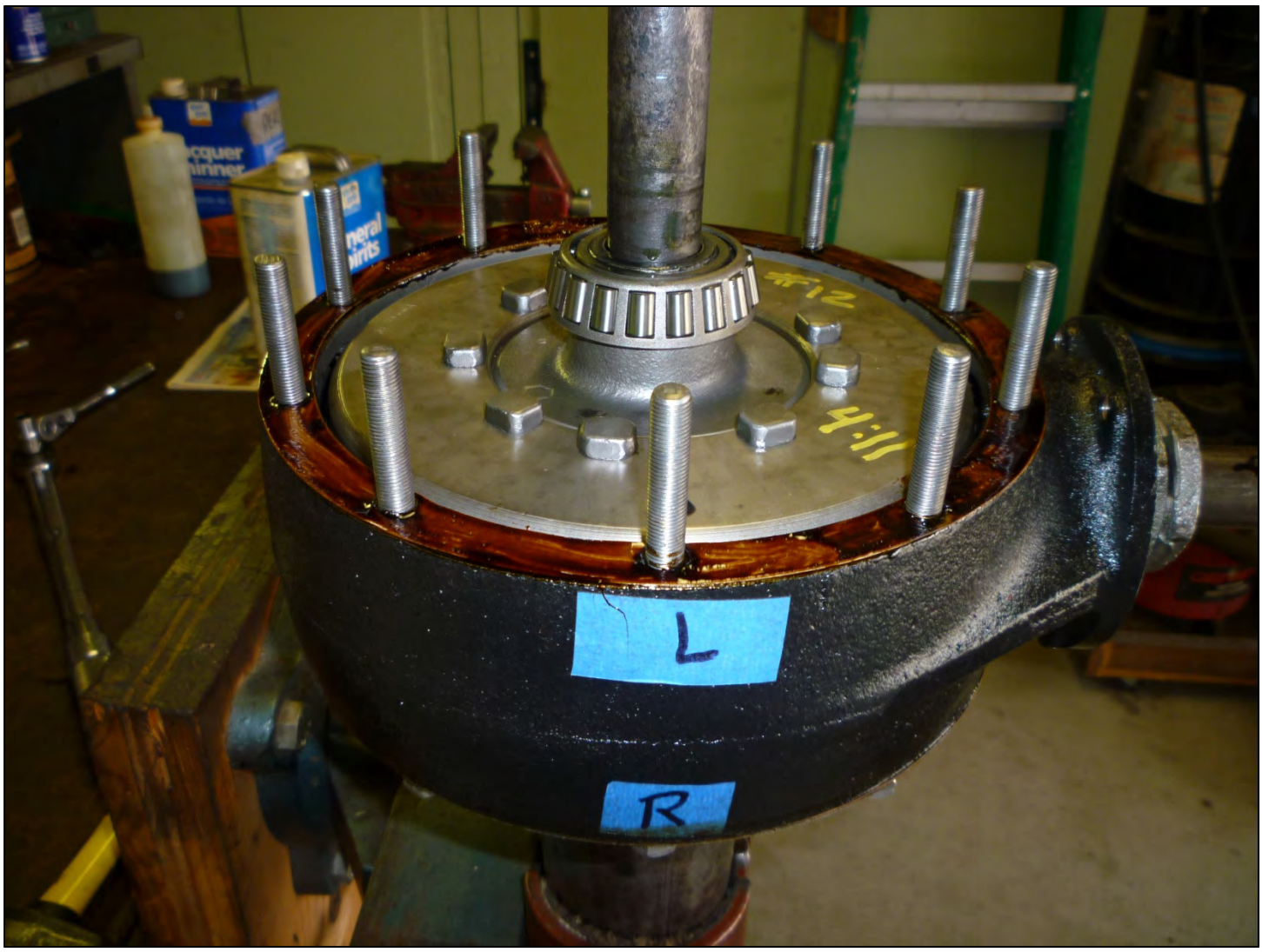
The next step is to do the final assembly with all the hardware installed. The photo shows the right side of the banjo with the two gaskets coated with Indian Head gasket sealer. Both sides of each gasket are coated. The threaded studs are used to align the gaskets with all the bolt holes.

Indian Head sealer is good to use in this application. It will get into the threads of the banjo and form an oil seal. Most of it will squeeze out when the banjo bolts are torqued, but it will form a good seal and will not affect gasket thickness and the pre-load previously established.

It should be noted that the integrity of the three housing is not provided by the banjo bolts, they merely hold the assembly together. The integrity is established when the ribs machined inside each axle housing flange is tightly mated inside the inside edge of the banjo on each side.

The banjo with the drive shaft and pinion assembly installed is bolted to the right axle housing as before.

As each threaded stud is removed from the right side of the banjo a banjo bolt is installed. When all the bolts are in place they are torqued down to 35 ft. lbs.



The fully assembled carrier with the spider gears with both axles installed is lowered down into the banjo. The flat side of the ring gear faces up as before. The banjo gasket is installed on the left side of the banjo. Both sides of the gasket are coated with Indian Head gasket sealer. The threaded studs are again used to align all the banjo bolt holes.

It should be noted that the carrier assembly with the two axles can be installed from either the right or left side. The correct position is to have the ring gear on the left side of the pinion gear. It is possible to install the assembly so that the ring gear is on the right side of the pinion gear.

The rear axle assembly when installed in the car with the ring gear on the wrong side will function when the car is all back together, however, there will be one speed forward and three speeds in reverse.

The left axle housing is placed over the left side of the banjo. A banjo bolt is installed as each threaded stud is removed. When all the bolts are installed they are torqued down to 35 ft. lbs.

The rear axle assembly is shown fully assembled. The next step is to remove it from the vertical work stand and place it in a horizontal rolling cradle. An electric hoist positioned directly above will lift it out with ease.

This photo shows the rear axle assembly being lifted out of the vertical work stand and into the rolling horizontal cradle. Note the hoist cable is attached to the end of the left axle housing.

Note that threaded sleeves are installed on the threaded ends of each axle to protect them when the assembly is in the horizontal cradle.

This photo shows the threaded sleeve installed on the threaded end of the axle to protect the threads. The eye bolt was temporarily attached to the left axle housing to hook the hoist cable to.

The completed axle assembly is shown horizontal roll around cradle. The next step is to install the torque tube. That task will be accomplished with the assembly in the horizontal cradle.

This photo shows the rear view of the axle assembly in the horizontal roll around cradle. Note the U-shape portion directly under the banjo. This allows the cradle to be used for removal and installation of the rear axle assembly in a car. The U-shape allows a floor jack to be positioned directly under the banjo.

The assembly is ready for installation of the torque tube.

The torque tube has been cleaned up. The old seal and the roller bearing race have been removed. The exterior of the housing has been sanded down.

A new grease seal is installed into the front of the torque tube before the roller bearing race is installed. A short seal insertion tool is used. The seal is the same part number as the two seals that were installed in the axle housing.

The torque tube is stood up vertically and the seal is driven in with a hammer. It takes about 4 to 5 hammer blows to seat the seal. When the seal seats the hammer blows will change from a dull thud to a ringing sound.

It is important that the seal be installed before the bearing race is installed. If the race is accidently installed first you will have a difficult time removing it and will likely destroy it in the process.

It is best to use an original race if possible. Many of the reproductions on the market are of very poor quality. The one Bratton's sell is of good quality.

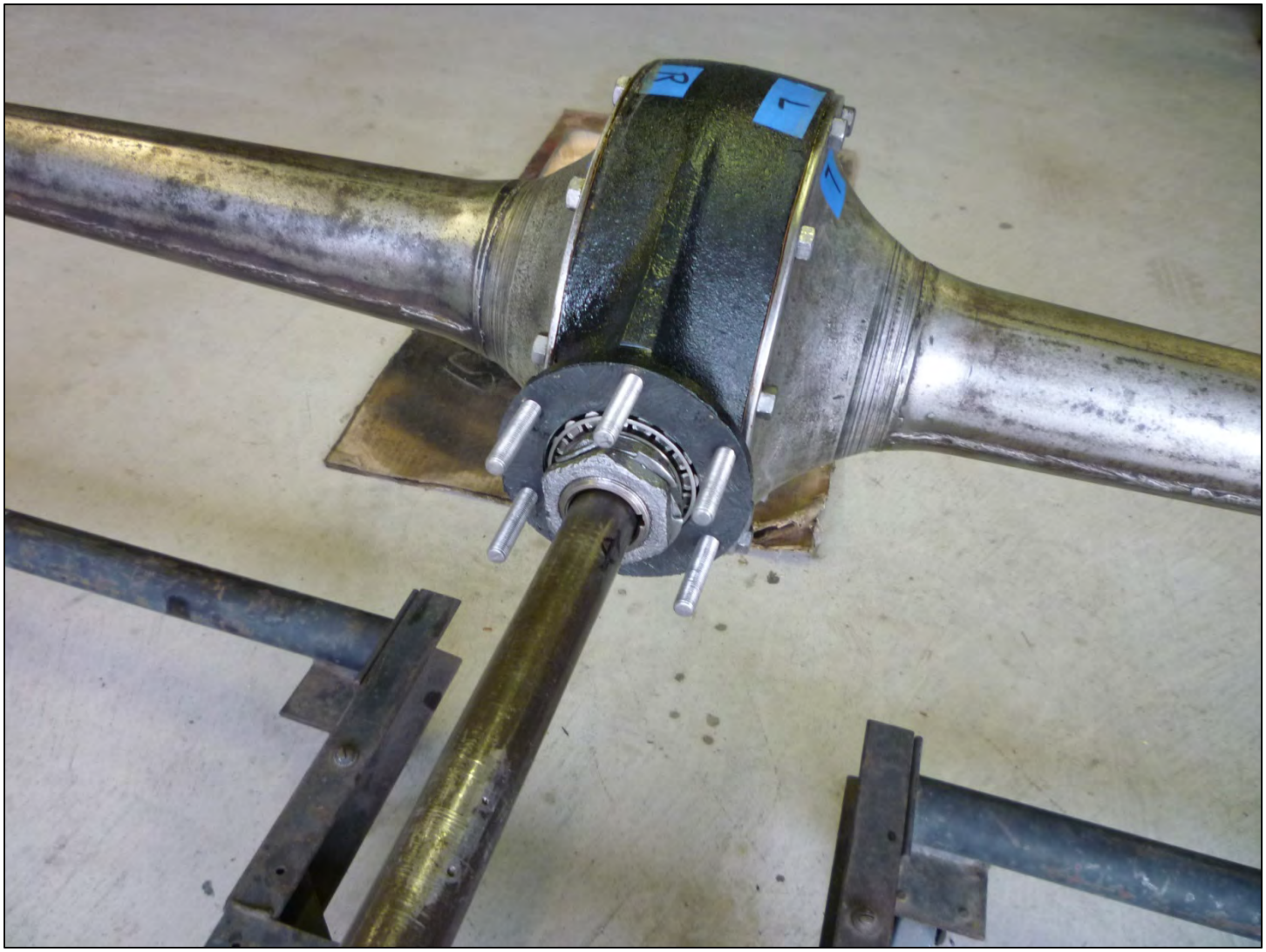
The roller bearing race (sometimes referred to as a sleeve) is prepared prior to installation in the front of the torque tube. The race has a split it in that expands when outside the torque tube. It must be compressed slightly for installation; the race is placed in a vice and squeezed slightly. A piece of wire is wrapped around the top to hold it slightly squeezed.

A chalk mark is placed at the top edge of the sleeve right above the dimple. Another chalk mark is placed on the torque tube directly above the recess where the dimple fits into. The two chalk marks are aligned before the sleeve is driven into place.

The sleeve is driven into place with the flat side of a large socket (this one is a 36mm). As the sleeve is driven into place the wire wrap previously installed will exit the top of the sleeve and is removed.

It is important that the sleeve is properly seated or it will not be possible to install the roller bearing once the torque tube is installed. Examine the sleeve installation carefully. The sleeve should have expanded and be tight around the 360 degree circumference. If it is not, it is not fully seated. If it is only slightly hanging up at the dimple take a punch and insert it through the opening for the speedometer drive and place it in the dimple and give a sharp smack with a hammer.

If this does not properly seat it, it will have to be removed by driving the grease seal and the sleeve out together. The process will have to be started over again.



The torque tube is ready for installation. A gasket is coated with sealer and placed on the flange of the banjo. Six of the threaded studs are used to align all the holes. The torque tube is then slid over it and bolted down.

The bolts are torqued to a nominal 35 ft. lbs. and safety wired. This completes the full assembly of the rear axle assembly. The assembly is ready for painting. According to Ford documentation all the bolt heads and the safety wire are painted black enamel along with the housings.

The rear axle assembly is readied for painting. Machined surfaces are masked off. This photo shows the bell on the front of the torque tube masked off. A rolled up piece of newspaper was inserted around the drive shaft a few inches to prevent paint from entering through the boss for the speedometer drive gear housing.

Each end of the axle housings were masked off where the backing plates attach. Pieces of paper towel were pushed into the shackle bushing to prevent paint from entering.

Since this axle housing is going into a modified car, the shock arm perches on both axles had been previously sawed off. During the rebuild a grinder was used to smooth the area.

This photo shows the rear axle assembly being painted. Note the assembly is up-side-down in the roll around horizontal jig. This allows the complete bottom to be painted. The front of the torque tube is being supported on a jack stand under the drop cloth by a threaded rod attached to the radius rod bolt boss.

The top of the assembly is painted by rotating the torque tube 180 degrees and resting the threaded rod on another jack stand under the drop cloth at the lower right of the photo.

The assembly was painted using a spray can of Rustoleum, professional grade paint, black enamel.

The project is finished. The speedometer drive gear assembly has been installed along with both axle housing grease fittings.

One final step is to attach a tag to the assembly that reads; “no oil in banjo”. The tag should be left in place until the banjo is oil serviced.

These are some of the tools used in the process of rebuilding the rear axle assembly. From left to right is a brush on a long rod that can be clamped in a drill motor and used to clean out the area at the end of the axle housing where a new grease seal will be installed. The next tool is a grease seal insertion tool used to drive new seals into the axle housings. The next tool is used to measure the carrier pre-load. The long rod is inserted down through the left axle housing and screws into the modified spider yoke. When rotated with an inch-pound dial indicator torque wrench it will read out the pre-load value. The next tool is a K. R. Wilson tool that presses in the new axle housing bearing races. The last tool is used to drive out the old grease seal and roller bearing race in the front end of the torque.