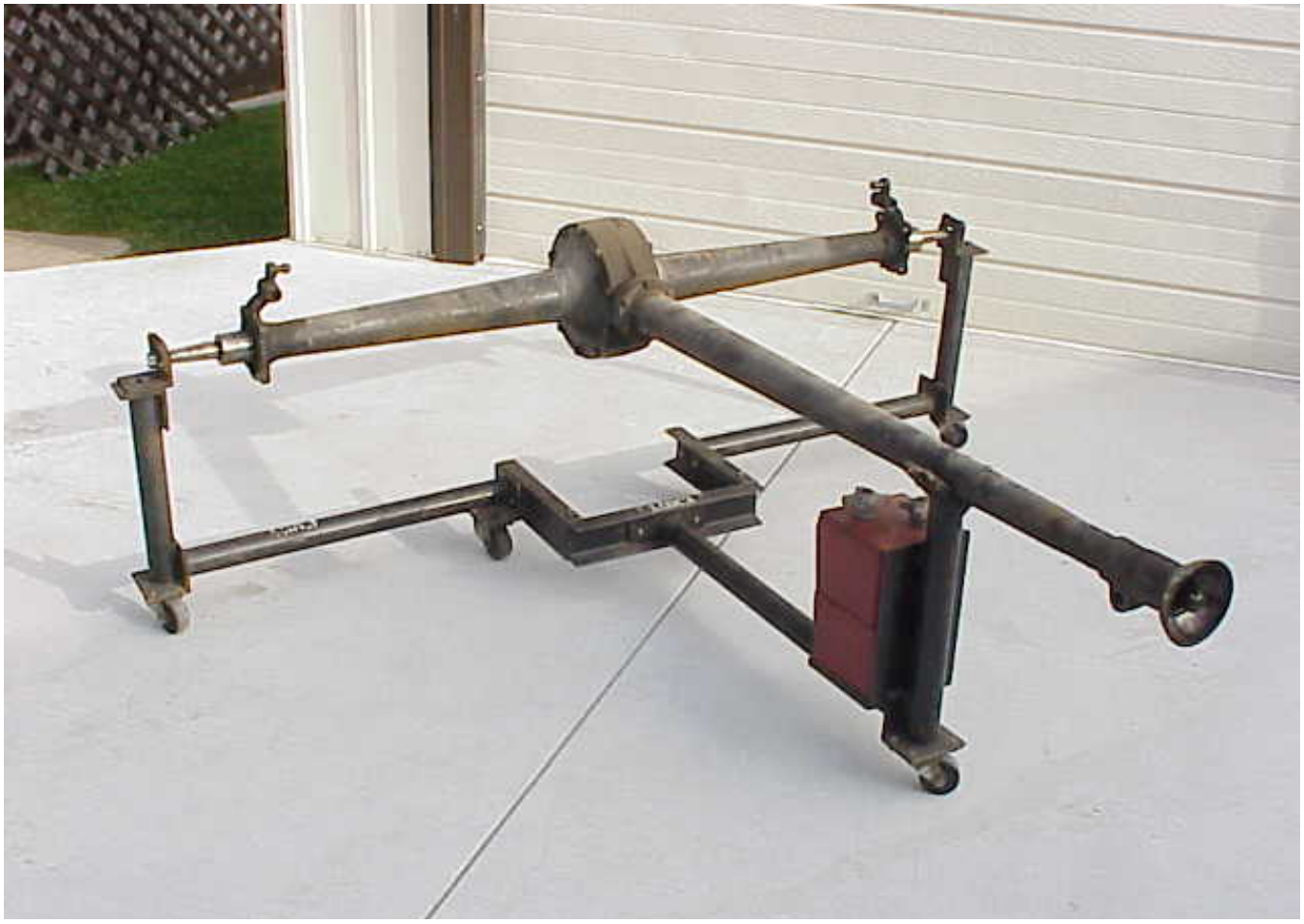
Model A Ford
Rear Axle Assembly Restoration
2014 Revision

by Tom Endy



Differential Cradle Tool

The differential cradle tool is used to remove and replace the rear axle assembly from the vehicle. It is also used as a platform for disassembly and for final assembly. Care should be exercised when removing the rear axle assembly from a Model A. The rear spring can be lethal. Use a proper spring spreader and disconnect and leave the spring in the vehicle.



Spring Spreader

The Model A Ford Differential:

The rebuilding of the Model A Ford differential, in addition to replacing worn or damaged parts, should take into consideration **three distinct adjustments**. **First:** the carrier bearing pre-load. **Second:** the pinion bearing pre-load. T**hird:** the ring & pinion gear backlash. Each of these adjustments is described in this procedure.

Axle housing orientation:

Axle housings are all functionally interchangeable from left to right. The only consideration is the judging standard orientation of the seams. The majority of axle housings are found with the seams on top, so it makes no difference how you orient them because both seams will end up on top either way. If the seams are on the side, to be correct they should be oriented so they face forward. Axle seams can also be found on the bottom, and again the orientation makes no difference, as they will both end up on the bottom. The later axle housings also had replaceable shock link balls. Consult the judging standards to determine what year and month configuration is correct for your car.

Banjo housing orientation:

Banjo housings are all functionally interchangeable. The only consideration is the judging standards. There are three distinct versions. The first and very early ones have no reinforcement gussets at the front flange, and the drain and fill holes are in line in the center of the housing. The second has reinforcement gussets, and the fill and drain holes are still in line. The third, and later banjo has reinforcements gussets, but the fill hole is offset to the left. Consult the judging standards to determine what year and month configuration is correct for your car. The early banjo housings without support gussets are prone to cracking.

Torque tube housing orientation:

Torque tube housings are all functionally interchangeable. The only consideration is the judging standards. Most of the changes have to do with various diameters of the tube. Mounting attachments are all the same. Consult the judging standards to determine what year and month configuration is correct for your car.

Tear down preparation:

The tear down procedure is assuming that the rear end has been removed from the car, the rear spring, rear brakes, backing plates, and the radius rods have all been removed. If you want to reassemble as originally found, mark each axle housing as left and right. **Drain the oil from the banjo.**

Speedometer gear housing removal:

Remove the two 7\16 hex bolts and lock washers at the front end of the torque tube and remove the speedometer housing. There should be a gasket under the housing.

Torque tube roller bearing assembly removal:

Reach through the hole where the speedometer housing was removed and pry loose the circular snap ring from around the drive shaft. Slide it forward and off the end of the drive shaft. Next slide the speedometer drive gear, thrust washer, and roller bearing off the end of the drive shaft. Use a screwdriver to push everything forward.

Torque tube removal:

Cut the safety wire from the six 9/16 hex bolts that attach the torque tube to the banjo and remove the bolts. The torque tube can now be removed by sliding it forward and off the end of the drive shaft. There may or may not be a gasket between the banjo and the torque tube. Ford did not originally use a gasket in this location, later a gasket became available.

Torque tube roller bearing race and seal removal: (Photo P-1)

To remove the seal in the torque tube, the race for the front roller bearing has to come out first. Both are removed at the same time with a very simple technique. Stand a drive shaft up vertically with the threaded end resting on a block of wood. Place a 1-1\16 inch, six point, 1/2 drive socket over the spline end of the drive shaft. Slide the torque tube down over the drive shaft until it seats against the end of the socket. Hold the torque tube in a vertical position and gently bounce it up and down until the socket pushes the grease seal and roller bearing race out the end of the torque tube. It is best to hold a rag loosely over the end of the torque tube during the process to capture the seal, bearing race, and socket as they exit the torque tube.



Photo P-1. Removal of the bearing sleeve and grease seal: The sleeve is at the top followed by the grease seal, then the socket. All are sitting on top of the drive shaft spline. A 1&1\16", 1\2" drive, six point socket fits over the splines on the end of the drive shaft.

Axle keys:

Assuming that the rear brake backing plates have been removed from both sides, check that both axle keys have been removed from the axles. If they are not removed the axle housings will be prevented from sliding off the axles. Usually they can be pried out with a small screwdriver. For the more stubborn ones, clamp a portion of the key with a pair of vice grips. Lock it tightly and tap the vice grips with a hammer.

Axle housing removal:

Remove the ten 9/16 hex bolts from the left side of the banjo. The left axle housing can now be removed by pulling it off over the left axle. For the more stubborn housings, tap the end of the axle housing with a brass hammer to dislodge it from the banjo. Remove the entire axle shaft assembly by taking hold of the left axle and pulling the whole assembly out from the banjo and the right axle housing. Set the axle shaft assembly aside and remove the ten 9/16 hex bolts from the right side of the banjo. Remove the right axle housing from the banjo in the same manner as the left housing was removed. There should be any number of gaskets on either side of the banjo between the two axle housings. Set both axle housings aside on some newspapers to allow the residual oil to drain out.

Banjo disassembly: **(Photos P-2, P-3)**

There are two ways to remove the pinion bearing assembly from the banjo. (1) You will need a pinion puller tool. Slide the tool over the drive shaft and lock it to the shaft. As you tighten the bolts on the puller the entire assembly including the banjo race, pinion gear, and the two bearings all still attached to the drive shaft will pull out of the banjo. (2) The other way is to unbolt the two large nuts holding the pinion gear assembly together. Using a large pinion nut wrench and a pipe wrench, remove both large pinion nuts. Use the pipe wrench to hold the drive shaft from turning while unscrewing the two large pinion nuts. Once the two nuts have been backed off from the pinion gear sleeve, remove the two nuts, the locking washer, and the thrust washer off the end of the drive shaft. With a brass hammer gently tap on the end of the drive shaft to drive the pinion gear in toward the banjo. This will loosen and remove the front pinion bearing. Slide the bearing off the end of the drive shaft. The drive shaft with the pinion gear and the rear pinion bearing still attached can now be removed from the banjo by pushing the drive shaft in toward the banjo and turning it at an angle and removing it.



Photo P-2. Mitchell drive shaft puller tool: This tool can be purchased from the Mitchell Company. When purchasing an overdrive from them it can be rented.

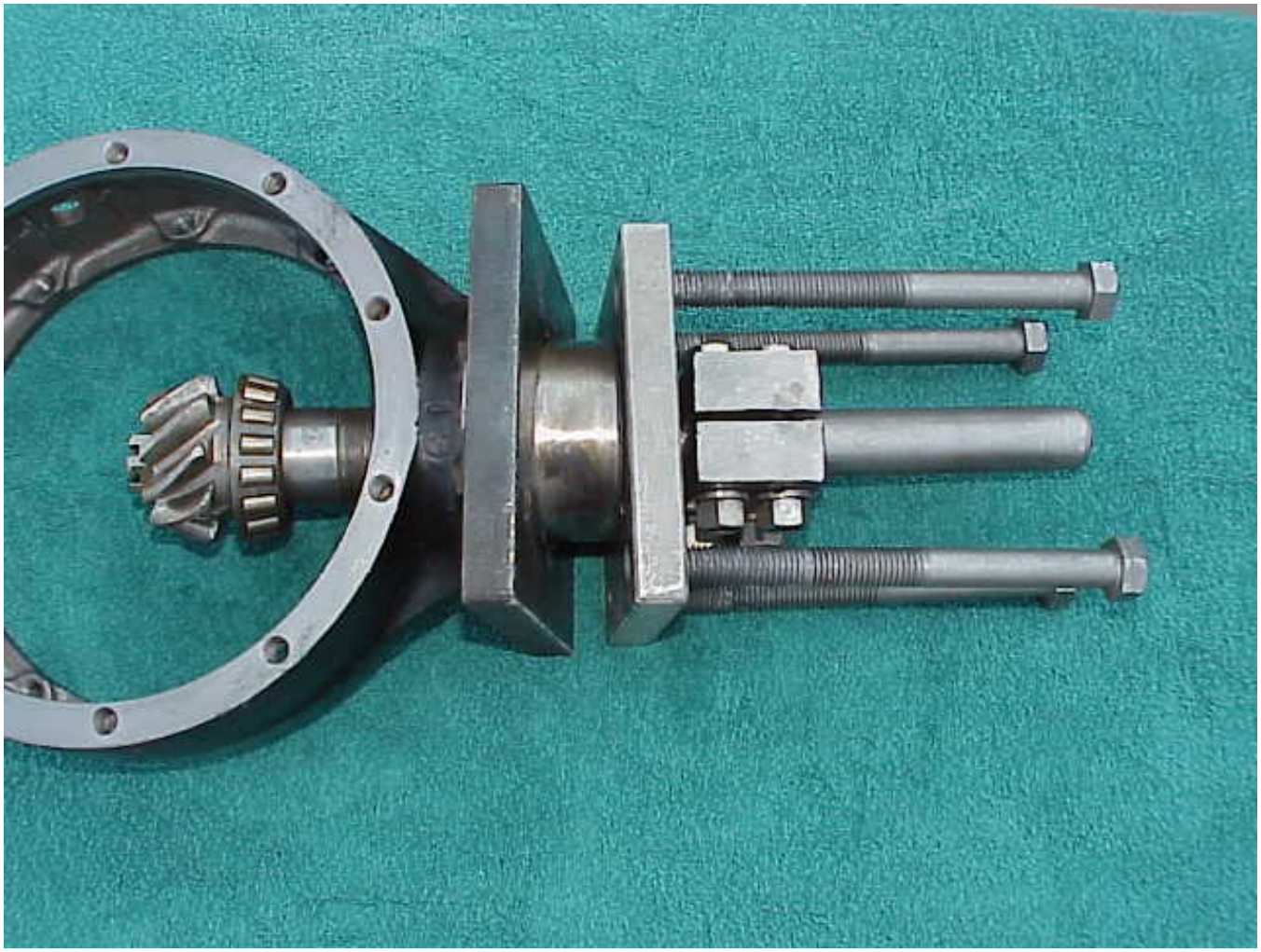


Photo P-3. Tom Endy drive shaft puller tool:

Banjo bearing race removal:

If the double cone-bearing race that is pressed into the banjo mounting flange was left in place when the pinion gear assembly was removed it has to be removed. The drive shaft with the pinion gear and the rear tapered pinion bearing still attached can be used as a puller. The drive shaft is temporarily reinstalled in the banjo and a pinion puller tool is attached to the drive shaft at the banjo flange. As the pinion puller tool is tightened against the banjo flange the bearing race is pulled from the banjo. The use of a small hydraulic jack placed inside the banjo housing to push the bearing race out is discouraged. Bearing races that have been installed for many years can be very tight and the banjo housing can easily become distorted during the process. Bearing race removal should be accomplished by pushing against the outside of the banjo flange, not against the inside of the banjo.

Pinion gear removal: **(Photos P-4, P-5, P-6, P-7, P-8)**

The pinion gear is removed from the drive shaft with a gear puller and a bearing puller. Place the drive shaft in the pipe jaws of a vice. Remove the cotter pin from the drive shaft nut at the pinion end of the drive shaft. Using a 15\16 hex socket, back the nut off about 1/4 of an inch (do not remove the nut completely). Place a small bearing puller around the drive shaft behind the pinion gear (at the end of the threads on the pinion gear sleeve) by sliding it on over the front end of the drive shaft. Using the gear puller, place the center point of the puller in the détente at the pinion end of the drive shaft. Hook the arms of the gear puller around the bearing puller and tighten until there is sufficient tension against the end of the drive shaft. Smartly tap the end of the gear puller with a hammer. Alternately tighten the puller and tap the end until the pinion gear

comes loose from the taper on the end of the drive shaft. Remove the drive shaft nut and slide the pinion gear off the end of the drive shaft. The rear bearing that is still attached to the pinion gear will have to be removed with a bearing puller and a shop press.



Photo P-4. Pinion gear puller tool: This tool was originally sold by Sears years ago. Its intended purpose was for the removal of the flywheel on small lawn mower engines. The block of steel with the hole was fabricated. A small bearing puller will also work.

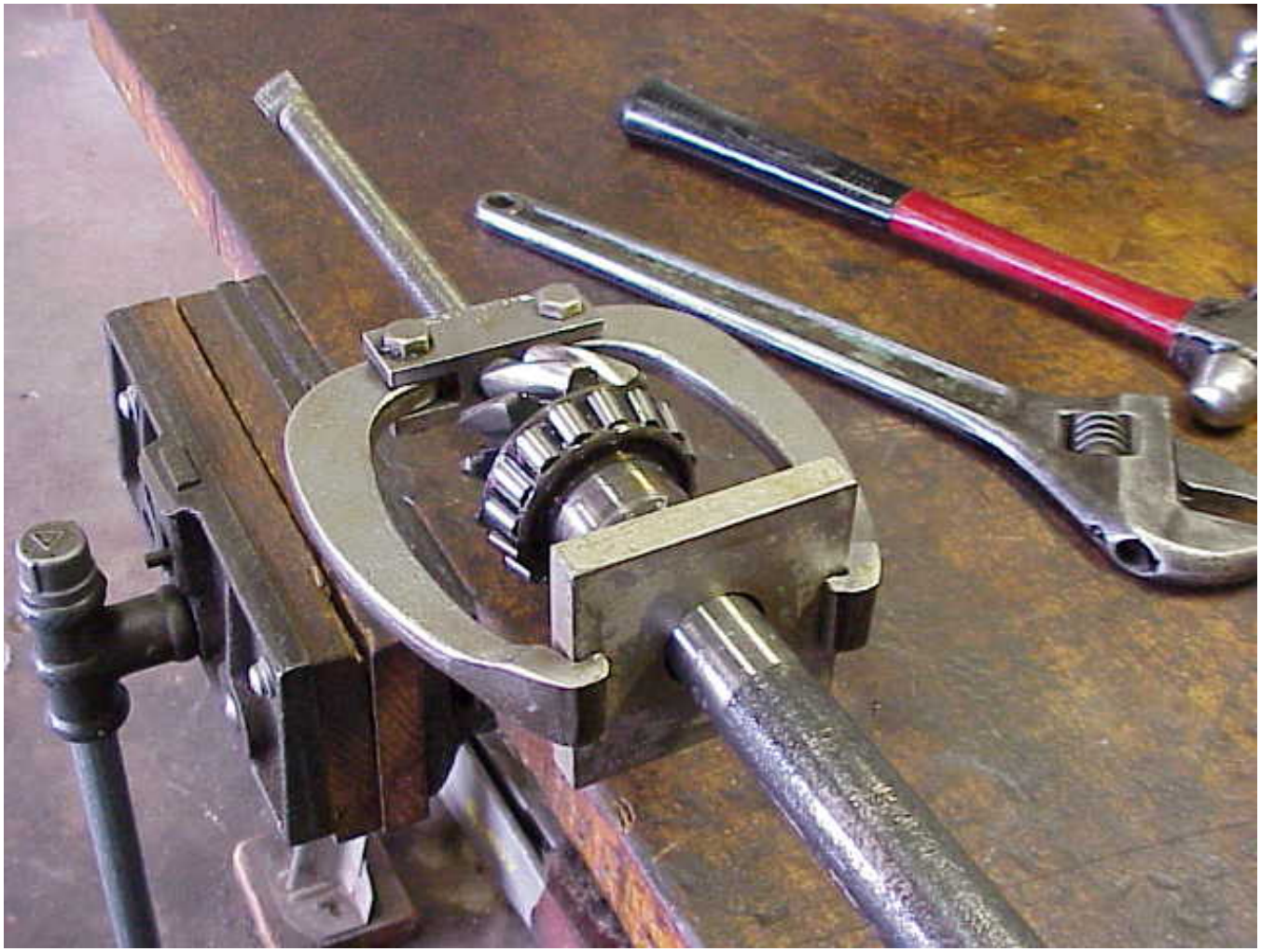


Photo P-5. Pinion gear removal: Tension is applied to the puller tool; the end is then smartly tapped with a hammer. Repeat tightening and tapping with the hammer until the gear comes off the shaft.



Photo P-6. Pinion gear removal: Do not remove the nut when attempting to remove the gear as it may come off and fly across the room. Once the gear breaks loose from the taper on the shaft the puller will drop free. Remove the nut then.



Photo P-7 Pinion gear removal: Photo 5. Pinion gear removal: Tension is applied to the puller tool; the end is then tapped smartly with the hammer. Repeat tightening and tapping until the gear comes off the shaft.

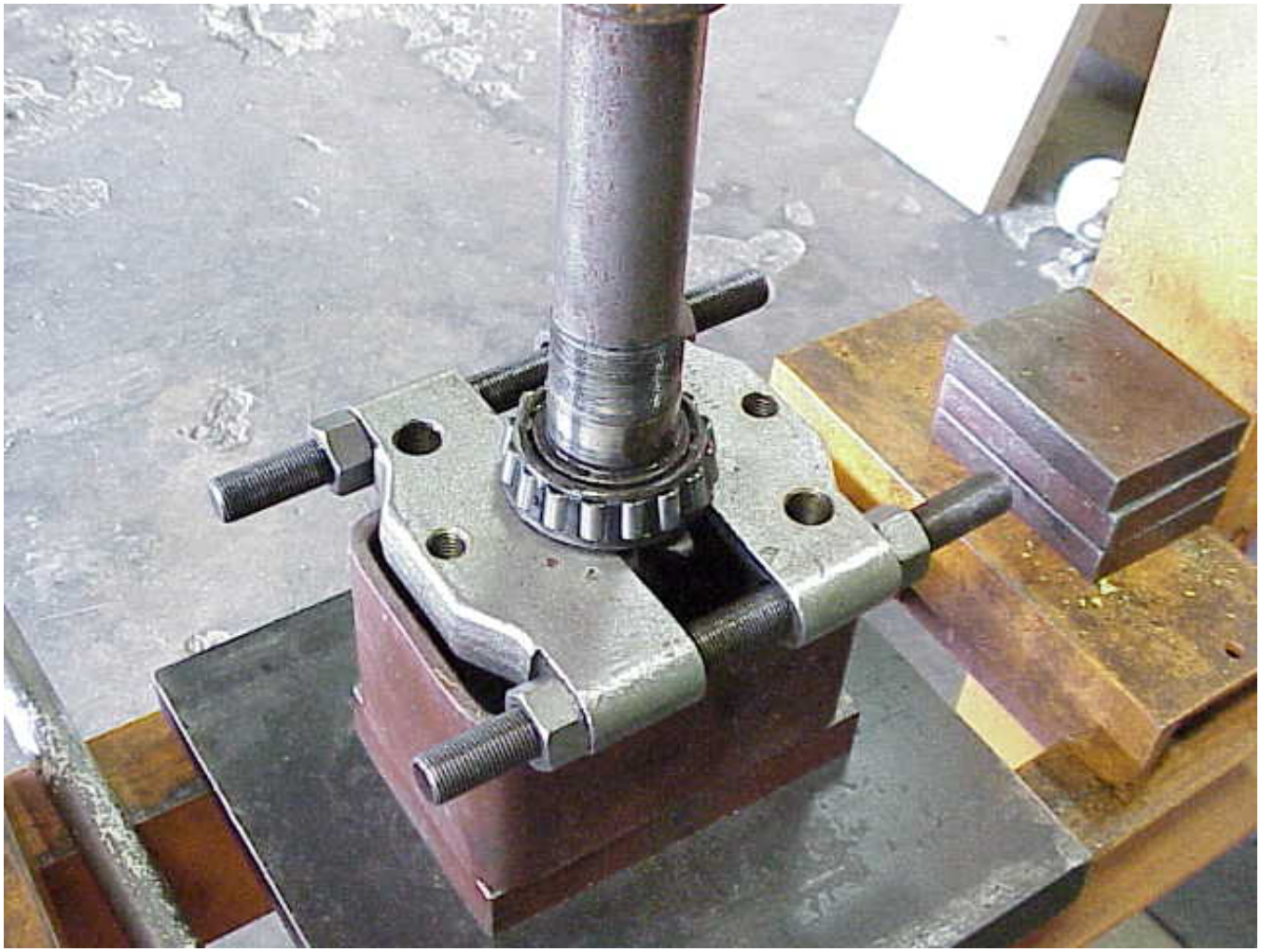


Photo P-8. Removal of rear pinion bearing: A shop press is used to press the rear pinion bearing off the pinion gear sleeve.

Axle housing disassembly: **(Photos P-9, P-10, P-11)**

The bearing race and axle grease seal are removed from each axle housing in the following manner. Place the housing on the floor with the wheel bearing end up. Select a screwdriver you like the least and insert the tip inside the axle exit hole in the housing. Place the tip of the screwdriver against the grease seal (it is a matter of feel). Tap the end of the screwdriver until you hear the grease seal hit the floor. The grease seal will be destroyed in the removal process. The bearing races are normally removed using a special puller tool. They can also be removed by placing the housing on the floor with the wheel bearing end up. Using a 3 foot length of 1/2 inch water pipe, place the end of the pipe against the inside lip of the bearing race. With a hammer, gently tap on the other end of the pipe. Move the pipe around the circumference of the bearing race between hammer blows so as to force the race out evenly. Take your time so as not distort the bearing race seat machined inside the housing.



Photo P-9. K. R. Wilson axle housing race removal tool: The left end of the tool is placed down into the axle housing and grips the edge of the bearing race. As the nut is tightened it pulls the race out.



Photo P-10. Removal of axle housing bearing race: As the nut is tightened the race is removed. An impact wrench works very well for this task.



Photo P-11. Removal of axle housing bearing race: The axle housing is supported in the vertical jig for the removal process.

Axle/carrier/ring gear disassembly: (Photo P-12, P13)

The axle assembly, which includes the ring gear and carrier assembly that was removed and set aside earlier, should now be disassembled. Cut the safety wire securing the nine 9/16 hex nuts holding the two carrier halves together. For reassembly reference, punch two center punch marks opposite one another on each carrier half. This will allow you to reassemble it, as you originally found it (do not put the punch marks in line with any of the nine bolts, as they will tend to lock the bolt in place in the sleeve of the carrier). Remove the nine hex nuts. Using a brass hammer, very gently tap on the threaded end of each of the nine carrier bolts to see if they can be easily dislodged. If they can, remove as many as possible with the brass hammer. Do not hammer on any that do not move easily, leave those in place and using the brass hammer, tap on the edges of the carrier halves in an attempt to drive them apart. One axle can also be clamped in a vice and the opposite axle pulled on while tapping on the carrier. It is important that the carrier halves come apart without damaging the threads on the nine carrier bolts. Once the carriers are apart, the axles can be slid out from each carrier half. The spider gear assembly consisting of three spider gears and the gear shaft yoke will also drop free when the carrier halves are separated. The ring gear can now be tapped free from the left carrier half using a brass hammer or a shop press. There is an early and a late version of the carrier assembly. The parts from the two are not interchangeable. Refer to **(Appendix C)** to determine which carrier assembly you have.



Photo P-12. Carrier disassembly: Before beginning the process, center punch both carrier halves so they can be re-assembled as before. The safety wire is removed and the nine carrier bolts are removed. When the two carrier halves are separated the spider gear assembly will drop out and the two axles can be removed. Care should be taken to not damage the threads on the nine carrier bolts. Do not hammer aggressively on the threaded ends of the bolts.



Photo P-13. The nine carrier bolts have been removed and the two carrier halves separated and the spider gear assembly drops out: Note the three spider gears are installed on the three shaft segments of the yoke so that the taper of each gear faces the center of the yoke. When assembled inside the carrier the three spider gears mesh with the gear on the end of each axle. When the car is going straight down the road both axles are turning at the same speed. The spider gear assembly is rotating with it, but the individual spider gears are stationary. When the car is turned in either direction one axle speeds up, the other slows down. This is the only time the three spider gears rotate on their individual shafts.

Carrier bearing removal: **(Photos P-14,)**

A bearing is mounted to each carrier half. They should be removed using a bearing puller and a shop press. Inspect the carrier bearing mounts carefully prior to removing the bearings to see that the bearings are securely mounted on the bearing mounts. You should not be able to turn the bearing on the mounts by hand. If the mounting portion can be turned by hand it means the bearings were previously set up too tight and they have spun on their mounts. This condition leaves the carriers in an unserviceable condition and it will have to be repaired or replaced. The rear end assembly is now completely disassembled.

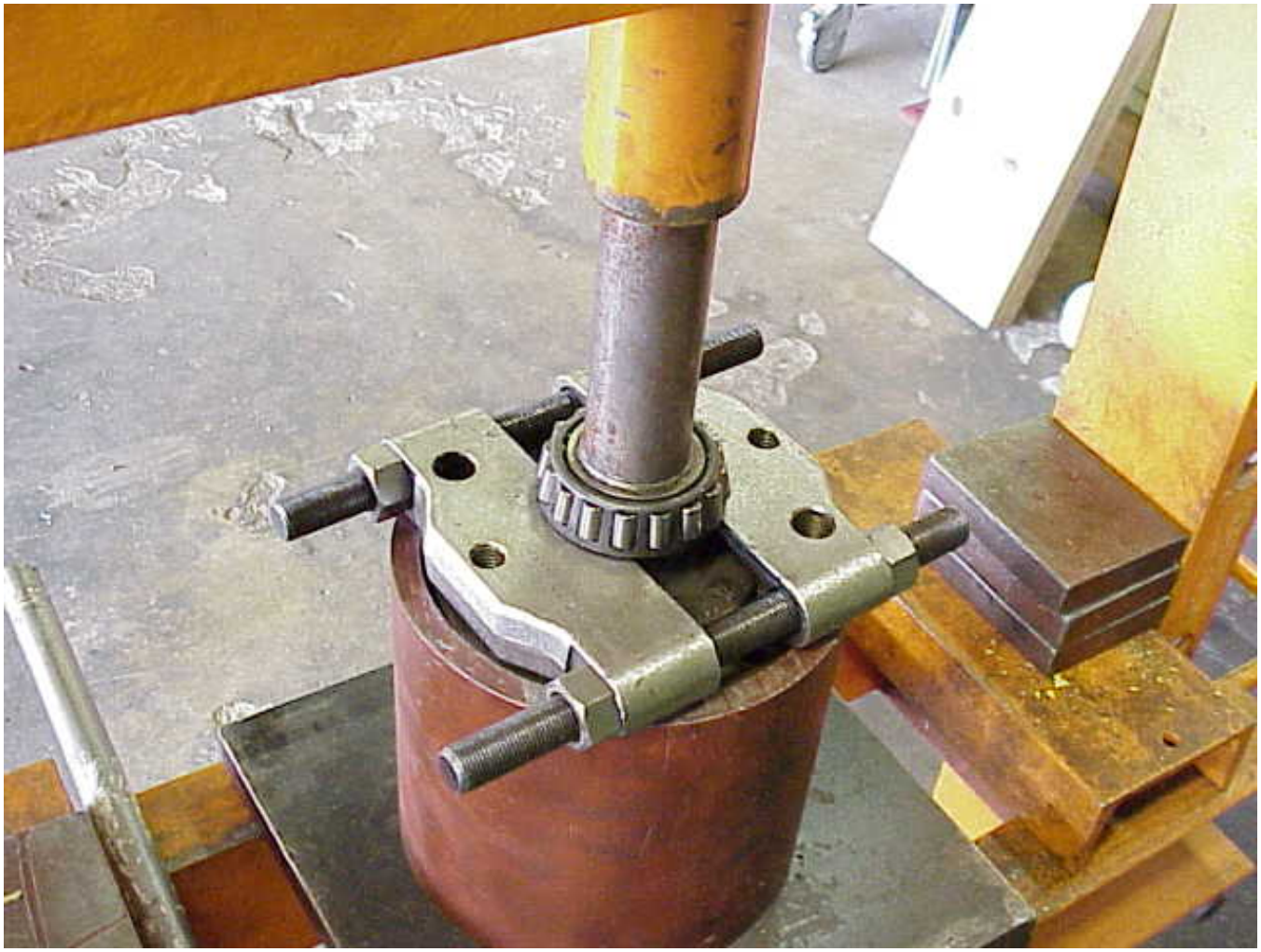


Photo P-14. Carrier bearing removal: A shop press and a bearing removal are used to press both bearings off. If either or both bearings have spun on the mounting hubs, the hubs will have to be repaired by knurling or the carrier replaced.

Carrier inspection: (Photo P-15)

If the bearings have found to be spun on the carrier mounts prior to removing them, the carrier must be replaced or repaired. Spun mounts are usually caused when the previous mechanic did not set up the pre-load correctly and the bearings were set too tight against the races. I find more than half of those I take apart to have one or both bearings spun. If the mounts are not damaged too badly repair can be made by knurling the bearing mounting surfaces so that the new bearings will mount with an interference press fit. More than likely shims will have to be placed behind the new bearings when reinstalled as the carrier was probably also machined in toward the center by the spinning bearing mounting surface. If you find just one side spun it is generally the ring gear side because that is where the initial torque is applied. Carrier bearing shims can be obtained from Bratton's Antique Auto. The part number is 6071 and they are.005 in thickness. One or more shims may be required.

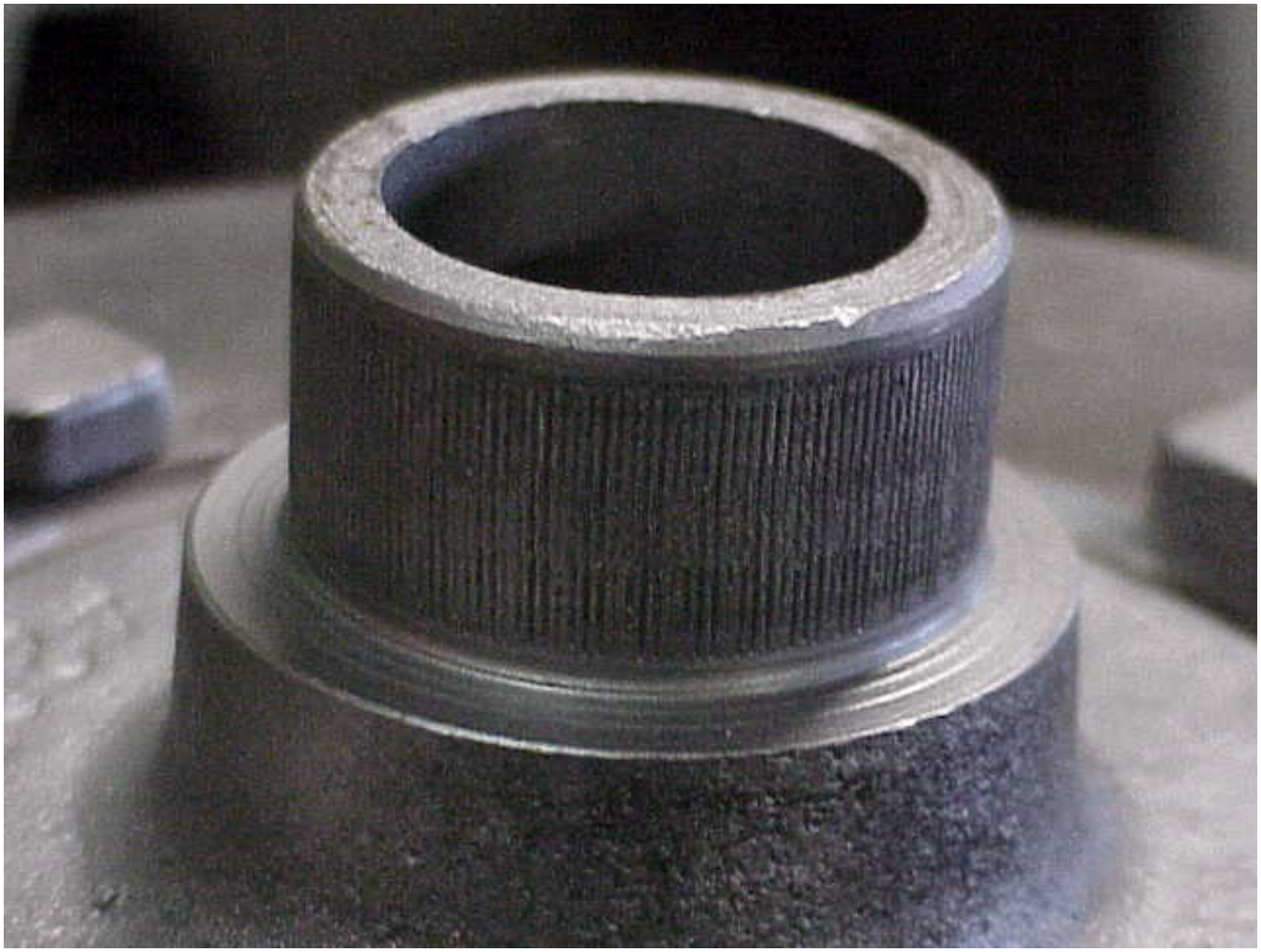


Photo P-15. Knurled repair of a carrier bearing hub: Very often the carrier bearing hubs are found where the bearings have spun on the hubs. Knurling can restore the carrier half to serviceable use if the material that has been worn away is not severe. A shim or two may be required to compensate for wear to the bearing stop.

Axle Shaft inspection:

Check both axles by inspecting the gear ends. Some wear and pitting is not a problem. More important is the condition of the threaded ends and the key slots. Make sure there are no cracks at the key slot and the threads are not stripped. Reject any axle that has the slightest crack at a key slot or has marginally serviceable threads. Axle shafts are interchangeable left to right, but you may want to mark them left and right for reassembly as they were originally installed.

Spider gear assembly inspection:

Check the condition of the three spider gears and the yoke they rotate on. Wear on the gears and some pitting is not a serious problem. What is important is that the three spider gears turn freely on the three hubs of the spider yoke. Check the hubs and the inside of the gears for damage. The later gears have an oil hole in each gear. The earlier gears do not have the hole. Both types are interchangeable.

Ring & pinion inspection: (Photo P-16)

Check both gears for broken or damaged teeth. Some amount of wear and pitting is not a problem. Legend has it that the gears were a matched set at the factory. Some speculation is that they are only matched when they have been run together for some period of time as a set in a car. Often you can find a matching number on the two gears, but not always. It is prudent to keep them together as a set once removed from the differential.



Photo P16. Quite often matching numbers are found on an original ring & pinion gear set where the number is stamped onto the end of the pinion gear and the same number is found hand written on the back side of the ring gear with an etching tool. This is found so frequently that I believe this must have been a factory practice when a new ring and pinion were mated up to go into an assembly.

Ring & pinion gear ratios:

There are four different gear ratios available for the Model A Ford differential. The **378:1** ratio is the standard and is most often found in a differential. The majority of Model A Fords were produced with the 378:1. The **411:1** ratio was used for lower gearing and was generally installed in commercial pick-ups, station wagons, or other vehicles expected to haul heavy loads or climb steep hills. The **354:1** ratio was an after market ratio used for higher gearing and became generally available when the nations roads were greatly improved after the Model A era. The **370:1** ratio was used in the very early 1928 cars that are generally referred to as an AR car. The physical shape of the 370:1 pinion gear is different than the other ratios and is not interchangeable. An AR drive shaft is required with the use of the 370:1 ring & pinion gear set (**See appendix D).** To determine the ratio of a gear set count the number of teeth on both gears and divide the smaller number into the larger number.

Ring gear	Pinion gear	Ratio
34	**9**	**3.78:1**
37	**9**	**4.11:1**
39	**11**	**3.54:1**
37	**10**	**3.70:1**

Clean up:

Thoroughly clean the inside of the axle housings and banjo. Often there is metal wear particles embedded inside the axle housings. A wire brush attached to a length of angle iron makes a suitable tool. Pay particular attention to the area where the grease seal will be installed. Quite often you will find pieces of metal shims that were used on the tapered axle shaft ends. Remove the grease fittings and clean out the area where grease is supposed to flow into the wheel bearings from the grease fitting. Clean the torque tube as well. Clean all the other parts. Bead blasting of the gears, carrier halves, and axles is recommended. If you do not have a bead blaster in your garage, treat yourself to an evening of wire wheeling.

Banjo bolt inspection and cleaning: (Photo P-17)

There are ten banjo bolts on each side of the banjo (20 total). These are special bolts; examine them to be sure they are original. They should have a space between the head of the bolt and the threads. This is to prevent oil from spiraling up the threads and causing an oil leak. The head of the bolt will also appear to be thicker than a normal bolt. It is best to use the original bolts and avoid the reproductions. Do not use lock washers with these bolts, as they will leak oil. Clean the bolts by first soaking them in lacquer thinner to remove all the paint. Wire wheel the threads to remove all gasket sealer and other contamination.



Photo P-17. Original banjo bolts, Quantity 20: Note space between the threads and the head of the bolt. Lock washers are not used with these bolts. The bolt head has a unique thickness. The stud at left is one of the alignment studs used to position the gaskets. The thread size is 3\8-24.

Burr removal:

Run a flat file lightly over the machined surfaces of the axle housing flanges, the three banjo flange surfaces, and the mating surfaces of the two carrier halves to remove any burrs or high spots.

Minimum new parts required:

It is prudent to replace all bearings, seals, and gaskets regardless of the visual condition they appear to be in. The following parts\price list is taken from **Bratton's Antique Auto Parts 2014 catalog.**

Quantity	Description	Ford part number	Price (each)
4	**carrier-pinion bearing**	**A4221**	**$45.00**
2	**carrier bearing race**	**A4222**	**$29.00**
1	**banjo bearing race**	**A4616**	**$64.95**
3	**axle\drive shaft seal**	**A4245**	**$2.25**
1	**drive shaft key**	**A4606**	**$0.85**
1	**torque tube gasket**	**A4507**	**$1.00**
Qty	**banjo gasket .009**	**A4035A**	**$1.25**
Qty	**banjo gasket .006**	**A4035B**	**$1.25**

***** Approximate 2014 total cost $330.00**

***** Timken bearings increase in cost dramatically every year.**

Part number cross-reference:

Original Ford	Timken	Bratton
A4221	**28156**	**6070**
A4222	**28317**	**6090**
A4616	**28314XD**	**6330**

Assembly preparation: **(Photo P-18)**

The assembly of the differential and the adjustments made to several components is easier to achieve if the differential housing is mounted in a vertical position. A wide jawed wood vice or a fixture adapted to a standard bench vise can be used to mount the right axle housing in a vertical position with the banjo flange facing up. The other components are then attached above it in a vertical plane. **(See Appendix A)**



Photo P-18. Vertical assembly jig: The carrier with part of the pre-load tool inside is inserted into the banjo between the two axle housings. Gaskets are added and subtracted from only the left side (top) to achieve the correct carrier pre-load. The other half of the pre-load tool can be seen at the top of the left axle housing.

Temporary carrier re-assembly: (Photos P-19, P-20)

Bolt the two carrier halves and ring gear together without the spider gears and without the two axles installed. Install only the spider yoke, preferably one that has been made into a tool. Torque the nine bolts and nuts to 35 ft. lbs. Do not safety wire the nuts at this time. Press a new bearing onto each side of the carrier. Make sure they press tight onto each hub. **(See Appendix B and Appendix C)**



Photo P-19. Carrier bearing installation; New bearings are pressed onto the hub on each side of the carrier. They must press on with an interference press fit.

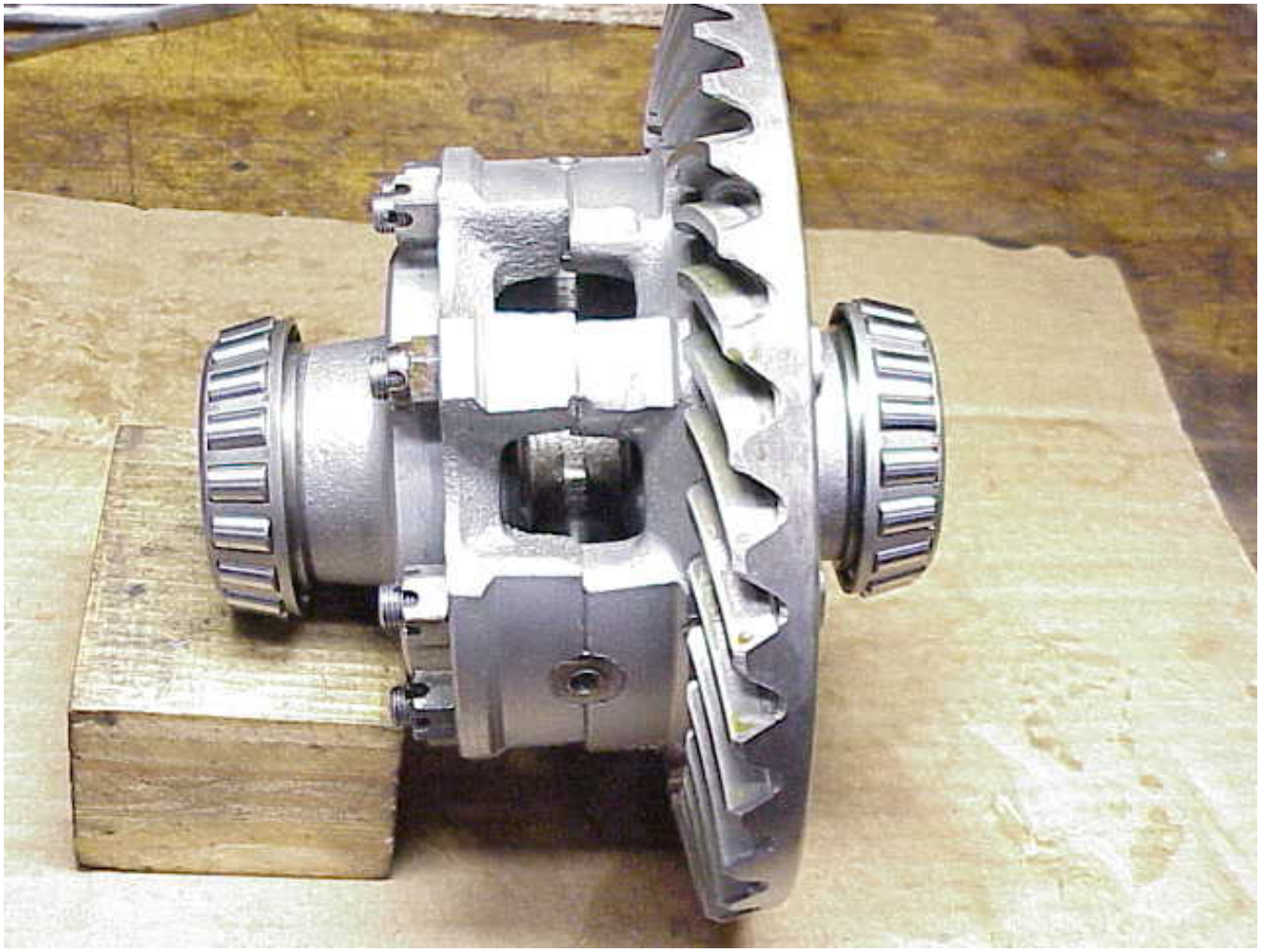


Photo P-20. Carrier assembly ready for pre-load setting: Both bearings have been pressed on. Part of the pre-load tool has been installed in place of the spider gear yoke. All 9 carrier bolts are torqued to 35 ft. lbs.

Axle housing race installation: (Photos P-21, P-22)

Press a new race into each axle housing with a shop press. A good technique is to place the banjo on the horizontal rails of the press. Set the axle housing down inside the banjo with the flange up and the backside resting on the banjo. This provides a solid platform to press the races in. Make certain the race is fully seated. Check it with a dental mirror.

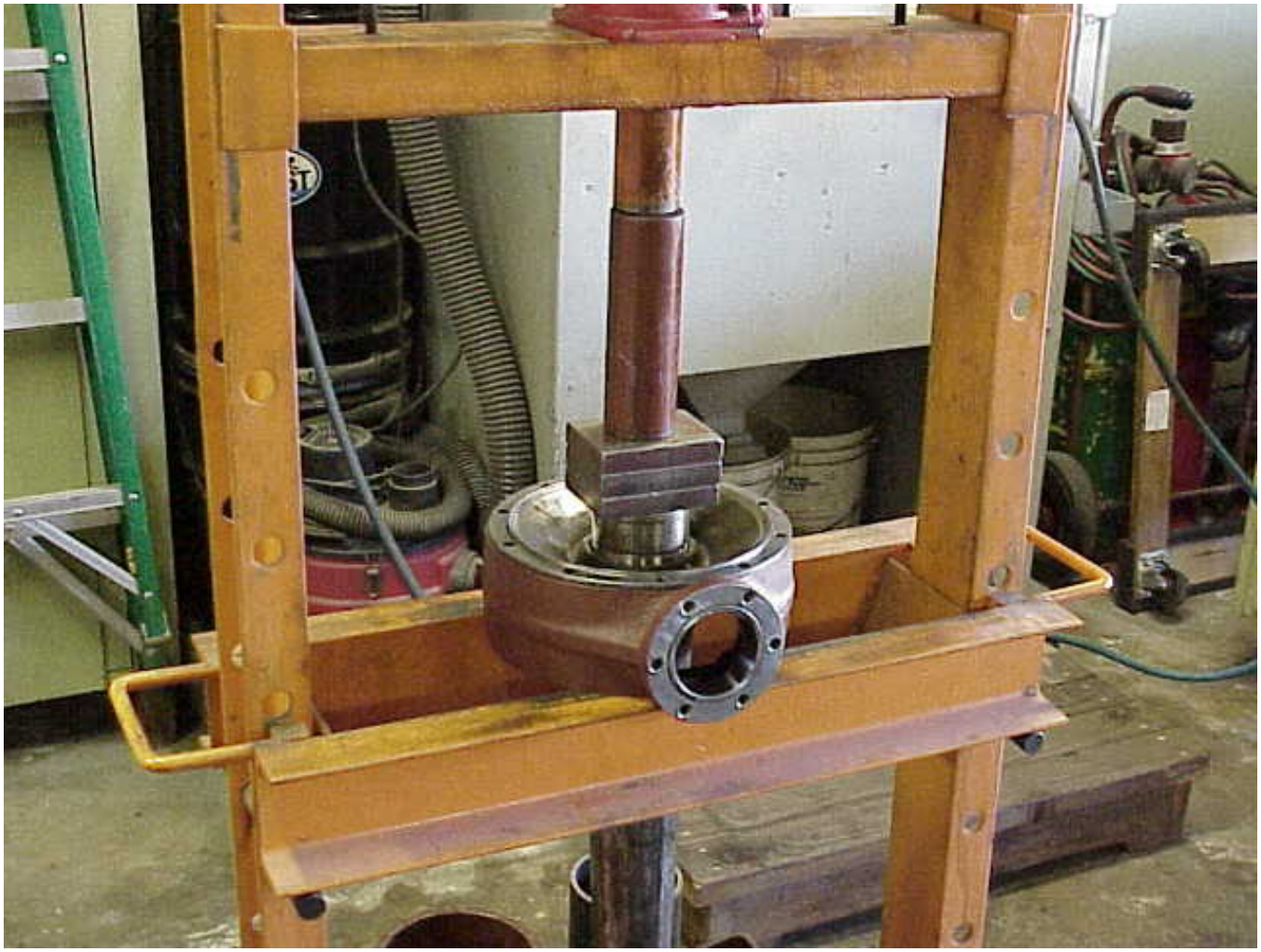


Photo P-21. Installation of axle housing bearing races: The banjo is used as a platform to install the bearing races in the axle housing. The banjo is placed on the press rails and the axle housing is placed down inside.

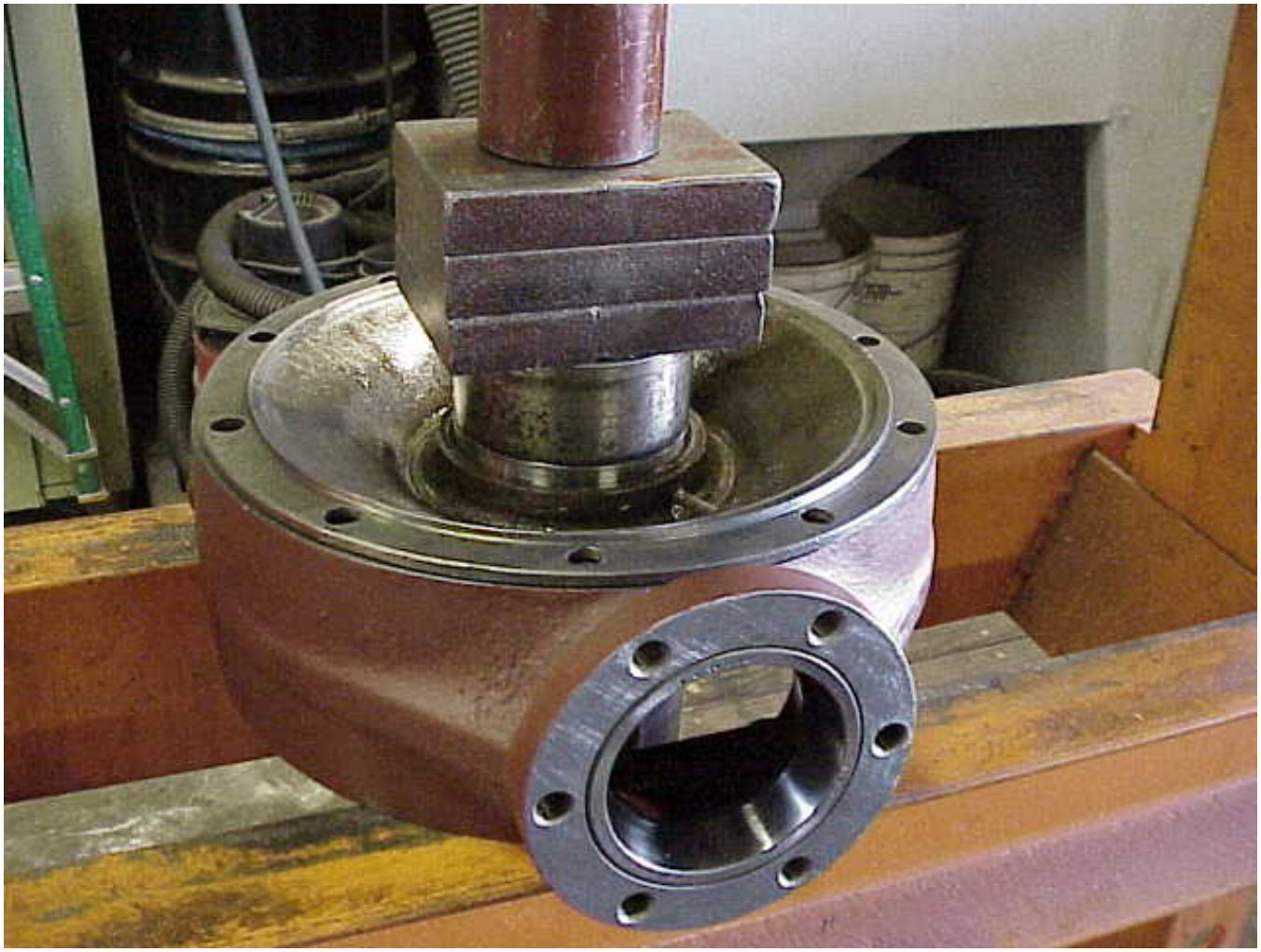


Photo P-22. Installation of axle housing bearing races:

K. R. Wilson axle housing bearing race installation tool. (Photo P-23).

An alternate method of installing the axle housing bearing races is to use a K. R. Wilson installation tool when one is available.



Photo P-23. K. R. Wilson axle housing bearing race installation tool: The long shaft is placed down inside the axle housing with the end fixture at right resting on the bearing race. The T-handle at left and the shaft guide are installed on the threaded end of the long shaft. As the T-handle is turned it pulls the race into place. Tapping on the fixture on top of the race with a hammer will aid in seating the race. Use a dental mirror to determine that the race is fully seated around the race stop.

Axle housing seal installation: (Photos P-24, P-25, P-26)

To install new seals in the axle housings a seal driver tool (Bratton part number A4246) must be used on the end of a three-foot length of 1\2 inch water pipe. Set the axle housing on a concrete floor with the wheel bearing end down. Coat the tool and the seal with grease and insert the tool with the seal on the end down into the axle housing until it is in place against the seat. The trick is to hold the end of the three-foot length of pipe steady and dead center in the middle of the axle housing. Using a hefty hammer, drive the seal into place. It will take about six hammer blows. When the seal fully seats you will hear the sound of the hammer blow change to a ringing sound. You can check that the seal is fully seated by shinning a flashlight into the wheel-bearing end of the axle housing.



Photo P-24. Grease seal installation tools: The long tool is used to install the seals in the both axle housings. The short tool is used to install the seal in the front of the torque tube. Both tools are made from a length of 1\2" water pipe with the seal tool threaded onto the end. A seal installation tool can be purchased from most any Model A supplier.

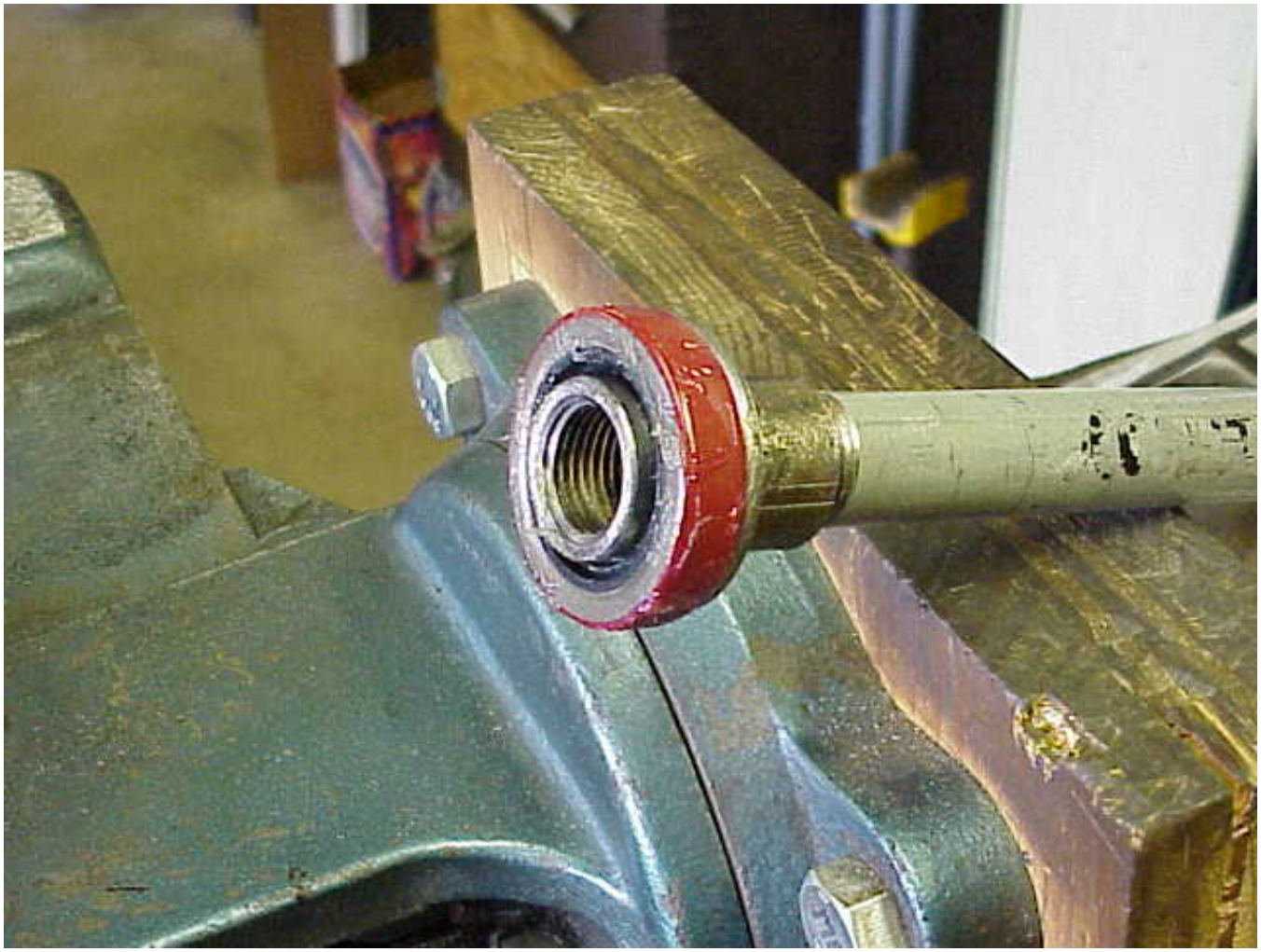


Photo P-25. The grease seal is inserted on the installation tool: Apply a coat of grease to the seal: The original grease seals were made by a company called Chicago Rawhide. They will have CR stamped on the side. The actual sealing portion of the seal was made of leather. New seals are made of neoprene.

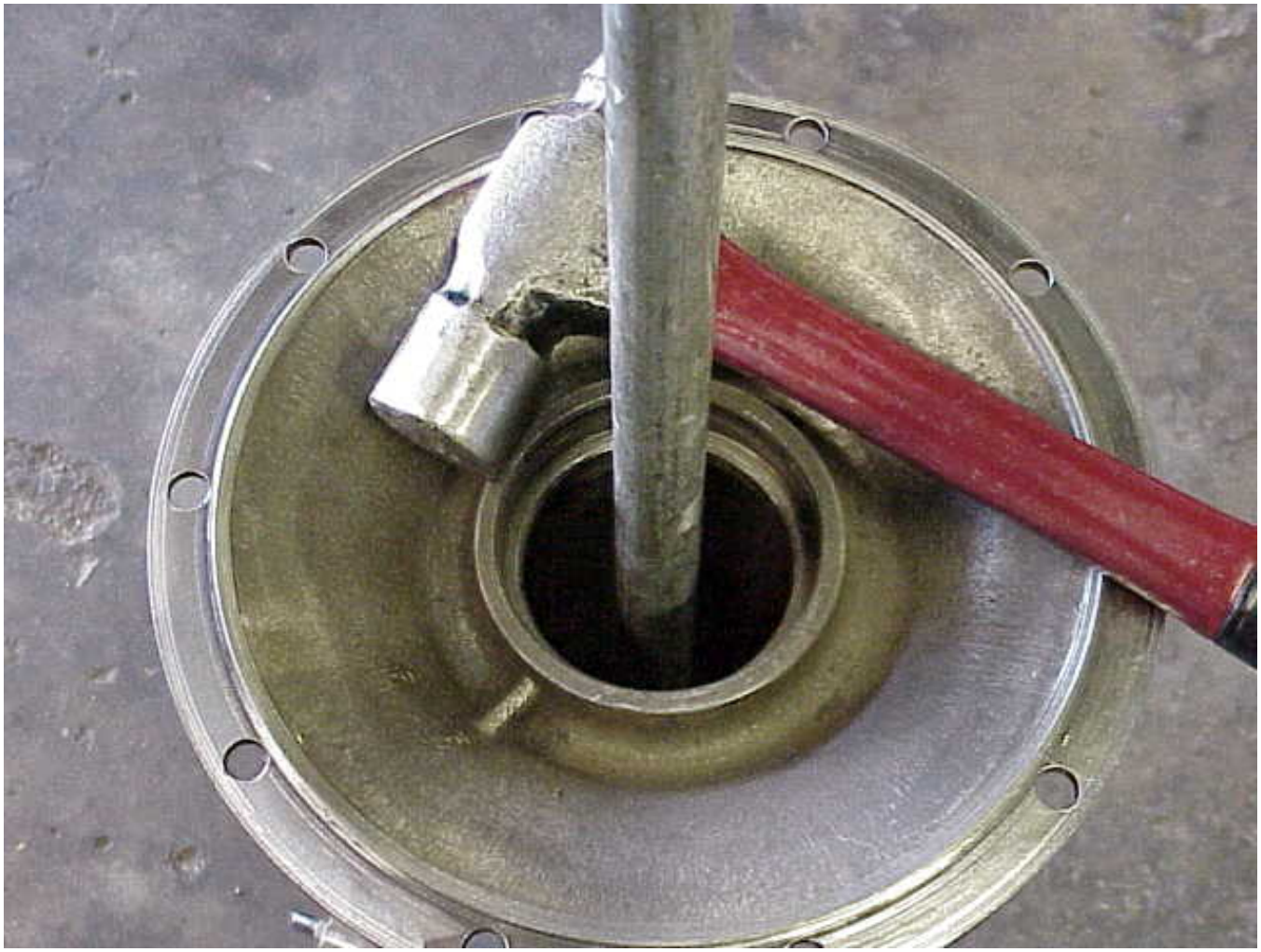


Photo P-26. Grease seal installed in axle housing: The grease seal is driven into place with the hammer. When the seal has bottomed out against the stop there will be a change to the hammer sound as the seal goes in. When it bottoms there will be a ringing sound. Be certain the seal has bottomed correctly. Run your finger down into the hub end of the axle housing and feel that the seal is up against the stop.

Temporary re-assembly of the banjo and axle housings: (Photos P-27, P-28, P-29, P-30)

Bolt the right axle housing to the right side of the banjo without any gaskets. Orient the drain hole correctly. Torque the bolts to 30-35 ft. lbs. Place the assembly in a large wood vise or vertical holding fixture and orient it so that the assembly is vertical with the left side of the banjo facing up. Lubricate the bearings and races with 600W oil and place the ring gear and carrier assembly inside the banjo with the ring gear at the top. Install the left axle housing onto the banjo without any gaskets. Begin tightening the bolts to 35 ft. lbs.



Photo P-27. The axle assembly is in the vertical jig for the pre-load setting:



Photo P-28. The right axle housing is at the bottom of the jig: The banjo is on top and properly aligned with the mounting holes in the axle housing flange. It is recommended that the two axle housings and the banjo be marked for proper orientation before beginning the process.

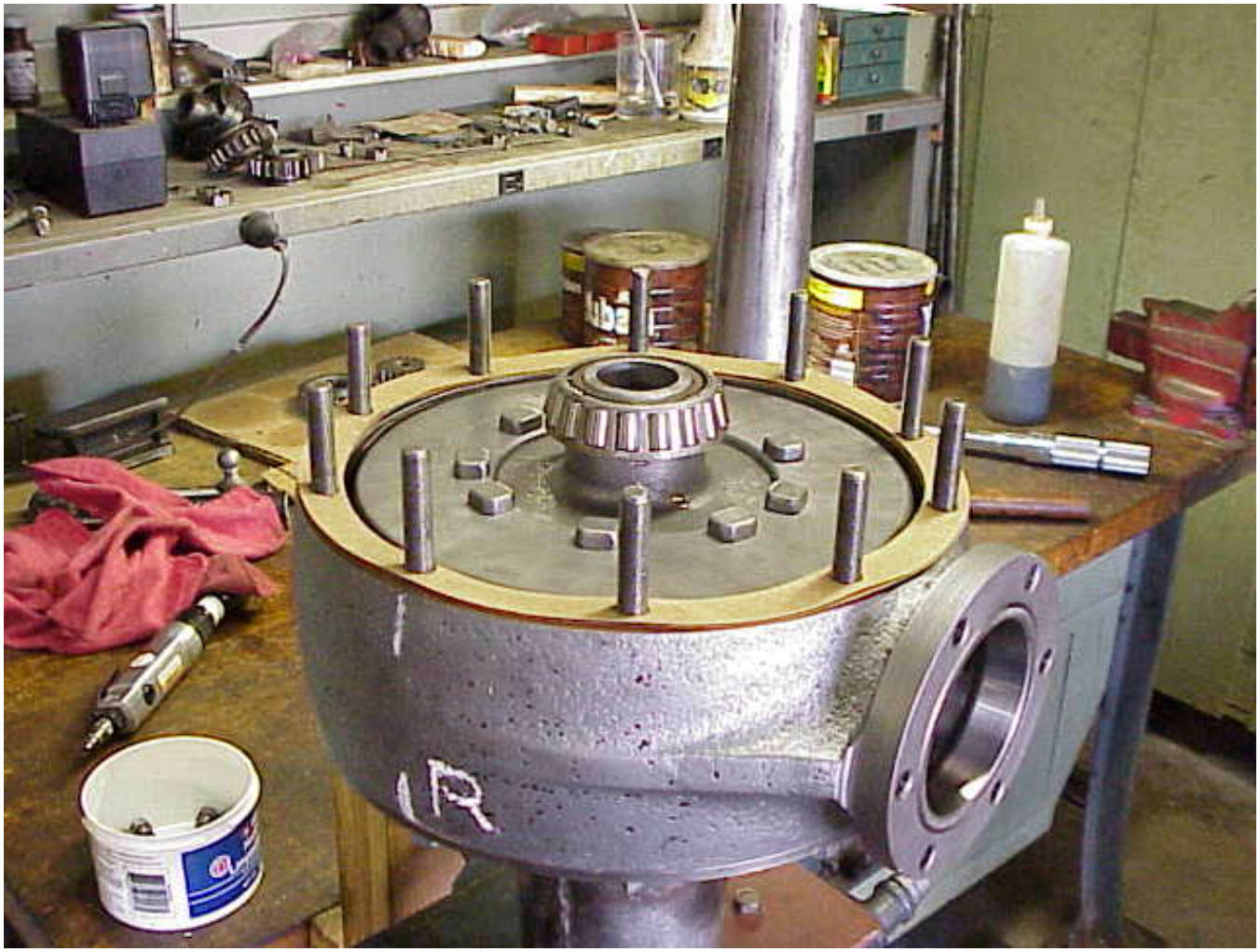


Photo P-29. Alignment studs are used during carrier pre-load adjustment: The task is a trial and error effort to determine the total quantity and thickness of banjo gaskets that will be used on both sides of the banjo during the final assembly.

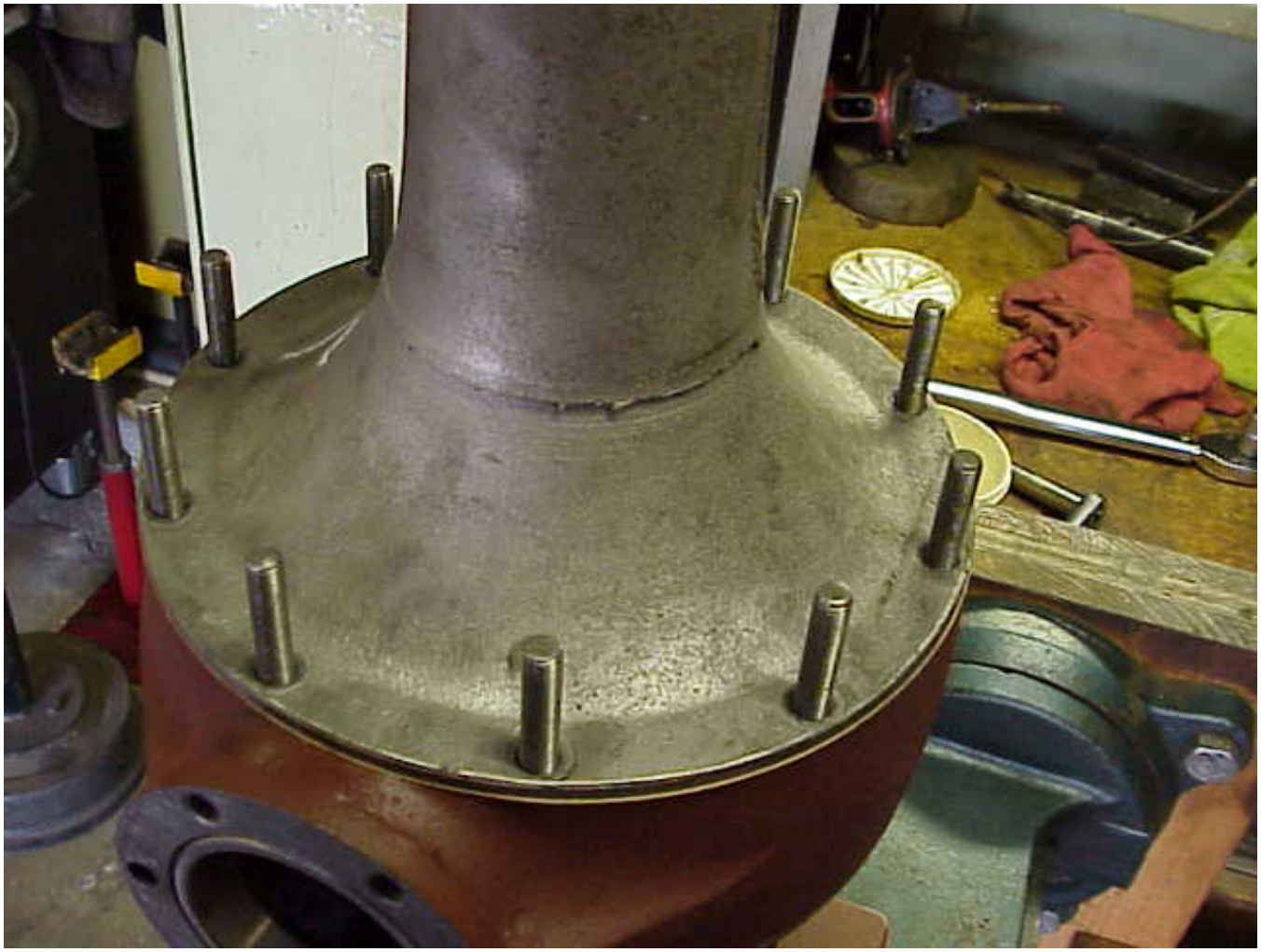


Photo P-30. The left axle housing is on top in the jig with alignment studs installed in the banjo: The studs will aid in the trial and error process of selecting the quantity and thickness of banjo gaskets required to set the pre-load.

Carrier pre-load adjustment: (Photos P-31, P-32, P-33, P-34, P-35, P-36, P-37)

Reach in through the pinion opening in the banjo and try to turn the ring gear. It should be locked up tight before you reach 35 ft. lbs. If it does not, remove the left axle housing and place shims behind either of the carrier bearings or the axle races. The purpose of the shim is to move the bearings and races closer together relative to the position of the junction of the banjo and axle housings. If you cannot lockup the ring gear you will never be able to achieve the desired carrier pre-load. The installation of the shims is a trial and error effort. After adding shims, bolt the left axle housing on again and check if you are able to lock up the movement of the ring gear. Once you have achieved this, remove the left axle housing and install a number of banjo gaskets between the banjo and the left axle housing. A very helpful tool is to obtain a length of **3\8-24** threaded stock and cut ten 2-inch long studs to be used as guides when installing banjo gaskets. Continue adding and subtracting gaskets until you can move the ring gear with your finger, or can measure 20-in. lbs. on a dial indicator using the spider yoke tool **(See Appendix B, carrier pre-load tool)**. This is also trial and error effort. If you are adjusting by feel, the ring gear should turn with some amount of force from your finger. If you cannot turn it, it is too tight, if it spins free, it is too loose. The correct pre-load is somewhere in between. Once you are satisfied with the pre-load, remove the left axle housing and the gaskets and set the gaskets aside. It is a good idea to write down the number and thickness size of each of the gaskets. During the final assembly the total quantity of these gaskets will be used on the two sides of the banjo. The

determination of how many on each side will be done later when the backlash adjustment is performed. Remove the carrier and both axle housings from the banjo.

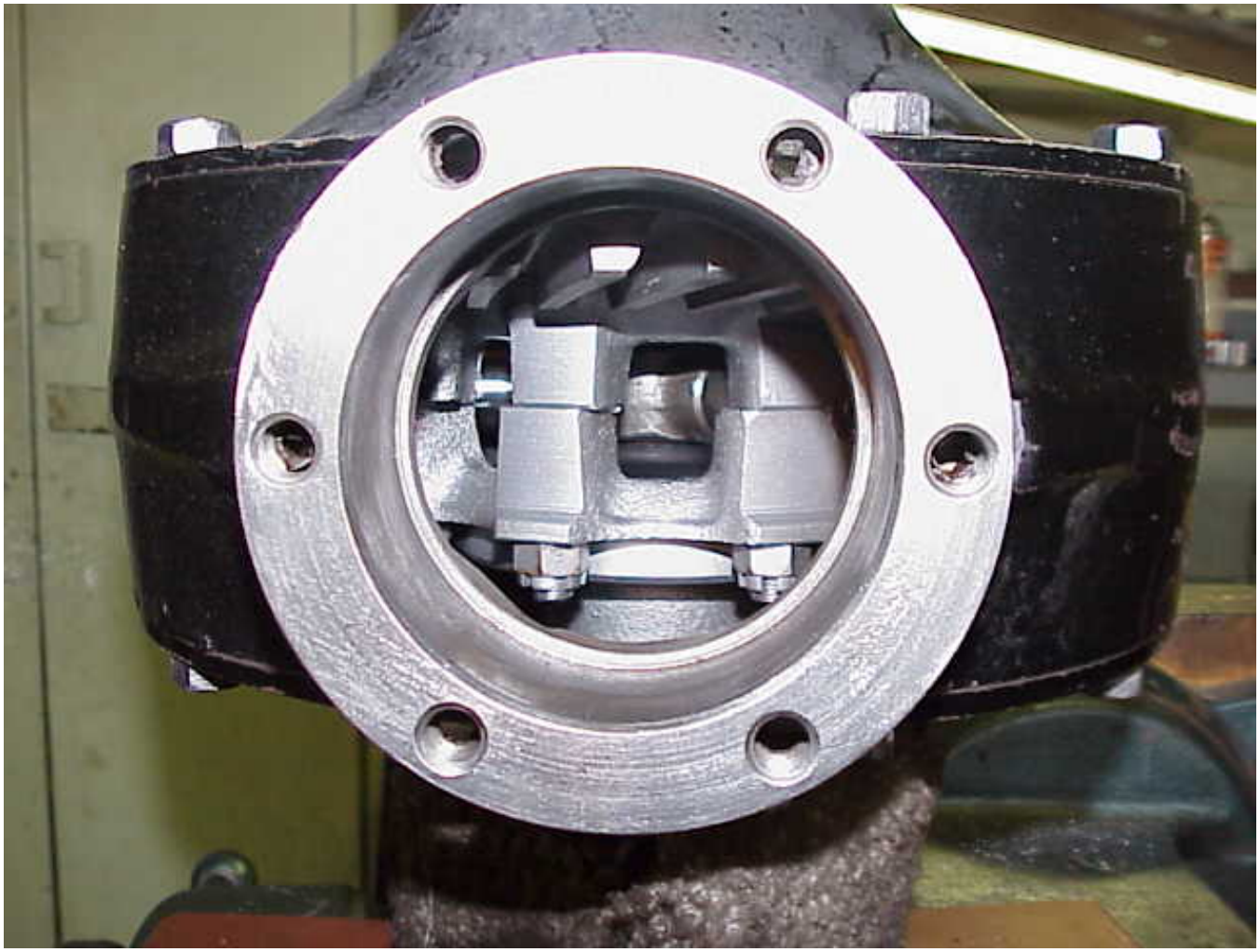


Photo P-31. Carrier pre-load adjustment without axle shafts and spider gears installed: During the pre-load process you can reach your finger in through the banjo torque tube flange and turn the ring gear. This will give you a ballpark indication that you are zeroing in on the pre-load. If the ring gear is locked or difficult to turn more gaskets will need to be added. With zero gaskets installed the ring gear should lock up. By adding gaskets the ring gear will become free to turn.



Photo P-32. Carrier pre-load adjustment: Add and subtract banjo gaskets on the left (top) side when the banjo is installed. Note the carrier half markers. These punch marks were in place when the rear axle assembly was taken apart. Center punch marks should not be made over the tunnel for any of the 9 carrier bolts as it will make it difficult to remove the bolt. Add the punch marks below and above the end of any of the three spider yokes.

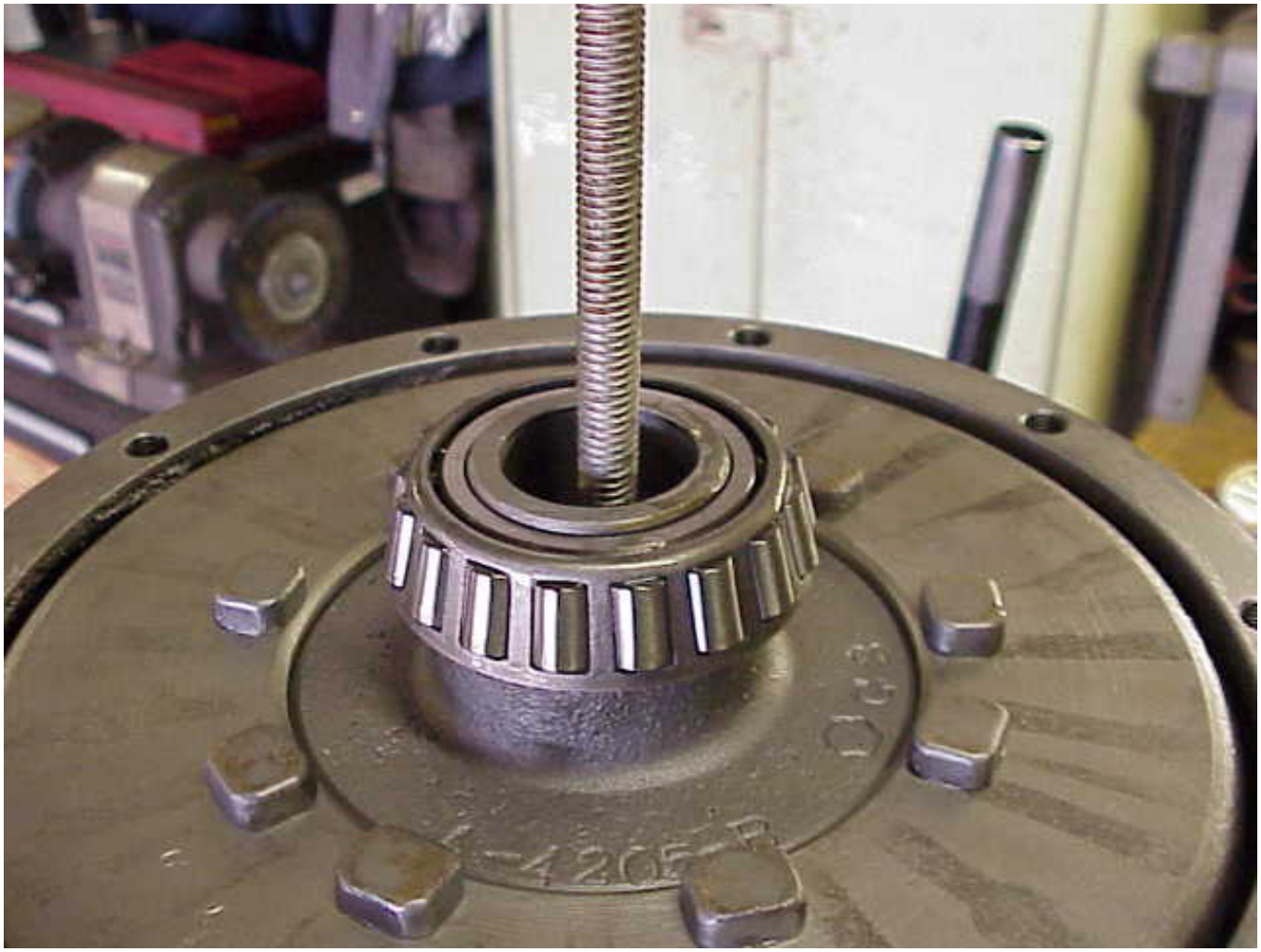


Photo P-33. The carrier pre-load measuring tool is inserted into carrier spider tool: The left axle housing has been removed to show that the pre-load tool shaft passes through the left axle housing and into the carrier where it threads into the modified spider gear yoke inserted between the two carrier halves. Turning the threaded shaft will rotate the entire carrier and ring gear assembly. The pre-load on the two bearings can them be read from a dial indicator torque wrench.

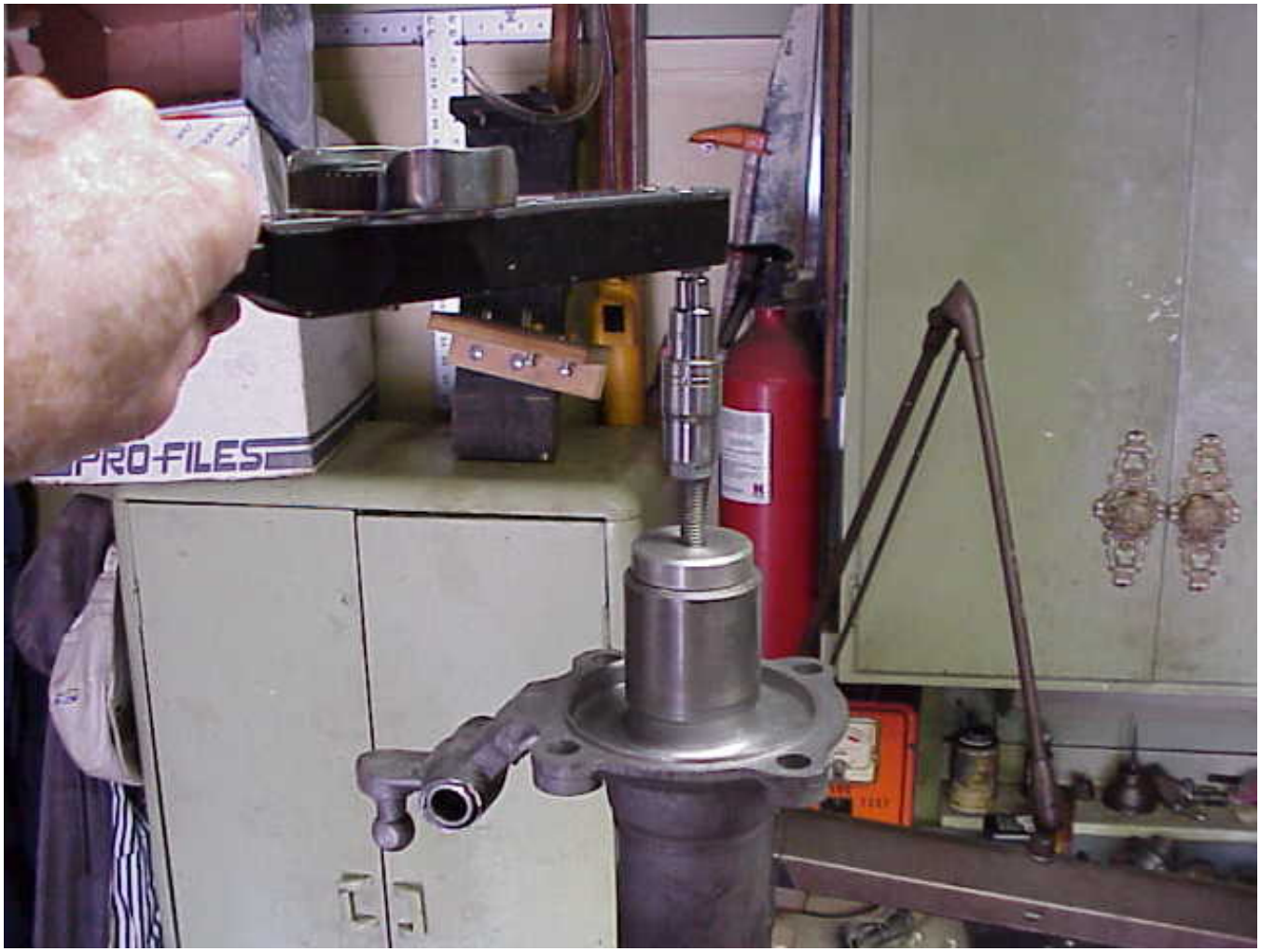


Photo P-34. Dial indicator torque wrench measuring carrier bearing pre-load: The desired measurement is 20 inch pounds.



Photo P-35. Dial indicator reading 20 inch pounds of torque:

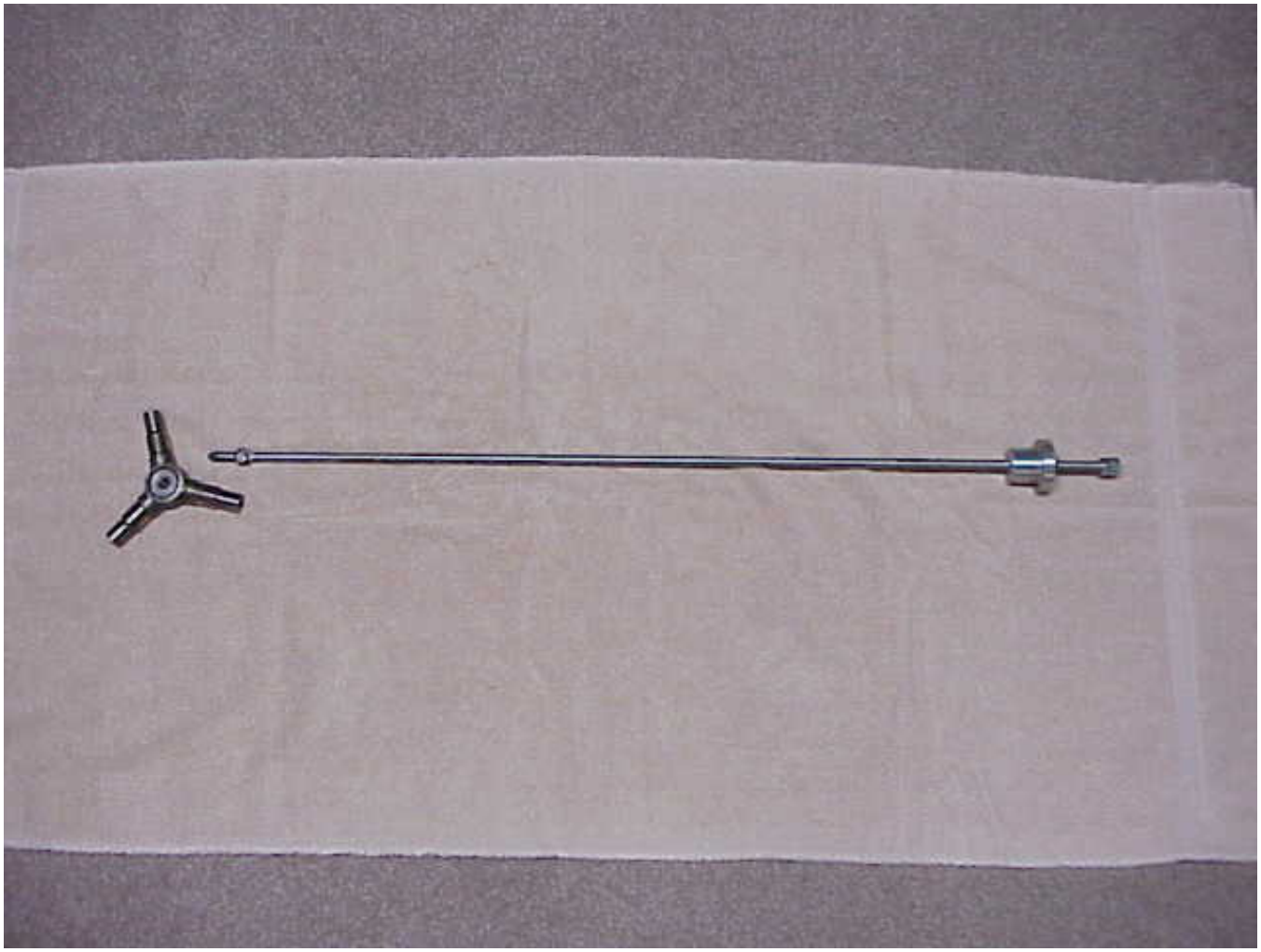


Photo P-36. Carrier bearing pre-load measuring tool: The modified spider gear yoke is temporarily installed in the carrier to accept the threaded shaft. The shaft turns the carrier and the torque reading is taken off the hex nut at the right end of the shaft.

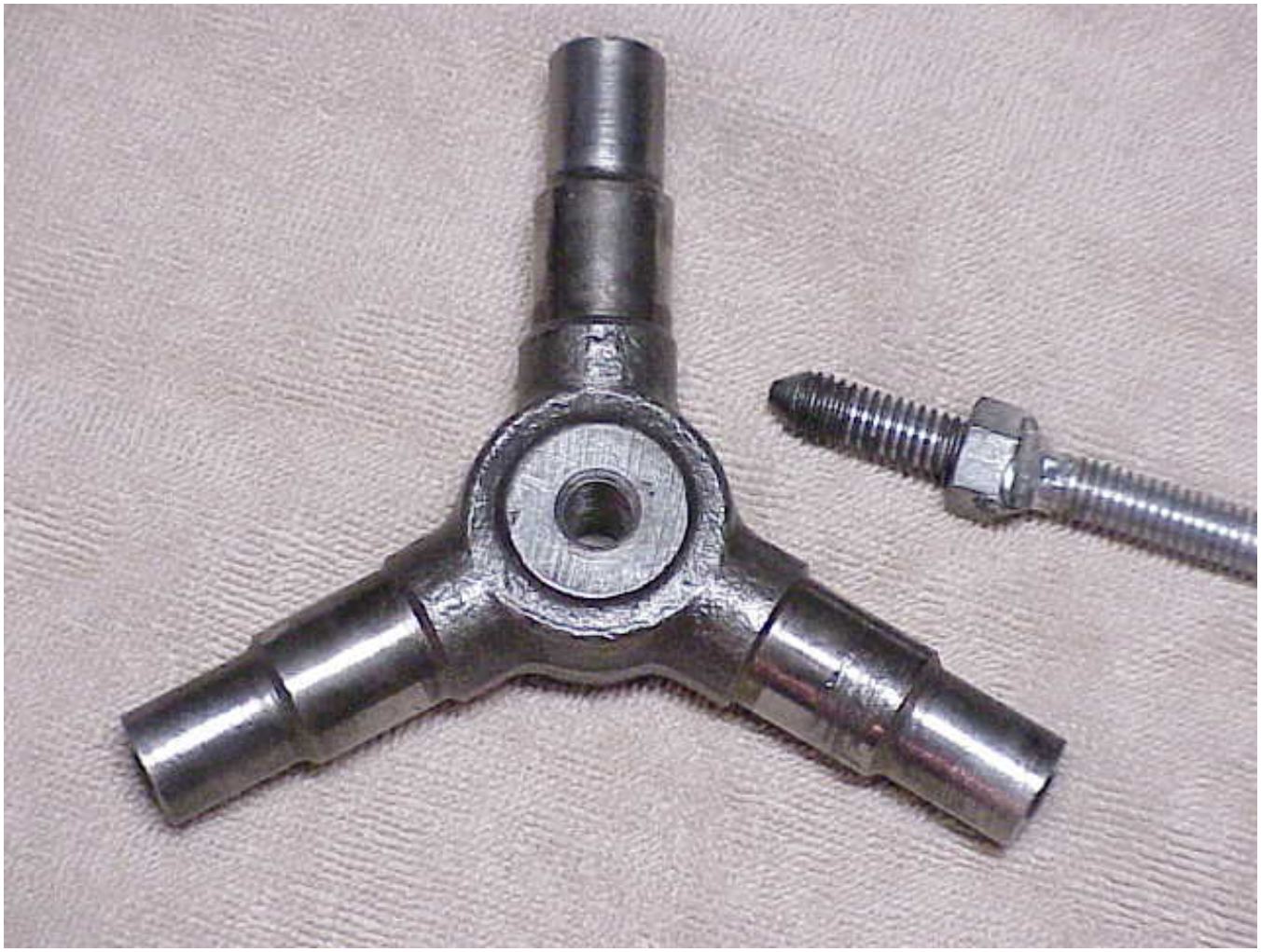


Photo P-37. Carrier bearing pre-load measuring tool: The spider gear yoke has been modified with a threaded hole that will accept the end of the threaded shaft.

Banjo race installation: **(Photos P-38, P-39)**

Press the double cone-bearing race into the banjo housing using a shop press. Do not set the bottom of the banjo on the surface of the press. The pressing action will distort the circular shape of the banjo to that of egg shape. Instead insert a metal plate through the axle housing openings and allow the banjo to hang over this plate while under the press. You can also place the old race that was previously removed on top of the plate at the backside of the banjo flange to add support while pressing in the new race.



Photo P-38. Installation of the banjo double bearing pinion race: The inside of the banjo where the race stop is located should be supported when pressing in the new double race. Placing the bottom of the banjo on the press platform will cause the banjo to become deformed.

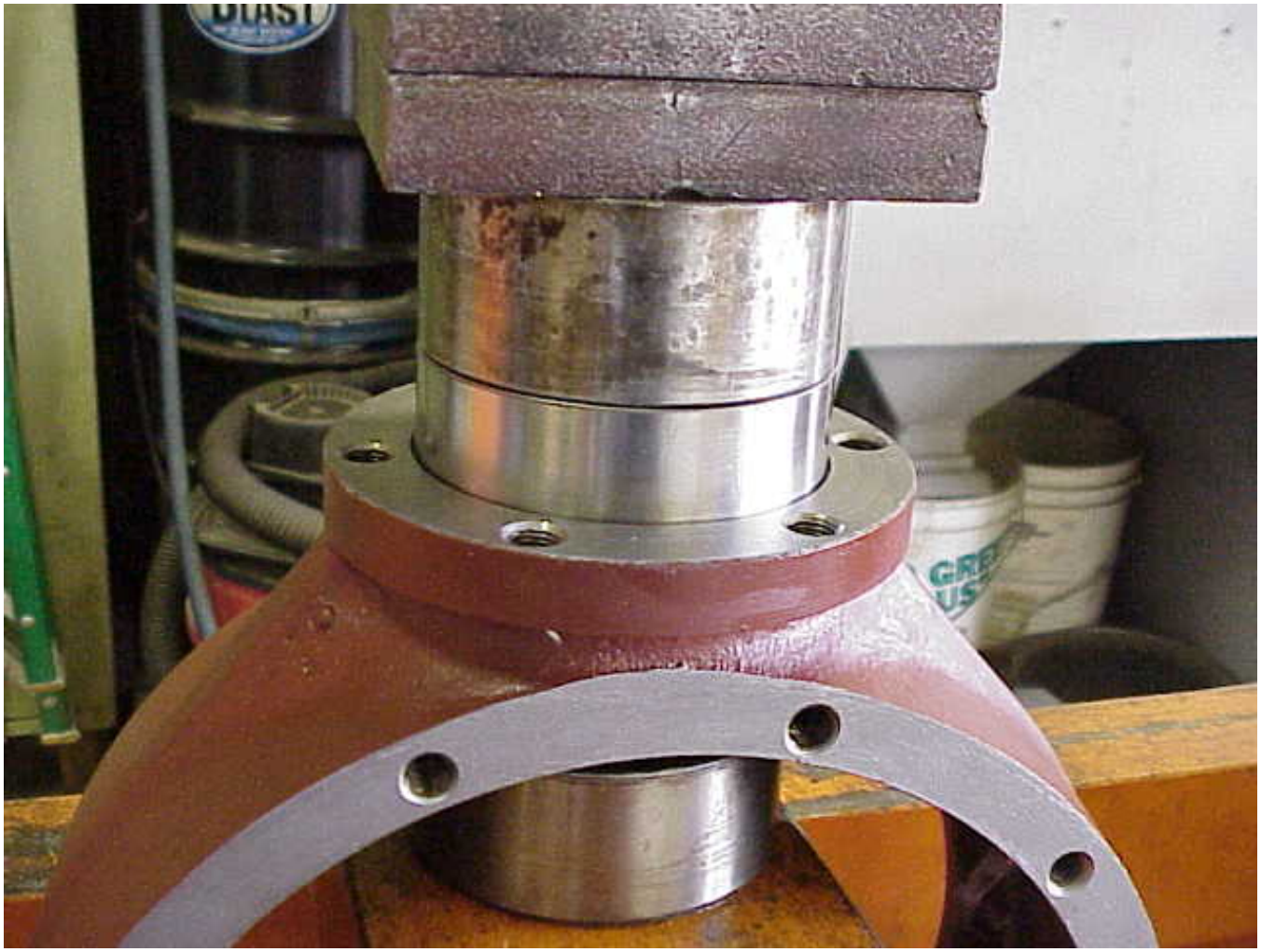


Photo P-39. Installation of banjo double bearing pinion race: Note the inside of the banjo is being supported at the back side of the race stop with a discarded banjo race with a small block of steel on top of it (not visible).

Pinion gear re-assembly: **(Photo P-40)**

Press a bearing onto the pinion gear sleeve using a shop press and a short length of pipe the diameter of the bearing inner mount. Press it down until it seats against the pinion gear. Place the banjo in a wood vice. Lubricate the bearings and race with 600W oil and assemble the pinion gear into the banjo race. The second bearing is an easier press on; it can be tapped on with a length of pipe and a hammer. Do not use one of the large nuts to pull it on as you can damage the threads on the pinion gear. Install the thrust washer onto the pinion gear sleeve. One of the large pinion gear nuts goes on next, followed by the tabular locking washer, followed by the second large nut. Run the nuts down to only snug.



Photo P-40. Installation of pinion gear rear bearing: The bottom (rear) bearing is pressed on with an interference fit. The pinion sleeve should have (an original does) two different dimensions on the sleeve of the gear. The dimension for the front bearing is slightly smaller to allow the bearing to be able to be snugly maneuvered during preload adjustment. The rear bearing should slide over the area of the first bearing before it encounters the second dimension where it will press on with an interference fit. Many reproduction pinion gears do not have the two dimensions on the sleeve and this will make it very difficult to achieve proper pinion bearing preload. Reproductions with only one dimension should have the area for the front bearing turned down slightly before installation is attempted. The difference in the two dimensions is .0015".

Special tools needed for pinion adjustment:

1. Two large pinion nut wrenches **(Photo P-41)**
2. A large pipe wrench.
3. An inch pound dial indicator torque wrench.
4. A 1-1\16 inch 6-point deep socket wrench (to fit over end of drive shaft spline).



Photo P-41. Two large Ford factory pinion nut wrenches:

Adjustment of the pinion bearing pre-load: **(Photos P-42, P-43)**

The pinion pre-load is set by the bottom large nut and locked in place with the top large nut. This can be a tedious task, with much trial and error. Insert the drive shaft (or an overdrive stub shaft) into the pinion gear sleeve using a new locking key. Note that the key used for the drive shaft is not the same as used for the two axles. The drive shaft key is part number A4606; the axle shaft key is part number A4243. Install the 15/16" hex nut onto the drive shaft, torque to 100 ft. lbs. and install the cotter pin. A note of caution, bend the legs of the cotter pin forward along side the nut, not over the end of the drive shaft, as it may interfere with the carrier. The drive shaft nut should be torqued before setting the pinion pre-load as it can increase pre-load if set before the nut is torqued. The pinion pre-load is also adjusted to 20-in. lbs. The trick is to set the pre-load low, to about 8-in. lbs., then when the lock nut is tightened the pre-load will increase, hopefully to the correct value. The pre-load adjustment is read off the dial indicator applied to the end of the drive shaft (or stub shaft). Rotate the torque wrench smoothly. Some amount of fluctuation is unavoidable. When the pre-load is set, bend two ears of the large locking washer over, one in each direction. Beware of reproduction locking washers. Some have oversize ears that will scrape on the inside of the torque tube and make a lot of noise.

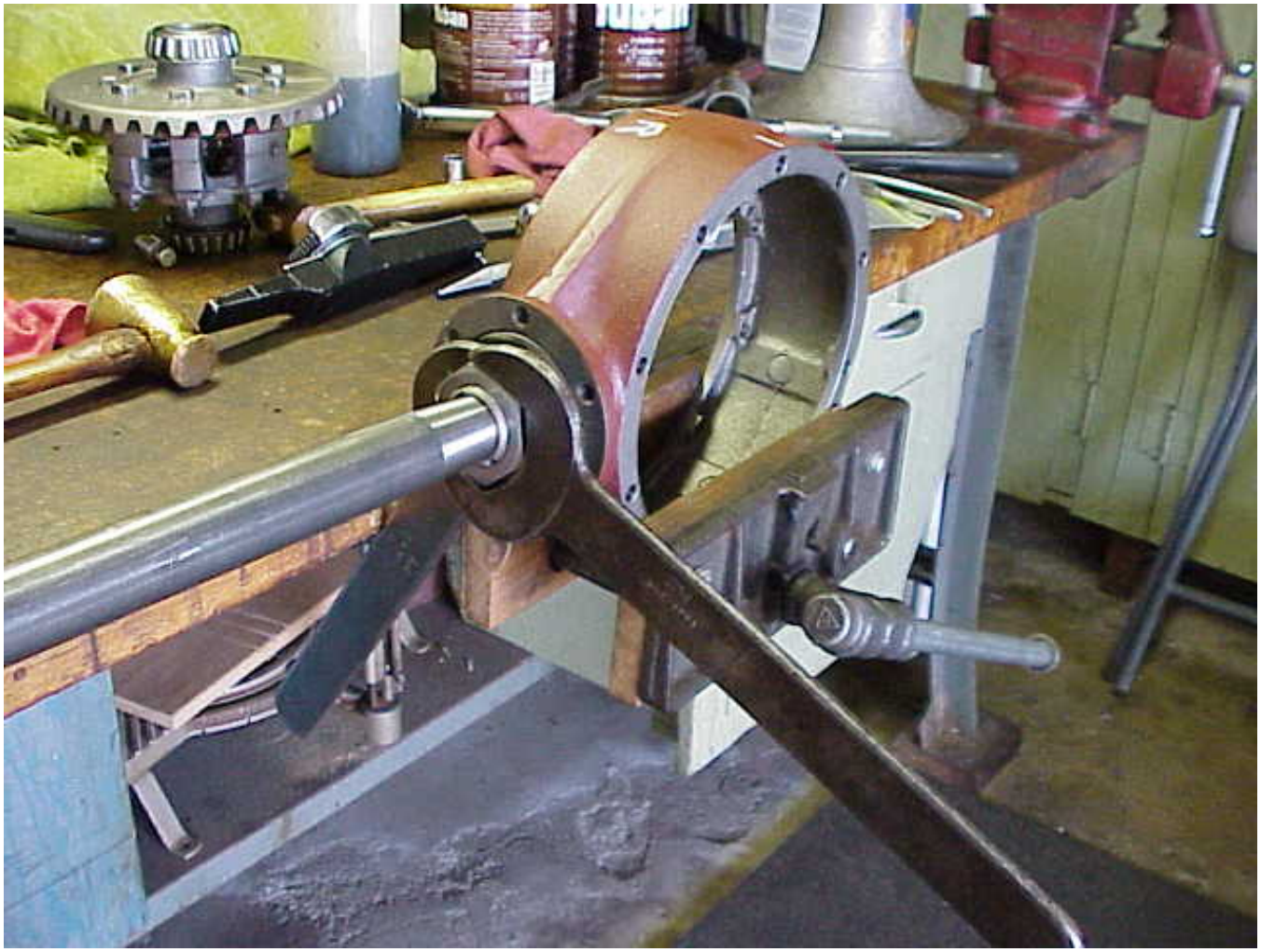


Photo P-42. Adjustment of pinion bearing pre-load: The inboard nut is held with the wrench on the left locked against the workbench. The nut on the right is used to tighten the outboard nut up against the inboard nut to lock it in place. A pipe wrench is also used to hold the drive shaft from turning. This can be accomplished by one person. The pre-load setting can increase as the nuts are tightened. For this reason the pre-load should be set lower than 20 inch pounds initially before tightening the outboard nut. This is a trial and error effort and it can be frustrating. This is the reason there should be two dimensions on the pinion gear sleeve so that the front (outboard) bearing can snugly slide back and forth as required to set the pre-load..

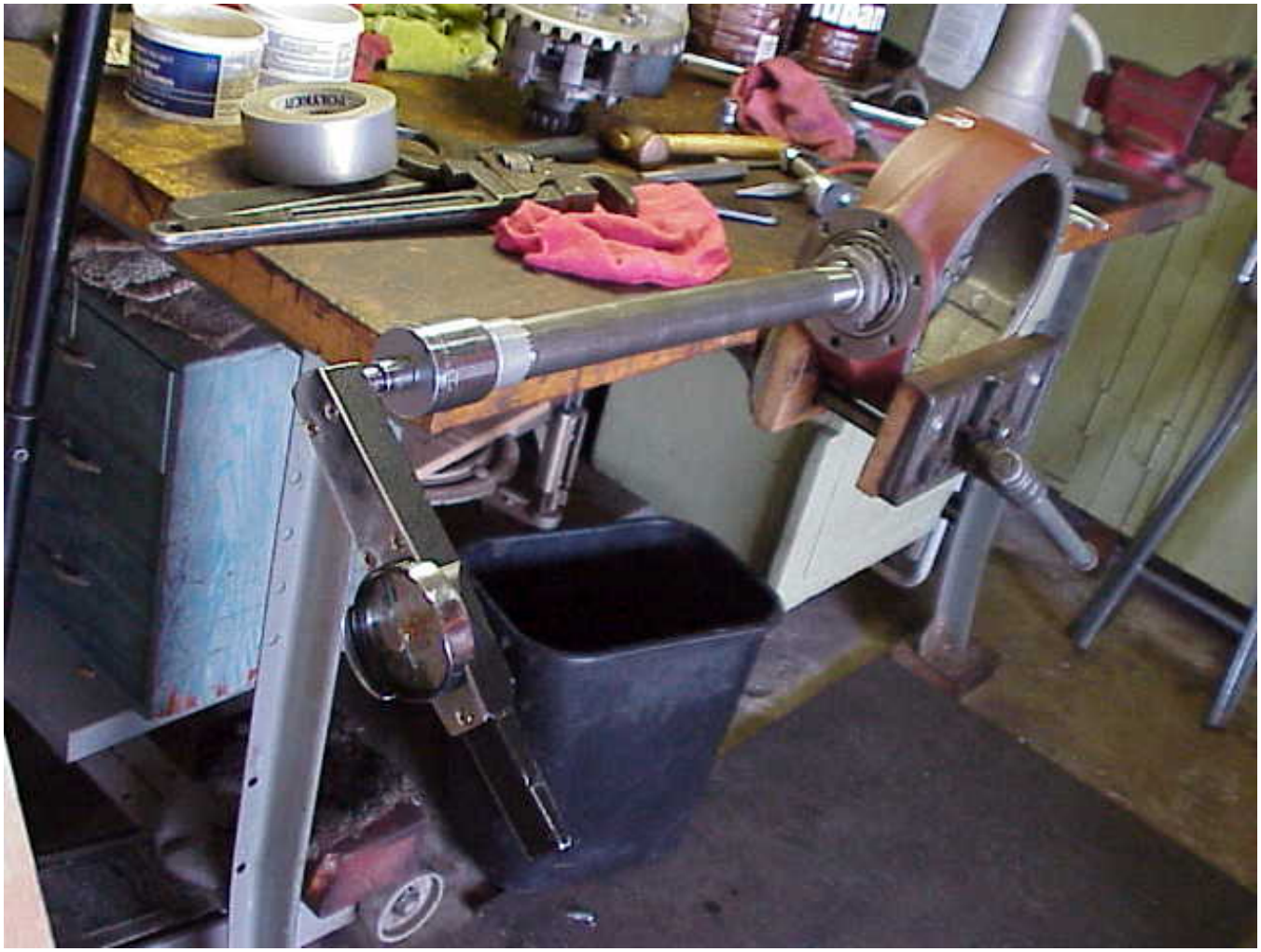


Photo P-43. Adjustment of pinion bearing pre-load: The adjustment of this pinion pre-load is being done with a Mitchell stub shaft installed. In this case duct tape was applied to the spline on the end of the shaft and a 36mm socket was pushed on over the end of the shaft. A 1&1\16" six-point socket is used over the end of a standard Model A drive shaft to set the pre-load.

Backlash adjustment:

The backlash adjustment is best done before the axles are installed in the carrier. Reassemble the banjo and axle housings as before with the carrier inside. Place all of the banjo gaskets previously selected on the two sides of the banjo temporarily with an educated guess. This will also be a trial and error effort. The backlash adjustment is made by shifting the number of banjo gaskets between the right side of the banjo and the left side of the banjo. These are the quantity and thickness of gaskets that were previously determined to be required to set the pre-load on the carrier bearings. The more gaskets installed on the right side of the banjo, the less backlash there will be. The more gaskets installed on the left side of the banjo, the more backlash there will be. The gaskets are essentially moving the ring gear laterally in relationship to the fixed position of the pinion gear. Use only the gaskets previously determined during the carrier pre-load adjustment. Do not add or subtract any gaskets. Some books say that backlash can be as great as .020, other say that .010 is the max. The desired backlash is sometimes difficult to achieve since you are working with a fixed number of gaskets as determined by the carrier pre-load adjustment. You also do not want to end up with no gaskets at one side of the banjo or you will have an oil leak. Generally you may end up with more backlash than you want. This is usually due to the wear in a used ring & pinion gear set, and it cannot be avoided. You

also do not want to end up with no backlash. When that is the case the gears are bottoming out and are binding. Always provide at least some amount of backlash in the gears. You can also experiment by moving any shims you placed under the bearings or races from side to side. The backlash adjustment is the least critical of all the adjustments but it can be very tedious and time consuming, as you will be taking the assembly apart numerous times. The end result should be some amount of play as you rotate the drive shaft back and forth slightly by hand to feel the amount of space between the gears. This is called backlash. Once the backlash has been achieved disassemble the banjo and axle housings and make a note of the number and quantity of banjo gaskets that will be placed on the two sides of the banjo during the final assembly.

Final carrier reassembly: **(Photo P-44, 45, 46)**

Disassemble the carrier and remove the spider yoke or the spider yoke tool that was temporarily installed. Install the spider yoke with the three spider gears, along with the two axles into the carrier halves. Lubricate the parts with 600W oil while assembling. Install and torque the nine nuts and bolts to 35 ft. lbs. and install safety wire. Grab hold of each axle, one in each hand, and make sure that each turns freely in the assembly in opposite directions. There should be no binding.

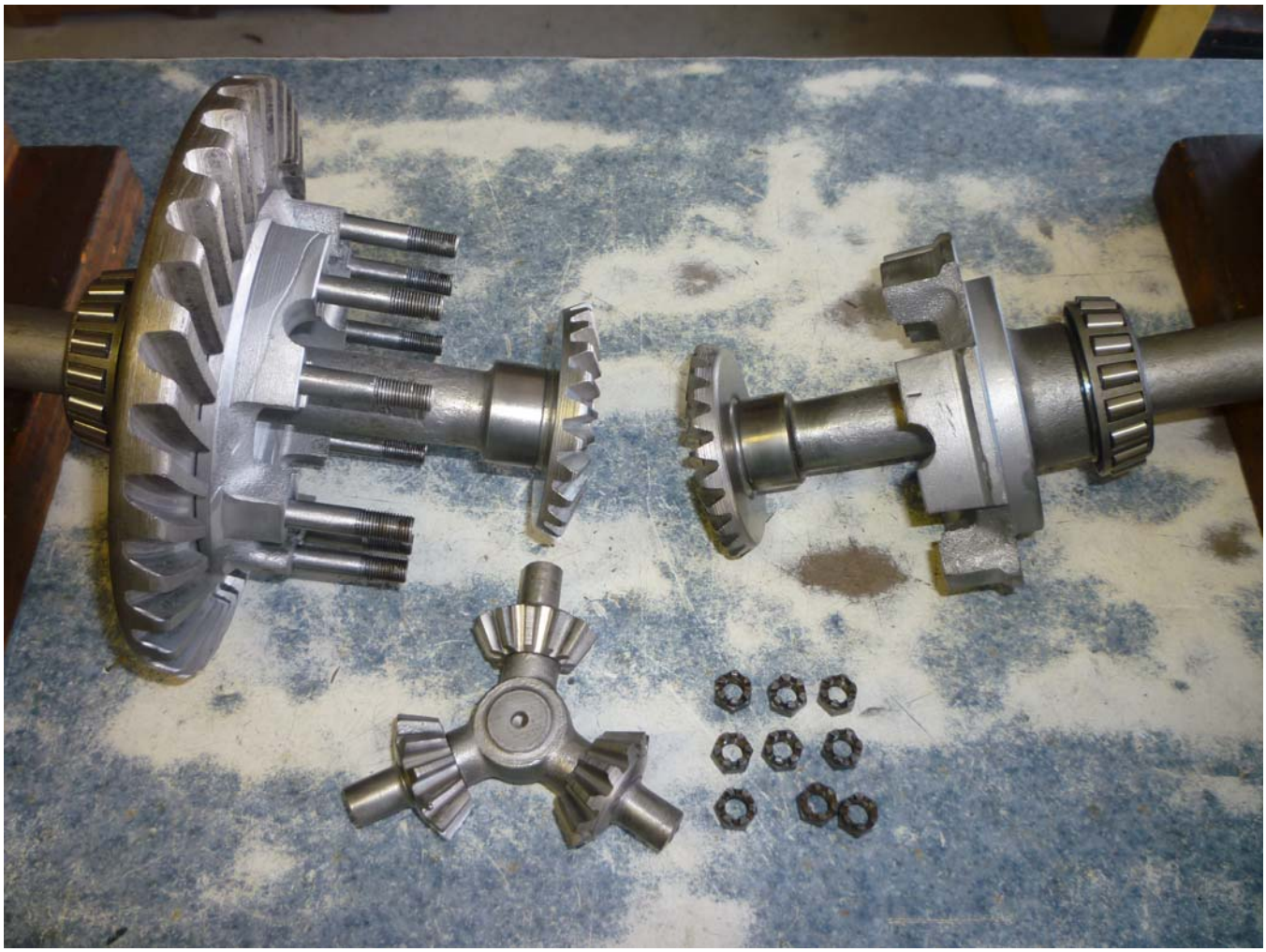


Photo P-44, The two carrier halves are re-assembled with both axles and the spider gears installed.



Photo P-45. Final assembly of carrier: The axle shafts and spider gears are installed: The 9 bolts are torqued to 35 ft. lbs. and safety wired. Rotate both axles by hand in opposite directions to ensure there is no binding. Note: Some reproduction axles will bind inside the carrier because they are made incorrectly.



Photo P-46. The nine carrier bolts are torqued to 35 ft. lbs. and safety wired.

Final differential assembly: (Photo P-47)

Make certain the axle seals are installed in the axle housings before you proceed. Be careful inserting the axle shafts into the axle housings, so as not to damage the seals. It is best to apply a coat of grease to both axle shafts. Bolt the right axle housing onto the right side of the banjo using the selected number of gaskets. Here is where the ten threaded studs come in handy if you are installing multiple gaskets. Do not use a silicon type gasket sealer, as it tends to allow the gaskets to squeeze out of place. I recommend Indian Head shellac gasket sealer. Place the right axle housing and banjo vertical in the wood vice or holding fixture. Install the axle and carrier assembly in from the left side. It is important to understand that it is possible to install the ring gear on either the right or left side of the pinion gear. It must go on the left side (driver's side), if you install it on the right side, the car will operate with one gear forward, and three gears in reverse. Install the left axle housing onto the banjo with the selected number of gaskets. Use Indian Head gasket sealer. Torque all 20 banjo bolts to 35 ft. lbs. Remove the assembly from the holding fixture and set it in a horizontal fixture or on some wood blocks on the floor. Rotate the drive shaft with the 1-1\16 in. socket and check for any binding as it rotates. It should rotate smoothly.



Photo P-47. Indian head gasket Shellac compound is recommended for use on the banjo gaskets. Coat each side of all gaskets used during final assembly.

Torque tube grease seal installation:

The same procedure is used to install the torque tube seal as with the axle seals. Stand the torque tube in a vertical position on a concrete floor with the front end up. Use the same type of seal insertion tool on a shorter length of pipe. It will take about the same six hammer blows, and the sound will change to a ringing sound when the seal is seated fully. Make sure to keep the tool centered while driving it in.

Torque tube roller bearing race installation: (Photo P-48, P-49)

Before attempting to install the bearing sleeve, make absolutely certain you have already installed the new grease seal. It will be difficult to get the sleeve back out if you forgot. The bearing sleeve is split down one side. Put the sleeve in a vice with the protruding dimple facing up and tighten until the two sides of the sleeve are almost together. Wrap a piece of safety wire around the sleeve just under the dimple (I use .040 safety wire). Twist the ends of the safety wire together and bend the end so that it faces straight up. When you remove the sleeve from the vice the split will open up slightly, but it won't be a problem. Put a chalk mark on the top edge of the sleeve right above the dimple. Put another chalk mark on the top of the torque tube right above the slot the dimple is to seat in. It is important that you place these two chalk marks accurately. Lubricate and set the sleeve down inside the top of the torque tube and align the two chalk marks. Take a large socket (I use a 36 mm ½ inch drive socket) and attach an extension to it upside down. With the flat part of the socket against the top of the sleeve, gently tap the end of the extension with a hammer to insert the sleeve down into the torque tube. As the sleeve goes into place it will push the safety

wire up and over the dimple and to the top of the sleeve. Remove the safety wire and discard it. Check to make certain that the sleeve is properly seated. There should be a visible gap where the two sides of the split come together. There should be no visible gap around the circumference of the sleeve. If there is, it means that the dimple did not properly seat in the slot. You may have to tap it in more. Insert a punch in through the speedometer housing slot and into the dimple. Tap it with a hammer several times to positively seat it. If you were off to the side of the dimple by a large margin the dimple will not drop into the slot and there is no way you are going to rotate it. The only alternative is to start over by driving the seal and the sleeve back out. Another method of removing and installing the bearing race sleeve is to use a K. R. Wilson tool made for the purpose.



Photo P-48. Installation of torque tube roller bearing race: Squeeze the sleeve slightly in the vice to bring the split together. Wrap safety wire around it. Put a chalk mark on the top edge right above the dimple. Note dimple on the lower right side of the sleeve.



Photo P-49. The K. R. Wilson tool is used to remove and install the bearing race sleeve in the torque tube: This is an alternate option if the tool is available.

Reproduction bearing and race:

It is best to try to use an original torque tube bearing race sleeve. The reproductions are not very good. The bearing surface is very course, it is not hardened, and the dimple is not formed well. It will want to hang up the safety wire and it can also allow the sleeve to slip down past the slot and go too far into the torque tube. The same applies to the roller bearing; an original is preferable to a reproduction. The originals have spiral slots in the roller elements, the reproductions do not. In recent years Bratton's Antique Auto have been marketing a reproduction sleeve that they are having made from the original Ford drawing and they are a reasonably good reproduction.

Torque tube installation: (Photo P-50)

Place a gasket on the banjo torque tube flange with the notched side down and slide the torque tube on over the drive shaft. Orient the torque tube so that the hole at the front for the radius rods faces down. Install the six flange bolts and torque to 35 ft. lbs. Install safety wire. Six of the banjo bolt stud tools can be used to aid alignment.



Photo P-50, Safety wire the torque tube: There are a number of safety wire techniques. It is unknown to me how Henry did it. Most I have seen were a sloppy zigzag technique. My method is to form a perfect circle that looks very neat. This requires that the wire holes in the head of the bolt be lined up correctly. To achieve this I have a sufficient quantity of original torque tube bolts that are installed on a trial and error basis to line the bolt holes up properly and have the bolts tight.

Roller bearing and speedometer drive gear installation:

Pack the roller bearing with grease and slide it onto the drive shaft and down into the race. Slide the thrust washer on next followed by the speedometer drive gear. The drive gear goes on with the collar end in first. It can only go on one way; it is impossible to install it backwards. Slide the snap ring on last and into the groove of the drive shaft.

Speedometer gear housing installation:

Coat the speedometer gear with grease and install the housing onto the torque tube with the cable head end pointing toward the right side of the car. A gasket goes on under the housing. Install the two 7\16" hex bolts and lock washers. Care should be taken when installing the speedometer housing, rotate the drive shaft before tightening the bolts to be certain the drive gear and driven gear of the assembly are in mesh. It is very easy to crack the speedometer housing if not installed correctly.

Painting:
The entire assembly (axle housings, banjo, and torque tube) should be painted gloss black as a unit when it is completely assembled. This includes painting of the 20 banjo bolts, the 6 torque tube bolts, and the safety wire installed through the torque tube bolts. I leave the speedometer housing off until the rear axle assembly is painted.

Remember to put 600W oil in the banjo

It is prudent to hang a tag on the assembly with the following notation: leave the tag in place until the assembly is installed in the car and is oil serviced.

"No Oil In Banjo"

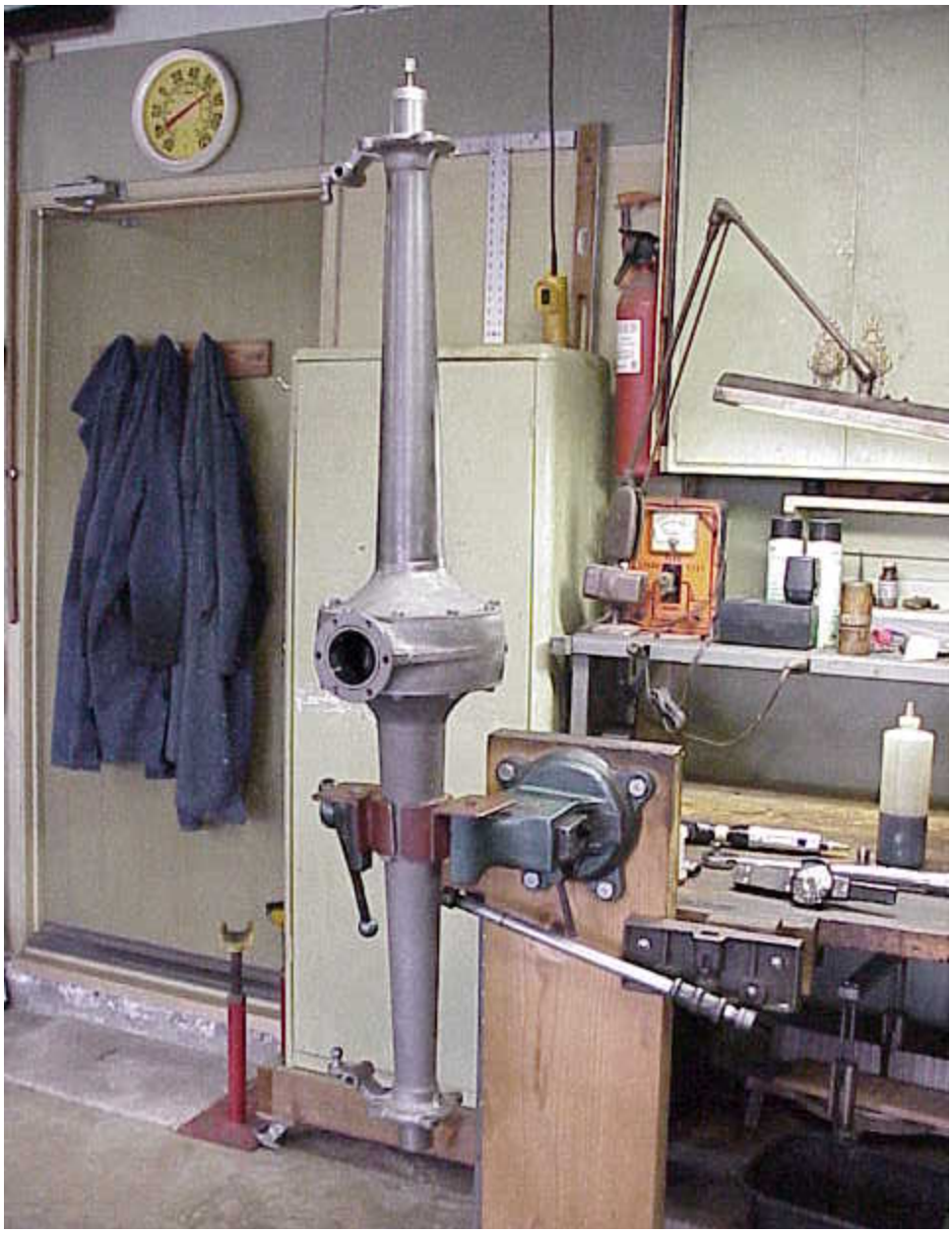


The Rear Axle Assembly Restoration is Complete!

Appendix A
Differential Assembly Fixture

The vertical mounting fixture:

The rebuilding of a Model A Ford differential is better accomplished if it can be mounted in some type of vertical fixture. The **right** axle housing is clamped in the fixture. The banjo and the **left** axle housing can be installed and removed with little effort. After both pre-loads and the backlash adjustments have been accomplished the differential is completely assembled in the fixture minus the torque tube. Directly above the fixture is a small electric hoist used to lift the differential out of the fixture and set down into the differential cradle tool. The differential shown in the photo has the carrier pre-load tool inserted in the top of the **left** axle housing.



Vertical Mounting Fixture

Appendix B
Carrier Bearing Preload Tool

How to make the tool:

A carrier pre-load adjustment tool can be made from a discarded spider yoke, part number A4211. Drill a hole through the center with it mounted on a lathe. It is important to have the hole perfectly perpendicular to the three gear shafts on the spider yoke. Tap the hole was for a **3/8-16** thread. Obtain a three-foot length of threaded stock from a local hardware store; make certain it is perfectly straight. Also purchased three hex nuts. Make an aluminum insert plug on a lathe with a flange on it that will fit snugly into the opening of the axle housing where the axle protrudes out. Drill a hole in the center of the plug to allow the threaded stock to slide through smoothly. Cut the threaded stock to a length of 31". Chamfer one end and run a hex nut on about one inch from the end and tack weld in place. Slide the threaded stock through the insert flange and Install the other two hex nuts on the opposite end of the threaded stock and lock them together.

How to use the tool:

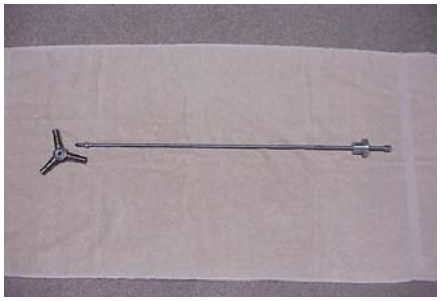
Bolt the two differential carrier halves together with the modified spider yoke inside and without the axles and spider gears installed. Proceed in the normal manner to determine by feel the number of banjo gaskets needed to get the bearing pre-load somewhere in the ballpark. When that is achieved insert the chamfered end of the threaded stock down through either axle housing. Screw the end of the stock into the threaded hole in the yoke until it bottoms. Slide the insert flange into place in the end of the axle housing opening. The purpose of the insert flange is to align the threaded stock in the center of the housing in line with the hole in the yoke. Now it is an easy task to place the socket of a dial indicator torque wrench over the top nut and rotate it for a torque reading. Add or subtract banjo gaskets until you reach the desired reading of 20-in. lbs.



Carrier yoke (A4211) tool



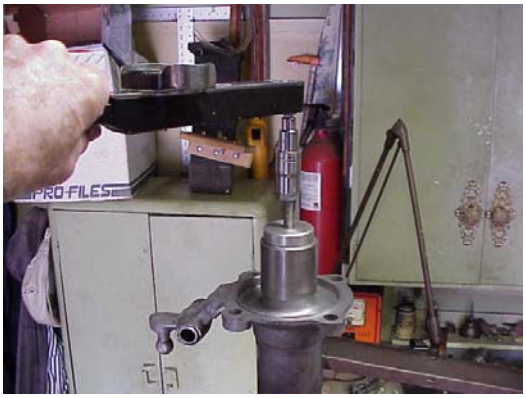
Insert and threaded shaft



The complete tool



Carrier pre-load tool inserted



Measuring carrier pre-load

Appendix C
Differential Carrier (Early & Late)

Description:

The differential carrier is the device the ring gear is bolted to and it is located inside the rear axle assembly. There are two halves to the carrier assembly. Inside the two halves is located the three spider gears and the gear end of each rear axle. There are nine carrier bolts and nuts that hold the two halves together. There is an early version and a late version. Either can be interchanged as a complete assembly.

Early Carriers:

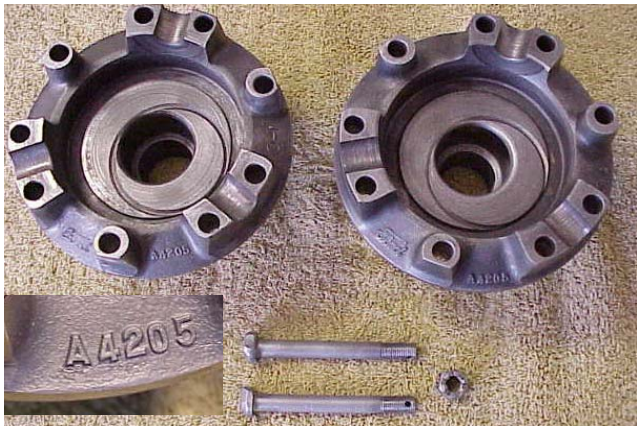
The early carriers used at the beginning of production are identical halves. Each half is the same part number A-4205. The ring gear can be installed on either half. Where the two halves join together the mating surfaces are not notched. They join together flush with one another. The nine bolts have a half round domed head. The head of the bolts go on the carrier half on the opposite side from the ring gear. The flat side of the domed bolt head fits up against the machined surface where the ring gear would install if this half were used for the ring gear side. This prevents the bolts from rotating when the nuts are tightened. The nine nuts mount flush against the ring gear surface. Early carrier halves are not interchangeable with the later halves.

Later Carriers:

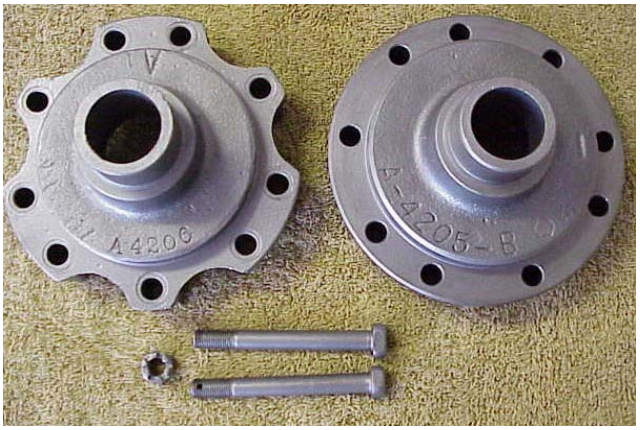
The later carriers were introduced some time after production began. The two halves are not identical and each half has a separate part number. The ring gear side is part number A-4205B and is the only side the ring gear will fit on. The opposite side is part number A-4206. The ring gear will not fit on this side. The surface where the two carrier halves join together is notched so that they lock together when joined. The nine mounting bolts have a flat rectangular head. The bolt head goes on the ring gear side with the bolt head flush against the ring gear surface. The nine nuts go on the A-4206 carrier. The nine bolts are able to rotate when tightening so it is necessary to hold the bolt head in place while tightening the nuts to line up the safety wire holes.

Nuts & Bolts:

The nine nuts and bolts used in ether assembly are a 3/8-24-thread size. The early and late bolts are not interchangeable; the nine castellated nuts are the same for both. Early and late carrier bolts should all be torqued to 35 ft. lbs. and then safety wired. The domed shaped bolts used in the early carriers lock into place and the safety wire holes in the end of the bolts will line up automatically.



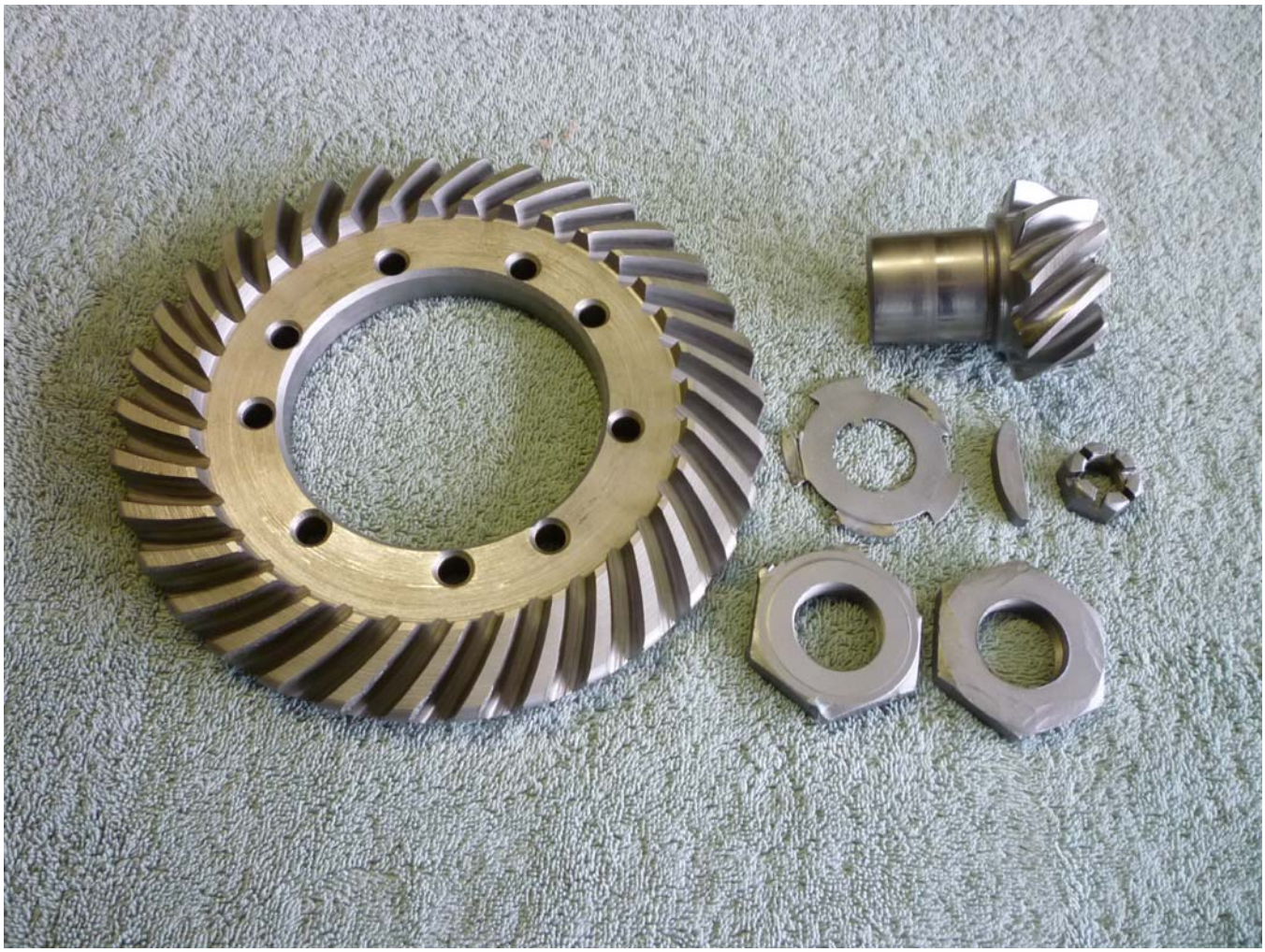
The Early Carrier A4205



The Late Carrier A4205-B and A4206

Appendix D
Early Ring & Pinion

The early cars, from the beginning of production until mid 1928 used a very different style ring & pinion gear combination than is found in the later cars.



The early ring gear looks the same as the later; however, the pinion gear is very much different. Note the pinion gear sleeve does not have threads on it for the two large nuts used to set the pre-load. The early pinion nuts are smaller than the later, as is the tab washer. The pinion gear is installed on the drive shaft with a woodruff key instead of a locking key.



The early drive shaft is threaded to accommodate the two pre-load nuts. The nuts and tab washer must first be installed on the drive shaft before the pinion gear and bearing assembly are installed. Note the drive shaft is machined for a woodruff key instead of a locking key.



The later pinion gear has a longer sleeve and has the threads the two pre-load nuts and the tab washer install on. The later pinion gear also uses a thrust washer inserted between the front bearing and the first nut. Note the later nuts and washers are much larger than the early. The later drive shaft does not have threads on it and is machined for a locking key.



Drive shaft used with the later style pinion gear.



Comparison of early and late pinion gears: Early on the left, late on the right.

At the beginning of production the ring & pinion gear ratio was 370:1 (10-37). When the change was made to the later style ring & pinion the ratio was changed to 378:1 (9-34).

A service bulletin was issued in March 1929 to accommodate replacement parts for the early cars. The gear ratio of the early pinion gear was changed from 370 to 378 (from 10 teeth to 9 teeth) so it could be mated up to the later style 34-tooth ring gear. I have personally encountered both 370 and 378 ring & pinion ratios of the early style. The photos in this article are of the early style replacement 378 ratio ring & pinion gear set.

The Service Bulletin, March 1929, page 327.

DIFFERENTIAL DRIVE GEAR AND DRIVING PINION

To simplify production of gears and pinions we have discontinued manufacture of the A-4209AR, gear and pinion, 10-37 ratio, and will hereafter supply a 9-34 gear and pinion under part number A-4209AR.

Note that Ford retained the same part number even though they significantly changed the part.

Mitchell overdrive:

The Mitchell overdrive stub shaft is not compatible with the early pinion gear. When encountering one of these early cars it becomes necessary to replace the ring & pinion with that of the later configuration in order to install the overdrive.

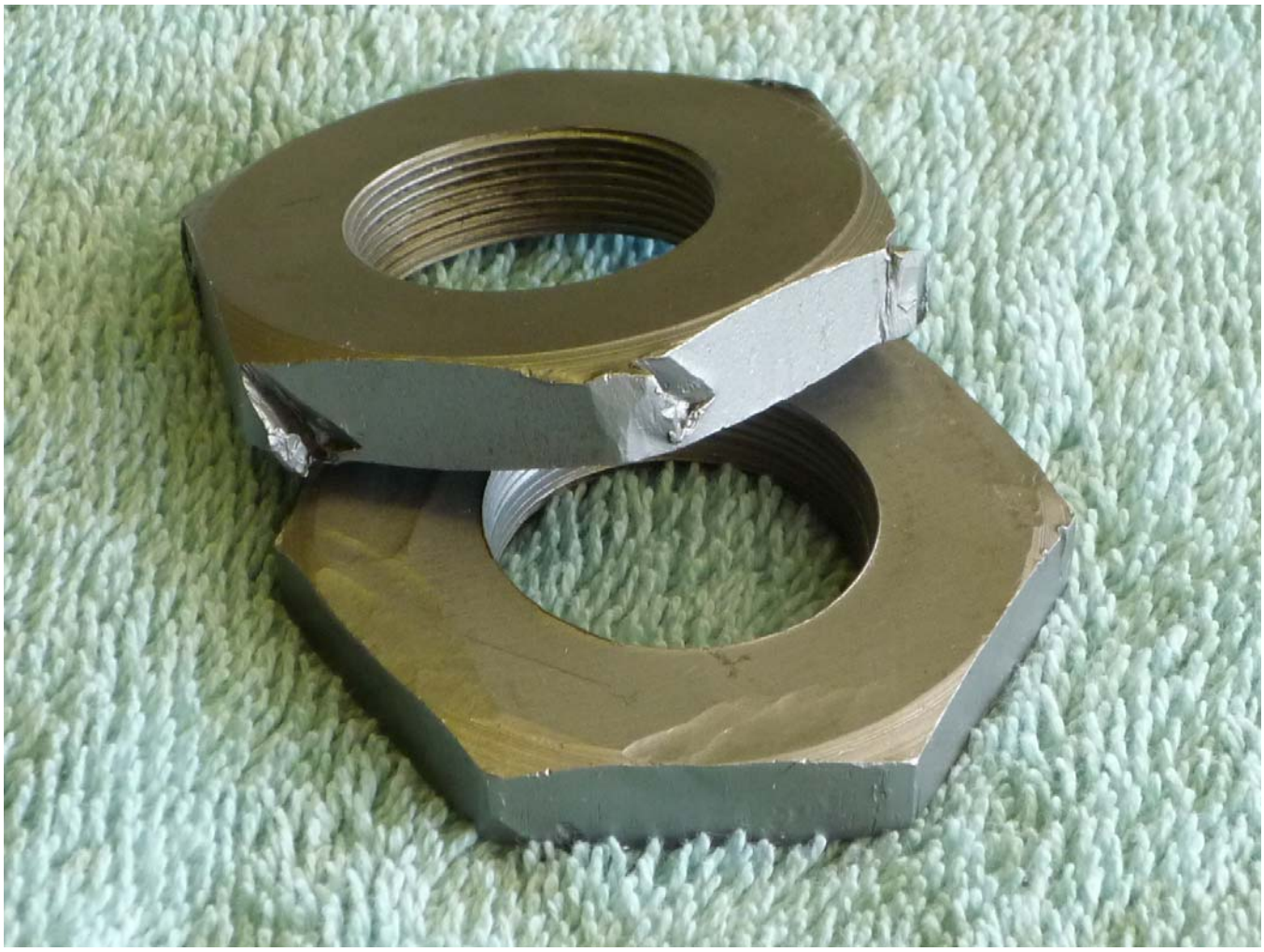


Mitchell overdrive stub shaft with later pinion gear assembly:



Ford factory wrenches used to set the pre-load on the later pinion gear assemblies that use the larger pinion nuts.

Though the late and early pinion pre-load nuts differed in size, they had one thing in common. Most seem to have been molested with a chisel over the years by people attempting to set the pre-load without using the proper wrenches.



Early pinion nuts molested with a chisel.

Suppliers today only stock the later configuration ring & pinion gear set. When a failure occurs to the early style ring & pinion gear set it is necessary to replace the ring & pinion with the later style. The drive shaft also has to be replaced with the later style, along with the later larger pre-load nuts, tab washer, and thrust washer.