

Introduction

The T90 is as much a tradition as it is a transmission for classic Jeep people. It is a legendary gear-box and surprisingly tough. However, a couple of the T90's kinks are a bit legendary themselves and your Novak rebuild kit contains items not just for a standard rebuild, but to make lasting improvements over factory units. After 45 years of rebuilding these transmissions, we've assembled the most complete master rebuild kits available anywhere.



About the T90 Transmission

The Borg-Warner T90 transmission was one of the most common transmissions found in 1946 to 1971 Jeeps. Because of its long production span, it is nearly legendary. It is a good transmission when well maintained and has often been adapted to V8, V6 and I4 power.



The T90 was the improved progeny of the T84, of military MB & GPW fame. The T90 was the standard three-speed as found in CJ Universals, Utility Trucks & Wagons, J Series and Forward Control Trucks.

Features

The T90 is a top loaded, top shifting or side shifting transmission. It is synchronized in the second and third gears. All gears are helically cut except first and reverse, which are spur gears.

Identification

The T90 transmission is 9" long and features a cast iron top cover that is retained by six bolts and a main case of cast iron. The case itself has a prominent bulge on the

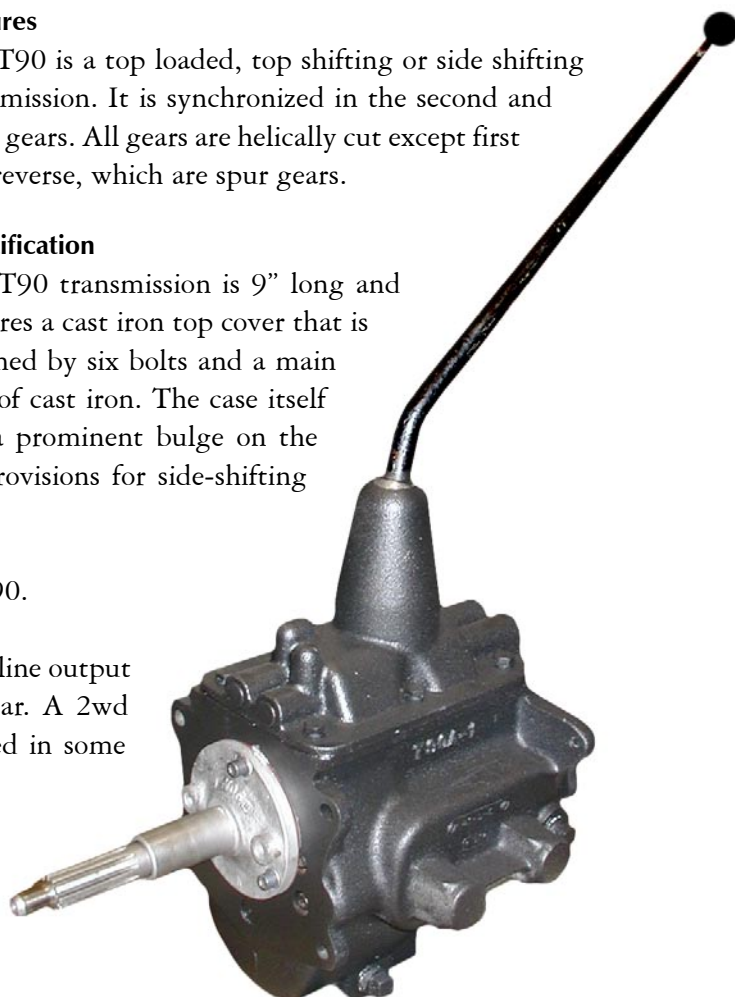
driver's side with two protruding bosses as provisions for side-shifting actuators.

T90 Side-Shift version

The side-shift or column-shift version of the T90.

All 4wd T90 transmissions have a 1-3/8" x 6 spline output shaft for mounting the transfer case input gear. A 2wd version of the T90 does exist and was installed in some Jeeps but is a rarity.

Jeeps also had a T86 transmission that appears similar to the T90. Many parts interchange, however first & reverse gears are helically cut in the T86 in lieu of the spur cut gears in the T90.



More detailed information about the T90 can be found in the Novak Conversions Knowledge Base on the web at novak-adapt.com.

Introduction to Rebuilding

About These Instructions

Due to the many questions we get from curious rebuilders, there is some non-procedural, technical information in this guide, discussing a bit of power transmission theory and info about the NP435 that some people find interesting. It's our goal to make this write-up interesting as well as useful.



Cleaning

Keep bearings and other rebuild parts sealed in their boxes until the moment of installation. Foreign objects in a transmission, ranging from chunks to specks to particles can wreck bearings, journals, faces and bores. Every rebuild should have a dirty phase and clean phase, with a cleaning of your work area and tools demarcating the two. A clean transmission and work area make the rebuild a more

enjoyable experience.

You should scrape and pressure wash the transmission with hot water and detergent prior to putting it on your bench for disassembly. If you plan on doing a partial rebuild (upper end / mainshaft changeout) only, getting it as clean as possible prior to disassembly is just as important. If you do this, do not allow the transmission internals to be in contact with water for any real length of time.

If you are doing a full rebuild, a hot-tanking or solvent-bath in addition to the above methods are great ways to get the most sanitary rebuild and optimal paint adhesion.



Reuse of Bearings

It may well be that your bearings look fine. They may even roll fine. Unless you really know your transmission's rebuild history and the age and care of the bearings, replace them. All of the bearings cost less than your time and effort to remove a gearbox, buy the bearings, rebuild it for a second time and reinstall the transmission in your vehicle.

Additionally, mixing old needle rollers with new will also risk shortening your gearbox's life. Think of a bad apple in a barrel, except this bad apple has 65 Rockwell "C" hardness flakes that may be eager to escape into the rest of the bearings and journals and wreck chain-reacting havoc.

Chips & Breaks

Remember throughout your installation/rebuild, that you are dealing with hardened metals in this transmission. Hammering, pressing or shocking any surface with any tool that is not appropriate for the job can chip or break parts. Always use brass, aluminum or wood drifts to drive parts. Never use screwdrivers alone to pry off snap rings.



Instructions Disclaimer

While every attempt at informational accuracy has been made, the information in these instructions is for guidance only. Novak also may offer third-party product recommendations, which are also for guidance only.

Because Novak has no control over the Customer's project procedures, Novak instructions and recommendations do not constitute a warranty of fitness, applicability or compatibility with the customer's particular project and do not constitute warranties.

Suitability of parts or information for any application is fully the responsibility of the customer and / or rebuilder.

Synchro Rings

Every shadetree rebuilder is an expert on synchros, as evidenced by the fact that many call in and tell us that their rings look great because the beveled clutch teeth look decent and are hardly blunted. This is not the primary measure of a synchro ring's suitability. It is the grooved and relieved taper on the inside (the part not visible without disassembly) of the blocking ring that is the critical area. These tapers cannot be measured without very specialized tools, and for what little the synchro rings cost, the rebuilder should just replace them.

You'll notice various levels of blunting of the gear's clutch teeth if your synchro rings are worn past efficacy.

Using Input Retainers & Tail housings / Adapters as a Press

Input retainers, tail housings and adapters - whether factory or aftermarket - that can handle hundreds of foot pounds of torque, can break when used as a bearing presses. Don't ever use an adapter or input bearing retainer to press on a bearing or bring the transmission together with its bellhousing or transfer case. Don't use these end caps and their bolts to pull them up to the case when they will not seat on their own with anything more than light coaxing with a soft mallet. A broken casting will end your project and attempting to force a transmission together is merely avoiding the resolution of the real problem.



Suggested Rebuilding Tools & Supplies

You probably already have most of the hand tools required to build a transmission, including wrenches, ratches, screwdrivers, scrapers, hammers, etc. Additional tools and supplies that may include:

Use safety glasses or goggles. Otherwise, take a poppet ball, snap ring, solvent or case-hardened shaft / gear fragment in your eye and you'll become an experienced convert.



A set of large, bevel tipped, external snap ring pliers is indispensable for removing the large Eaton type retaining rings you'll encounter. These shown are under the Blue Point brand.

The tools that transmission disassembly requires that may not be in your tool chest already are:

- 1) Various external snap ring pliers
- 2) Bearing puller
- 3) Hydraulic shop press and various press arbors and sleeves
- 4) Urethane or other type of soft mallet
- 5) Small pry tool or a three-jaw slide hammer
- 6) Dial indicator with magnetic base
- 7) Feeler gauges

Some of these tools can be rented, borrowed or even purchased for prices that should not be too shocking.



This style of snap ring plier is more universal. With dimpled and knurled flats. They are great for smaller snap rings.



Gasket Sealants

After years of rebuilding and testing transmissions Novak has settled mainly on the use of Permatex Aviation Gasket Sealant on flat, machined surfaces. More uneven sealing surfaces such as PTO covers may warrant the use of The Right Stuff or other RTV sealant.

Always use RTV or other sealants sparingly, as any break-away piece could go rogue in your transmission and plug an oil passage, to your transmission's demise.



Assembly Lubricants

Grease, including all axle and bearing greases, are *absolutely not* acceptable assembly lubricants as they will not melt and flow out of bores, bearings, synchros and journals, clotting transmission oil passages to the demise of those components.

Use a few squirts of regular oil into deep-ball roller bearings that are otherwise inaccessible to assembly lubricants.

It is critical to lubricate all mating and adjoining parts upon assembly with a proper assembly lubricant to protect components during initial spin-up of the transmission. Consider our three product recommendations:

1. SmartBlend Transmission Assembly Lubricant #5500: This is marvelously sticky stuff, which makes it ideal for “gluing” loose needle rollers together into their bores, as well as sticking thrust washers and other items together where the factory may have used assembly tooling such dummy shafts or magnetic assembly methods. This lubricant will melt out of the parts upon the first sign of operating heat and be subsumed into the transmission fluid.

We recommend you keep your SmartBlend in the refrigerator to make it as sticky as possible.

2. Frozen Petroleum Jelly: Will generally perform like the above, but not quite as sticky and may not offer as good of spin-up protection prior to the transmission fluid reaching the components.

3. Engine assembly lubricant: This is a fairly safe assembly lubricant for transmissions, but is no good at sticking parts together for ease of assembly.

Fluids

A precursory word is in order about fluids, understanding that it is one of the great hornet’s nest debates in automotive maintenance circles. We’ll go into it to the extent of making these short points:

1. Essentially all of the lowest grade transmission oils available today are chemically engineered and refined to higher standards than when these transmissions were produced. We have disassembled and inspected more of these transmissions than just about any shop in the nation, and we are constantly impressed at how hard-wearing the gears are, still showing their original machining marks.

2. Synthetic fluids are generally terrific in the fact that they resist heat breakdown better than conventional mineral oils. Actual lubricity, if any better, should only be marginally so. The real question for the installer to ask is whether their transmission will be subject to punishing heat levels as induced by duty level and environmental factors such as the climate in which the vehicle is operating, and then for the installer to decide if this is worth the extra money these fluids may cost.

3. Most gear oils are specifically for hypoid axle gears and some older formulations even have unstabilized sulphur additives that are not yellow-metal-safe (think corrosion to synchronizer rings). Generally avoid the ultra-mega-extreme-super duty oils. Avoid oils with friction modifiers in them or excessive lubricity, as the transmission may shift poorly due to inadequate synchronizer ac-



These are a few gear oil products that have a good reputation in the automotive manual transmission world:

- Pennzoil Synchronmesh (~30WT)
- Red Line 75W90NS synthetic
- Amsoil 75W90 synthetic
- Sta Lube 85W90 conventional (not pictured)
- Straight Weight Engine Oils, 40wt or 50wt with API Service Rating of SF through SL

tion. A good example of this is Red Line's 75W90NS oil which is similar to their regular 75W90 but better for synchro rings.

GL ratings are pressure ratings. GL4 rates higher than GL3, etc. Though it's an older rating, GL3 is still recommended for transmission gears due to a good balance of protecting both gears and synchros. But, good luck finding GL3 anywhere as it has been superceded by the superior GL4. However for transmissions, GL5 is not better than GL4. Capische?

If you must use GL5, look for the "MT1", designating it as appropriate for manual transmissions. Oil that's great for gears is not always good for synchro rings. Many GL5 oils bond well to steel gear teeth but too well to brass synchro rings, causing them to prematurely lose their layers. Again, GL5 is rated at higher pressure than GL4 and very appropriate for hypoid axle gears which can experience around four times the pressure that transmission gears see.

4. Because they lack the additives that can damage synchros and yet are made to such high specifications, some engine oils are actually appropriate for use in transmissions with the following considerations: engine oil viscosity / weight designations are on a different scale than gear oils. As such a 40 weight engine oil is similar to 75W90 gear oil in functional viscosity and a 50 weight engine oil is similar to 80W90 gear oil. And, with the terrific rise in the grade of engine oils over the last several years, these products are actually great alternatives to gear oils. In some cases, 50 weight engine oil was even recommended by manufacturers from the factory. 40 weight oil would be an alternative in cooler environments, or where slightly quicker shifts may be desired.

If using an engine oil, do not use one with an API service rating newer than "SL". SN oils have removed an anti-scuff component which may be detrimental for use in a transmission. SE, SG, SH, SJ & SL are all acceptable. Diesel engine oil may also work very well due to their durability. These ratings include CG4, CH4, CI4.

Transmission Oils Summary

Outside of these questions, choose a brand that you like and trust. We do not necessarily endorse any one product over another and the presentment of the listed products is only to aid the reader in more quickly finding their options. Go with a good, honest oil and your transmission will have a long, reliable, service life.

Common Symptoms

Worn synchronizers will cause gear clash when shifting between gears. Bearing noise, gear whine and fluid leakage are also factors encouraging a full rebuild of the T90.

A nearly notorious (but curable) problem with the T90 is its slipping out of second gear on deceleration. This is due to excessive wear in 2nd gear's integrated bronze journal bushing, allowing 2nd gear to tilt on the mainshaft - action that forces the disengagement of the gear's clutch splines from its synchronizer's sliding sleeve. If this has persisted over many miles of use, or if the T90 has experienced abusive shifting, the synchronizer sliding sleeve may also need replacement, as its internal splines edges may have worn themselves to a shape no longer conducive to keeping the transmission in gear.

Other factors that can contribute to slipping out of 2nd gear are a worn mainshaft bearing spacer ring, loose transfer case input gear retaining nut, worn pilot bushing, worn or bent shift forks, broken or sticking poppet balls and springs. Once again – these are contributing factors – usually the cause is second gear bushing wear as described above.

Transfer Case Removal

Warn Overdrive Removal

If so equipped, the Warn overdrive must be removed from the Dana 18 transfer case before the transfer case can be

separated from the transmission. This is accomplished as follows: shift overdrive into direct drive. Remove the shift linkage from the overdrive. Remove the five bolts that hold the overdrive to the transfer case (the four bolts on the back cover of the overdrive do not require removal). The overdrive housing can now be pulled straight back for removal. If necessary, the housing can be tapped back (while pulling on it by hand) with a plastic faced hammer or block of wood. Be careful! – the housing is aluminum and is easily damaged by hammering. When we remove a tight overdrive, we use an adapter that we made for our slide hammer that attaches to the overdrive via two of the rear cover bolts.



With the housing removed, the hub assembly is now accessible. Use a light to look down in the hole in the center of the hub assembly. You should see a square shaped flat wire lock ring in a groove. A thin pair of long nose pliers can be used to squeeze the ends of the lockring together for removal. With the lockring removed, use a regular 1/2" drive socket extension to remove the special hub retaining nut. This has a regular right hand (counter-clockwise to loosen) thread. When the hub nut threads disengage, the hub can be removed from the T90 output shaft.



The transfer case can now be separated from the T90 by removal of the 5 retaining bolts. One is on the front side near the front driveshaft yoke.

Remove these five bolts, and then the transfer case input gear. Since the input gear is larger in diameter than the Dana 18 input bore, the gear must be removed through the PTO port of the transfer case.

Removal of the Model 18 Transfer Case (without the Warn Overdrive)

Remove the five bolts on the sheet metal power take off cover on the rear of the Model 18 transfer case and remove the cover. Remove the cotter pin in the nut at the center of the input gear and remove the nut using 1-5/16" socket. Remove the gear from the T90 output shaft taking care not to drop the hub washer or nut into the transfer case. The transfer case can now be separated from the T90 by removal of the five retaining bolts. One bolt is on the front side near the front driveshaft yoke.

Removal of the Model 20 Transfer Case

The Model 20 transfer case is used in 1962-65 J-series with the T90. It is removed by taking out the 5 retaining bolts (one on the front side near the front driveshaft yoke) and separating the transfer case from the T90. The nut and gear are removed after the T90 has been separated from the Model 20 transfer case.

Transmission Disassembly

An exploded view the the T90 is available, below.

Shift Cover Removal

The transmission top cover and its shifter should have been removed prior to removal of the T90 from the vehicle,

but if not, remove it now by taking out the six top cover bolts. If adhered together, break the seal between the top and case by using a soft mallet. It is not recommended to pry the top cover away from the case as this may mar the machined sealing surface.

Input Bearing Retainer Removal and Disassembly

Remove the three socket screws and seal washers holding the front bearing retainer to the transmission. Remove the front retainer and gasket. Remove the snap ring from the input gear.

Oil Collector Bolts Removal

Remove the two socket screws from the recesses in the front of the case. These retain the oil collector inside the case. Note that these are 5/16-24 SAE thread and they have seal washers under their heads.

Countershaft Removal

Using a brass or soft steel drift, tap on the front end of the cluster shaft to free the lockplate. This is the metal piece in the slots at the rear of the cluster and reverse idler shafts. Remove this lockplate. Using the drift, tap the cluster shaft pin out towards the rear of the case, remove the shaft and drift, allowing the cluster gear to drop to the bottom of the transmission case.

Rear Bearing Removal

Remove the rear bearing, rear bearing retainer, and rear bearing spacer from the mainshaft. These usually pull off without any difficulty.

Mainshaft Assembly Removal

Remove the mainshaft and gears assembly out of the back of the case through the rear bearing retainer hole. The pilot roller bearings will fall out as this is done, but these and the cluster rollers are supplied new in the Novak rebuild kit.

Oil Collector Removal

Tap the input gear into the case far enough to allow removal of the oil collector. Remove the oil collector from the bottom of the case.

Input Shaft Removal and Disassembly

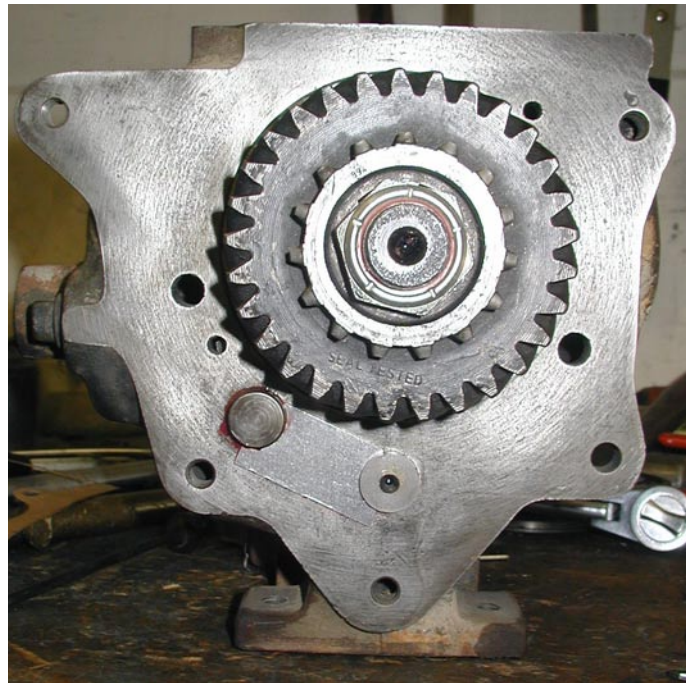
Tap the input gear into the case and remove through the rear hole. Remove snap ring and then press off the front bearing from shaft.

Cluster Gear Removal and Disassembly

Remove the cluster gear and thrust washers from the case. Remove the rollers, spacer rings and spacer sleeve from inside the cluster gear.

Reverse Idler Gear Removal

The reverse idler shaft and gear may be removed by driving the shaft just slightly into the case, using a soft drift. This will break it free. You can then drive the shaft rearward through the case. Note that it is not always necessary to remove the reverse idler gear during a rebuild. Bushing wear can be usually checked with the gear in place.



T90 oil collectors are no longer available by any manufacturer. However, no other major transmission uses such a device. The main problem presented to engineers here is that the T90 and Dana 18 typically shared transmission fluid, and on a steep incline, fluid could drain from the T90 into the Dana transfer case. The collector was a last line of defense in keeping the front bearings of the transmission oiled in such a scenario.

If your T90's oil collector is damaged or missing, we recommend running a full face gasket or port plug between the T90 and Dana transfer case, and then filling them with oil independently. This will allow a T90 perform safely without the need for an oil collector.

Second Mainshaft Gear Disassembly

Complete the disassembly of the mainshaft by removing the snap ring that holds the synchro hub to the mainshaft. Remove the synchro hub, blocking ring and second gear.

General Inspection

Inspect all parts for discoloration, warpage, brinelling, breakage and wear. We receive frequent questions as to whether gears should be replaced if nicked or otherwise damaged. As a general rule, if the lead-in portion of the gear tooth can be reasonably smoothed back to its proper shape with a stone or fine file, it can usually be reused. Gear breakage, excessive rust pitting and other damage that extends to the pressure faces of the gear teeth themselves are grounds for replacement. Should you need such components, call us. We keep on hand nearly all T90 parts, new and used.

Detent springs should be checked for fatigue or damage.

Slip the synchro sleeve on the hub and slide back and forth. Remove burrs with a hand stone until the sleeve slides freely.

Check the first / reverse sliding gear on the mainshaft to be sure it slides freely.

Check the condition of the bearing area on the front of the mainshaft. Quite often this will be worn. The diameter of the bearing area on a new mainshaft is .7625". Check the condition of the transfer case drive gear splines on the other end of the mainshaft. If the sides of the teeth are worn considerably, it will be impossible to keep the retaining nut (or overdrive hub) tight. Replacement of the mainshaft would be required to solve either the worn bearing area or worn splines condition.

Cleaning & Case Finishing

All internal transmission components not being replaced during this master rebuild should be fastidiously cleaned to insure that no harmful particles are introduced into sensitive components. A proper cleaning also makes it easier to read parts that could warrant replacement. It is convenient to use hot-water and detergent based methods similar to an industrial parts washer. These are like glorified dishwashers. However, it is recommended that you quickly coat any steel shafts and gears with oil to prevent rust from forming if using this method.

Otherwise, it is totally acceptable to use solvents and cleaners as you deem safe and effective. Whatever your method, always follow up with a blast of compressed air to each part and any passages it may have to insure readiness for reassembly.

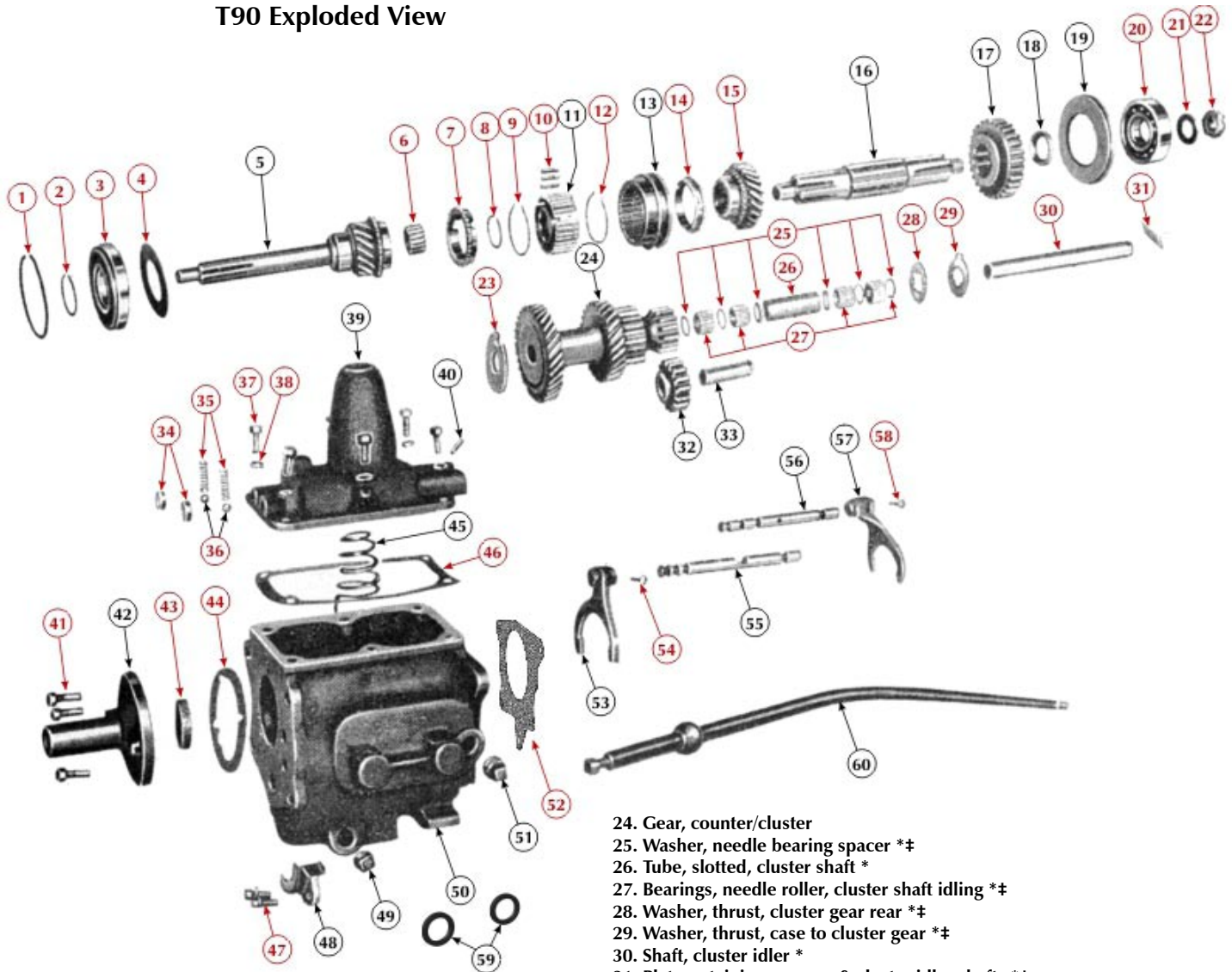
This is also the best time to really clean and finish the transmission case. Many individuals will use a solvent tank, pressure wash or otherwise. We also recommend media blasting the case if you have the equipment, as it allows for great adhesion of any paint finishes you may wish to use. As to paint, we recommend industrial grade enamels or epoxies, preceded by their respective recommended priming methods.

We do recommend and choose to mask surfaces that will have mating parts, such as top covers, PTO ports, adapters / tail housings and input bearing retainers. This gives your gasket sealer a native surface to which it may form the best seal.

Case Magnet: To Install, or Not?

Many transmissions feature a magnet at the bottom of their cases to catch any damaging filings as the oil flows around it over the course of a transmission's service. With the ready availability of strong, rare-earth magnets and their ability to stay firmly stuck to the transmission case, we think this is a good idea for the T90, though we still recommend using small amount of a durable, heat resistant adhesive such as epoxy or other industrial grade adhesive. Also be careful to install it clear of any spinning counter-shaft gears.

T90 Exploded View



For your reference, all asterixed * items below are included in our master rebuild kit, above. Items indicated with a "‡" are not available singly, but are available in the Small Parts Kit, #A below.

A. Kit, small parts *. Includes all items listed below with a "‡"

B. Kit, gaskets and front seal

1. Ring, retaining, front bearing to case *‡
2. Ring, retaining, front input shaft to bearing *‡
3. Bearing, front input shaft *
4. Slinger, front input bearing *‡
5. Shaft, input, main drive gear
6. Bearings, needle rollers, input shaft to mainshaft *‡
7. Ring, synchronizer, 3rd gear *
8. Ring, retaining, 2nd-3rd clutch hub to mainshaft *‡
9. Spring, radial, 2nd-3rd clutch hub *‡
10. Keys, synchronizer (also called pawls, dogs, struts, etc.) *‡
11. Hub, synchronizer, 2nd-3rd gear
12. Spring, radial, 2nd-3rd clutch hub *‡
13. Clutch, sliding, 2nd-3rd gear
14. Ring, synchronizer, 2nd gear *
15. Gear, mainshaft 2nd *
16. Shaft, main
17. Gear, sliding, 1st-Reverse
18. Spacer, mainshaft to rear bearing
19. Retainer, adapter, rear output bearing
20. Bearing, rear output *
21. Washer, transfer case input gear retention *‡
22. Nut, transfer case input gear retention *
23. Washer, thrust, cluster gear front *‡

24. Gear, counter/cluster
25. Washer, needle bearing spacer *‡
26. Tube, slotted, cluster shaft *
27. Bearings, needle roller, cluster shaft idling *‡
28. Washer, thrust, cluster gear rear *‡
29. Washer, thrust, case to cluster gear *‡
30. Shaft, cluster idler *
31. Plate, retaining, reverse & cluster idler shafts *‡
32. Gear, idler, reverse
33. Shaft, idler, reverse
34. Plug, top cover shift rail port *
35. Spring, shift rail poppet *
36. Ball, shift rail poppet *‡
37. Bolt, top cover *
38. Washer, lock, top cover *
39. Cover, top, control housing
40. Interlock, shifter rails
41. Bolt, front input bearing retainer *
42. Retainer, front input bearing
43. Seal, front input shaft *
44. Gasket, front input bearing retainer *
45. Spring, shifter cane
46. Gasket, top cover *
47. Bolt, oil collector *
48. Collector, oil
49. Plug, drain
50. Case, transmission
51. Plug, fill
52. Gasket, rear, transfer case *
53. Fork, shifter, 2nd-3rd gears
54. Pin, shifter fork to rail *
55. Rail, shift, 2nd-3rd gears
56. Rail, shift, 1st-Reverse
57. Fork, shifter, 1st-Reverse gears
58. Pin, shifter fork to rail *
59. Seal, oil, side shift versions only
60. Cane, shifter

Transmission Assembly

Reverse Idler Installation

If the reverse idler gear and shaft have been removed, install these in the case. Use assembly grease in the gear bore and orient the slot in the reverse idler shaft towards the cluster shaft so the lock plate will slide in. Drive the reverse idler shaft in till the slot is about $1/32$ " to $1/64$ " from the rear face of the case.

Cluster / Counter Gear Assembly

Assemble the new rollers, spacer washers and spacer sleeve in the cluster gear bore using assembly grease to hold the rollers in the bore. Use grease to stick the thrust washers to the ends of the cluster gear. As discussed earlier, do not use grease such as the old style wheel bearing grease. That type of thick grease can actually prevent gear lube from reaching the rollers for some time after start-up and your transmission will crash and burn. A cluster bearing loading tool can be made from a piece of $3/4$ " diameter cold rolled steel shafting that has been cut to $7-1/16$ " long (with the ends "squared"). This will retain the bearings, spacers, and thrust washers in the cluster gear and simplify assembly of the transmission.



The sequence of assembly on the cluster gear bearings is:

1. In the center is the split spacer sleeve
2. On each end of this is a spacer ring
3. On each end of this is a row of rollers
4. One each end of this is another spacer ring
5. Add another row of rollers (there are 88 rollers total in the T90 cluster)
6. Add the outer spacer rings
7. Lastly are the face thrust washers. The bronze alloyed side faces the gear, not the case

The cluster gear, when installed in the case, should have .012 to .018 end play. It used to be that there were two choices of selective thrust washer of .0555" and .0625". Now, only the latter, thicker washer is available and if the installer is faced with the unusual case where this is too thick, the washer can be sanded down on a flat surface (granite table, for example) with fine grit sand paper adhered to it, moving the washer in a figure-8 pattern and even pressure to prevent sanding off-plane. Follow up with solvent and compressed air to clean the washer.

The cluster gear and thrust washers are laid in the bottom of the case. A piece of wire or string is guided under the gear and up over the sides of the case. This will be used to lift the cluster gear for installation of the cluster shaft after the rest of the transmission is assembled.

Mainshaft Geartrain Assembly

Assemble the mainshaft and synchronizer assembly as follows: Put a new pawl spring (this is a circular wire spring with the ends bent outward) in each side of the synchro hub with one of the ends of each spring in opposite ends of the same slot. Put the three synchro pawls in the three slots in the hub with the "hollow" face down. One of the turned out ends of the springs should go into the hollow face of one of the pawls. Hold the pawls in the hub by circling the parts with the thumb and index finger.

Slide the clutch sleeve over the hub with long beveled edge towards the long end of the hub. Center the sleeve on the hub making sure the long end of both match and that the 3 pawls and springs are properly seated. install a bronze blocker ring on the short hub side of the synchro, engaging the 3 slots in the blocker ring with the 3 pawls in the synchro assembly.

Lube the second gear bore and install the gear on the mainshaft with the synchro taper facing forward. Install the synchronizer assembly on the mainshaft with the long taper/long hub side forward. (The bronze blocker ring should be towards the synchro taper on the second gear.)

Install the snap ring that retains the above described mainshaft parts.

Oil Collector Positioning

If you are opting to install the oil collector, place it in the bottom of the case, rotated so the top portion will allow installation of the input gear. Do not fasten it with the bolts at this time.

Sealing the T90 Input Assembly

T90's are tricky to seal the front input shaft, and we at Novak are now supplying a sealed front bearing to confront this problem. With this upgrade, you'll see fewer spots on your garage floor and likely eliminate clutch contamination.

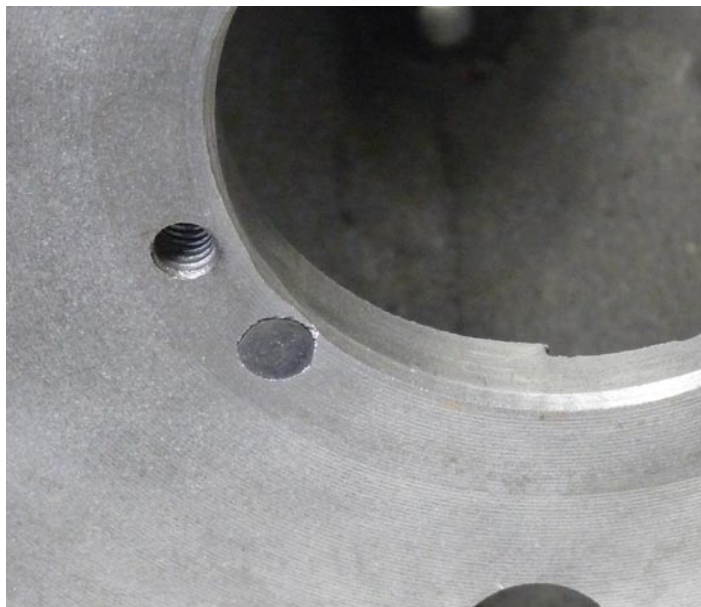


We were once skeptical of sealed bearings for some purposes, but the bearings have evolved somewhat, as have we. First of all is the speed at which the bearings are rated has increased some. We have also a better understanding of the nature of a Jeep-oriented transmission vs. a racing transmission. Jeep engines commonly run predominately in the 2500 range. These bearings are duty rated predominately in the 7,000 RPM zone. When compared to an open bearing rated at 14,000 RPM, it may seem like a discouraging contrast. But in real Jeep terms, it's not relevant. If we were running a Vette at WOT on the track a lot, we might choose an open bearing instead.

We think that the benefits of running a sealed bearing / transmission and eliminating the leaks outweigh the possibility of a bearing that may have a life that's a few miles shorter. In the end - as a company that tears down many hundreds of transmissions a year, the input bearing is hardly ever the cause of a demise.

The installer will also notice a two rubber tapered plug included in the Novak rebuild kit. The larger one is to plug a hole at about 7-8 o'clock on the front face of the transmission behind the bearing retainer. The retainer will hold the plug in when it is attached. Just make sure it does not protrude past the transmission front face so that no excess pressure will be put on the case or retainer.

The smaller plug is to seal the oil port hole drilled in many T90 input shafts. Press and drive this plug in nice and tight with the wider portion of the taper facing frontwards. Once it is secure, razor any protruding



remainder of the plug off.

Special note on the retainer oil seal. The felt oil seal washer that is supplied in T90 gasket sets is only used on stock installations that use the 15/16 diameter four-cylinder input gear and not the 1-1/8" version. Oil this felt washer if and before installing it.

If you are assembly a Novak T90 to GM engine conversion, we have provided a conventional front oil seal. You can use this, but then do remove the oil seals from the input bearing or find a way to provide oil to this seal to keep it from burning up in service.

Input Gear Assembly

Place the oil slinger on the input gear with the outer offset away from the bearing. Press on the new front bearing. The side closest to the outer snap ring groove goes out. Take care to prevent grit or other contaminates from getting in the bearing. Install the large snap ring on the OD of the bearing.



Check to see that the retainer will go over the snap ring but do not install the retainer at this time. On occasion, a replacement snap ring may be found that will prevent the retainer from mating up flush with the face of the case. It may also overlap the three bolt holes for the retainer screws preventing these from engaging their threads properly. In the latter case, three flats can be ground on the snap ring for screw clearance. It's a rare occurrence, but if the new snap ring is too large, re-use the old one.

Input Gear Needle Bearings

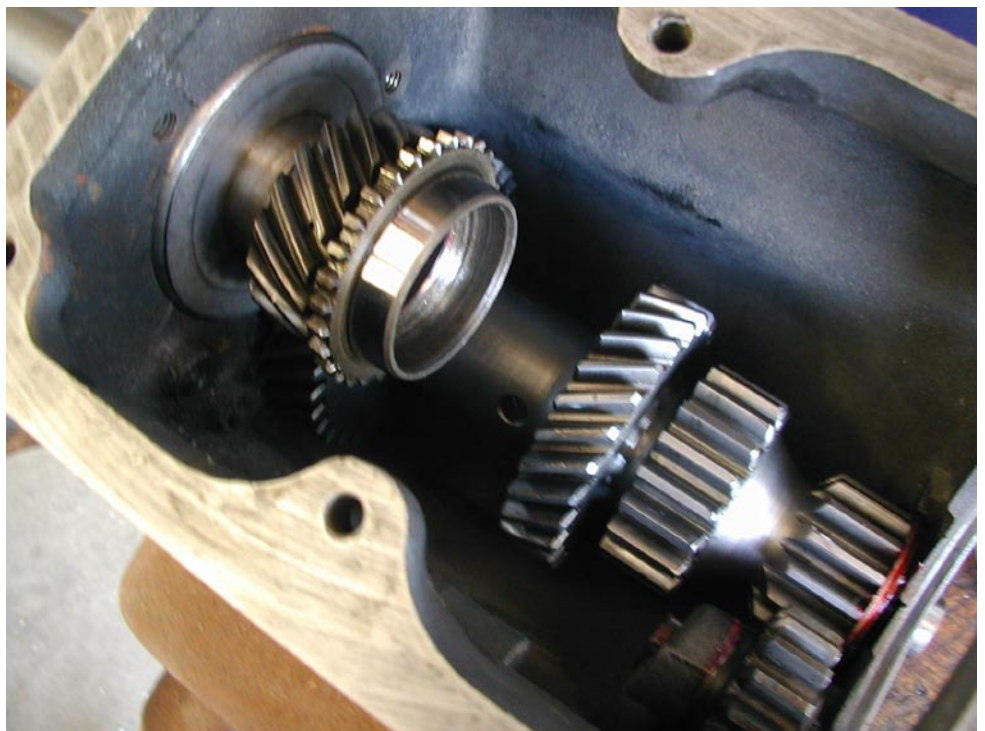
Use assembly grease to retain the fourteen rollers in the input gear. Note that the last roller must be slid in longitudinally, as it cannot be snapped in axially.

First / Reverse Slider

Install the sliding first and reverse gear on the mainshaft with the shift fork groove towards the front of the transmission.

Second / Third Synchro Assembly

It is easiest to preassemble the synchro hub assembly before sliding it onto the mainshaft. Insert the three new pawls (also called dogs, struts or keys) into their slots in the hub. Insert the two springs into each side of hub cavity. Note that the offset and chamfered portion of the hub faces forward and that the front





of the sliding clutch is the chamfered and striped side forward.

Mainshaft Assembly Installation

Install the mainshaft assembly, tail first at a tilting angle in the case through the hole in the rear of the case. Then place the factory ~.280 " thick bearing spacer on the back of the mainshaft. This is not typically a wear item and the factory one is normally reused.

Cluster Shaft Installation

Using the piece of wire that was previously looped under the cluster gear, lift the cluster gear into position and install the cluster shaft. (This shaft must always be installed, as well as removed, from the rear of the transmission.) Align the lock plate slot opposite the slot on the reverse idler shaft and drive the cluster shaft in to within 1/32" to 1/64" of the slot.

T90 Oil Collector Fastening



Two Allen socket head bolts are used to secure the oil collector. We recommend using thread sealant on this bolt and / or the supplied sealing washers under the bolt heads.

If you are omitting the oil collector as discussed above, then simply substitute and fasten these bolts with two 1/4" nuts. A servicable thread locking compound (such as Loctite blue) is recommended.

Now, using a stiff piece of wire, extension magnet, or other suitable tool, position the oil collector to line up with the retaining screw holes. Install the socket screws (5/16-24 SAE) and tighten 10-12 foot pounds.

Front Bearing Retainer Installation

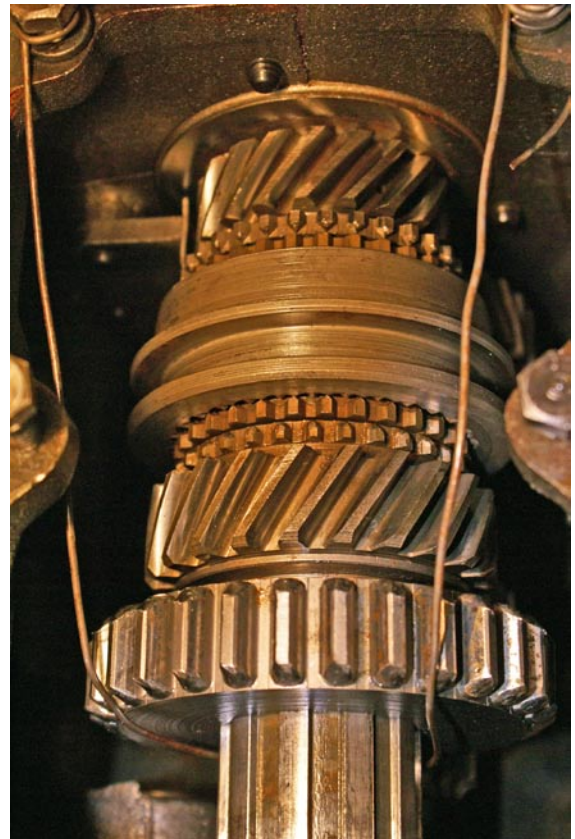
Using gasket sealer and a new gasket, install the front bearing retainer. Seal the bolt threads with thread sealant or servicable thread locker compound and tighten to 10-12 foot pounds. Note that the oil drain slot in the front retainer and gasket must line up with the drain hole in the case. Do not use excessive gasket sealer, or excess stray silicone may contaminate the transmission.

Assembly Inspection

Check to see that the second to third blocker ring is in proper location. Also check to see that the blocker ring has not gotten jammed onto the input gear taper.

Check the operation of the transmission in all three gears and reverse. The input gear should turn easily by hand. It will be necessary to hold the mainshaft in while checking the transmission "in gear" to prevent the gear thrust from pushing the mainshaft rearward.

Temporary Mainshaft Retention



Here's an alternative way to hold the T90 geartrain assembly together before installing the transfer case as the final rear bearing retainer.

Thread a piece of wire through the cotter pin hole in the mainshaft and pull it tight through two of the retaining bolt holes on the rear face of the transmission case. This will prevent the mainshaft from moving rearward out of the case until it is assembled to the transfer case.

Idlers Retention Plate

Install the lock plate in the reverse idler and cluster gear shaft slots and tap the two shafts in to retain the plate. Note that the plate must line up with the clearance slot in the transfer case. If it doesn't it could prevent the transfer case from mating at assembly, causing an oil leak or a broken casting if they are forced together.

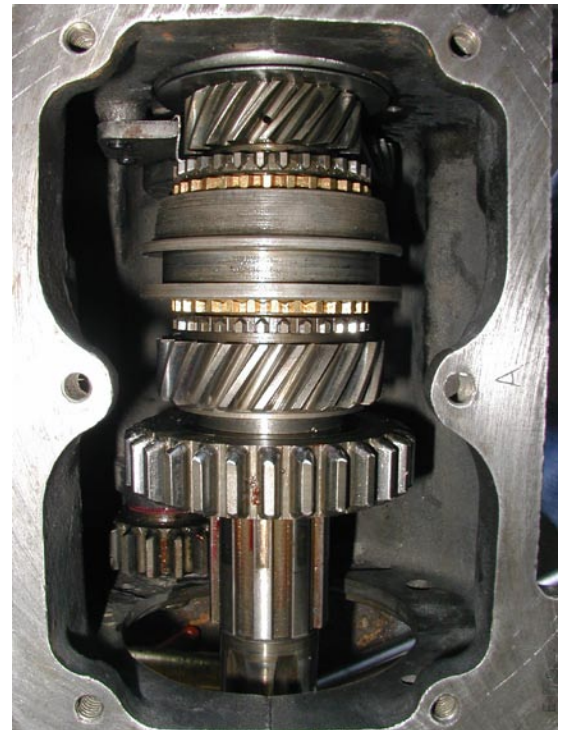
Transfer Case Installation

Remove the mainshaft retaining wire and coat both the transmission and transfer case with gasket sealer, and assemble the transfer case to the transmission using the supplied gasket. Install the five transfer case bolts. The bolts must be the proper length. Thread damage or a locked up transfer or transmission could result if they are too long or too short. Three 1-1/8" long bolts and two 1" long bolts are used. These five bolts are threaded 3/8-16 N.C. Install the 1" long bolts in the lower left and front holes.

Transmission Lubrication

Fill the transmission with your choice of gear oil as discussed above. We like to fill through the top cover, as it's a good opportunity to douse the gears and shafts, not to mention the speed to fill.

This T90 is assembled and ready to close up.



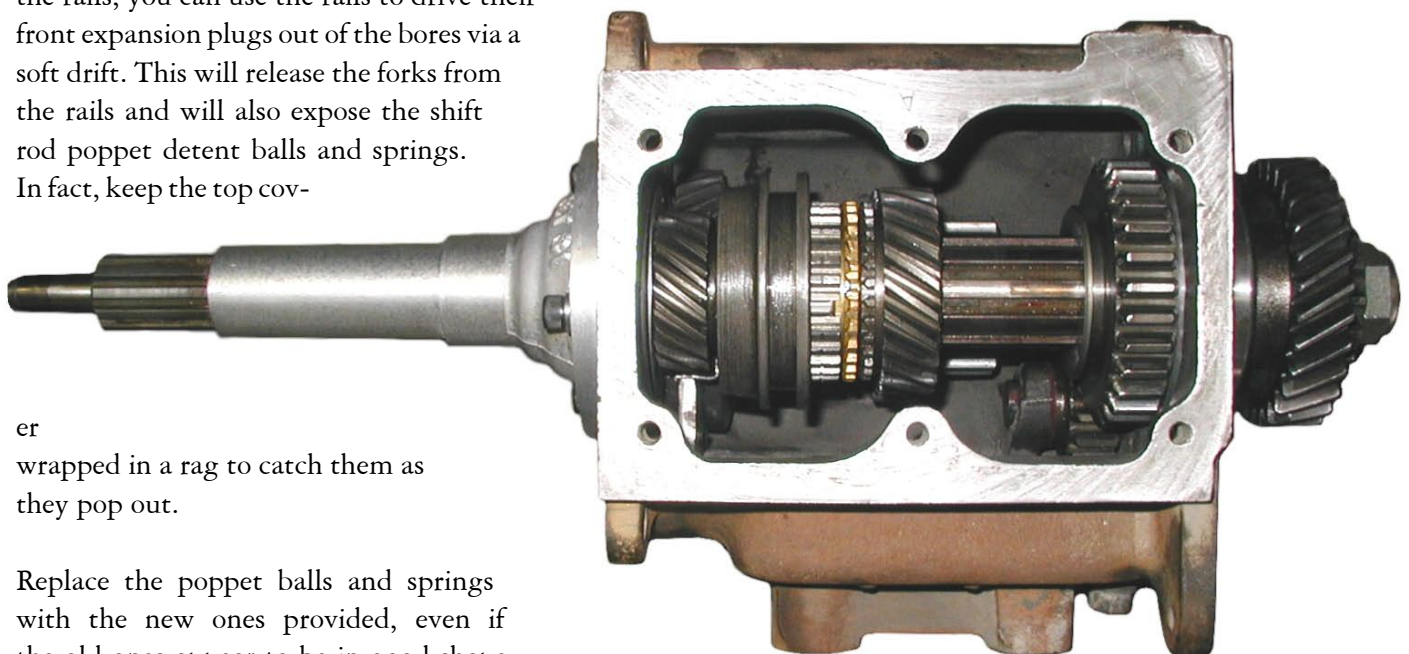
T90 Top Cover Rebuild

Rebuilding a T90 shifter control and top cover assembly is among the easiest of all transmissions.

Using a punch or drift of smaller diameter than the roll pins, drive the roll pins out of their transverse bores in the shifter rails. Once the shift forks are loose on the rails, you can use the rails to drive their front expansion plugs out of the bores via a soft drift. This will release the forks from the rails and will also expose the shift rod poppet detent balls and springs. In fact, keep the top cov-

er wrapped in a rag to catch them as they pop out.

Replace the poppet balls and springs with the new ones provided, even if the old ones appear to be in good shape.



The springs can fatigue and are broken in a number of the transmissions we rebuild here at Novak. You'll need to keep the balls and springs depressed with your thumb or a tool while you push the rails inward over their bores to capture them.

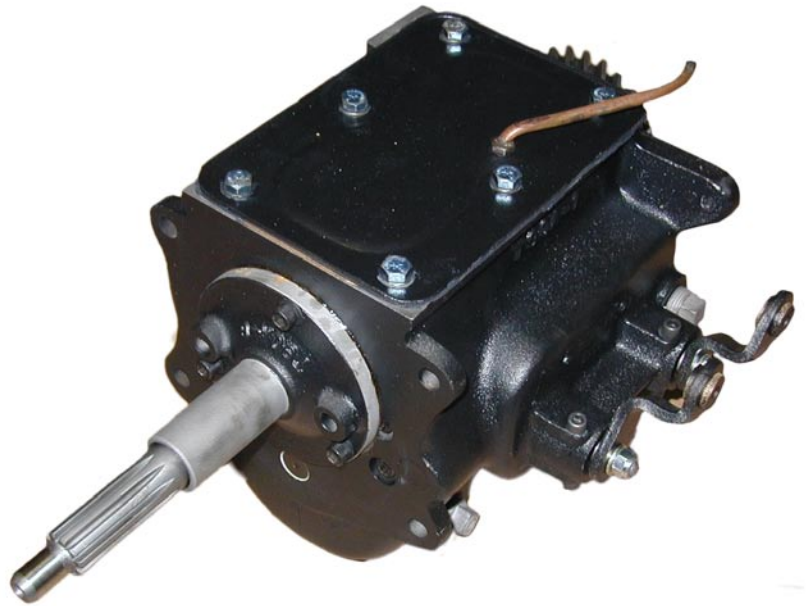
Reinstall the shift forks, and their shift rails along with their roll pins.

Install the new expansion plugs as provided in your Novak kit. You may choose to use sparing amount of sealant around them. Once in place and with their domes facing forward, punch them with a drift to flare them out and securely in place.

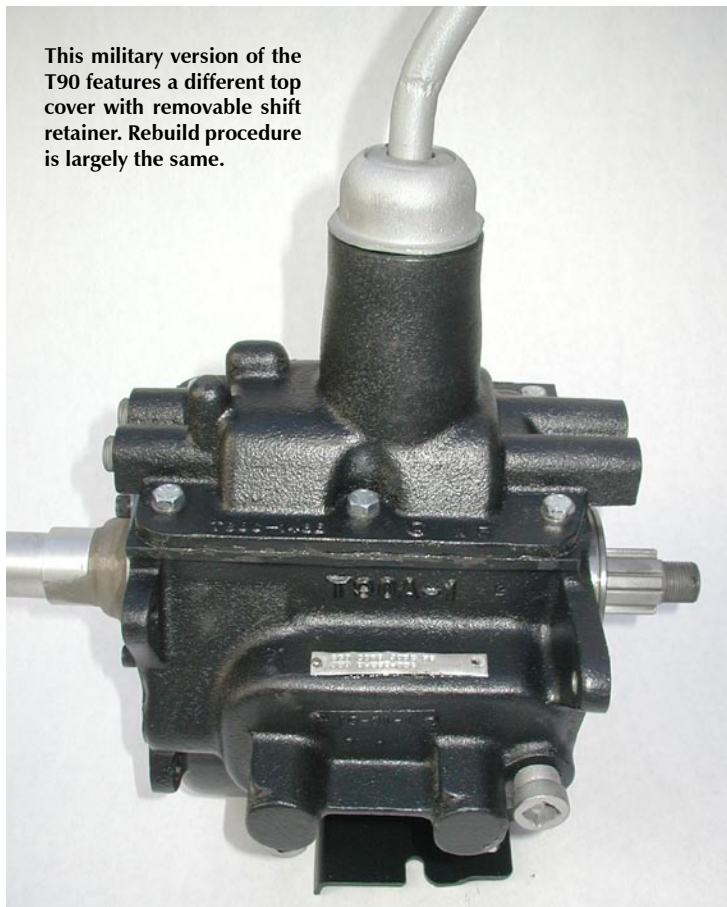
Test the shifter in a vice or other secure holding method to verify the action of the forks and feel of the detents.

Completion

Install the top cover onto the transmission case using a gasket and sealer. Use a thread sealant compound on the bolt threads.



A side-shift T90 rebuilds in essentially the same way, minus the top cover, of course.



This military version of the T90 features a different top cover with removable shift retainer. Rebuild procedure is largely the same.

Before installing your T90, test it as completely on the bench as possible, shifting through all the gears while turning the in-put and output shafts.

T90's Being Married to the Dana 20 Transfer Case

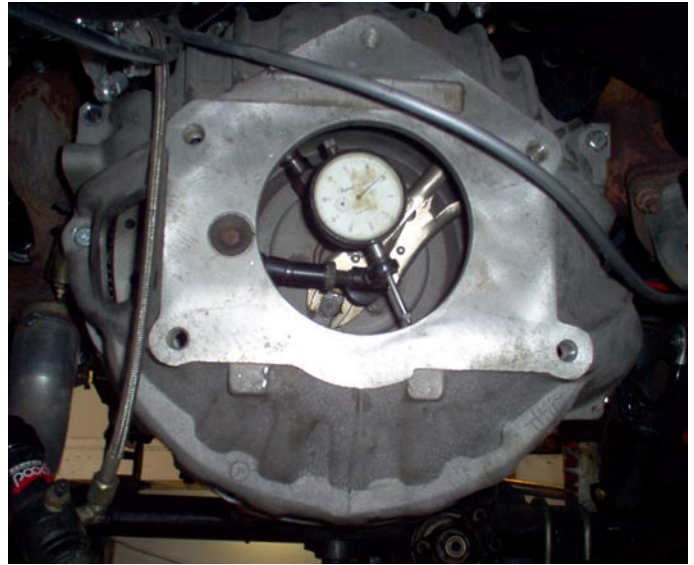
Install the rear retainer and bearing (and bearing retainer snap ring on J-series truck T90). Check to see that the second to third blocker ring is in the proper location and is not stuck on the taper of the gear.



Bellhousing Alignment

On any engine using a standard shift transmission, with or without an adapter, it is important to check the bellhousing locating bore location relative to the crankshaft. The potential for transmission failure or premature wear is so great, due to misalignment at this point, that no engine should be assembled without being checked. The checking procedure is quite simple. Correcting misalignment is not so simple but must be done to insure normal service from the transmission. A dial indicator is required, as well as a suitable means to mount this instrument on the engine crankshaft.

A dial indicator is a device that has an arm or contact point, suitably connected to a pointer, that moves in front of a dial with markings on its face. These markings usually represent .001" each. The purpose of a dial indicator is to measure in thousandths of an inch that can be read directly on the dial of the indicator.



To check a bellhousing, mount it on the engine it's going to be used with, make sure there are no burrs or dirt on the block or bellhousing. All bellhousing to block bolts should be in and tight. Mount the dial indicator on the crankshaft of the engine using a suitable magnetic base attachment or mechanical clamping means. The contact point of the indicator should be touching the bore of the bellhousing. The indicator must be mounted rigidly enough so it does not move on its mounting to prevent false readings. Rotate the engine by hand with the spark plugs removed and observe the reading on the dial. Keep adjusting the dial assembly until the needle moves the least amount per rotation. When you have achieved the least amount of needle movement through the 360 degree sweep of the indicator, this is your runout. You can then determine the direction it is offset by the movement of the needle.

1. Install dial indicator base to the flywheel using a magnetic base, or use the crank bolts.
2. Remove the spark plugs from the engine. Have an assistant rotate the engine crank with a wrench.
3. Read the runout and mark the "high" and "low".
4. If runout exceeds .005" to .007", then you must install offset dowel pins, of the appropriate value and install them in the direction to correct the offset.
5. Check your work again with the indicator.

The total number of thousandths misalignment of the bore relative to the crankshaft is read directly on the dial. Total runout should not exceed .007", with .010" being maximum. The greater the misalignment, the sooner transmission problems and failure will occur. A symptom of misalignment is unusual wear of the pilot bushing. We have checked stock Chevy bellhousings on engines that were out more than 1/32" (.032"). Some Ford ones are reportedly worse. Anything over .010" runout must be corrected before the engine and bellhousing are put in service or you can count on pilot bushing, transmission, and clutch problems, followed by transmission failure. The simplest way to correct misalignment is to try another bellhousing or bellhousings. Machining the bellhousing is the best cure but offset dowel pins are simpler. Shims between the block and bellhousing will also work if you have the patience to use this method. Offset dowel pins are sometimes available from speed shops, parts houses and other specialty suppliers.



Conclusion

There is no final word to our instruction packages. We update them often and invite our customers to offer any suggestions, images or questions they may have that can make the process easier for any to follow. Note our contact information below.

We strongly suggest that you keep these instructions and the following, associated parts list for future reference. For questions concerning your conversion, contact the 4wd retailer or technician you bought the kit from, or if you bought your conversion kit directly from us, contact us and we'll be happy to answer your questions.



Some may ask, "But, what do I do with my old second gear?"

Customer M. Paznar, being the ecologically minded soul he is, used his to incubate a jade plant. :)

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www.novak-adapt.com

support@novak-adapt.com

877.602.1500