T5 Rebuild: The saga…by Chris Neighbors Date: July 30, 2002

The problem:

After many abusive, over-torqued powershifts, the venerable T5 is left a little worse for wear. Couple this with no built-in shift fork limits and sheer age, and the frequency of failure is quite high in any spirited driven vehicle. Or, in some cases, the high-mileage often seen on Mustangs results in worn out friction linings on the blocker rings. (My first (and only, so far!) failure was a delaminated fourth gear blocker. I could upshift, but had to pause a while to downshift, until it went out altogether, at 125,000 miles!) **Update:** July 2, 1999: Blew input shaft at lunch! Thing sounded like a grenade going off; left with fourth gear only! Now I feel like a real man, LOL!

The solution:

Why, a thorough rebuild, of course! While going through the rebuild, do you and your trans a favor by spending some of the money saved on upgrades: the two most notable are a steel input shaft bearing retainer and a decent aftermarket shifter (or at least do something about the factory rubber isolators, like remove them!). Besides learning how to do a rebuild to get yourself out of trouble, it's a great bartering skill when your "friends" blow theirs up!

The sources:

I have purchased parts from D&D Performance, Hanlon Motorsports, and National Drivetrain. I have received outstanding service from all, and always receive my parts in a timely manner. However, I will not do business with NDT again over a petty issue (actually, not petty; based on principals that they claim but did not uphold; they do have good deals on inputs and clusters from time to time, but their kits, uh, suck, IMHO…). Personally, I prefer to deal with Hanlon; Linda, Bob's wife, always makes me laugh when I speak with her, and they had the courtesy to call me several months after I placed an order to let me know the Tremec rebuild manuals were in, and overnight a part that they let slip through. You cannot go wrong with D&D or Hanlon…

Vendor	Phone	Fax	Website
D&D Performance	(248) 926-6220		http://www.ddperformance.com
Hanlon Motorsports	(610) 469-2695	(610) 469-2694	http://www.hanlonmotorsports.com
National Drivetrain	(800) 507-4327	(773) 376-9135	http://www.nationaldrivetrain.com
TTC (Tremec)			http://www.ttcautomotive.com/onlineorder/product.asp

Required tools: (well, maybe not all required; some merely desired…)

Metric combination wrench set (at least 10mm, 13mm, 15mm)
Metric sockets and ratchet (same sizes as above…)
7/8" open-end wrench (reverse light/neutral switch)
3/16" diameter punch (shift block, reverse idler shaft, shift forks)
External snap ring pliers
Retaining ring pliers
6" or 8" calipers
1" travel dial indicator
Magnetic base and stand for dial indicator
4" C-clamp
Two- or three-jaw puller
Scribe
File (no, fingernail file won't work!)
Parts washer or many cans of carb cleaner!
Air compressor and air nozzle
Regular screwdrivers (large and small)
Valco Tube-Grip (RTV sealant dispenser; the best $15 I ever spent!)
3/8" or 1/2" diameter punch (I use Chevrolet fuel pump pushrod)
Bushing driver, 1.625" O.D. x 1.500" I.D.
Foot-pound torque wrench
Dremel w/ cut-off wheel (for marking synchro hubs/rings)
4" C-clamp (or Quick-grip)
3lb sledge
Cold chisel
T40 Torx bit

1-7/8" O.D. x 1–1/4"(1-1/4" pipe) to 1-3/8" I.D. x 5-1/2" long pipe (for cluster bearings)
3" diameter slug of material, approximately 1-1/2" thick or so…
Bearing separator, or harmonic balancer puller and threaded rods
Shop press (optional, but makes life much easier)

Required chemicals:

RTV (I prefer Permatex UltraBlack, but any oil resistant RTV will work.)
Loc-tite 242 (blue, removable)
Non-hardening thread sealer (Pli-A-Seal, Grey Bolt Prep, etc.)
Vaseline (for holding loose parts in place)
Three quarts of your favorite trans fluid
Loc-tite 271 (red, permanent)

Note: *The above-italicized tools and Loc-tite are required for cluster gear replacement!*

The Teardown:

I am going to assume that you have successfully drained and removed the trans from the vehicle; if you haven't, shut off the computer and back away slowly! Seriously, it is my contention that if you can remove the trans without hurting yourself or breaking something, you should be able to accomplish the rebuild. If the trans is fairly dirty, cart it down to the local car wash for degreasing and pressure washing; nothing (personally) bothers me more than to try to do a rebuild on a grungy component. We'll break the trans into seven areas: tailhousing, cover, input shaft, overdrive, main shaft, cluster gear, and reverse. Before you begin, study the exploded views (in the Helm or Tremec manual, or the download from TTC) of the entire trans. You might (and should) blow a copy up and keep it handy during the rebuild.

Tailhousing:

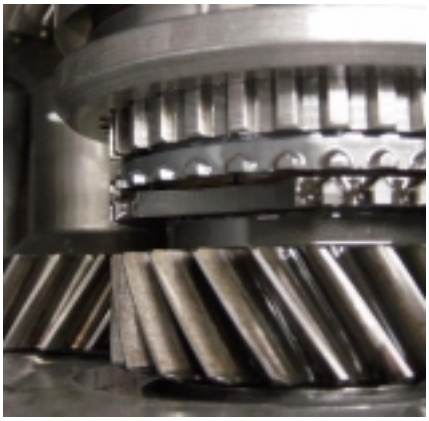

Remove the eight (8) tailhousing to main case fasteners with a 15mm wrench/socket. Breaking the fasteners loose first with a box-end wrench and a hammer makes things much easier, as would air tools. With the shifter removed (if not already), drive the roll pin through shift block with 3/16" punch. The pin may not fall all the way through; as long as it clears the shift shaft you're fine. Break the sealant bond between the tailhousing and main case by tapping the end of the housing with a rubber mallet; don't try to remove housing, just break it free of the case. Apply slight downward pressure on the shift block, and simultaneously slide block off the shift shaft while removing the tailhousing from the trans. Once the block is free, continue to pull all the parts off and place on the bench. If the vent didn't come off (in a 265 ft-lb tranny case), remove it from themain case and place it into the locating feature on tailhousing (normally the sealant keeps it in place).

Cover:

The cover, which also contains the shift forks and shift shaft, is attached with ten (10) fasteners. Remove the neutral indicator switch (top, front, driver's side of trans) using a 7/8" open-end wrench; be careful not to damage it (I broke one of mine, and found out later it is a Ford only item (Hanlon had a used one, thank goodness…). Try and save yourself some aggravation!). You'll also find an activation pin below the switch; retrieve and secure it. Using your 10mm tools, remove all the fasteners. Two (2) of the fasteners are shoulder bolts; they fit in one place (well, two actually…) only, and align the cover to the main case. Use a screwdriver between the cover and the main case to break the seal (intentional pry points provided!). Slide the loose cover towards the passenger side, to clear the reverse mechanism, and lift up.



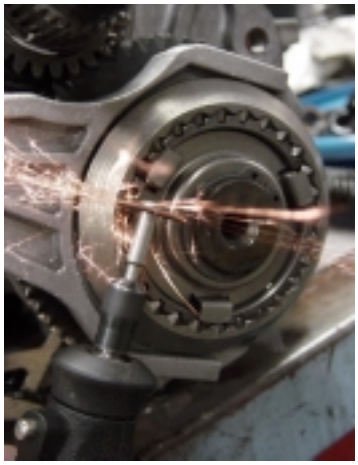
Input shaft:

To gain access to the input shaft, remove the four fasteners that hold the input shaft bearing retainer to the main case with 13mm tools, and remove the retainer. Rotating the input shaft, notice the crescent shaped cutout in the fourth gear mate (blocker-like portion). To remove the shaft, align the cutout with the cluster gear and pull forward. As you pull the input shaft, take weight off the interface by wiggling/pressing down on the mainshaft, and watch the interface between the two; there are loose roller bearings inside the input that support the mainshaft. It's OK if they fall out, but pay attention to the bearings and shims that cage the loose bearings and provide clearance between the input and main shafts. Some T5's use a steel spacer (looks like a flat washer) on top of the loose bearings; others do not (most later-model units use the spacer). Just be aware of this, and reassemble with the same parts stack-up. Remove the thrust bearing, spacer, and blocker from the 3-4 synchro at this time. If you plan to replace the input shaft bearing, remove it using a bearing separator and balancer puller (or shop press).

Overdrive:

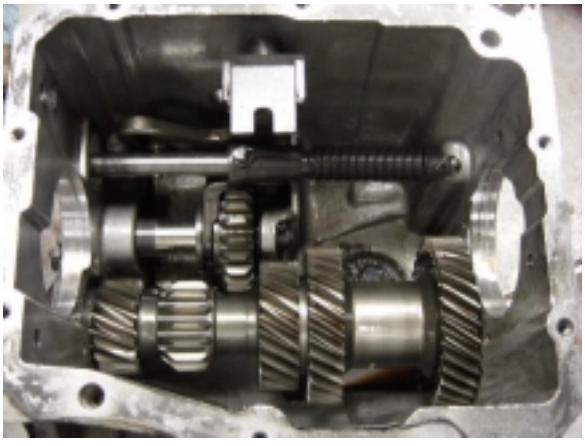
I am grouping all of the components located inside the tailhousing in the overdrive area, even though not all are related. Remove the small plastic oil slinger that is in the end of the cluster gear with pliers, screwdriver, etc. If your trans is equipped with a rubber output shaft seal, align it with the splines and pull off. Depress retaining clip that holds the speedo gear in place, and slide gear rearward, off the output (it may take some persuasion with a hammer). The clip will fall loose, once the speedo gear slides far enough to clear. Remove the retaining ring that holds the 5th driven gear onto the mainshaft with retaining ring pliers, and slide the gear off. Match mark the fifth gear synchro ring to the hub with a Dremel, and remove the snap ring that holds the shield and hub to the end of the cluster (**Note:** The pre-'92 unit is shown; see details near bottom for the 'synchronized' style, which I think started in mid-'92…). Support the end of the fifth gear shift shaft with a block of wood, and drive the roll pin out of the shift fork with the 3/16" punch. Simultaneously slide the shift fork and the 5th synchro assembly off their respective shafts; remove brass blocker and 5th drive gear and set the parts aside.


Main shaft:

With everything removed from the front and rear, the mainshaft assembly should come right out. Wiggle the front a little to unseat the bearing race at the rear of main case, and remove the race. Lift the front of the shaft slightly and towards passenger side, and pull assembly out, guiding output shaft through bearing race hole. Set the whole assembly aside for now. We'll treat it as a separate subassembly, as it contains the bulk of the parts.

If you are "fortunate", and haven't blown up third with a missed shift, you will most likely be able to skip the next two steps (unless you want to replace the bearings and races)…

Reverse:

Unhook the rail spring, and pull the rail out the back of the main case. *Note: Sometime in mid-1992, Borg-Warner changed to a torsion spring (from an extension spring) to force the shift rail forward. Unhook the end of the torsion spring from the pin with a large flat screwdriver, and rotate it out of the way.* Remove the shift rail block, and set aside. Remove the reverse light switch, located on the driver's side of the main case, with a 7/8" wrench. The Helm and Tremec manuals both require you to remove the reverse gear shift lever pivot pin BEFORE you do anything (well, before you remove gearsets). For the life of me, I have not been able to remove three of three, to date (and that is dated!). Don't fret it too much. Remove the retaining clip and reverse shift lever (if it won't come out now, remove it after the shift rail and reverse idler are removed). Drive the roll pin through the reverse idler gear shaft (This can be fun! The shaft will try to rotate as you drive the pin through. If you manage without getting blood blisters, congratulate yourself!).

Cluster gear:

Stand the main case on its forward face (bellhousing mount face). Use a hammer and chisel to bend over the four fastener lock tabs on the bearing retainer. Remove the four fasteners with the T40 Torx bit, and set fasteners, retainer, and shim aside. Remove the reverse idler gear shaft, gear, and o-ring. To allow removal of the cluster, the rear bearing must be removed, or at least the cage and rollers. If you desire to reuse the bearing, use a bearing separator and balancer puller (or shop press) or two/three jaw puller to remove the bearing. If you are planning to replace the bearing, the quickest approach is to cut the cage with aviation snips, allowing the removal of the cage and rollers. Finagle the cluster gear out of the main case. Remove the front cluster bearing race by tapping it out from the front with a hammer.



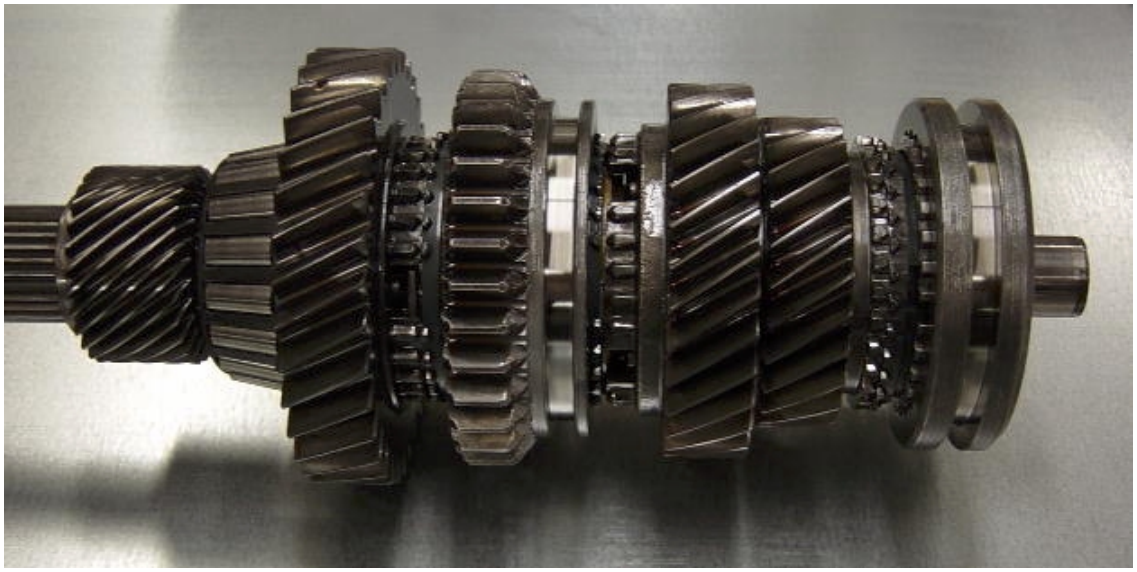
Congratulations! You successfully completed the teardown, and should have quite a pile of parts around you!

Clean up on aisle 9!

One of my pet peeves is casting flash; the other is sharp edges left after machining. You should have noticed during disassembly that nearly every edge of the T5 is sharp; some nearly razor. I take a flat file and break all the sharp edges on all major aluminum parts. While this isn't required, it only takes about five minutes, and if you can avoid a cut or three (and then getting cleaning fluid in it) it is well worth the time (in my opinion). If you blew third gear up, the large magnet in the bottom of the main case will have many pieces of shrapnel stuck to it. Carefully pick these away, and wash out the main case. Don't worry about removing the magnet; it's epoxied in (*I fought the first one for about ten minutes, then realized this!*). Blow the case out with compressed air, or let it air-dry. Inspect the cover fastener holes, and make sure to remove any RTV that may be in the hole (it is not uncommon to split a case with the cover fasteners if the hole is full of cured RTV; it simply hydraulics the case until it fractures). Repeat as required on all the other parts, save for the main shaft (leave it assembled for the time being).

If you plan to replace the tailhousing bushing, do so now. Remove the old seal by driving a flat-blade screwdriver between the lip of the shell and the tailhousing, in several areas, until you can pry the seal out. Remove the bushing by either driving it out with a driver, or deform it with a screwdriver or cut it with cold chisel (the bushing has a seam in it; if you can find it and pry on one side, they usually "split" and come out without getting overly aggressive). There is a drain groove in the tailhousing; the perfect place to get a chisel/screwdriver under the bushing to start deformation. If you damage the bore while removing the bushing, touch up the damage

with a small file and 180-220 grit sandpaper. Inside the shifter well you will see a shifter detent plate; pay particular attention here, as a good deal of sludge builds up. Chamfer the oil drain-back hole with a countersink/deburr tool, or a large drill bit.



Main shaft:

The mainshaft has a greater number of components than any other single sub-assembly. For this reason, it is advisable to clear the area of all other parts while working on it. I like to stack the parts in order and correct orientation upon removal. Starting from the front of the main shaft, mark the 3/4 synchro hub and outer ring with the Dremel (as before) to insure proper reassembly. Remove the ring, being careful to not let the synchro inserts and springs fly off. The synchro hub may slip off, or it may need some coaxing with a two/three jaw puller or bearing separator. *Some units ago, I could not get a hold of the hub with my small two-jaw pullers. I didn't want to set up the shop press, so I placed a piece of ¼" thick aluminum plate on the concrete floor, and repeatedly dropped the main shaft assembly on the plate until the hub came off. It took about eight to ten blows, and the plate protected the end of the shaft from damage*.

Remove the blocker, 3rd driven gear, caged bearing, and spacer (if you removed the hub civilly). With the retaining ring pliers, expand the retaining ring and slide it off the mainshaft. Slide off the spacer, 2nd driven gear, caged needle bearing, and spacer. Using picks or thin screwdrivers, remove the spiral retaining ring, then remove the thrust washer, inner and outer cones, and 2nd gear blocker.

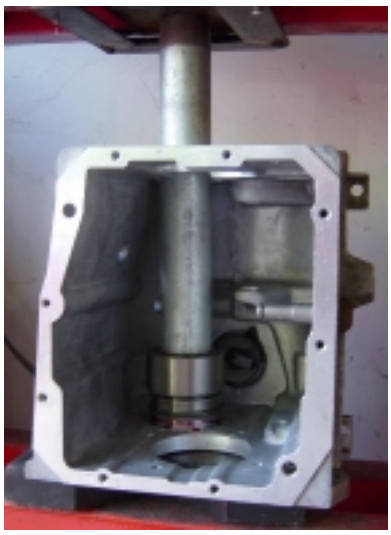
Mark the orientation of the 1-2 synchro ring to hub. Remove the ring, inserts, and springs. From the rear of the mainshaft, remove the retaining ring and slide off 5th driven gear and main shaft bearing. Slide the 1st driven gear, caged bearing, sleeve, blocker, and inner and outer cones off the mainshaft. Be careful during removal, as there is a spring and ball or pin detent under the sleeve; don't let it fall out and get away from you.

Inspect all components (per Tremec manual) as you clean and install them in the proper order. Lube the caged needle bearings with trans fluid before installing into the appropriate gears. When installing the first gear sleeve, note the notch in the I.D. that engages the detent (pin or ball) on the main shaft. Synchro assemblies can be trying; I usually have to do them two or three times to get them together without springs flying and inserts falling out. Just be patient and persistent, and you'll get them in place (but make sure marks are lined up!). Refer to the Helm or Tremec manuals for assembly details (There aren't many! 3-4 synchro has "winged" inserts; the 3-4 synchro ring is installed with the chamfer or groove (not the shift fork groove!) towards the input shaft; the springs that hold the inserts in place should be installed in opposite directions on each side (actually, if you install both clockwise, as you look at them, they will be opposite)). The tabs or ears on the outer rings of the 1-2 synchro should be oriented so that they fall into the notches in the 1st and 2nd gears; if not, the parts won't stack up properly.

And now for a little assembly!

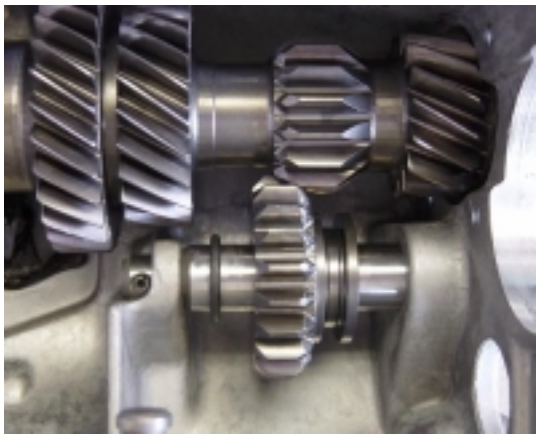
Cluster gear front bearing race:

If you are replacing the cluster gear, and desire to change the front race (if it's not galled, pitted, or damaged, it may be reused…), then do so now with nothing else in the main case. Refer to the Helm manual for procedure and set-up to correctly replace the race. I initially placed races in the freezer for a couple of hours prior to installation, but no longer do so, as it doesn't make a great deal of difference when using a press. Lube the o-ring with a light coat of oil or Vaseline, and apply a narrow ring of Loc-tite 271 to the race just above the o-ring. Set the race into the case (oriented properly!), then set up your driving system/adapters into the press (I use an old race, turned upside down, so the new race is driven in only by the outer lip, a slug of round bar, and a length of pipe). Slowly press the race into place, and stop when you feel consistent resistance in the ram. Not difficult, but some care must be exercised.



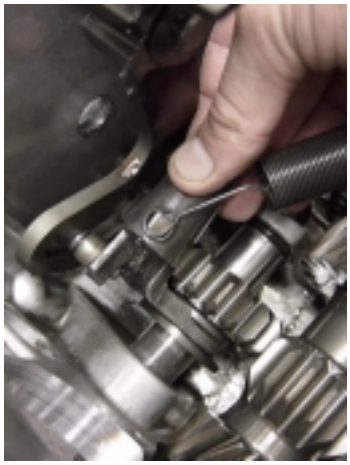
Cluster gear:

Clean the cluster gear, regardless if new or used. Install the new front bearing (either with a press, or by using the 1-7/8" O.D. pipe driving it on with a sledge. If you don't have a press, heat the bearing in an oven at 200 degrees for a few minutes prior to installation. Even with no heat, it will go on quite easily if lubed and driven on.), making sure small diameter of bearing is away from the cluster gear. Install the cluster into the main case, seating bearing in race. Stand the case on the bellhousing mount face. Install the rear cluster bearing using the same procedure as the front. Measure the thickness of the original shim, record, and install it, followed by bearing retainer and fasteners; torque to 11-15 lb-ft. DO NOT BEND TABS UP AT THIS TIME! With the top of the main case towards you, so you can see (and still on bellhousing face), set up dial indicator to read cluster gear endplay and zero out. Pry the cluster gear up with a large screwdriver, and note amount of endplay. The factory endplay range is .001"-.005". If the endplay is not within these specs, install the appropriate shim that will provide proper endplay. ***Note:*** *I could not achieve proper endplay on one trans I built with the shims I had available. I either achieved slight interference, or .008" endplay. I tried to lap the thicker shim a few thousandths, but failed to reduce the thickness after several minutes…I took the shims to work with me the next day, hoping to grind them. No grinder was available. I finally cyanoacrylated (super-glued) the shim centered on a piece of round stock. I placed four equidistant drops of adhesive, set the shim, and let it cure for a couple of minutes. I then chucked the slug in a lathe and turned a few thousandths off. To remove the shim, I simply rapped the shim on the edge of a table, and the adhesive broke free!* (Another ***note:*** [Paul Rebold passed on this tip! Thanks again Paul!] *8.8 pinion shims work very well to obtain the perfect total shim thickness. Most shims in a T5 kit have broad range, and do not allow 'fine tuning'. The use of an 8.8 shim in conjunction with a T5 shim allows dead-on accuracy. If you do not have an 8.8 collection, see your local Ford dealer and order an E4DW-4663 shim kit.)* Once the proper endplay is achieved, remove the rear bearing retainer and shims, temporarily. Hold the reverse idler gear in position, and slide the shaft through the rear case pilot and through the gear, installing the o-ring as it comes out. The o-ring keeps the reverse idler from slamming into the shaft boss cast into the main case. Drive the roll pin into the reverse idler shaft, leaving about 3/16" to 1/4" sticking above the top of the shaft. Reinstall the bearing retainer, shims, and fasteners; torque to spec (11-15 lb-ft) and bend the lock tabs up to contact one flat on each fastener.



Reverse/fifth shift shaft:

Install the shift lever and clip on the anchor pin. Locate the shift shaft block by engaging the 'ears' into the groove of the reverse idler gear, then roll it into the shift lever (roller will engage lever). While holding on the proper position, slide the shift shaft through the case, from the rear, until it just passes through the block. If your unit has an extension spring, orient it with the long eye towards the block, and slide the shaft through the center of it, into the pilot bore in the front of the main case. Hook the ends of the spring to the case and block, pulling it forward. Roll the shift shaft and maneuver the shift lever until the engagement roller is located properly in the lever.



Main shaft:

Insert the main shaft assembly by poking output shaft through hole in rear of main case. Let driven gears rest on cluster gears, and install rear bearing race into bore.

Input shaft:

Inspect the input shaft closely; check all bearing surfaces, engagement teeth, and shaft straightness. Sight down the shaft splines, and replace the shaft if twisted (before it has a chance to fail on you). Inspect the area that engages into the pilot bearing (in the end of the crank). If severely scored and rough, replace the shaft (as well as the pilot bearing). Make sure the engagement teeth are not worn or rounded over, and inspect the thrust bearing and roller bearing surfaces. These should be very smooth and free of defects, else the tranny will make noise. Remove and replace the input bearing by using a bearing separator and press (a length of 1-1/4" pipe makes a perfect driver for installation). Stand the tailhousing up, and slide the bearing retainer into the bushing end (this makes a handy stand while loading the bearings). Install the bearing race into the retainer without any shims for now (they will be added later, after determining proper thickness to achieve zero endplay). Apply a light coat of oil (or Vaseline) to the seal surface on the input shaft, and insert the shaft into the retainer and race. Apply a layer of Vaseline in the counterbore of the input, and load the loose roller bearings one at a time. The Vaseline serves to hold them in place until all are installed, and the input is attached to the tranny. Apply a dab of Vaseline to the thrust washer, shim, and 'washer' and place into position in the input.

Look at bearing race area of the retainer, and you will see two reliefs: a narrow deep one, and a wide shallow one. The wide, shallow relief should be installed towards the bottom, to allow oil to drain properly from the bearing. Place the fourth gear blocker into position on the main shaft and hold there (it helps to elevate the front of the tranny slightly). Rotate the crescent shaped cutout of the input shaft so that it will clear the cluster gear and install the input assembly, making sure the input seats fully to the mainshaft and the blocker notches clear the inserts. Install fasteners and torque to 11-20 lb-ft.

Overdrive:

Notice the step and the lettering on the 5th driven gear; they should be oriented towards the tail of the trans (closest to snap-ring). *(I got a call one night from a couple of guys who were rebuilding a unit, and had driven the gear on backwards; took them about an hour to remove it, without a press. They flipped it around, and it slid home!)* Install the 5th driven gear on the output shaft, then the snap ring, making sure it seats in groove. It may be difficult to get the gear on; if so, apply a light coat of oil to the output, and heat the gear in the oven for a few minutes (you still may have to 'persuade' it though). Install the 5th drive gear on the exposed end of the cluster gear with hub towards the front, and the blocker mating surface towards rear. Apply thin coat of Vaseline to the inside of the brass blocker (to keep it in position) and install. Simultaneously install the 5th gear synchro assembly on the cluster gear and shift fork on shift rail. Pay attention to orientation of 5th gear synchro assembly: the taper on the O.D. of the sliding ring should be installed towards the rear of the trans. The shift fork should be installed with the fork offset to the rear, also. Once assembled, align the holes in shift fork and shift rail, and drive the roll pin into place. Install the plastic oil slinger into end of the cluster gear.

Cover:

If you have to replace a damaged shift fork, see the Helm or Tremec manual for parts sequence and procedure. Install a new o-ring on shift shaft boss, and apply a 1/8" bead of RTV on the main case to cover sealing surface (on the main case itself). Let it set for a few minutes, then carefully lower cover onto main case while engaging shift forks into grooves in synchro rings. Install the cover fasteners and torque to 6-11 lb-ft, in a criss-cross pattern. Apply a small amount of thread sealant to the neutral switch; install the pin and switch.

Tailhousing:

If you removed the bushing during clean-up, and didn't install a new one, do so now. There are a couple of ways to get the bushing in; drive it in with the correct size bushing driver, or put the bushing in the freezer for several hours and hope you can get it in place before it warms up (it might help if you put tailhousing in the oven at around 200 degrees for fifteen minutes or so to expand it…). Lube the bushing with ATF, then drive it in until the end is even the tailhousing chamfer (not the major diameter; the diameter below the seal counterbore). Blow the housing out, as small slivers of aluminum and bushing material may be created during installation. Apply a 1/8" bead of RTV to the main case mounting surface (and around vent, if applicable) on the tailhousing. Let the RTV cure for a few minutes, then line it up over the output and shift shafts. Lube the o-ring on the cover with Vaseline or trans fluid. Install the spring in shift block, held in place with a dab of Vaseline. Drop the detent ball onto detent plate, in the neutral position; push the shift block over ball (with shifter bushing towards the rear), press down a bit, and align the hole with the shift shaft. Simultaneously push tailhousing and shift block forward, making sure shift rail and cluster gear bearing race pilot in their respective bores. Once "home", prep the bolts with sealant, install, and torque to 20-45 lb-ft.

Input/output shaft preload (endplay):

Stand the trans up on the bellhousing face and support it so you have access to input shaft (I normally use a couple of heads). Set up the dial indicator to read output shaft endplay and zero it out, after pulling down on the input shaft. With a block of wood, force the input shaft up, and read the endplay on the dial indicator; pull down on and rotate the input shaft, and repeat the reading. I do this three to four times to ensure I get consistent readings. Return the trans to the bench, and remove input shaft bearing retainer, being careful not to dislodge the input shaft. Remove the bearing race from inside the retainer, and install shim(s) of the same thickness as the observed endplay. This will provide .000" endplay (the factory allows plus or minus .002", however). Reinstall the bearing race, and apply 1/8" bead of RTV to bearing retainer sealing surface. Let the RTV cure for a bit, then install retainer with flat narrow drain back at bottom. Apply sealant to the fasteners, and torque to spec (11-20 lb-ft).

Apply a thin layer of RTV to the shell of the rear seal and drive seal into place with the 3/8" or 1/2" punch; tap with hammer around the

circumference of seal to avoid damage. Wait to install shifter until the trans is in the car; the easiest way to fill it with fluid is through the shifter hole.

Miscellaneous tidbits:

Speedometer drive gear:

If you have installed gears in your Mustang, you may be the victim of an inaccurate speedometer. Ford used a seven (7) tooth drive gear in the 1983 to 1989 T5's, then switched to an eight (8) tooth drive in 1990 (used through 1995). If you have 3.73's with an eight tooth drive, and the highest driven gear with twenty-three (23) teeth, the speedometer still reads 5% fast. Now is the optimum time to correct the situation, with the transmission apart for service. With the limited number of gears available, the combinations are (number in the table is the driven gear tooth number to be used with left hand gear ratio and drive gear column):

Rear end ratio / Speedo drive	Six (6) tooth drive	Seven (7) tooth drive	Eight (8) tooth drive
3.27	16	19	21
3.55	17	20	23
3.73	18	21	n/a
4.10	20	23	n/a
4.30	21	n/a	n/a
Part number	E3ZZ-17285-B	E3ZZ-17285-A	F0ZZ-17285-A
Color	Black	Yellow	Green

Shifter considerations:

If you don't want to cough up the money for an aftermarket shifter, there are a couple of things that can be done with the stock unit to provide more feedback; both involve removing the rubber bushing in the shifter handle. The cheapest is to braze the holes up, and drill with a "P" drill bit, in the correct locations. Steeda offers stainless steel shifter bushings; they install in place of the rubber units in minutes. While these two modifications improve driver feedback, they do not prevent the shift forks from overshifting inside the trans. Overtravel of the shift forks is the main cause of shift fork failure.

Trans fluid:

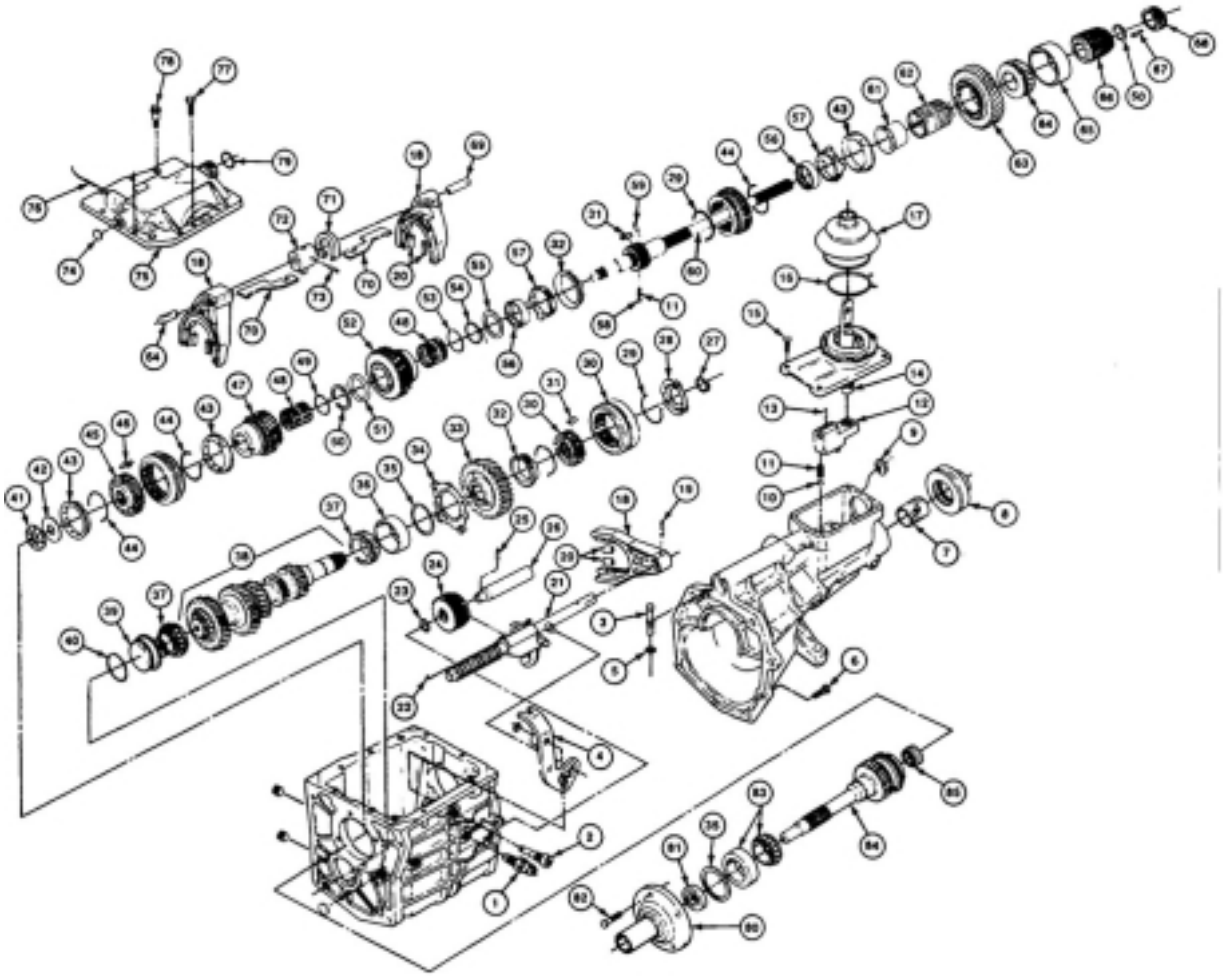
Whatever you do, do not use gear oil (e.g. 80W90) in a T5! The lubrication passages are so small on some components that gear oil will not flow readily and lubricate properly. You stand a chance of spalling, galling, or otherwise destroying a trans if pushed to extremes. Use Dexron II, Mercon III, or a synthetic ATF. Some synthetics have friction modifier in them; if you can find one without it, opt for that one (read the back of the container; usually they indicate whether modifier is present or not). If you use a synthetic, I have found (in the handful of friends' cars that run it) that the trans tends to whine a little more than with conventional ATF. If you don't mind the slight amount of noise, the increased service interval is nice (I drive mine 100 miles per day!). The fluid capacity is 5.6 pints (2.8 quarts); just fill up until it runs out of the top fill port (on the passenger side).

Parts list: (numbers correspond to exploded assembly drawings)

No.	Description	No.	Description	No.	Description
1	Switch, back-up lamp	32	Ring, 5th gear blocking	63	Gear, 1st drive
2	Pin, reverse gear shift	33	Gear, 5th drive	64	Bearing, output shaft rear
3	Vent, case	34	Retainer, cluster bearing	65	Race, output rear bearing
4	Lever, reverse gear shift	35	Shim, cluster endplay	66	Gear, 5th driven
5	O-ring, case vent	36	Race, cluster rear bearing	67	Clip, speedo gear retaining
6	Bolt, tailhousing to case	37	Bearing, cluster rear	68	Gear, speedo drive gear
7	Bushing, tailhousing	38	Gear, cluster	69	Shaft, shift
8	Seal, tailhousing output	39	Cup, cluster front bearing	70	Plate, gear selector
9	Plug, tailhousing shifter	40	O-ring, cup seal	71	Plate, gear interlock
10	Ball, shifter detent	41	Bearing, roller thrust	72	Block, gear selector
11	Spring, shifter detent	42	Shim, thrust bearing	73	Pin, block retaining
12	Block, shift	43	Ring, 3-4 blocker	74	Plug, shift shaft
13	Pin, shift block roll	44	Spring, ¾ synchro insert	75	Cover, trans top
14	Bushing, shifter	45	Hub, 3/4 synchro	76	Pin, reverse switch

15	Bolt, shifter	46	Insert, 3 /4 synchro	77	Bolt, top cover
16	Clamp, shifter boot spring	47	Gear, 3rd driven	78	Bolt, top cover shoulder
17	Boot, shifter	48	Bearing, 3rd caged roller	79	O-ring, tail to cover
18	Fork, 4-5 shift	49	Spacer, 3rd gear bearing	80	Retainer, input bearing
19	Pin, shift fork roll	50	Ring, external retaining	81	Seal, input shaft
20	Insert, shift fork (pad)	51	Shim, 2nd thrust washer	82	Bolt, input bearing retainer
21	Rail, shift	52	Gear, 2nd drive	83	Bearing, input shaft
22	Spring, shift rail block	53	Spacer, 2nd gear bearing	84	Shaft, input
23	O-ring, reverse idler stop	54	Spacer,	85	Bearings, loose roller
24	Gear, reverse idler	55	Shim, 1/2 synchro thrust	86	Ring, 3/4 synchro
25	Pin, reverse idler roll	56	Cone, inner 1/2 gear	87	Ring, 5th gear synchro
26	Shaft, reverse idler	57	Cone, outer 1/2 gear	88	Block, shift rail
27	Ring, external snap	58	Ball, 1/2 synchro detent	89	Fork, 3-4 shift
28	Retainer, 5th gear synchro	59	Pin, 1/2 synchro detent	90	Fork, 1-2 shift
29	Spring, 5th synchro insert	60	Shaft, output (main)	91	Spring, synchro pin detent
30	Hub, 5th gear synchro	61	Sleeve, 1st gear bearing	92	Shim, input shaft endplay
31	Insert, synchro hub	62	Bearing, 1st caged roller	93	Race, input bearing

Exploded assembly view:



Rebuild kits:

D&D 94-piece rebuild kit includes: 5, 8, 9, 10, 11, 19, 20, 23, 25, 27, 28, 29, 31, 32, 34, 35, 36, 37, 39, 40, 41, 42, 43, 44, 46, 48, 49, 50, 51, 53, 54, 55, 56, 57, 59, 62, 67, 73, 74, 79, 81, 83, 85, 92, 93

Hanlon refresh kit includes: 8, 20, 32, 43, 79,

Service parts: (if you didn't buy rebuild kits)

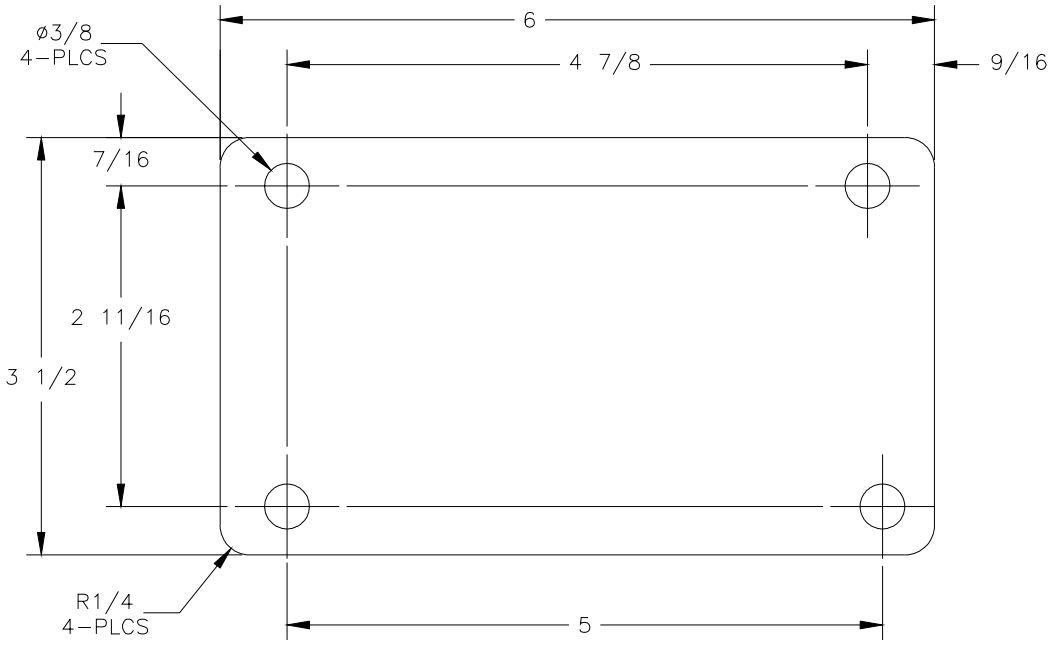
Cluster gear bearings:	*Note: if front race is still good, you can use A6 bearing sets. Use bearing only on front, bearing and race for rear.*	
Front race:	LM67010-BCE	
Rear race:	LM67010	
Bearings (same):	LM67048	
Input shaft bearing retainer:		
Bearing:	LM48548	
Race:	LM48510	
Seal:	UCO 159G	NOK
Main shaft rear bearing:		
Bearing:	25877A	Timken
Race:	25821	Timken
Tailhousing bushing:	02105	Clevite
Rear seal:	7692-S or 7052-AA	

Note: National/Federal-Mogul offers a bushing and seal kit, part number 5202, available at Hi-Lo/O'Reilly's for about $14 *(Thanks D!).*

Shipping info:

In some instances, it is necessary to ship or transport a T5 some distance. In those cases, I offer a couple of tidbits. Cut a length of 4" x 4" material (or two 2" x 4"'s) about 10" to 12" long, and secure the tranny to it by nailing through the mount holes from the top (once the mount is removed!) and bending the nails over. Quick, simple, and effective. Also, to cover the shifter hole (in lieu of duct tape!), fabricate a sheetmetal cover as

illustrated at right. Now your tranny will ride in style (albeit poor!)!



References: (There have been several other rebuilds published since my first write-up, and I have failed to keep up with them. If you discover one, and think it should be added, please let me know and I will add it below (with due credit, of course)…)

1991 Shop Manual. Helm Publishing
- Part #: FPS-12193-91 (last two digits = year)
- Cost: $52
- Phone: (313) 865-3418

T5 Transmission Service Manual. Tremec, a Division of Spicer
- http://www.ttcautomotive.com/onlineorder/product.asp
- Part #: LD05-0510-0199
- Cost: $8 (or $17 from Hanlon, or free to download…you decide!)

Mustang Performance Handbook. by William Mathis; HPBooks-1193
- ISBN #: 1-55788-193-6
- Cost: $17 (from Bookstop)

"Homebuilt T-5." by Vinnie Kung
Muscle Mustang & Fast Fords ; September 1998, 176…

"T5 101." by Rob Reasor
Super Ford; January 1999, 98-105.

Links:

T5 Index:
http://www.5speeds.com/t5/index.html

Cluster gear stabilizer:
http://www.gearzone.net/t5.htm

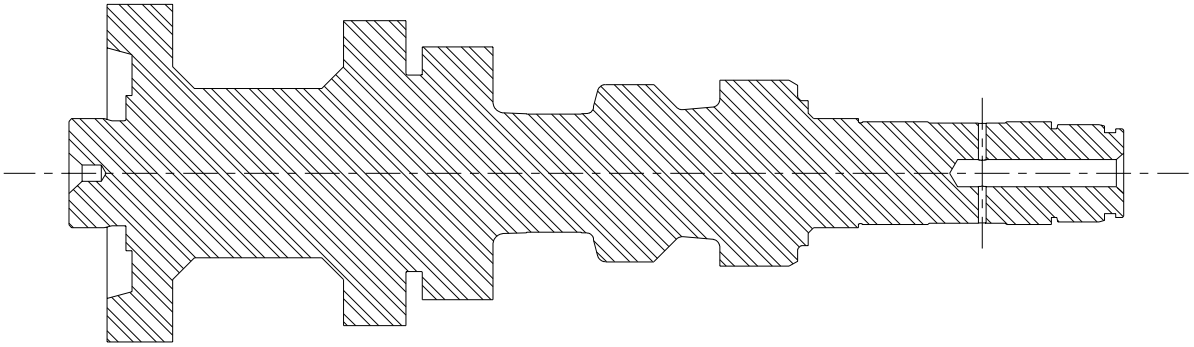
Need to add/correct:

Revision history:

May 25, 2002: update entire article; much needed!
July 27, 2002: added pictures based on ImmortalStang's rebuild…
July 30, 2002: added Cobra bearing info; corrected spelling…

Cluster gears:

265 ft-lb	Cluster #: 052	Fourth gear	Third gear	Second gear	Reverse	First gear	Fifth gear
	Tooth count	34	31	23	15	15	59
	Ratio	1.00	1.29	1.93	3.15	3.35	.68
	Mating tooth count	23	27	30	20	34	27
	Mating PN	1352085025	1352080044	941		930	



Fourth Third Second Reverse First (Fifth)

300 ft-lb	Cluster #: 065, 068	Fourth gear	Third gear	Second gear	Reverse	First gear	Fifth gear
	Tooth count	34	29	23	15	15	59
	Ratio	1.00	1.33	1.99	3.15	3.35	.68
	Mating tooth count	23	26	31	20	34	27
	Mating PN	1352085025	115			930	

330 ft-lb	Cluster #: 070	Fourth gear	Third gear	Second gear	Reverse	First gear	Fifth gear
	Tooth count	34	28	23	15	15	
	Ratio	1.00	1.34	1.94	2.76	2.95	.63
	Mating tooth count	24	30	33	20	32	
	Mating PN						

The ratio for any gear is a easy to calculate given the above info; a simple multiplication problem involving input gear ratio and output gear ratio:

(4^{th} gear cluster tooth count / input tooth count) x (driven gear in question / cluster mate tooth count)

e,g.: (34 / 23) x (34 / 15) = 3.35

Note: *I need information for a Z-spec/2.95 first gear unit…*

Tailhousing, fifth gear, and main case:

Subtle differences can make or break you…

Fifth gear synchro and tailhousing variations:

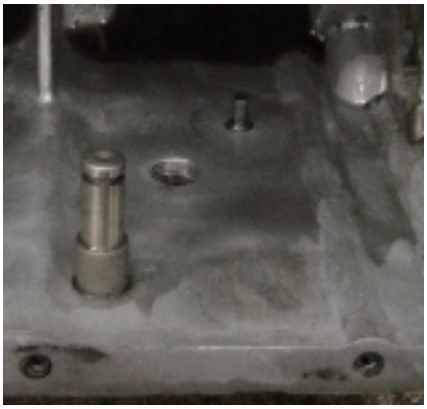
One of the common complaints about the T5 is the lack of a synchronizer while shifting into reverse. Borg-Warner made an attempt in mid-'92 to relieve the grinding by piggy-backing a synchronizer and blocker assembly on the fifth gear synchro. The attempt was to slow the cluster gear a bit to allow easier reverse idler gear engagement, but the 'fix' was only marginally successful. While the synchro assemblies can fit on any cluster, the tailhousings cannot (they are not forward compatible: you can use an old synchro with a new housing, but you cannot use an old housing with a new synchro).

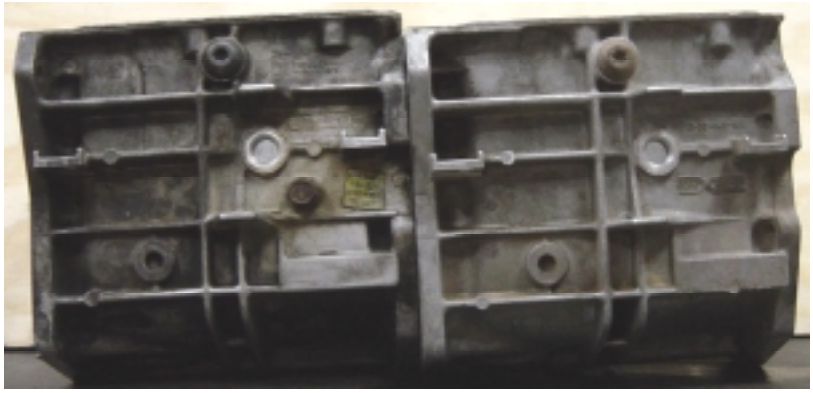
In the above photo, the late style fifth synchro is shown, with early style below it. Note the late version with the second brass blocker, the conical 'washer' (w/tab), and the internally-tabbed washer (locks into cluster splines), all of which replace the stamped sheetmetal insert keeper of the early style. All of the other parts are the same. In order to attempt to slow the cluster, the 'tab' on the conical 'washer' has to mate to a feature in the tailhousing.

The difference in the above photo is subtle, but can get you into trouble if you cannot tell the early unit on the left from the late unit on the right. The area that the plastic slinger goes into (to provide splash lubrication for the speedo gear and driveshaft bushing) is a bit different. Notice the material removed from the casting, just above the slinger well? The material removal is the anchor for the conical washer tab (as shown above). When assembling a late unit, pay attention to the orientation of the 'tab' so that it mates up properly (if not, the tailhousing will be difficult to seat to the main case). Enlarged views below:

Main case and reverse shift block variations:

Again, some time in mid-'92, Borg-Warner changed or added to the reverse shift block return system. The early units employ a tension spring to pull the block forward (see pictures above, in the main body), while the later units rely on a torsion spring for the returning force. I have encountered at least one unit that had both spring systems, but I am not sure if that was from the factory or an overly cautious rebuilder! The picture below has an early unit on the left, with a late unit on the right; notice both have the boss for the tension spring on top, but the late version has a longer roller pin that the torsion spring clips to. To use the torsion spring block, you will need a case with an anchor pin in the side. The picture (below right) shows the outside views of both cases; the late unit on the left, and the early unit on the right. Notice the hex-headed fastener to the lower right of the reverse light switch hole; that is the anchor for the torsion spring.





Looking inside the case (left), you can see the small anchor above and to the right of the shift lever anchor and the reverse light switch hole…

Photo Gallery o' Failures:

(courtesy of many people!)

Delaminated blockers: After years of use, the friction material of the blocker can debond from the blocker. This condition isn't a result of abuse or neglect, but causes the trans to grind when shifting with any speed (since the friction can no longer speed up/slow down the mating gear). The paper lining shown, used in the early units ('90 and earlier?), is more prone to do this than the later black friction material (Kevlar?). However, both materials can and will delaminate…

Input shaft damage: Ouch! This happens, especially with an early unit. Make sure you inspect the input shaft for twists and cracks closely. I did not pay attention on my first rebuild, and look what I found! While the twisting itself did not cause me grief, the failure of all the engagement teeth on the input did! When this happens, the ONLY gear you will have will be fourth (since that locks the input shaft to the output). If you see twisting of any kind, replace the input, as it's a had grenade…

Hmm, I'll take more pic's later; I have at least ten clusters that exhibit all forms of failures…

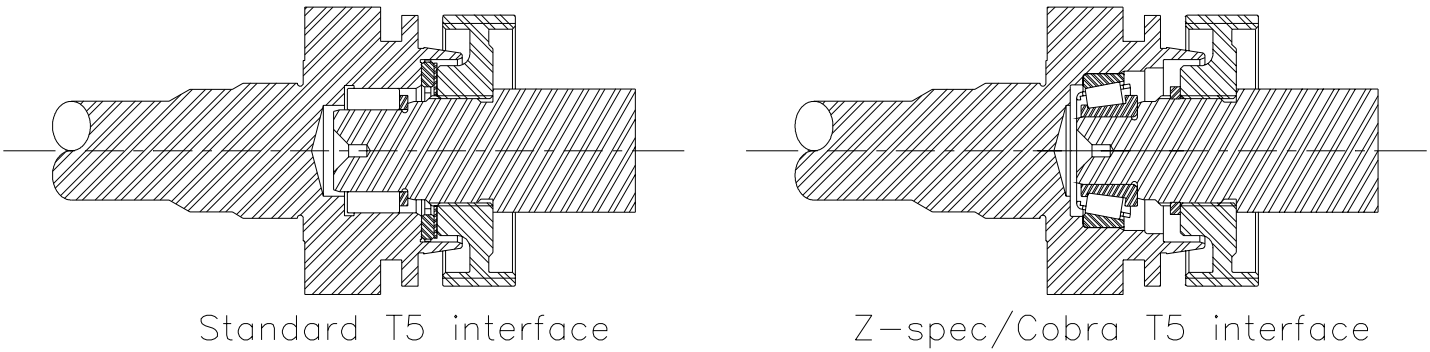
Technical Service Bulletin #612: T-5 input to mainshaft bearing upgrade… 01DEC00

A joint venture between John Pearson and Chris Neighbors…

I would like to take a moment to personally thank John Pearson for doing the hard part of this upgrade: the actual work! I managed to gather what I thought was sufficient information, but John brought forth a considerable volume of important information…Thanks for the effort, and sharing, John!

Scope:

The venerable T5 has gone through many changes since it's inception, trying to keep up with the ever increasing torque output of the Mustang in stock form (let alone 'enhanced'!). One of the last changes made to the T5 was to replace the potentially troublesome and cumbersome loose roller bearings, shims, and roller thrust bearing interface between the input and mainshaft with a single tapered roller bearing. This allows higher bearing preload, and subsequently less input shaft deflection and possible angularity issues. Retrofitting the tapered roller appears to be quite simple, if you have access to a machine shop, an understanding of T5 repair, and a few hours free time…It also allows the reclamation of previously damaged and unusable mainshafts, while increasing capacity! If the idea of attempting this yourself isn't appealing, Bob Hanlon offers a 'kit' that includes a modified mainshaft and new input for about $400, as does Jeff Bordelon…



Required components:

Bearing: Timken Set 1 or equivalent (CR BR1, Federal Mogul A1) [Autozone: $6.99]
- Cup: LM11710
- Cone: LM11749

Input shaft: '93 Cobra, Tremec part number 1352-085-050

Mainshaft: modified per drawing below

Input bearing shims, variety

Procedure:

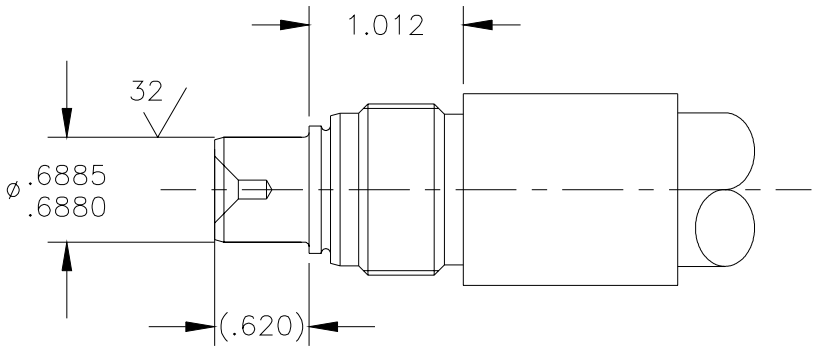
A word of ***caution*** before proceeding: The T5-Z and Cobra T5's (all with the tapered roller bearing) use a retaining ring to keep the 3-4 synchro hub in location on the mainshaft. The non-Z/Cobra trannys restrict movement with the stack-up of the roller thrust bearing and shim (between the hub and input bearing). The length of the splined shaft protruding beyond the synchro hub is shorter on the non-Z/Cobra T5's, and therefore prevents the ability to install a retaining or snap ring. I'm a bit nervous about this, but all of the hubs I've removed were nearly pressed on, and required some effort to remove them. A groove could be cut in the shaft for a smaller ID ring, but the reduction in cross-sectional area is very detrimental, especially coupled with the stress concentration (although very little torsion is present; mainly a bending moment). I hate to recommend Loc-tite bearing retainer, as it will make future service nigh impossible without heat…[other options might be available: staking, peening, swedging, deforming one spline to create *slight* interference…] Also, since the bearing is larger diameter than the ID of the synchro hub and will not pass through it, the bearing will have to be removed in order to remove the hub. A small bearing separator will be required…

Trans disassembly: Disassemble the transmission per the Tremec or Helms manual, Hanlon's video, or my previous literary work (LOL!). Remove the pressed on tapered roller bearing from the front of the input shaft and clean (carb cleaner works wonders!). Sight down the input shaft splines, checking for straightness [Oftentimes, a car that has been launched on slicks will tend to 'twist' the splines]. If the twist is slight, very closely inspect (better yet, magnaflux or Zyglo) the end of the splines towards the body for cracks. If your particular input is

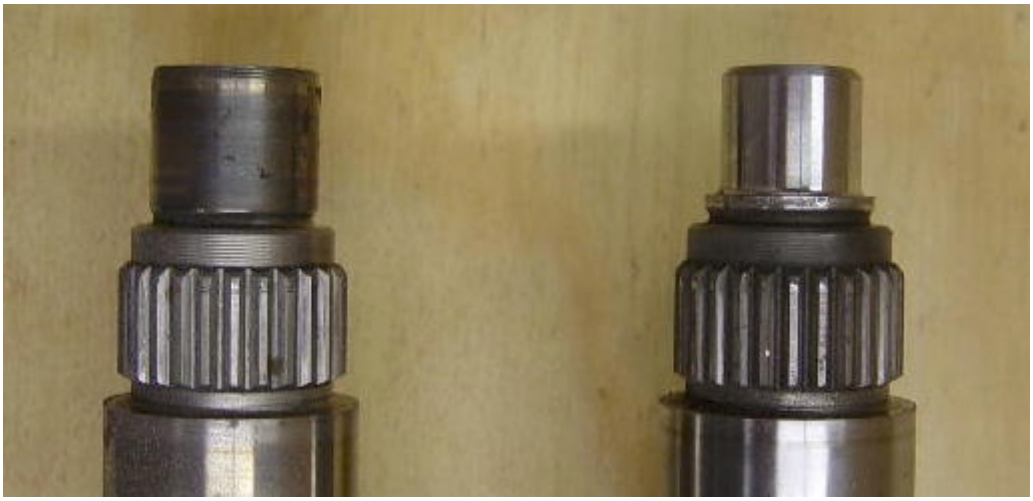
severely twisted or cracked, replacement is suggested. Remove the mainshaft assembly and disassemble down to the bare shaft (make sure you keep the parts in order); clean.

Machine shop work: Cart the mainshaft (and input, if brave!) to your 'favorite' local machine shop, with a copy of the drawings below. Smile, act civil, and try not to grimace when you are quoted a price. Keep in mind these guys make money with a running machine, and setting up new parts takes time. Expect to pay in the $25 to $35 range to get the mainshaft modified *(who knows about the input!).*

Mainshaft: Chuck up the mainshaft in the lathe, and set TIR to be .001" or less, as above. Machine the features as indicated at right, to provide .0005" to .001" bearing interference.



Original mainshaft **Modified mainshaft**

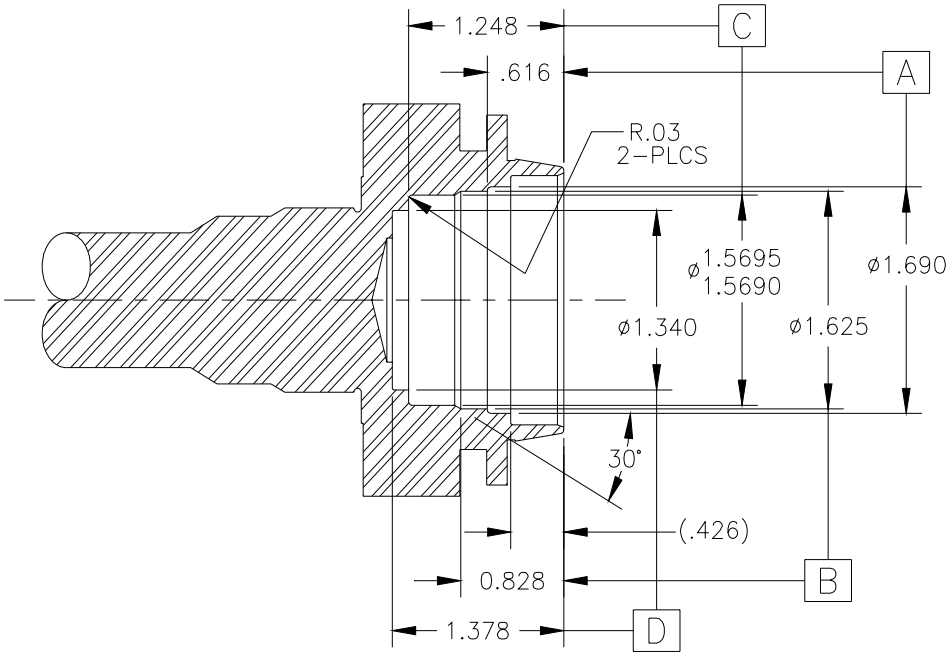


[Note: I had originally detailed the mainshaft using the .620" dimension only, but some variation in the end of the shaft caused a measurement plane concern (up to .008" variation recorded). Please use the 1.012" dim, as indicted…(I left the .620" as a reference dim.)]

Input shaft: Because the input shaft is hardened, machining the required features is nigh impossible. Grinding is about the only realistic modification option, but may prove too costly. It is recommended that you purchase the correct input shaft new. The correct input is from the '93 Cobra T5 (build code 1352-218); Tremec apart number 1352-085-050. You cannot use the 2.95 first-geared Z-spec input, as it has 24-teeth versus the 23 on the 3.35 first gear transmissions. National Drivetrain has this shaft available for $125. [I will leave the following verbiage intact, in the event that some of you are gluttons for punishment or have access to the proper grinding equipment…]

Chuck the input shaft up in the grinder (preferably at the bearing surface, to shorten the 'overhang'. Be careful to avoid damage to the bearing surface) and set the total indicator run-out (TIR) to .001" or less. While this sounds 'tight', keep in mind that a part with a similar tolerance will be mated with it, creating .002" maximum eccentricity. Machine the input to the dimensions below, which will provide .0005" to .001" interference fit on the bearing cup (race). While not indicated, shoot for a 32 microinch or better finish on the race seat features…

[*<u>Note</u>: the factory inputs do not provide a clearance feature to facilitate race removal in the event of damage. A small three-jaw internal (bearing) puller might allow removal, but I cannot confirm that at this point. If you have the means, two or three small milled slots just below the race seat (in the 1.340 diameter feature) will allow a two- or three-jaw puller to get under the race, allowing removal…***<u>Tech tip from Paul Rebold:</u>** *If you have a bearing race that is installed in a blind recess and it absolutely, positively must be removed, run a bead of weld around on the race where the bearing contacts and it will fall out everytime. Of course you need a new race, but...]*

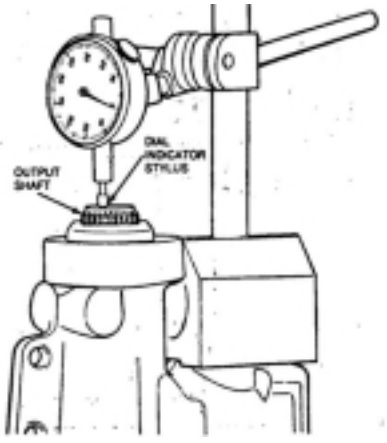


Feature	Diameter	Depth	Purpose
A	1.690	.616	??? (can be eliminated)
B	1.625	.828	Bearing race (cup) clearance
C	1.5695/1.5690	1.248	Bearing race (cup) seat
D	1.340	1.378	Bearing cage clearance

<u>Assembly:</u>

Upon receipt of your freshly machined parts, clean them with an appropriate cleaner and air dry. Lube the OD of the bearing race and press into the input shaft, making sure it seats in the bore [*place the race in the freezer for a period of time (thirty minutes or so…) prior to assembly, for easier assembly*]. Assemble the mainshaft (at least from the first and second gear synchro hub forward), and press the bearing onto the 'nose' of the mainshaft, making sure it is seated. Assemble the remainder of the trans per appropriate documentation and/or procedures…until you get to:

<u>Endplay set-up:</u> One of the main advantages of the tapered roller bearing is the ability to set the input bearing preload higher than with the flat roller thrust bearing. Following the Helm manual, install the input shaft (with bearing pressed on) and input bearing race in the retainer (without any shims), and tighten the four fasteners. Place the transmission on the face of the case, with the input shaft facing down, and tailhousing up [*I used a couple of heads to set mine on, as they were handy*]. Set up a dial indicator so that it contacts the end of the output shaft (see figure, right), and zero the dial. Using a block of wood, push upward on the input shaft, and note the reading on the dial indicator. Normally, the indicator reading would be the optimum shim, but with the tapered roller bearing, add .0005" to .004" (***Thanks to Glenn Forester for confirmation!***) for proper preload. Rotate the trans back to horizontal, remove the retainer, install appropriate shims,



apply a bead of RTV to the retainer, and install.

John's shim story (*slightly* edited):

I needed a .035" shim and found it more difficult to find than I thought. I had a .030" and a .010". I found an easy way to lap the shims. I lapped the .030 to .025 in no time after I got the technique down. I had a piece of Melamine, a plastic coated particle board, about 16x16". I cut a corner off a little bigger than the shim. Then I traced the inside of the shim onto a piece of .010" sheet steel *(CN: shim stock might work…)*, cut the steel 'dot' out a little smaller, and glued it to the small corner of Melamine I had cut. I used this to hold and move the shim down on the sandpaper. I then placed a full sheet of wet/dry 320 grit onto the large piece of Melamine, wetted the paper with paint thinner, and placed the shim on the paper. I placed the small piece of Malinine, with steel dot glued on, over the shim and wiggled it around to catch the shim. I ran the shim across the full width of the paper at one end about 100 times as I turned the shim every 10 times or so (CN: I usually use a figure eight (8) pattern…). I kept moving across the sandpaper as one 'track' would wear out. I got 4 tracks across a sheet. It took two (2) sheets of sandpaper and about 15 minutes to knock .005" off my shim.

I wasn't having any luck lapping the shim until I did it this way. Not bad if you are in a pinch, or you want to really get close with your shims… *Alright John!*

Note: *All the layouts were done in AutoCAD Version 14. If you would like an electronic copy, drop me a line, and I'll get it out to you ASAP…*

Cost breakdown: (from John's experience…)

'93 Cobra input shaft	$125.00
Shipping and handling	$9.00
Bearing	$7.95
Mainshaft machining	$25.00
Pressing cup into input	$5.00
Total:	$171.95

References:

http://www.blarg.net/~bossbill/t_5.html