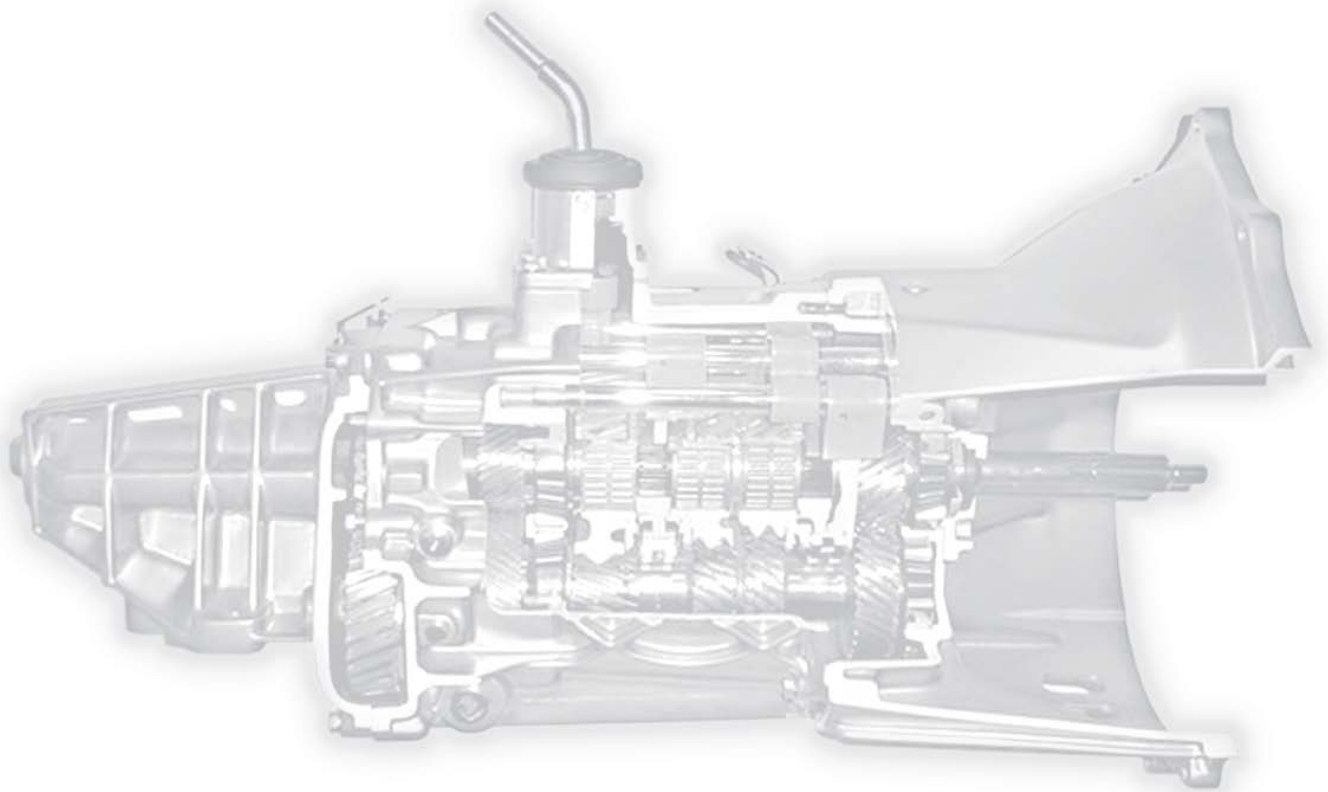


FSO-2405

Service Manual Transmission



Eaton® Fuller®
Light Duty Transmissions

2nd Ed. 02/07

EAT•N

General Information

1

Input Shaft Bearing Cover

2

Rear Section

3

Front Section

4

Gear Shift Lever Housing

5

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This manual is designed to provide detailed information necessary to service and repair the Eaton transmission FSO-2405.

Disassembly and assembly instructions in this manual make use of a typical FSO-2405 transmission. Provided illustrations and pictures show parts that may differ from one transmission model to another, according to its application and serial number.

In addition, it is also assumed that the transmission has been removed from the vehicle and the lubricant has been drained.

The manual has been divided into two main groups as follows:

1. Information and technical references, placed all together into one section.
2. Disassembly and assembly instructions, by its turn, divided into sections gathering specific component assemblies.

For more detailed information on product improvement, repair procedures and other subjects related to service, please contact:

Eaton Ltda. - Transmission Division
Aftermarket and Service
Rua Clark, 2061 - P.O.Box 304
13270 - Valinhos - São Paulo - Brazil
Fone: (19) 3881-9962
Fax: (19) 3881-9858

WARNING! Eaton reserves the right to make modifications in its products and to change specifications included in this manual at any time without previous notice.

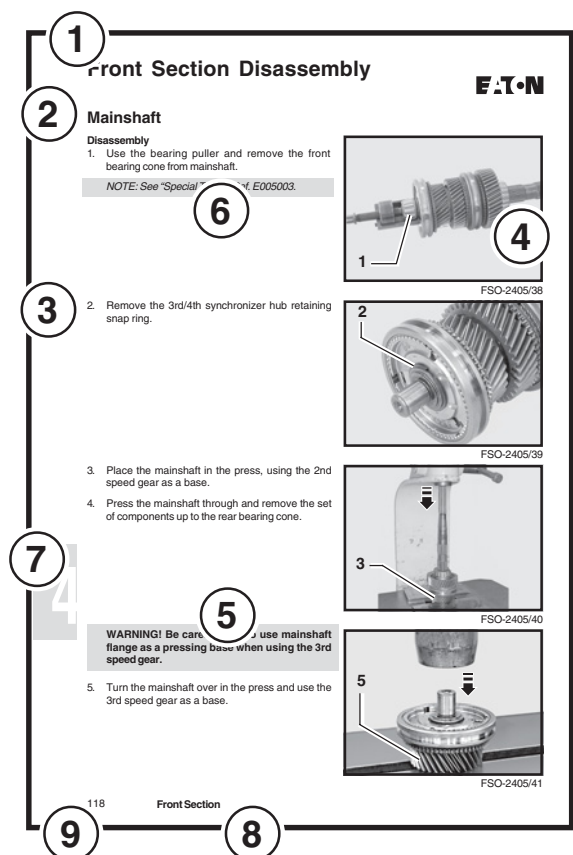
To disassemble and reassemble the entire transmission, follow the manual in sequence. However, if the problem involves only one component, refer to the table of contents of its related section, for the page number showing that component.

Example

- Component: Double gear shifting interlocking system
- Location: Front Section
- From the table of contents: Disassembly instructions, page 115.
Assembly instructions, page 145.

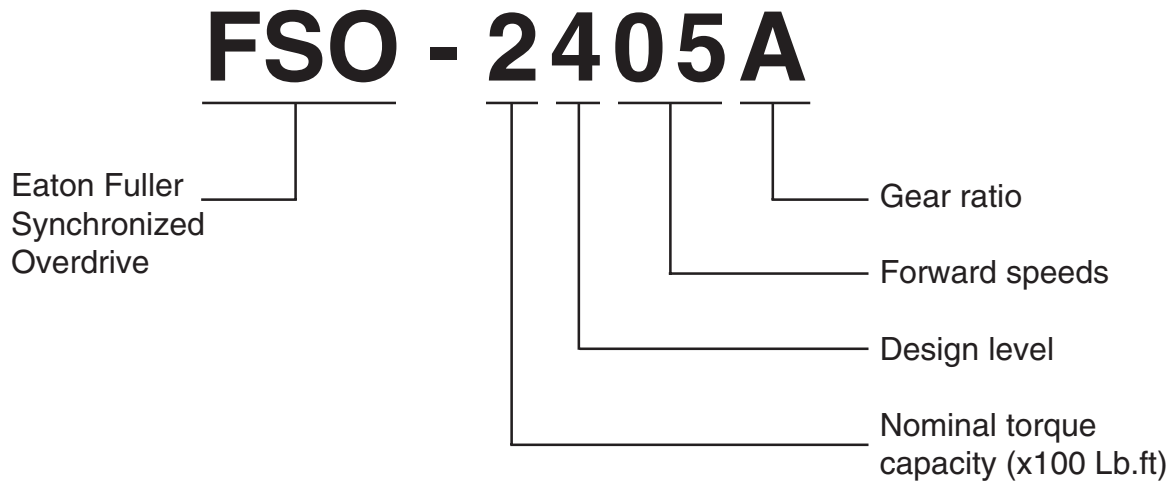
General page layout description

1. Heading of the topic covered in the section.
2. Subheading with a more specific description of the topic covered.
3. Number and description of the procedure in sequence.
4. Illustration or photograph illustrating the procedures.
5. WARNING! Information requiring special attention to avoid personal injury or product damage.
6. NOTE: Useful information to perform the procedure.
7. Manual's section number.
8. Manual's section description.
9. Page number.



Identification

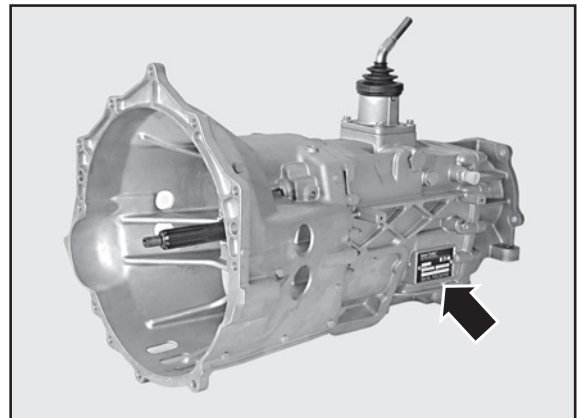
Model designation



All Eaton transmissions are identified by the model designation and serial number. These information are stamped on the identification tag fixed to the transmission case.

WARNING! Do not remove or destroy the transmission identification tag.

NOTE: When ordering parts or consulting service dept., please inform identification tag numbers.



FSO-2405/85



FSO-2405/86

Specifications

		FSO 2405 A		FSO 2405 B		FSO 2405 C		FSO 2405 D	
Torque	Lb.ft	310		310		280		280	
	N.m	420		420		380		380	
		ND	Gear Ratio	ND	Gear Ratio	ND	Gear Ratio	ND	Gear Ratio
Input Shaft		26		26		26		26	
Countershaft		37		37		37		37	
1st Speed	(CE)	15	4.079	15	4.079	14	4.473	14	4.473
	(EP)	43		43		44		44	
2nd Speed	(CE)	23	2.289	23	2.289	22	2.458	22	2.458
	(EP)	37		37		38		38	
3rd Speed	(CE)	29	1.472	29	1.472	29	1.472	29	1.472
	(EP)	30		30		30		30	
4th Speed	(CE)	-	1.000	-	1.000	-	1.000	-	1.000
	(EP)	-		-		-		-	
5th Speed	(CE)	53	0.725	51	0.809	53	0.698	51	0.809
	(EP)	27		29		26		29	
Reverse Speed	(CE)	12	3.795	12	3.795	12	3.795	12	3.795
	Reverse Idler Gear	29		29		29		29	
	(EP)	32		32		32		32	

ND = Number of teeth CE = Countershaft EP = Mainshaft

		FSO 2405 E		FSO 2405 F		FSO 2405 G		FSO 2405 J	
Torque	Lb.ft	280		391		369		369	
	N.m	380		530		500		500	
		ND	Gear Ratio	ND	Gear Ratio	ND	Gear Ratio	ND	Gear Ratio
Input Shaft		26		28		27		27	
Countershaft		37		34		35		35	
1st Speed	(CE)	14	4.473	15	3.481	12	4.213	15	3.716
	(EP)	44		43		39		43	
2nd Speed	(CE)	22	2.458	22	2.097	22	2.239	22	2.239
	(EP)	38		38		38		38	
3rd Speed	(CE)	29	1.472	29	1.382	29	1.475	29	1.475
	(EP)	30		33		33		33	
4th Speed	(CE)	-	1.000	-	1.000	-	1.000	-	1.000
	(EP)	-		-		-		-	
5th Speed	(CE)	53	0.725	44	0.745	45	0.749	45	0.749
	(EP)	27		27		26		26	
Reverse Speed	(CE)	12	3.795	12	3.238	12	3.457	12	3.457
	Reverse Idler Gear	29		29		29		29	
	(EP)	32		32		32		32	

ND = Number of teeth CE = Countershaft EP = Mainshaft

		FSO 2405 K		FSO 2405 M		FSO 2405 N	
Torque	Lb.ft	280		369		280	
	N.m	380		500		380	
		ND	Gear Ratio	ND	Gear Ratio	ND	Gear Ratio
Input Shaft		26		25		26	
Countershaft		37		38		37	
1st Speed	(CE)	14	4,473	14	4,994	14	4,473
	(EP)	44		46		44	
2nd Speed	(CE)	23	2,289	22	2,625	23	2,289
	(EP)	37		38		37	
3rd Speed	(CE)	30	1,376	30	1,469	30	1,376
	(EP)	29		29		29	
4th Speed	(CE)	-	1,000	-	1,000	-	1,000
	(EP)	-		-		-	
5th Speed	(CE)	61	0,653	53	0,774	53	0,698
	(EP)	28		27		26	
Reverse Speed	(CE)	12	3,795	12	4,053	12	3,795
	Reverse Idler Gear	29		29		29	
	(EP)	32		32		32	

ND = Number of teeth CE = Countershaft EP = Mainshaft

NOTE: The transmission specifications may be modified at any time. The data on table is provided for reference purpose only.

Weight

Transmission 4x2 = 60 kg

Transmission 4x4 = 57,5 kg

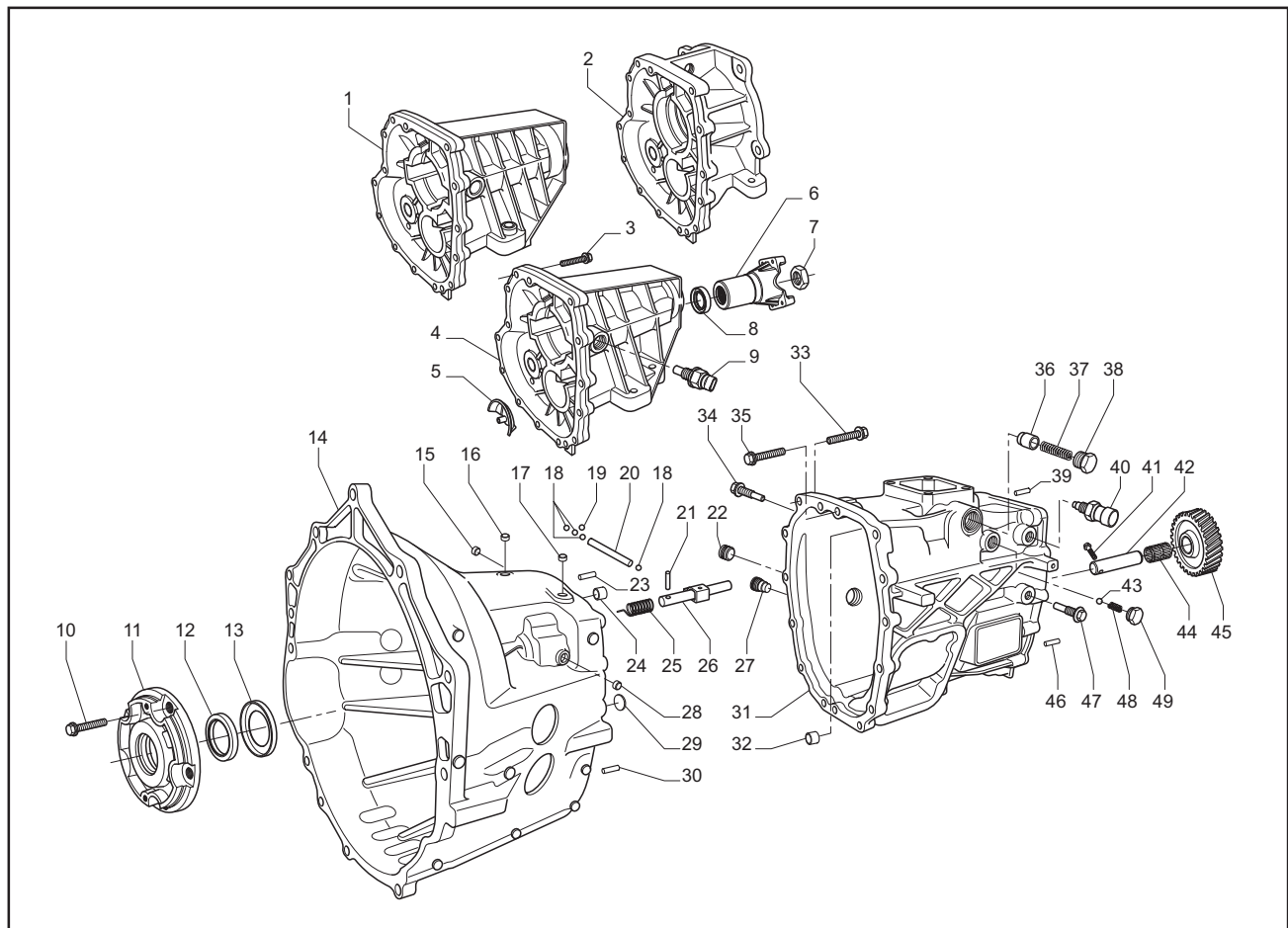
NOTE: Weight does not include the gear shift lever housing assembly.

Lubricant volume

3,0 liters (standard)

NOTE: The supplied oil volume may vary according the vehicle model and depends on both the engine and transmission inclination. Always refill the transmission with proper grade and type of lubricant to the level of the filler plug opening (see "Lubrication").

Housings

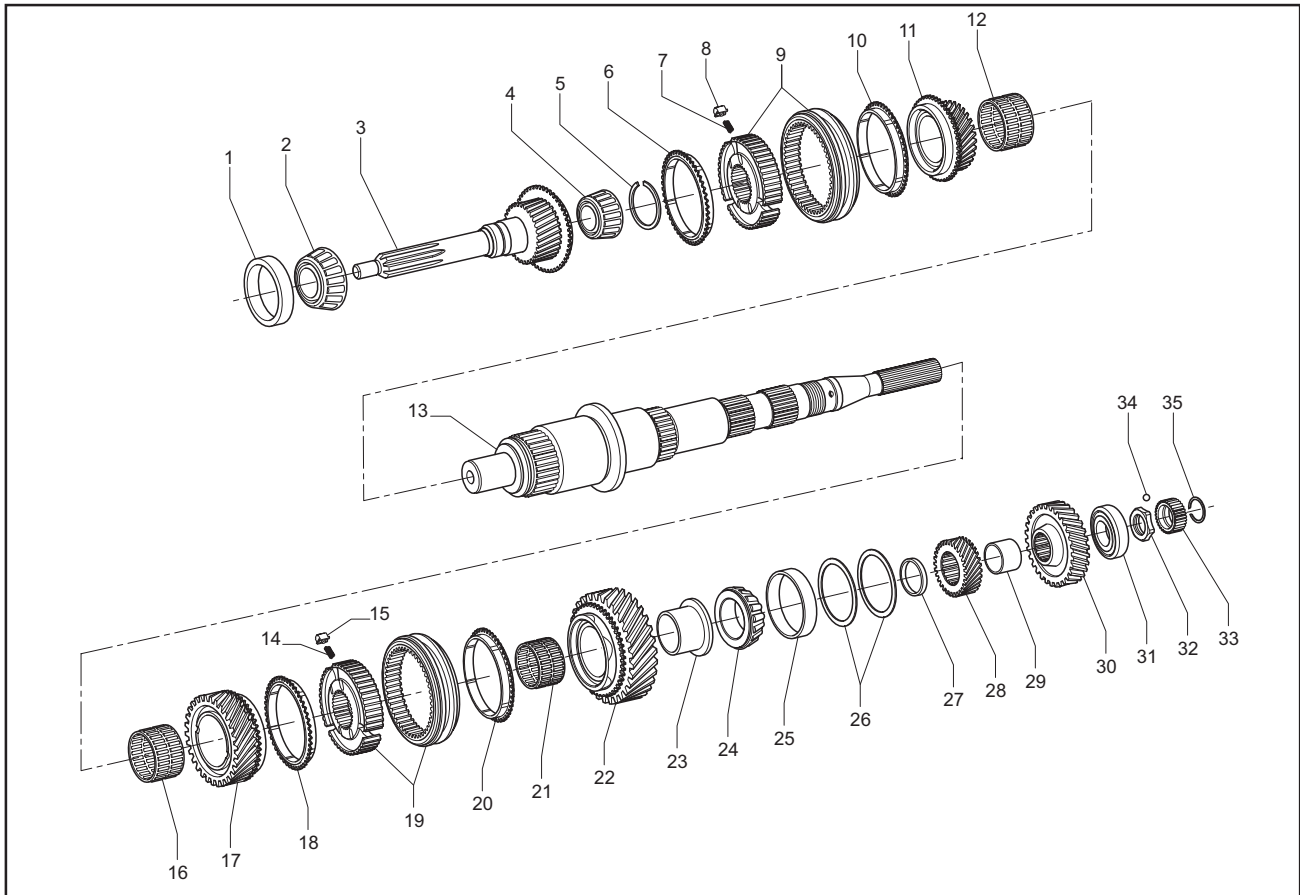


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- | | | |
|--------------------------------|--|-------------------------------|
| 1 - Rear housing 4x2 | 18 - Ball | 34 - Pivot threaded pin |
| 2 - Rear housing 4x4 | 19 - Ball | 35 - Capscrew |
| 3 - Capscrew | 20 - Interlock pin | 36 - Actuator |
| 4 - Rear housing 4x2 | 21 - Roll pin | 37 - Spring |
| 5 - Oil baffle | 22 - Oil fill plug | 38 - Plug |
| 6 - Universal joint yoke | 23 - Dowel pin | 39 - Dowel pin |
| 7 - Nut | 24 - Permaglide bushing | 40 - Reverse light switch |
| 8 - Oil seal | 25 - Spring | 41 - Capscrew |
| 9 - Speedometer sensor | 26 - Reverse shifting interlock assembly | 42 - Reverse idler gear shaft |
| 10 - Capscrew | 27 - Oil drain plug | 43 - Ball |
| 11 - Input shaft bearing cover | 28 - Plug | 44 - Needle bearing |
| 12 - Oil seal | 29 - Expansion plug | 45 - Reverse idler gear |
| 13 - Oil baffle | 30 - Dowel pin | 46 - Dowel pin |
| 14 - Front housing | 31 - Intermediate housing | 47 - Pivot threaded pin |
| 15 - Plug | 32 - Permaglide bushing | 48 - Spring |
| 16 - Plug | 33 - Capscrew | 49 - Plug |
| 17 - Plug | | |

Gearing

Input Shaft and Mainshaft

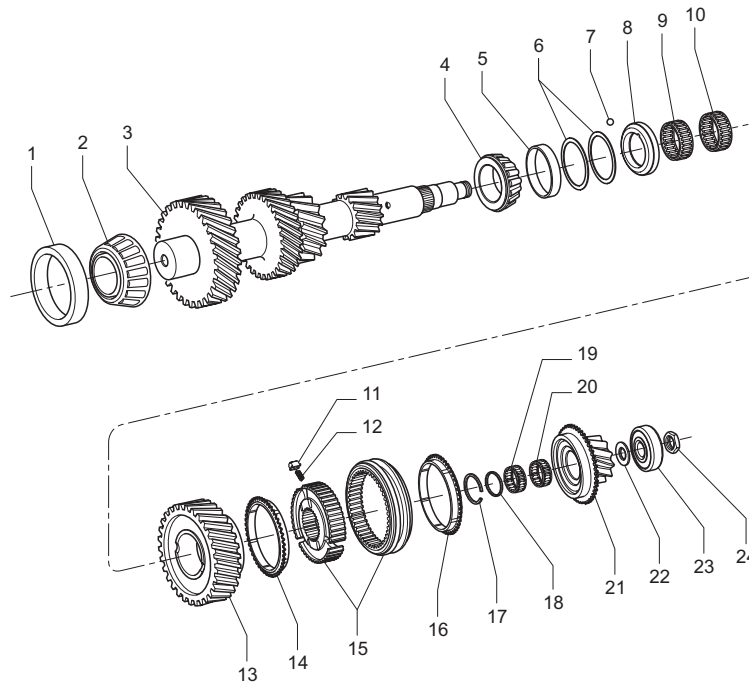


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1 - Input shaft bearing cup	12 - Needle bearing	Mainshaft bearing shim (0.254)
2 - Input shaft bearing cone	13 - Mainshaft	Mainshaft bearing shim (0.508)
3 - Input shaft	14 - Spring	Mainshaft bearing shim (0.762)
4 - Mainshaft front bearing cone	15 - Key	Mainshaft bearing shim (1.016)
5 - 3rd/4th speed synchronizer snap ring (2.175)	16 - Needle bearing	NOTE: Use shim thickness and quantity as required (see "End Play Adjustment")
3rd/4th speed synchronizer snap ring (2.250)	17 - 2nd speed gear - mainshaft	27 - Spacer
3rd/4th speed synchronizer snap ring (2.325)	18 - 2nd speed synchronizer ring	28 - 5th speed gear - mainshaft
NOTE: Use one snap ring thickness according to selective fit	19 - 1st/2nd speed synchronizer assembly	29 - Bushing
6 - 4th speed synchronizer ring	20 - 1st speed synchronizer ring	30 - Reverse speed gear - mainshaft
7 - Spring	21 - Needle bearing	31 - Ball bearing
8 - Key	22 - 1st speed gear - mainshaft	32 - Nut
9 - 3rd/4th speed synchronizer assembly	23 - 1st speed gear bushing	33 - Speedometer rotor
10 - 3rd speed synchronizer ring	24 - Mainshaft intermediate bearing cone	34 - Ball
11 - 3rd speed gear - mainshaft	25 - Mainshaft intermediate bearing cup	35 - Snap ring
	26 - Mainshaft bearing shim (0.050)	
	Mainshaft bearing shim (0.102)	
	Mainshaft bearing shim (0.178)	

Gearing

Countershaft and Reverse Idler Gear

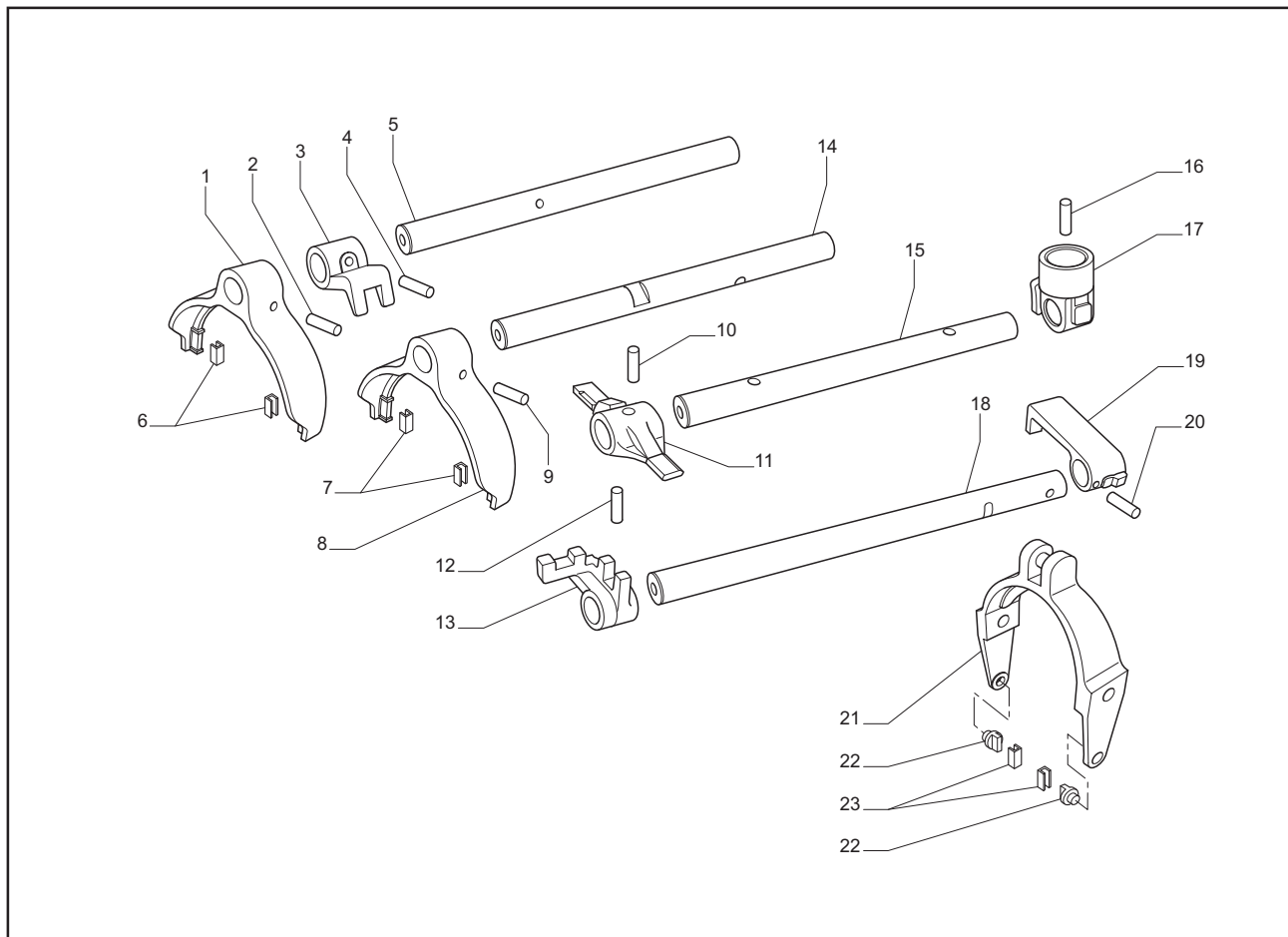


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1- Countershaft front bearing cup	Countershaft bearing shim (1.016)	17 - 5th/reverse speed synchronizer snap ring (2.215)
2- Countershaft front bearing cone	NOTE: Use shim thickness and quantity as required (see "End Play Adjustment")	5th/reverse speed synchronizer snap ring (2.290)
3- Countershaft	7 - Ball	5th/reverse speed synchronizer snap ring (2.365)
4- Countershaft intermediate bearing cone	8 - Thrust washer	NOTE: Use one snap ring thickness according to selective fit
5- Countershaft intermediate bearing cup	9 - Needle bearing	18 - Spacer
6- Countershaft bearing shim (0.050)	10 - Needle bearing	19 - Needle bearing
Countershaft bearing shim (0.102)	11 - Key	20 - Needle bearing
Countershaft bearing shim (0.178)	12 - Spring	21 - Reverse speed gear - countershaft
Countershaft bearing shim (0.254)	13 - 5th speed gear - countershaft	22 - Thrust washer
Countershaft bearing shim (0.508)	14 - 5th speed gear synchronizer ring	23 - Ball bearing
Countershaft bearing shim (0.762)	15 - 5th/reverse speed synchronizer assembly	24 - Nut
	16 - Reverse speed gear synchronizer ring	

Shifting System

Shift Yokes and Bars

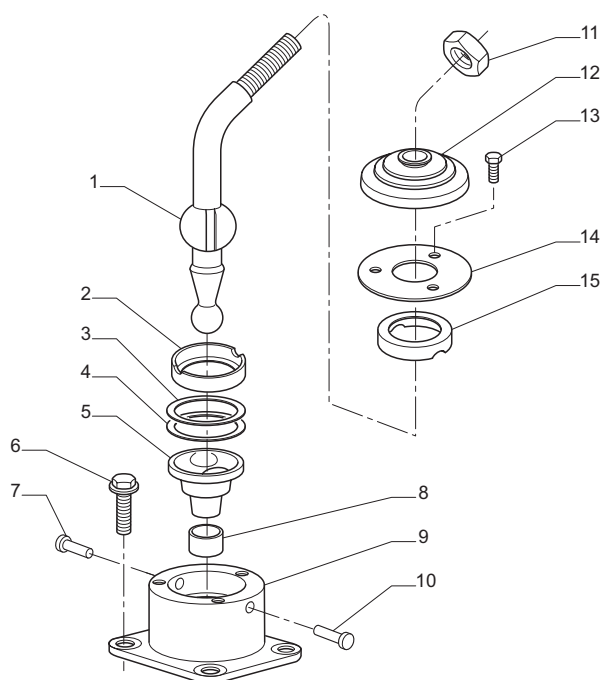


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1 - 3rd/4th speed shift yoke	9 - Roll pin	17 - Shift lug
2 - Roll pin	10 - Roll pin	18 - 5th/reverse speed yoke bar
3 - 3rd/4th speed shift block	11 - Shift selecting block	19 - 5th/reverse speed linked shift block
4 - Roll pin	12 - Roll pin	20 - Roll pin
5 - 3rd/4th speed yoke bar	13 - 5th/reverse speed shift block	21 - 5th/reverse speed swiveled shift yoke
6 - Nylon pad	14 - 1st/2nd speed yoke bar	22 - Nylon pad holder
7 - Nylon pad	15 - Shift selecting bar	23 - Nylon pad
8 - 1st/2nd speed shift yoke	16 - Roll pin	

Gear Shift Lever Housing

Direct



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1 - Gear shift lever	6 - Capscrew	11 - Nut
2 - Lower bushing	7 - Pin	12 - Boot
3 - Thrust washer	8 - Gear shift lever end bushing	13 - Capscrew
4 - Wave washer	9 - Gear shift lever housing	14 - Cover
5 - Oil baffle	10 - Pin	15 - Upper bushing

Proper lubrication procedure is the key to a good and complete maintenance program. If the oil is not doing its job, or if the oil level is ignored, all the other possible maintenance procedures will not be enough to keep the transmission running or to assure long transmission life.

Eaton transmissions are designed so that all the internal parts operate in an oil circulating bath, created by the motion of gears and shafts. Thus, all parts are amply lubricated if these procedures are closely followed:

1. Maintain proper oil level by inspecting it regularly.
2. Change oil regularly following maintenance interval chart.
3. Use the recommended grade and type of oil.
4. Buy from a reputable dealer.

Oil change and level inspection

Periodic transmission oil change eliminates possible bearing failures, ring wear and seizures, since the products of normal wear in service (tiny metal particles), which circulate in the transmission oil, are harmful to these parts. In addition, the oil changes chemically due to the repeated heating and cooling cycles of a transmission in use.

As a general guide, the following chart provides maintenance interval recommendation to level inspection and oil change.

WARNING! Always follow the vehicle manufacturer maintenance recommendation, that prevails over this chart.

Recommended lubricant oil: DEXRON III

Highway use

After first 15.000 km	→	Change transmission oil
Every 10.000 km	→	Inspect oil level and check for leaks
Every 40.000 km	→	Change transmission oil

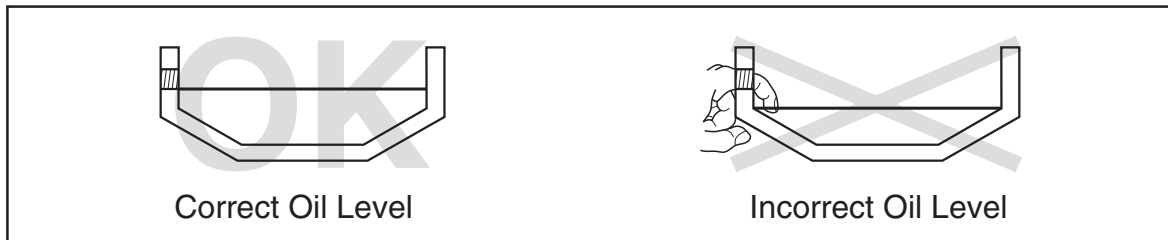
Off-highway use

After first 5.000 km	→	Change transmission oil
Every 7.500 km	→	Inspect oil level and check for leaks
Every 15.000 km	→	Change transmission oil

Draining

Drain the transmission while oil is warm. To drain the oil, remove the magnetic drain plug. Clean the drain plug before re-installing it.

Refilling



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Clean the case around the oil fill plug, remove the plug and refill the transmission to the level of the filler opening.

The quantity of oil necessary to refill the transmission depends on the transmission angle. So, refill the transmission with the vehicle on a flat and leveled surface.

Do not fill the transmission above the recommended level. This will cause oil to be forced out of the case through the front bearing cover, the control cover, the shift lever housing, etc.

Oil level inspection

Everytime the oil level is being checked, clean the area around the filler plug and, if necessary, add sufficient oil to maintain the proper oil level.

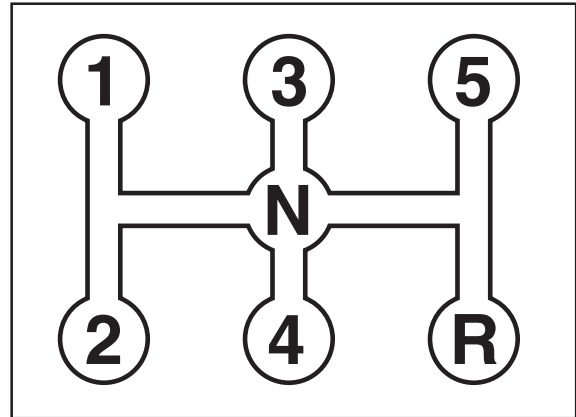
WARNING! Do not mix oils of different types and brands, because of possible incompatibility.

Gear shift lever pattern

FSO-2405 transmissions have 5 forward speeds and one reverse, all of them synchronized.

To shift the speeds follow the shift pattern shown by the illustration on the side.

A reverse gear shifting interlocking system prevents from accidental transmission shifting from 5th to reverse gear.



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Tips for the driver

Always use the clutch to change the gears. The incorrect use of the clutch may cause premature failures of the synchronizer assembly.

Always select a starting gear that will provide sufficient power (torque) for the vehicle's load and working conditions (terrain).

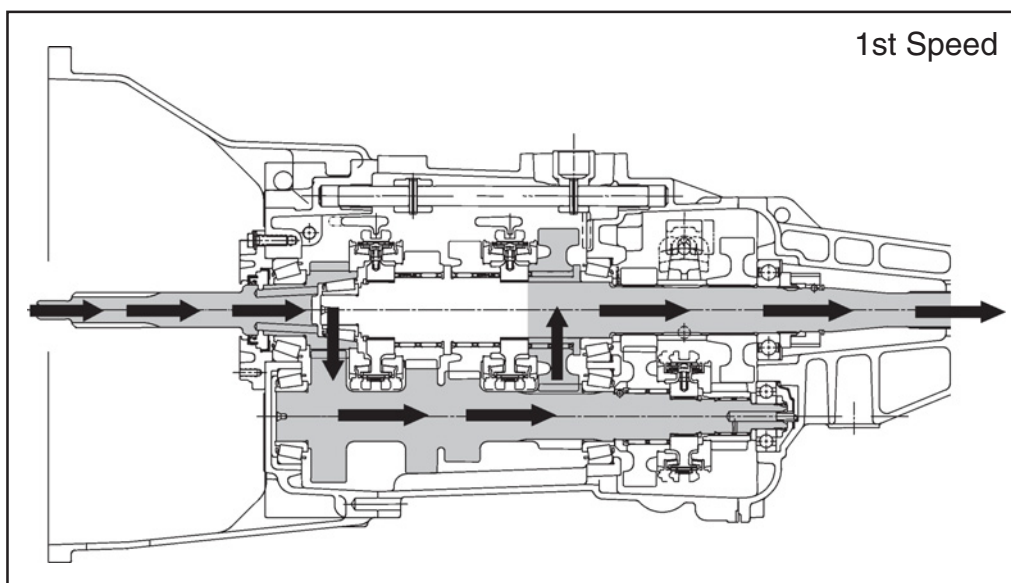
Never slam or jerk the gear shift lever to complete gear engagement.

Never leave the shift lever in the neutral position while going down hill.

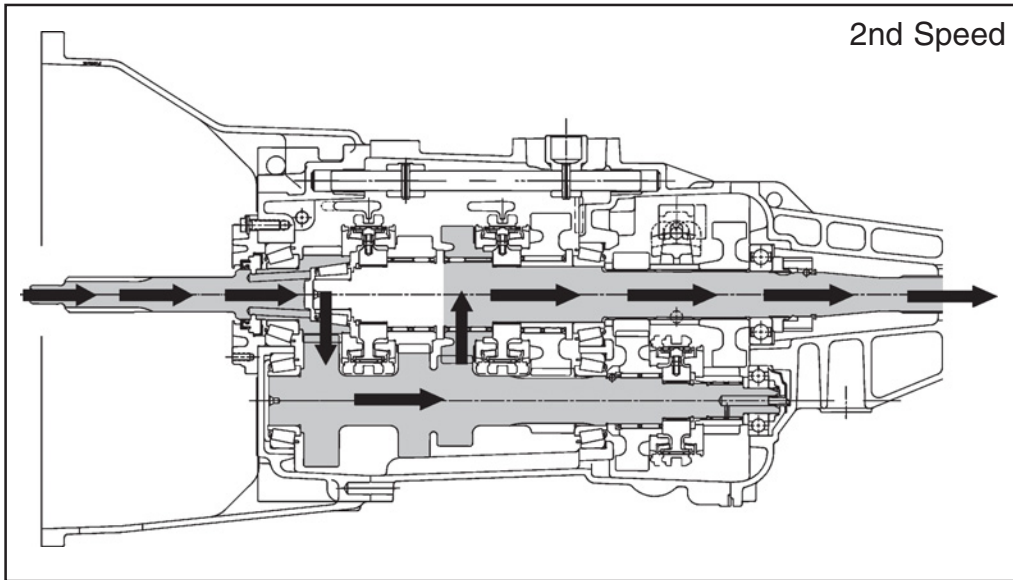
The transmission must efficiently transfer the engine's power or torque to the vehicle's driveline. It is essential to know what takes place in the transmission during torque transfer when troubleshooting or making repairs.

1st, 2nd and 3rd Speeds

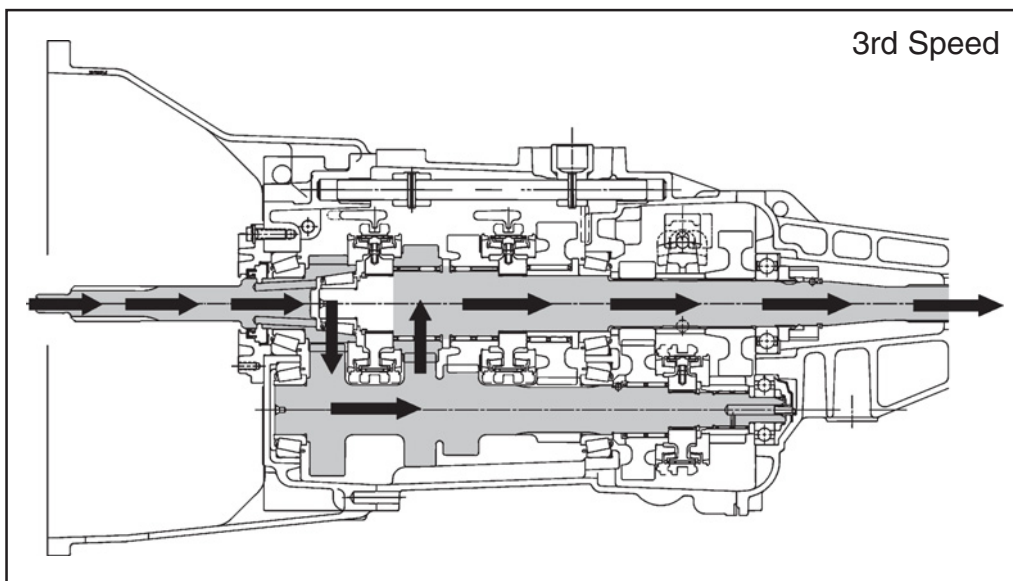
1. Torque from the engine is transferred to the transmission's input shaft.
2. The torque is transferred to the countershaft drive gear. In this way, input shaft and countershaft always run together.
3. The torque along the countershaft is delivered to all mainshaft gears assembled on bearings. These gears rotate free unless one gear is shifted.
4. When a gear is shifted, the torque is transferred from the corresponding engaged mainshaft gear, through the clutching teeth of the synchronizer assembly, to the mainshaft. Torque is, then, delivered along the mainshaft to the driveline components through output yoke.



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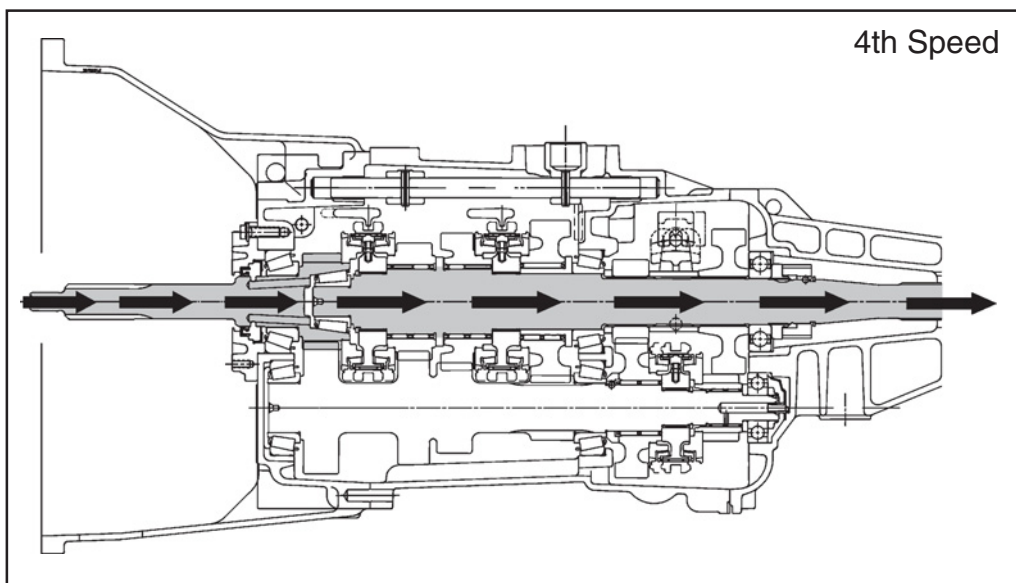
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4th Speed

The 4th speed gear is also named direct speed gear.

1. Torque from the engine is transferred to the transmission's input shaft that, despite driving the countershaft at the same time, transfers the torque directly to the mainshaft. The input shaft clutching teeth engage the clutching teeth of the 4th speed synchronizer unit which transfers the torque to the mainshaft.

The transmission's noise level in this speed is very reduced, since torque is delivered directly from one shaft to another and there is no gears under load.

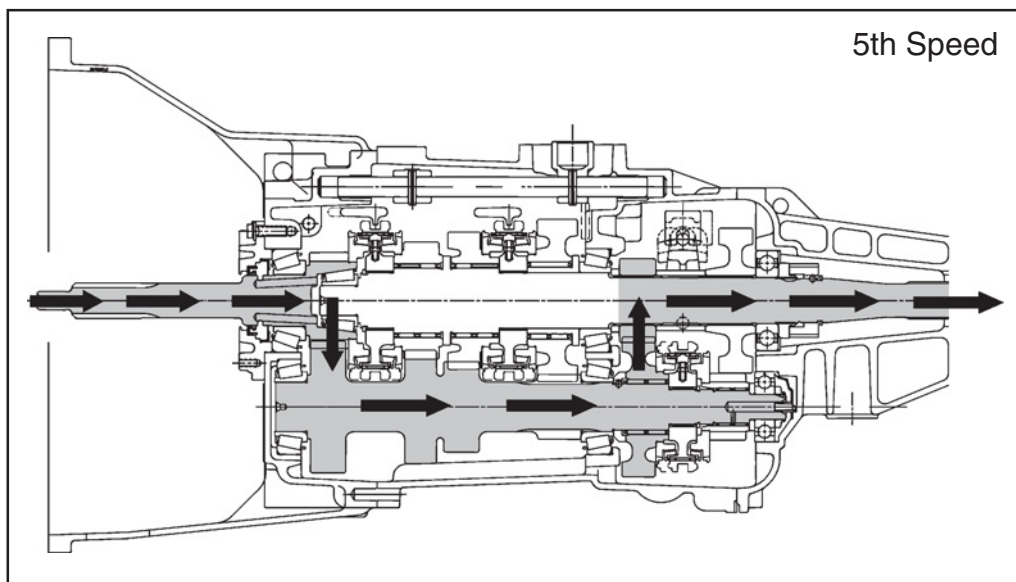


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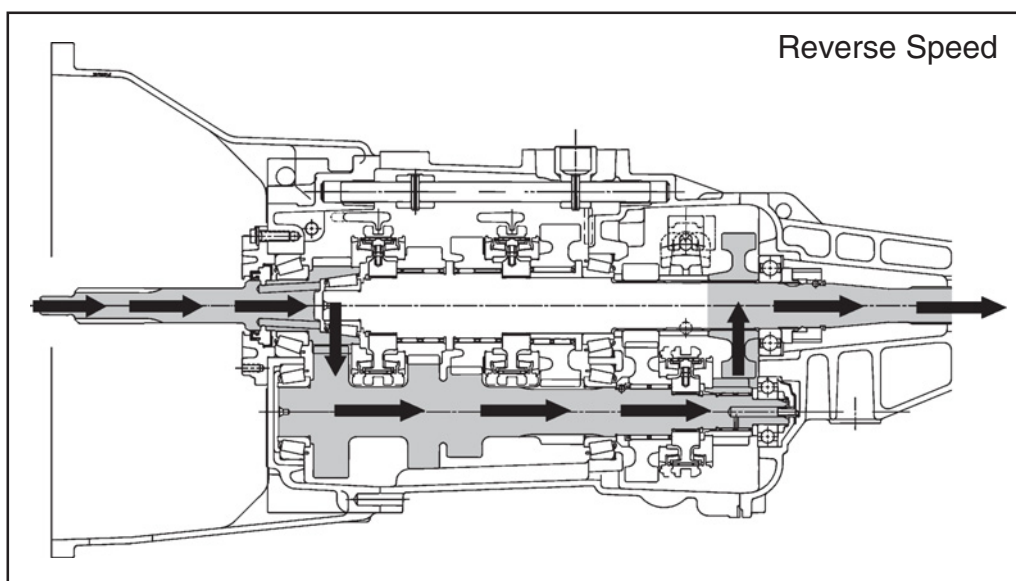
5th and Reverse Speed

The 5th and reverse speed gears synchronizer unit is assembled on the countershaft, unlike the other speed synchronizers that are assembled on the mainshaft. By its turn, their corresponding gears on mainshaft are assembled fixed to the mainshaft.

1. With the 5th speed gear shifted, torque is transferred from countershaft to the mainshaft corresponding gear through the clutching teeth of the synchronizer hub.
2. When the reverse speed gear is shifted, torque is transferred from countershaft to the reverse idler gear, that changes the rotating direction, and then, from that to the mainshaft reverse speed gear.

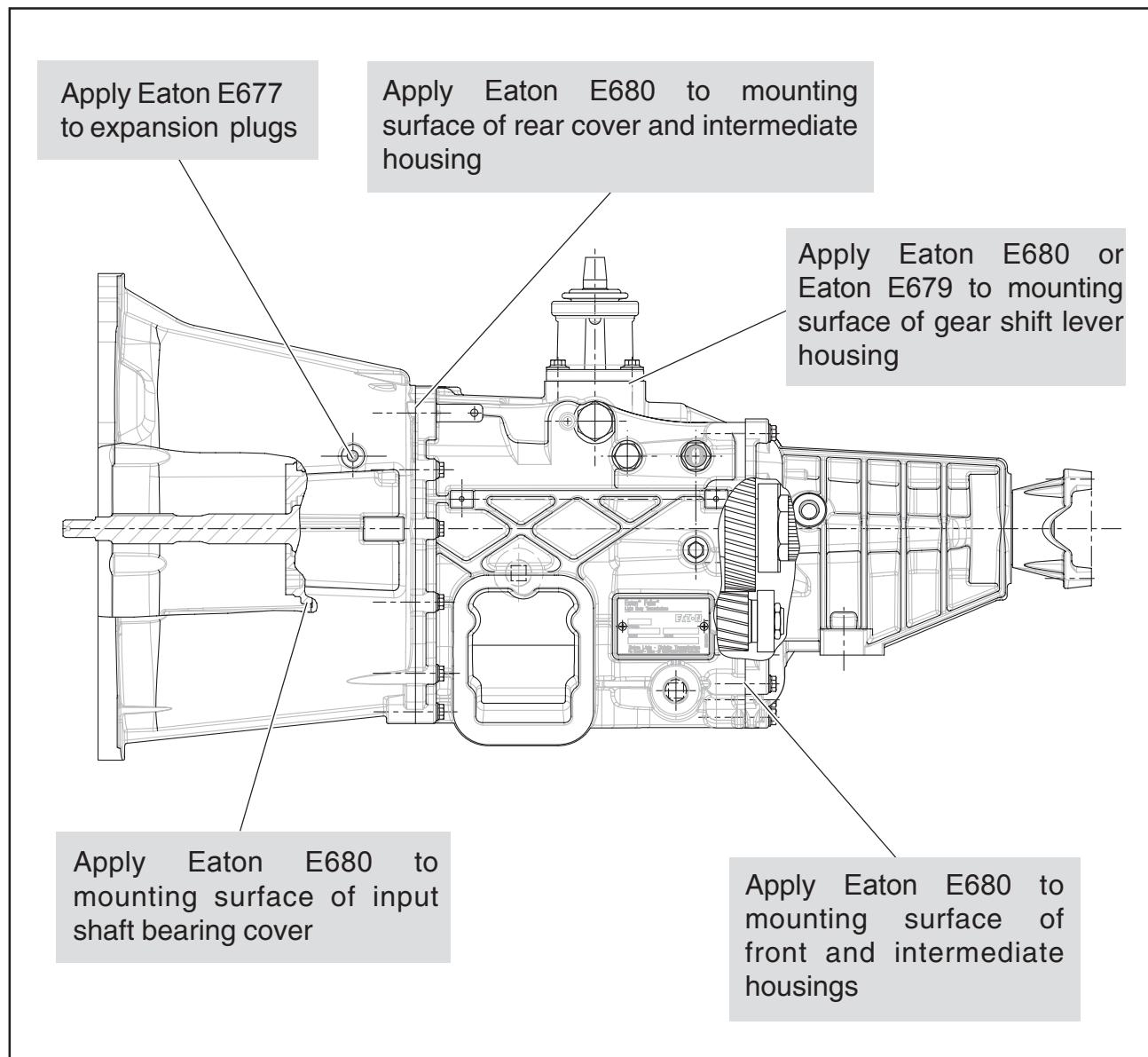


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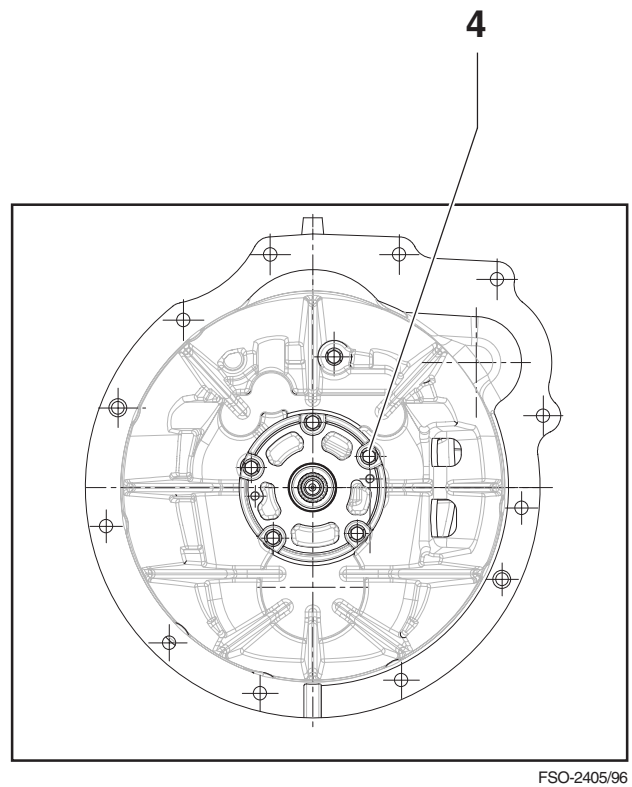
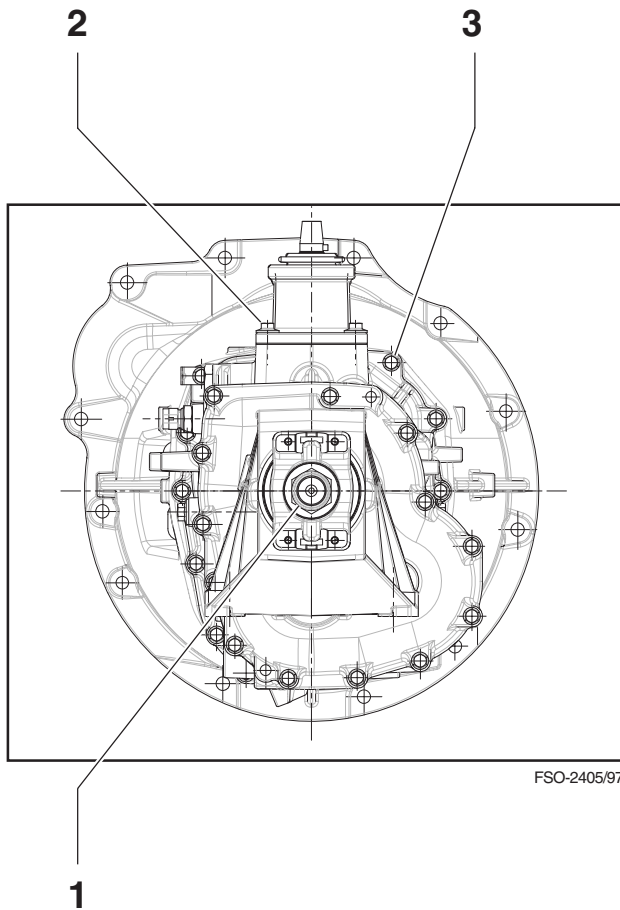
The correct application of sealing compounds is important to assure a suitable assembly and to avoid leakages.



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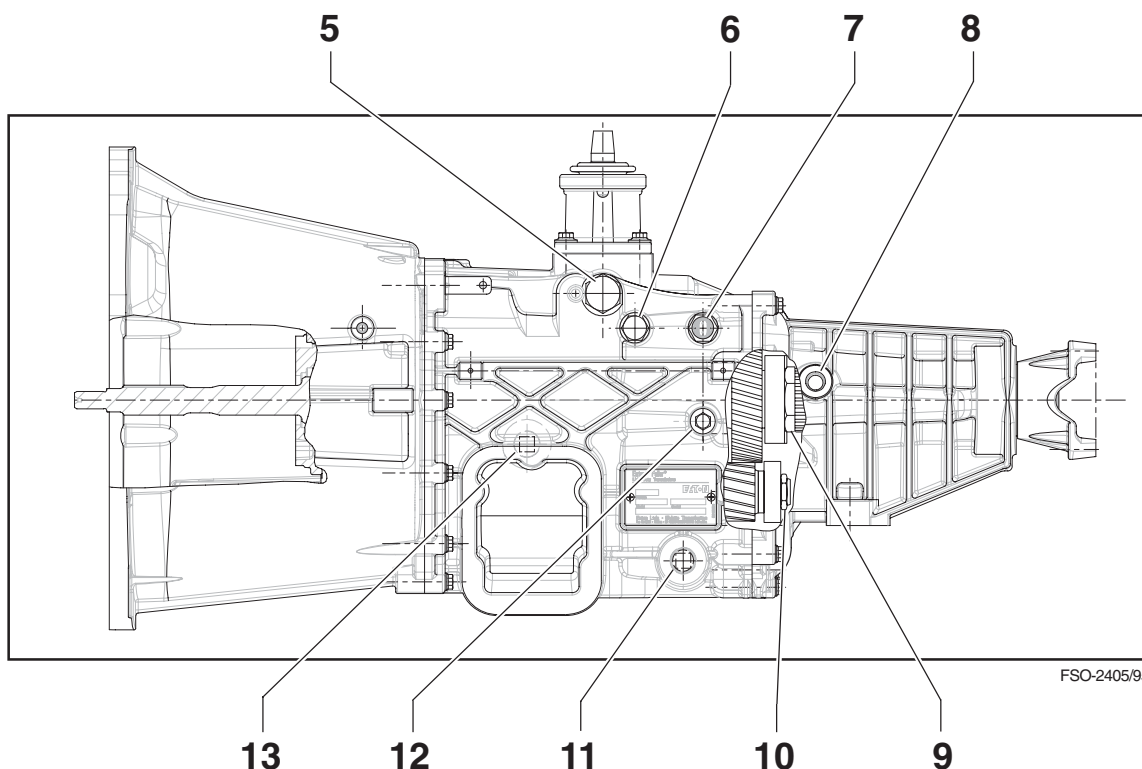
Tightening capscrews, plugs and nuts to the proper torque is important to prevent oil leakage and loosening, assuring a long transmission life. Additionally, apply the recommended sealant to the threads.

WARNING! Always use a torque wrench to tight to the recommended torque.



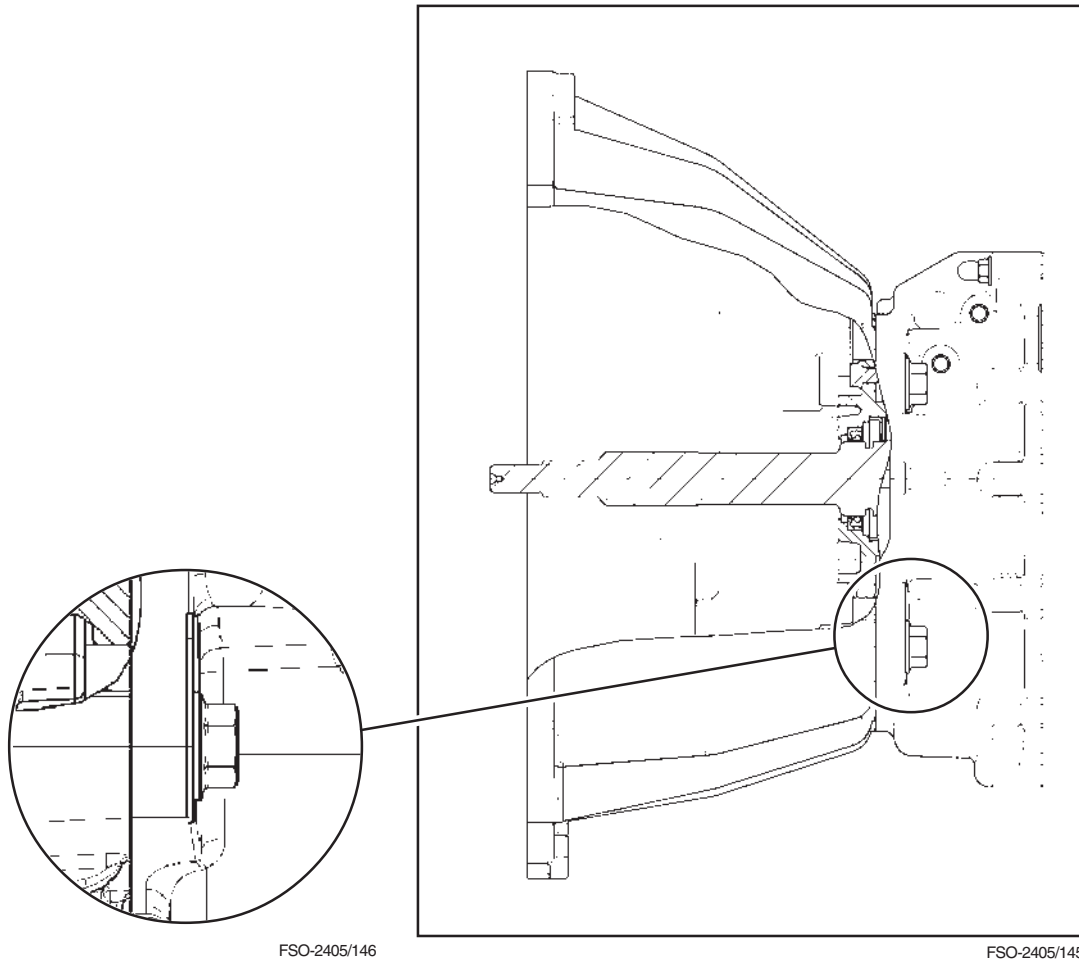
Item	Description	Thread	Torque N.m (Lb.ft)	Remarks
1	Yoke nut	1" - 20 UNEF	217-270 (160-200)	Apply Eaton E677 to threads
2	Gear shift housing capscrews	M10	19-25 (14-19)	Apply Eaton E677 to threads
3	Housing capscrews	M8	19-25 (14-19)	Apply Eaton E677 to threads
4	Input shaft bearing cover capscrews	M8	10-16 (7-12)	Apply Eaton E677 to threads

Torque Recommendation



Item	Description	Thread	Torque N.m (Lb.ft)	Remarks
5	Shift control actuator plug	M24	10-16 (7-12)	Apply Eaton E680 or Eaton E679 to threads
6	Shift positioning device plug	M12	10-16 (7-12)	Apply Eaton E680 or Eaton E679 to threads
7	Reverse light switch	M14	14-20 (11-15)	Apply Eaton E680 or Eaton E679 to threads
8	Speedometer sensor	13-16" - 20 UNEF	10-16 (7-12)	Apply Eaton E680 or Eaton E679 to threads
9	Mainshaft nut	M37	217-270 (160-200)	Lock
10	Countershaft nut	M20	108-122 (80-90)	Lock
11	Oil drain plug	3/4" - 14 NPTF	13-20 (10-15)	Apply Eaton E680 or Eaton E679 to threads
12	5th/reverse speed shift yoke pivot pin	3/4" - 14 NPTF	13-20 (10-15)	Apply Eaton E677 to threads
13	Oil fill plug	M12	10-16 (7-12)	Apply Eaton E680 or Eaton E679 to threads

NOTE: On clutch housings made of cast iron, apply torque of 165 to 185 N.m (122 to 136 lb.ft) to tightening capscrews.



Precautions during disassembly and assembly

WARNING! In order to prevent damage to transmission parts during initial gears movement, it is important when assembling the transmission, to lubricate gear bearings, needle bearings, non sealed bearings and all other parts under friction conditions, with the same transmission lubricant oil.

Cleaning and handling

In order to completely clean the parts, wash them into a bath of solvent (kerosene, for instance), moving every part up and down slowly until all the old lubricant and foreign material have been dissolved.

WARNING! Care must be taken to avoid skin rasher, fire hazard and vapor inhalation when using solvents.

Non sealed bearings

Immerse the bearings in clean solvent. Move them up and down slowly in order to loosen the deposits. Dry the bearings by means of moisture free compressed-air. Repeat the operation until the bearings are thoroughly clean.

WARNING! Never drive the air jet directly to bearings in order to rotate them in high speed. That can damage bearings.

Synchronizer assemblies

Avoid bad handling of synchronizer assemblies. Either drops or bumps when disassembling or assembling may cause they to lock.

Housings

Clean interior and exterior of cases, covers, etc., thoroughly. Cast parts may be cleaned in hot alkaline solution baths (we recommend a 7% soluble degreasing oil solution). The parts are to remain in the bath for the time it takes to become completely clean. The parts cleaned in alkaline solutions should be rinsed with clean water to remove any alkaline trace after cleaning process.

WARNING! Care must to be taken to avoid vapor inhalation and skin rashes when using alkaline solutions. Every cleaned part must be totally dried at once by means of moisture free compressed-air, or else, by means of a lint free soft cloth, not containing any abrasive material such as metal filings, contaminated oil or polishing compounds.

Inspection

A thorough and careful inspection of each part is very important for the transmission life. The replacement of parts showing either wear or fatigue will avoid future expensive and foreseen failures.

Gears, shafts and synchronizer assemblies

Whenever magna-flux is available, this process should be used to check the parts.

Check carefully gear teeth for wear, pitting, chipping and cracks. If gear teeth show areas where the case hardening is worn through or cracked, the gear should be replaced.

Check shafts for warping and excessive wear or damaged splines.

Cases, covers, etc.

Make sure cases, covers, etc. are completely clean and that mounting surfaces and bearing bores are free from nicks or burrs. Check carefully every part for cracks, excessive wear or for any other condition that may cause oil leak or a future failure.

Needle roller bearings

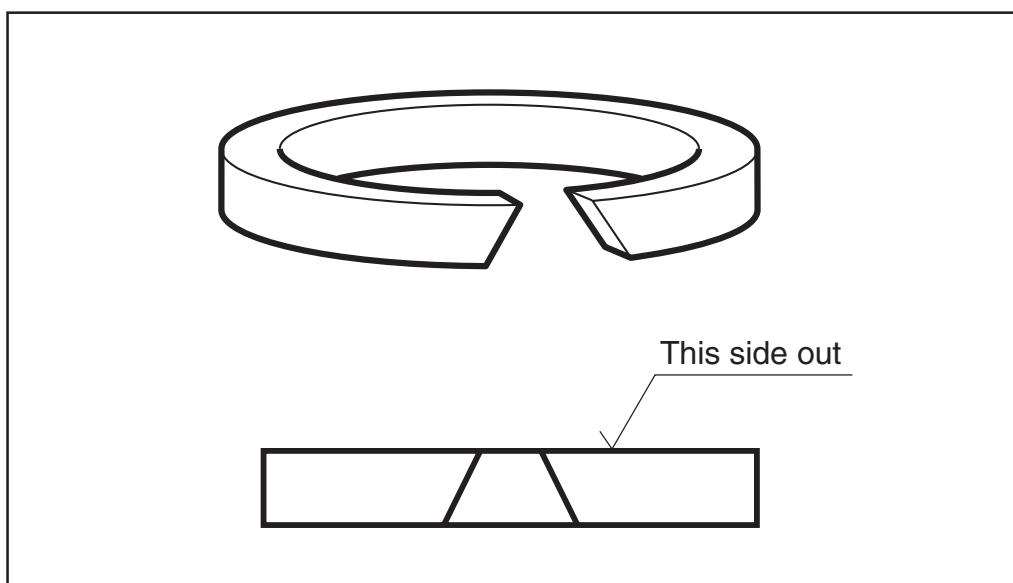
Check carefully every needle roller for wear, pitting or spalled areas to determine whether they are suitable for reuse or replacement. After inspection, dip the needle roller bearings in an oil bath and then wrap them in a lint free cloth or paper, so as to protect them until they are ready for assembling.

Oil seals and snap rings

Any oil seal, snap ring, etc. damaged during maintenance, should be replaced by a new one. Replacement of oil seals and snap rings is cheaper when unit is disassembled than a premature overhaul to replace these parts in a future time.

An oil leakage through a worn seal may result in failures of other more expensive components of the transmission. The sealing elements should be handled carefully, particularly during assembly. Cuts, scratches or rolled up seal lips decrease the sealing efficiency.

WARNING! Snap rings have proper assembling position due to the angle of their opening ends. The side with shorter opening should be faced towards the outside to facilitate the installation with pliers.



FSO-2405/98

Parts replacement

When replacement is necessary, use only genuine Eaton transmission parts to assure continued performance and extended life from the transmission. The use of either “pirate” or remanufactured parts, besides have not the factory’s warranty, may lead to severe damage of the unit.

Since the cost of a new part is generally a small fraction of the total cost of downtime and labor, do not reuse a questionable part which could lead to additional repairs and expense soon after assembly.

To aid in determining the reuse or replacement of any transmission part, consideration should also be given to the unit’s history, mileage, application, etc.



FSO-2405/140

The following chart presents some transmission malfunctions with their most common causes and possible solutions.

Problem	Probable cause	Possible solution	Reference
Transmission noise when in neutral	Incorrect idle speed adjustment	Adjust idle speed	As to vehicle's instruction manual
	Improper or damaged clutch disc	Replace disc	As to vehicle's instruction manual
	Low lubricant level	Fill with recommended oil to the proper level	Recommended lubricant - page 23
	Contaminated lubricant	Drain, clean transmission and replace with recommended lubricant	Recommended lubricant - page 23
	Worn or damaged gears or bearings	Replace damaged parts	As to this manual instructions
Transmission noise with shifted gear	Improper or damaged clutch disc	Replace disc	As to vehicle's instruction manual
	Low lubricant level	Fill with recommended oil to the proper level	Recommended lubricant - page 23
	Worn or damaged flywheel bushing or bearing	Replace	As to vehicle's instruction manual
	Vibration from other vehicle components (drive shaft, yoke, mounts)	Verify and repair as to vehicle's shop manual	As to vehicle's instruction manual
	Misalignment between engine and transmission	Correct or replace damaged parts	Requires specific procedure
	Worn or damaged gears or bearings	Replace damaged parts	As to this manual instructions

Problem	Probable cause	Possible solution	Reference
Hard shifting	Malfunction of clutch	Verify and adjust clutch	As to vehicle's shop manual
	Worn or damaged flywheel bushing or bearing	Replace	As to vehicle's instruction manual
	Not recommended lubricant	Replace	Recommended lubricant - page 23
	Worn or damaged gear shift lever components	Replace damaged parts	Gear shift housing - page 157
	Worn or damaged synchronizer rings	Replace rings	Synchronizer assemblies - page 140
	Excessively worn or damaged synchronizer assemblies (springs, keys, sleeve or hub)	Replace synchronizer assemblies	Synchronizer assemblies - page 140
	Worn or damaged shifting system components (shift yokes, nylon pads, bars, shift blocks)	Replace worn or damaged parts	As to this manual instructions
	Mainshaft or countershaft end play improperly	Adjust end play	End play adjustment - page 148
Hard gear disengaging	Malfunction of clutch	Verify and adjust clutch	As to vehicle's shop manual
	Worn or damaged gear shift lever components	Replace damaged parts	Gear shift housing - page 157

1

Problem	Probable cause	Possible solution	Reference
Hard gear disengaging (continuation)	Excessively worn or damaged synchronizer assemblies (springs, keys, sleeve or hub)	Replace synchronizer assemblies	Synchronizer assemblies - page 140
	Worn or damaged shifting system components (shift yokes, nylon pads, bars, shift blocks)	Replace worn or damaged parts	As to this manual instructions
	Mainshaft or countershaft end play improperly adjusted	Adjust end play	End play adjustment - page 148
Gear shift rubbing	Malfunction of clutch	Verify and adjust clutch	As to vehicle's shop manual
	Malfunction of clutch linkage	Verify and adjust linkage	As to vehicle's shop manual
	Worn or damaged flywheel bushing or bearing	Replace	As to vehicle's instruction manual
	Worn or damaged synchronizer rings	Replace rings	Synchronizer assemblies - page 140
	Shift yoke nylon pads worn	Replace	Shift bars - page 124
Transmission slips out of gear	Gear shift lever console out of position, forcing the lever	Adjust console	As to vehicle's shop manual
	Worn or damaged synchronizer assemblies	Replace synchronizer assemblies	Synchronizer assemblies - page 140

Problem	Probable cause	Possible solution	Reference
Transmission slips out of gear (continuation)	1st/2nd and 3rd/4th synchronizer hub swapped (anti-escape relief)	Remove and assemble properly	Synchronizer assemblies - page 140
	Mainshaft or countershaft end play improperly adjusted	Adjust end play	End play adjustment - page 148
	Worn or damaged shifting system components (gear shift lever, shift yokes, bars, shift blocks, etc.)	Replace worn or damaged parts	As to this manual instructions
Oil leak	Lubricant above proper level	Correct to proper lubricant level	Recommended lubricant - page 23
	Clogged breather	Verify an clean breather	
	Worn or damaged oil seals	Replace	As to this manual instructions
	Housing capscrews not properly tightened or lack of sealant	Reassemble aplying sealant and torque properly	As to this manual instructions - pages 30 and 31
	Cracked housings or damaged housing surfaces	Replace or repair damaged parts	Requires specfic procedure
Bearing failures	Low lubricant level	Fill with recommended oil to the proper level	Recommended lubricant - page 23
	Contaminated or not recommended lubricant	Drain and replace with recommended lubricant	Recommended lubricant - page 23
	Transmission components assembled improperly	Reassemble	As to this manual instructions

Problem	Probable cause	Possible solution	Reference
Bearing failures (continuation)	Mainshaft or countershaft end play improperly adjusted	Adjust end play	End play adjustment - page 148
	Bearings were not lubricated before assembling	Replace damaged parts. Reassemble as to proper procedure	As to this manual instructions
Double shifting	Double gear shifting interlocking system improperly assembled	Reassemble properly	As to this manual instructions - page 134

To properly service the Eaton FSO-2405 transmission, the following specialized tools are recommended:

Eaton Ref.	Description
E001010	Permaglide bushing installer
E001013	Universal handle
E001020	Front housing expansion plug installer
E001021	Input shaft bearing cover seal installer
E001032	Input shaft bearing cover oil baffle installer
E001033	Front housing bearing cup installer
E001034	Rear seal installer
E001035	Mainshaft bearing cup puller
E001036	Countershaft bearing cup puller
E001037	Bearing cup puller/installer support
E001038	Mainshaft bearing cup installer
E001039	Countershaft bearing cup installer
E001040	Rear seal installer
E001041	Rear seal installer
E001042	Rear seal installer
E001043	Countershaft bearing cone installer
E001044	1st/2nd, 3rd/4th and 5th/Reverse gear yoke bar pin punch
E001045	Shift lug pin punch
E003001	Slide hammer (impact puller)
E004002	Slide hammer end - for removing the expansion bushing
E005003	Pocket bearing cone puller
E005005	Thread cutter
E006002	30 mm special socket
E006003	54 mm special socket
E006004	23-spline input shaft spline socket
E006005	10-spline input shaft spline socket
E006006	54 mm special wrench
E006007	Mainshaft lock - 27 splines
E006008	Mainshaft lock - 31 splines

Eaton Ref.	Description
E006009	Mainshaft lock - 30 splines
E006010	Mainshaft lock - 25 splines
E007002	Input shaft bearing cone puller
E007007	Mainshaft bearing cone puller
E007008	Countershaft bearing cone puller
E008001	Pry bar for measuring end play
E009001	Plate for measuring end play
E010001	Mainshaft front bearing cone installer
E010002	Mainshaft rear bearing cone installer
E010003	Input shaft bearing cone installer
E012001	2-hook universal puller
E012002	Reverse gear puller
E012003	Input shaft bearing puller
E012004	Front housing bearing cup puller
E014002	Transmission stand adapter plate
E014003	Transmission stand
E014010	Base for locking the mainshaft
E014011	Support for transmission stand adapter plate

These special tools should be ordered directly from the approved tools supplier:

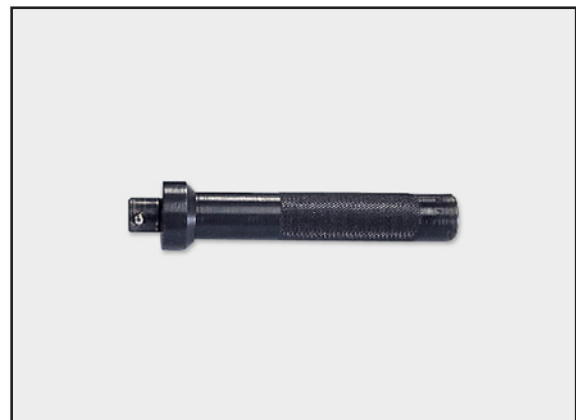
Especifer Indústria e Comércio de Ferramentas Ltda.
Av. Tranquilo Gianinni, 1050
13329-600 - Salto - São Paulo - Brazil
Phone: 55 11 4028-8700
Web Site: www.especifer.com.br

E001010 Permaglide bushing installer



E001010

E001013 Universal handle



E001013

E001020 Front housing expansion plug installer



E001020

E001021 Input shaft bearing cover seal installer

*NOTE: Used with **E001013***



E001021

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E001032 Input shaft bearing cover oil baffle installer

*NOTE: Used with **E001013***



E001032

E001033 Front housing bearing cup installer

*NOTE: Used with **E001037***



E001033

E001034 Rear seal installer

***Application:** All 4x4 vehicles*



E001034

E001035 Mainshaft bearing cup puller

*NOTE: Used with **E001037***



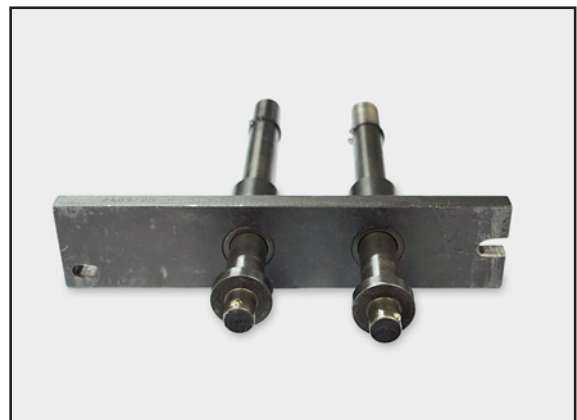
E001035

E001036 Countershaft bearing cup puller
*NOTE: Used with **E001037***



E001036

E001037 Bearing cup puller/installer support
*NOTE: Used with **E001037***



E001037

E001038 Mainshaft bearing cup installer
*NOTE: Used with **E001037***



E001038

E001039 Countershaft bearing cup installer
*NOTE: Used with **E001037***



E001039

1

E001040 Rear seal installer
Application: Ranger 4x2 / Troller 4x2 / VM Motori / Agrale Daily
NOTE: Used with **E001013**

E001041 Rear seal installer
Application: Frontier 4x2
NOTE: Used with **E001013**

E001042 Rear seal installer
Application: S10 4x2
NOTE: Used with **E001013**



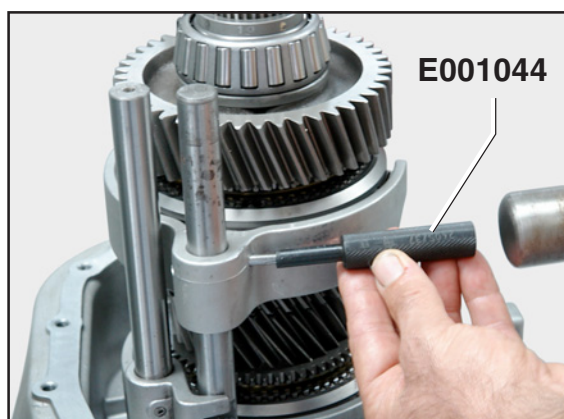
E001040

E001043 Countershaft bearing cone installer



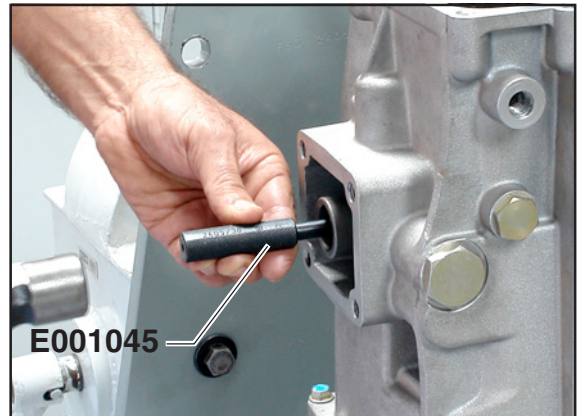
E001043

E001044 1st/2nd, 3rd/4th and 5th/Reverse gear yoke bar pin punch



E001044

E001045 Shift lug pin punch



E001045

E003001 Slide hammer (impact puller)



E003001

E004002 Slide hammer end - for removing the expansion bushing



E004002

E005003 Pocket bearing cone puller

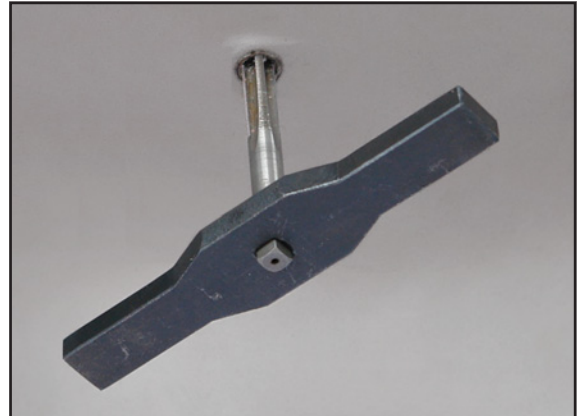


E005003

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E005005

Thread cutter



E005005

E006002

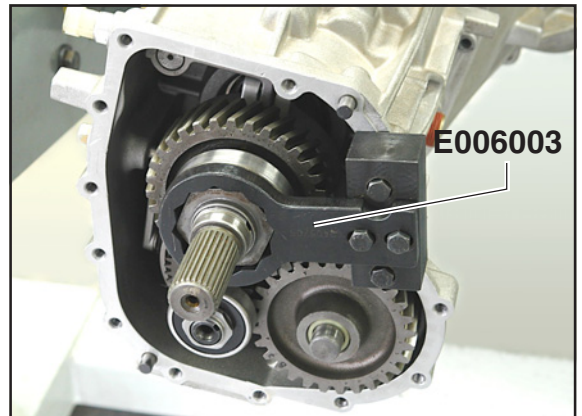
30 mm special socket



E006002

E006003

54 mm special socket



E006003

E006004

23-spline input shaft spline socket

Application: *Ranger 4x2 / Ranger 4x4 / Crosslander*

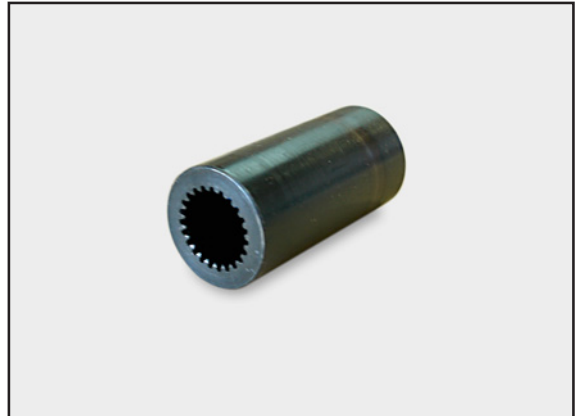


E006004

E006005

10-spline input shaft spline socket

Application: *Frontier 4x2 / Frontier 4x4 / VM Motori / S10 4x2 / S10 4x4 / L200 RS 4x4 / Jinbei / Troller 4x4 Jeep / Troller 4x2 Pickup / Agrale Daily*



E006005

E006006

54 mm special wrench



E006006

E006007

Mainshaft lock - 27 splines

Application: *S10 4x2 / S10 4x4 / Jinbei / Crosslander*

E006008

Mainshaft lock - 31 splines

Application: *Ranger 4x2 / Troller Pickup 4x2 / VM Motori Agrale Daily*

E006009

Mainshaft lock - 30 splines

Application: *Frontier 4x2 / Frontier 4x4*

E006010

Mainshaft lock - 25 splines

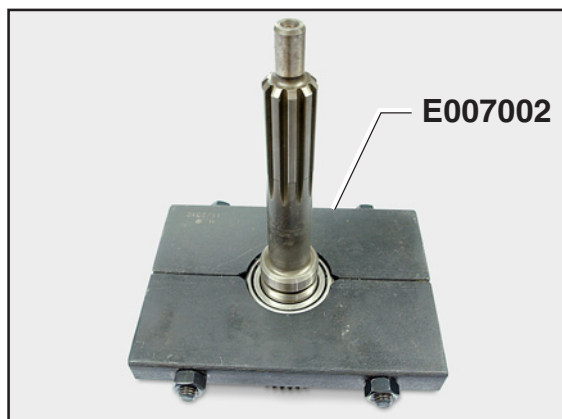
Application: *Ranger 4x4 / L200 RS 4x4 / Troller Jeep 4x2*



E006007 / E00608 / E006009 / E006010

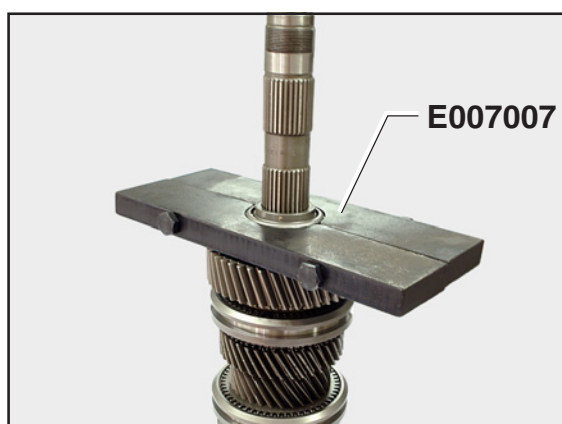
1

E007002 Input shaft bearing cone puller



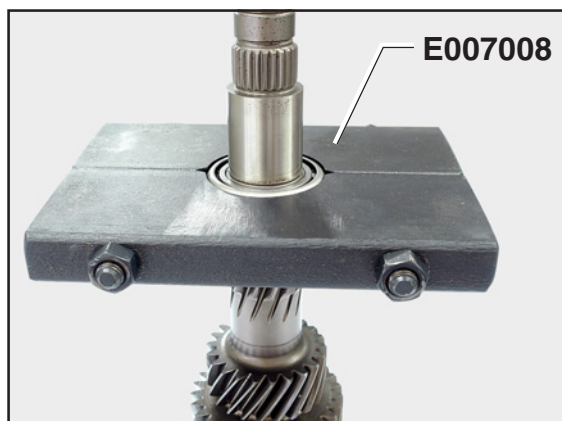
E007002

E007007 Mainshaft bearing cone puller



E007007

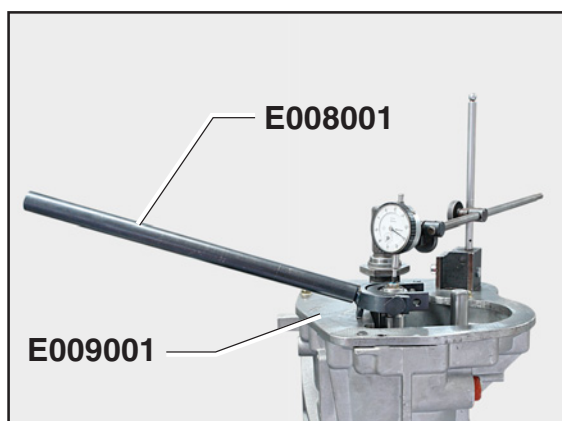
E007008 Countershaft bearing cone puller



E007008

E008001 Pry bar for measuring end play

E009001 Plate for measuring end play



E008001 / E009001

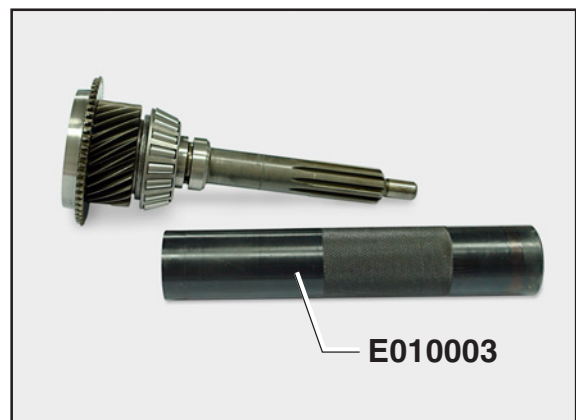
E010001 Mainshaft front bearing cone installer

E010002 Mainshaft rear bearing cone installer



E010001 / E010002

E010003 Input shaft bearing cone installer



E010003

E012001 2-hook universal puller



E012001

E012002 Reverse gear puller
NOTE: Used with E012001



E012002

1

E012003

Input shaft bearing puller

*NOTE: Used with **E012001***



E012003

E012004

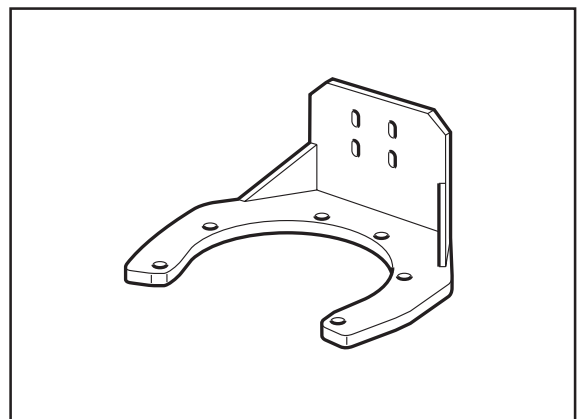
Front housing bearing cup puller



E012004

E014002

Transmission stand adapter plate

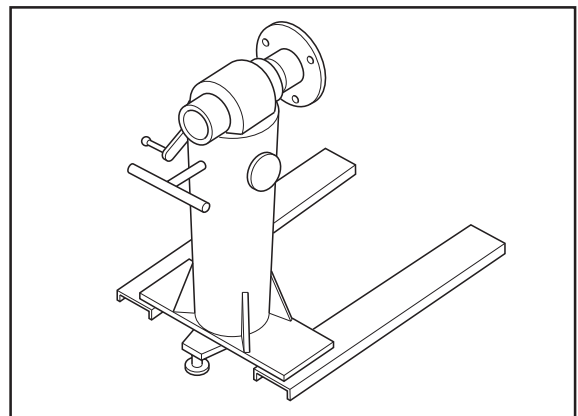


E014002

E014003

Transmission stand

Option: Without reductor, with reductor or electric powered



E014003

E014010

Base for locking the mainshaft

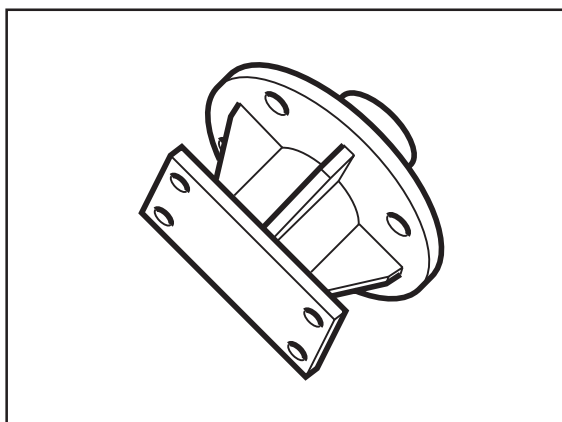
*NOTE: Used with **E006007**,
E006008, **E006009** or **E006010***



E014010

E014011

Support for transmission stand
adapter plate



E014011

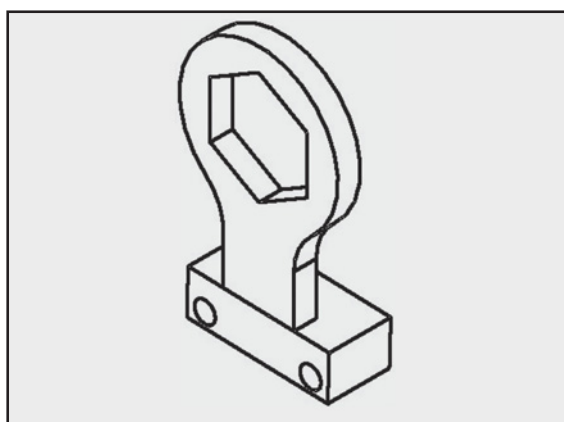
1

Using the Eaton tool # E006003

This tool is used as an option for locking the transmission mainshaft, allowing transmission disassembly and assembly by one mechanic only. The tool uses the transmission gear ratio as a torque amplifier wrench.

Installing the tool # E006003

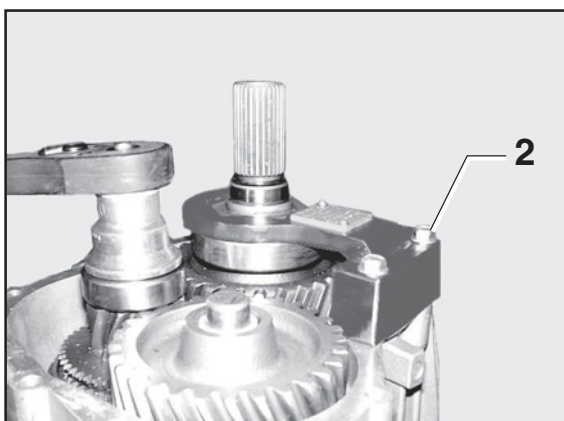
1. Install the 54 mm special socket (tool # **E006003**) on the mainshaft nut and rotate the shaft until the two holes on the socket match to the nearest two holes on the housing.



E006003/2

2. Tighten the special socket to the housing with two housing's capscrews.

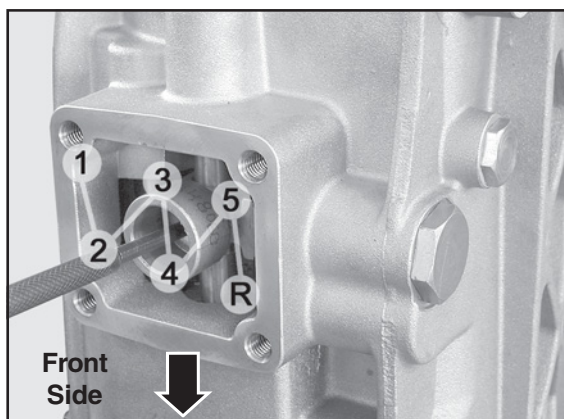
WARNING! Be carefull do not overtighten the capscrews or leave them loose in order to avoid damage to the aluminum housing.



FSO-2405/147

3. Shift transmission into 1st gear.

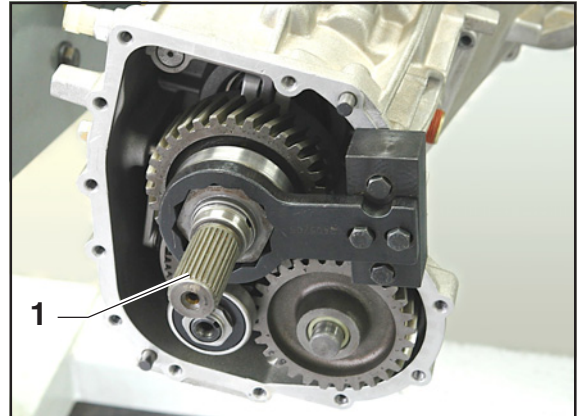
NOTE: With no gear shift lever housing installed, the gear shift lever pattern is inverted.



FSO-2405/28

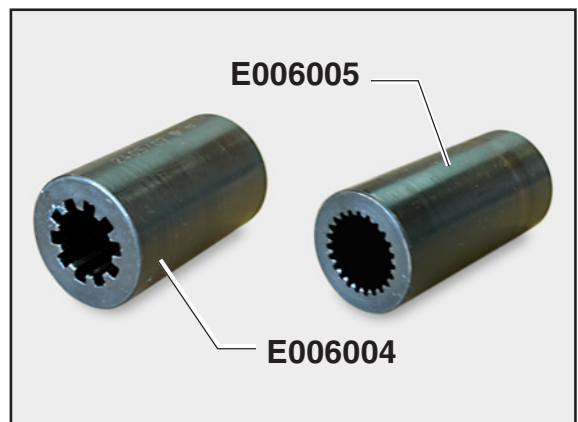
Removing and installing mainshaft nut

1. Lock mainshaft as described before, using tool # **E006003**. Shift transmission into 1st gear.



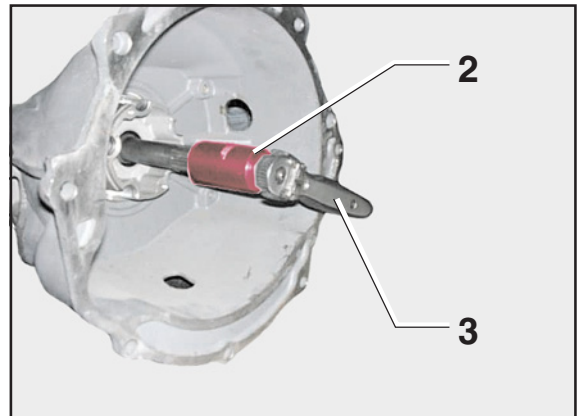
E006003

2. Install tool # **E006004** or # **E006005** depending on the application, on the input shaft spline.



E006004/E006005

3. Using a ratchet wrench, rotate counterclockwise for loosening the nut.



FSO-2405/148

4. For tightening the nut, see the following table for the torque to be applied. Use a torquemeter and rotate clockwise to the calculated torque.

Transmission	1st gear ratio	Torque to be applied	Transmission	1st gear ratio	Torque to be applied
FSO2405A	4.079	54 à 66 N.m	FSO2405F	3.481	63 à 77 N.m
FSO2405B	4.079	54 à 66 N.m	FSO2405G	4.213	52 à 64 N.m
FSO2405C	4.473	49 à 60 N.m	FSO2405H	4.994	44 à 54 N.m
FSO2405D	4.473	49 à 60 N.m	FSO2405J	3.716	59 à 72 N.m
FSO2405E	4.473	49 à 60 N.m	FSO2405K	4.473	49 à 60 N.m

WARNING! Check the vehicle's Service Manual for the transmission to see if the 1st gear ratio matches to the gear ratio informed in the table above. If necessary, calculate the torque amount as follows.

Example:

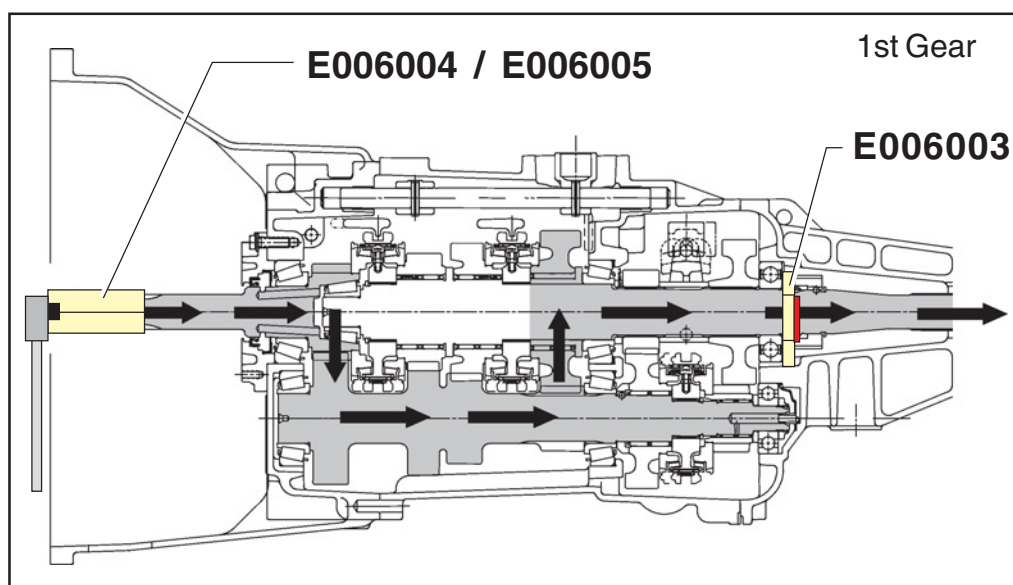
- Specified torque for the nut: **217 a 270 N.m**
- Transmission 1st gear ratio: **4.079**

Divide **217** by **4,079** and round off to the higher nearest integer:

$$217/4.079 = 53.199 \Rightarrow \text{use } 54$$

Divide **270** by **4,079** and round off to the lower nearest integer:

$$270/4.079 = 66.192 \Rightarrow \text{use } 66$$

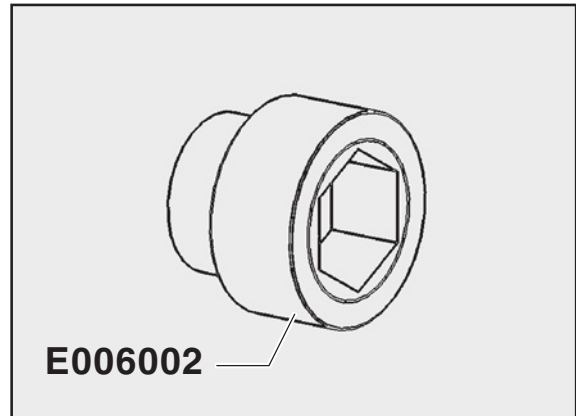


FSO-2405/89

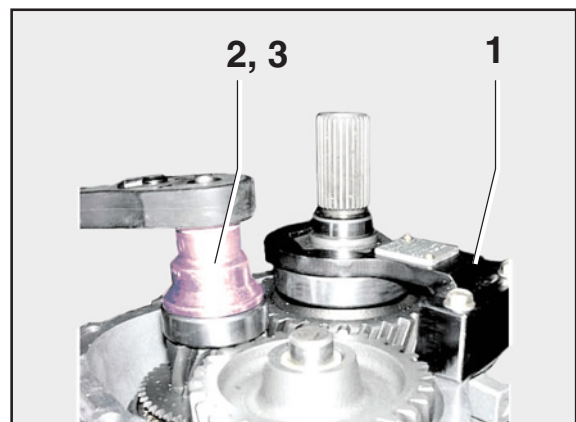
Removing and installing countershaft nut

1. Lock mainshaft as described before, using tool # **E006003**. Shift transmission into 1st gear.
2. Remove the nut using the 30 mm special socket (tool # **E006002**) directly on the countershaft nut.
3. When installing, tighten the countershaft nut to the specified torque.

NOTE: Torque = 108-122 N.m (80-90 lb.ft)



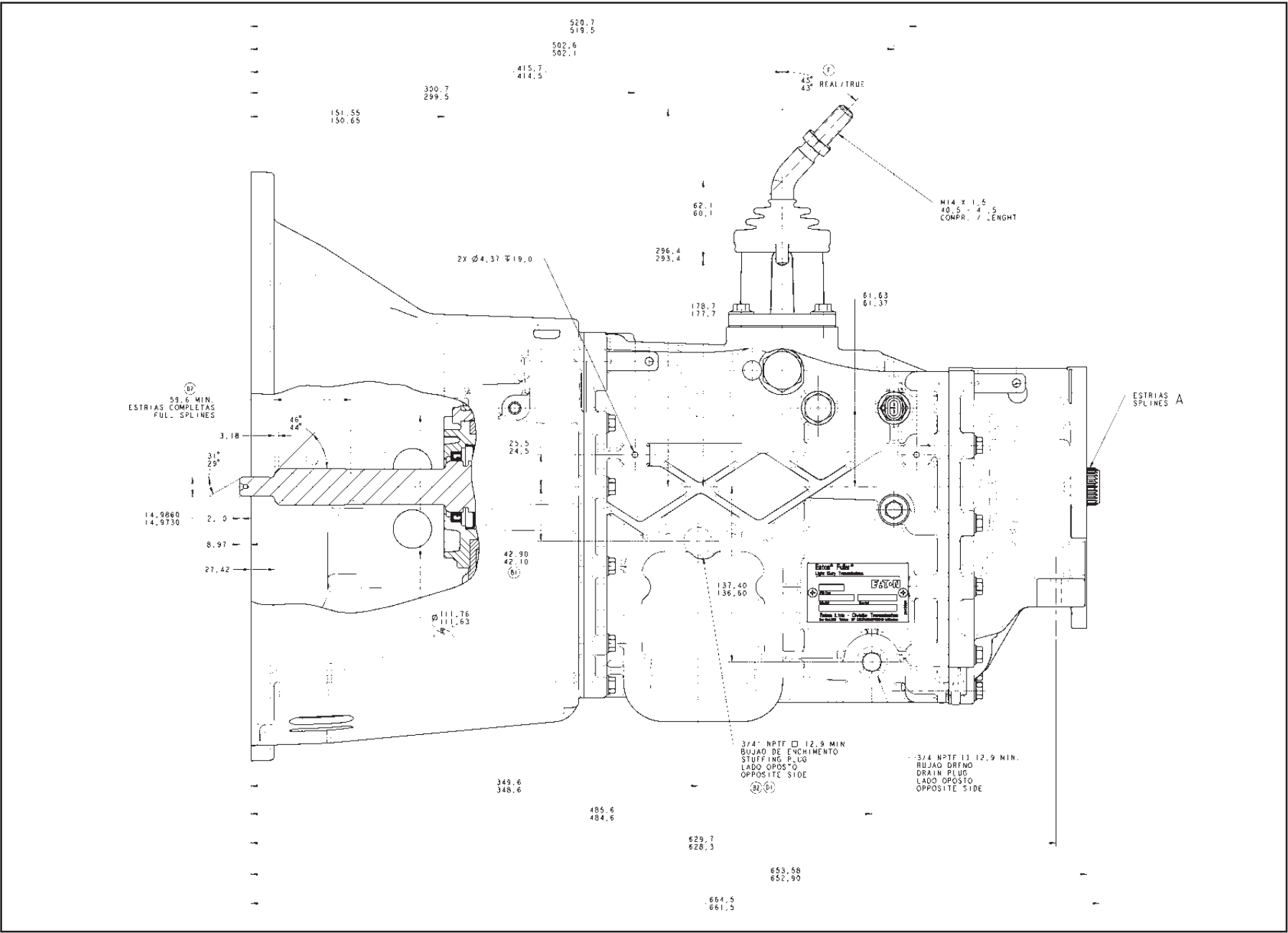
E006002/2



FSO-2405/149

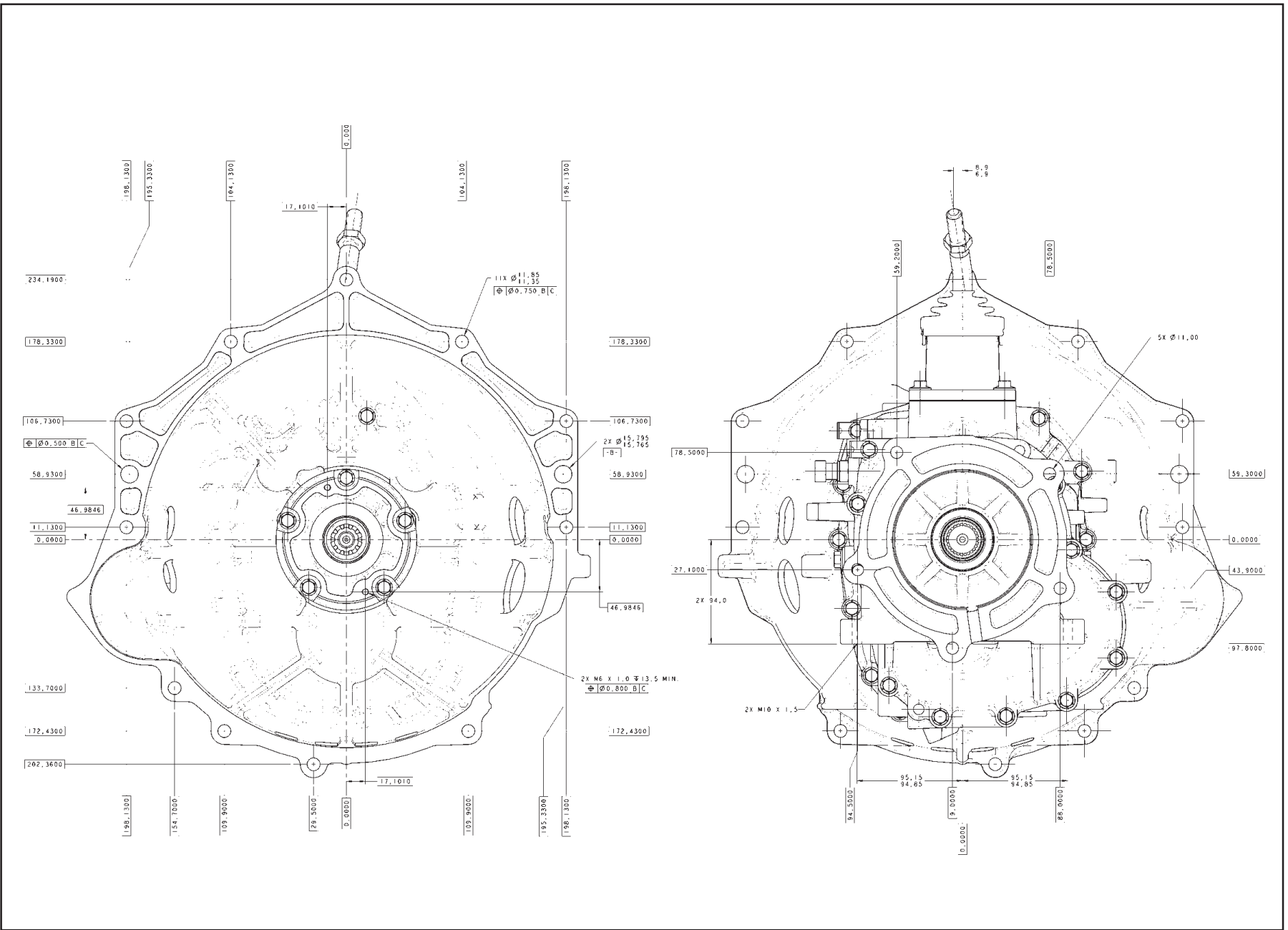
Installation Reference

GM S10 V6 4x2



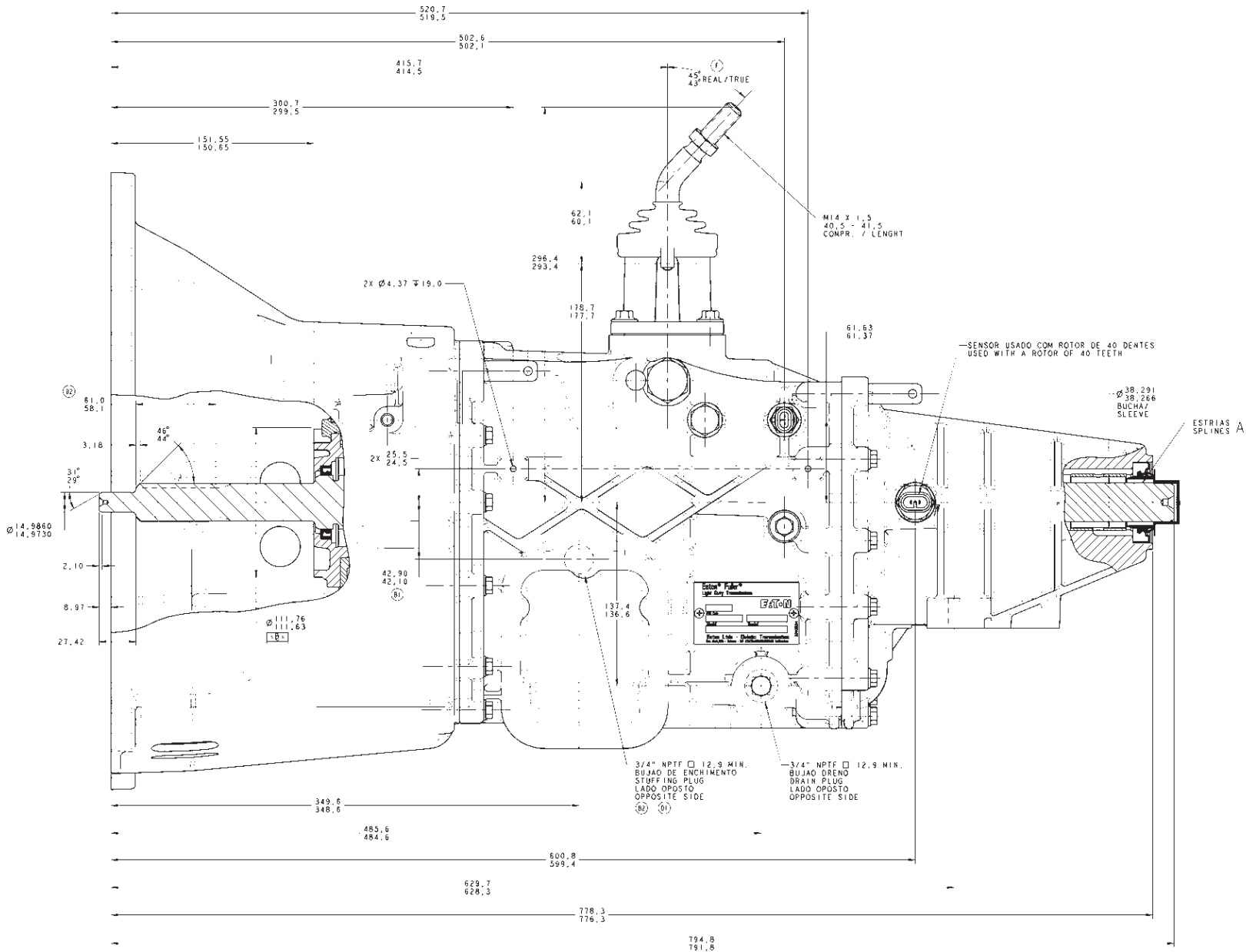
GM S10 V6 4x2 01

GM S10 V6 4x2

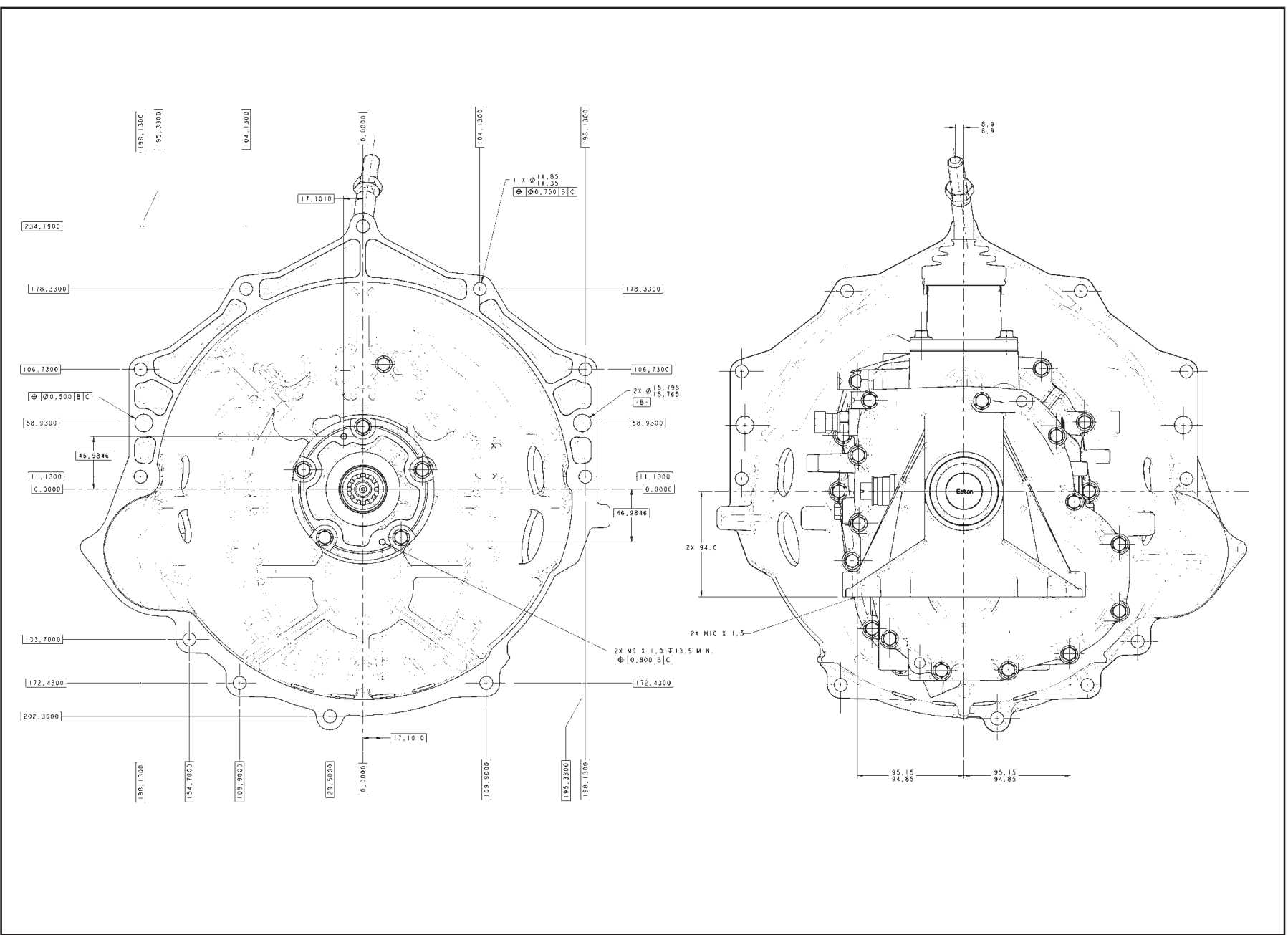


Installation Reference

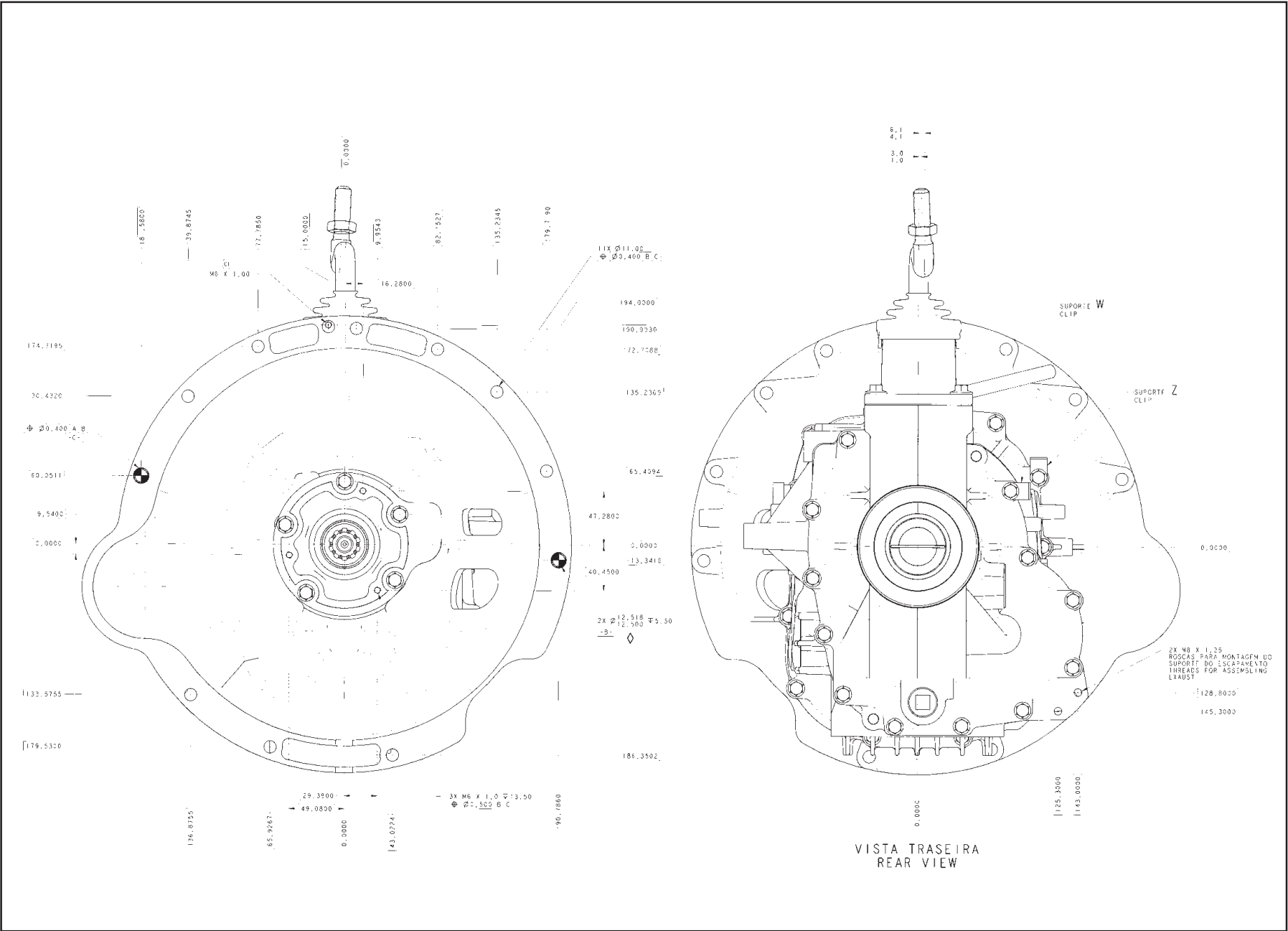
GM S10 2.8 4x2



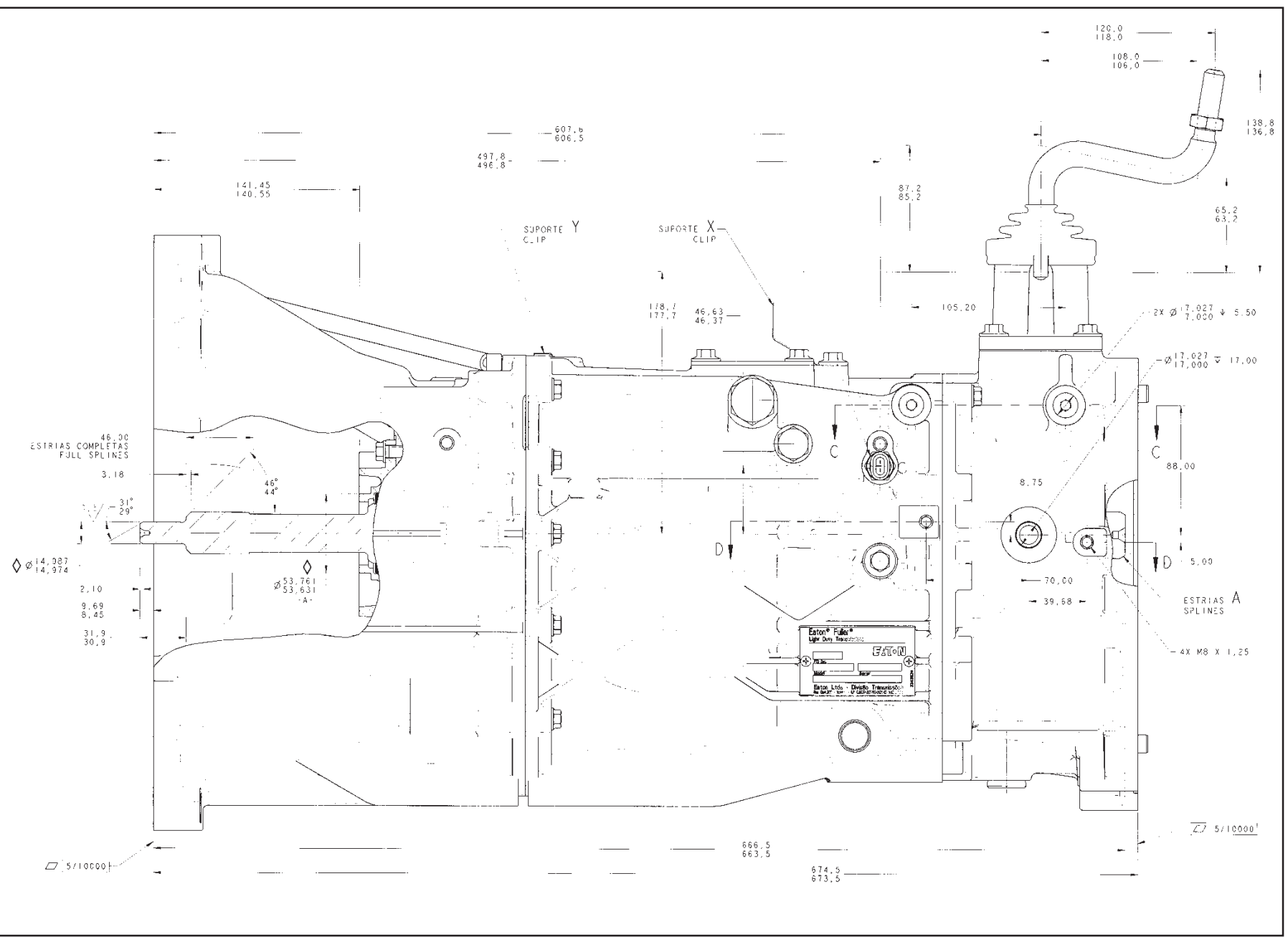
GM S10 V672801



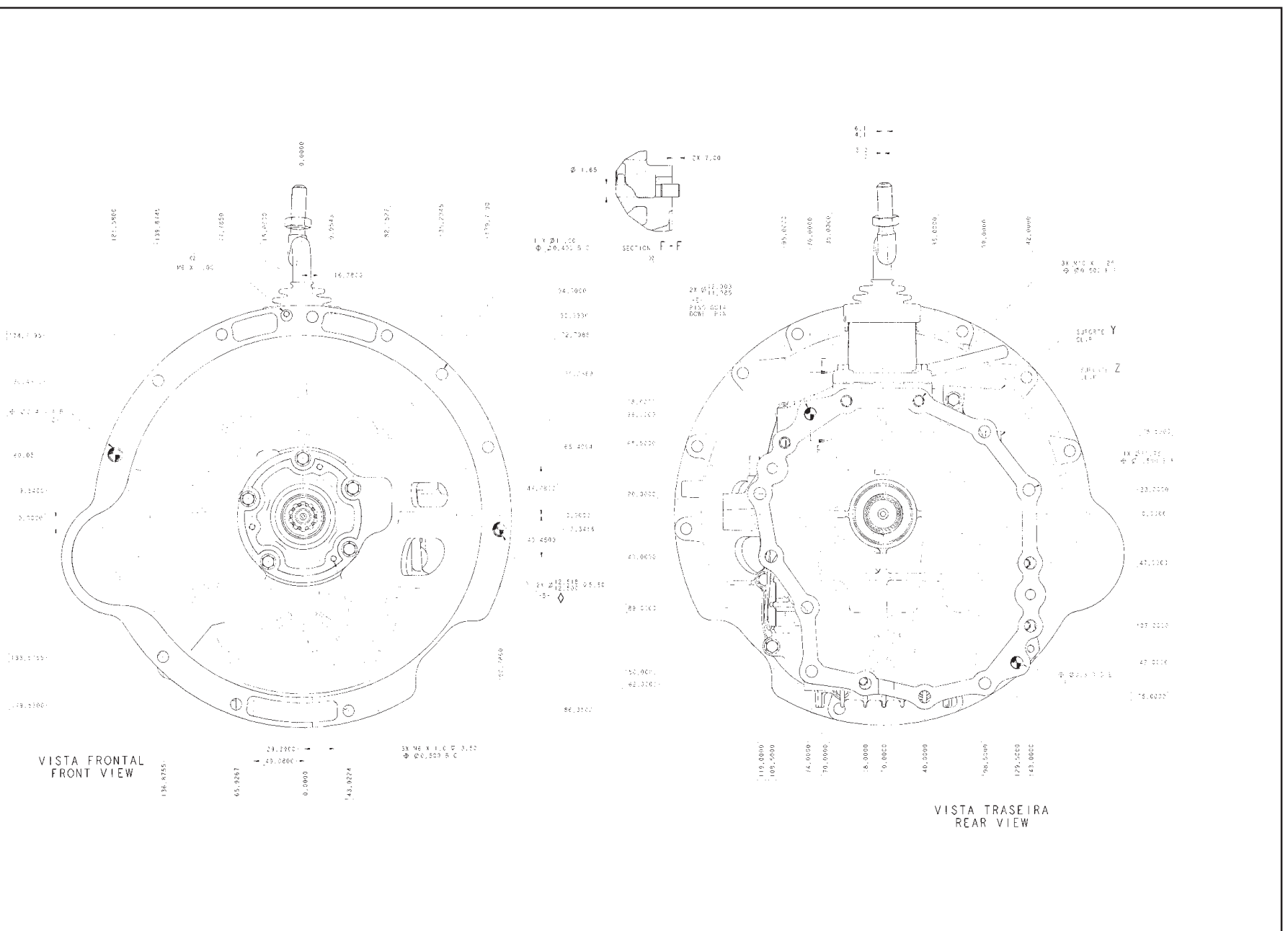
Nissan Frontier 4x2



Nissan Frontier 4x4

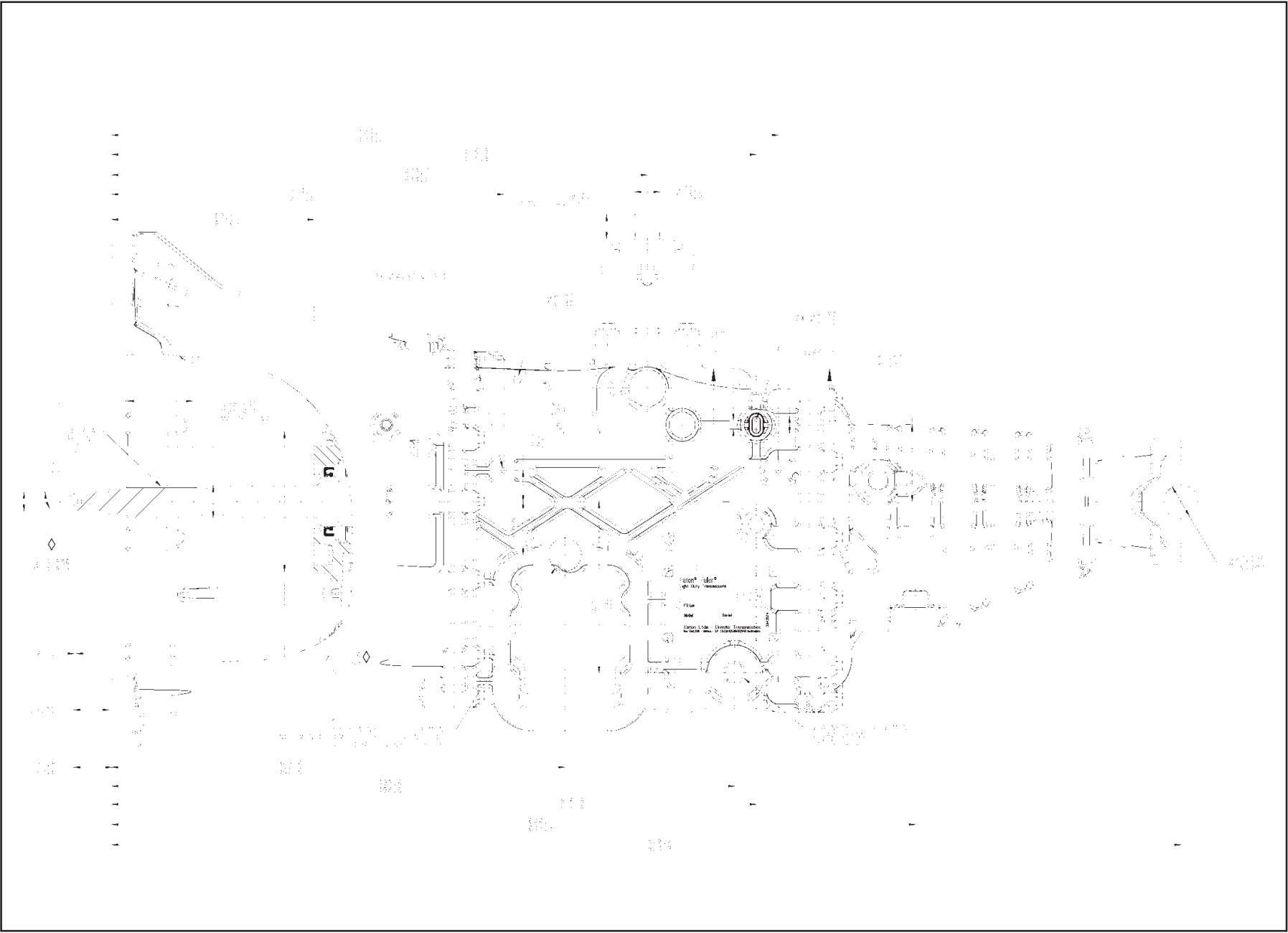


Nissan Frontier 4x4



Installation Reference

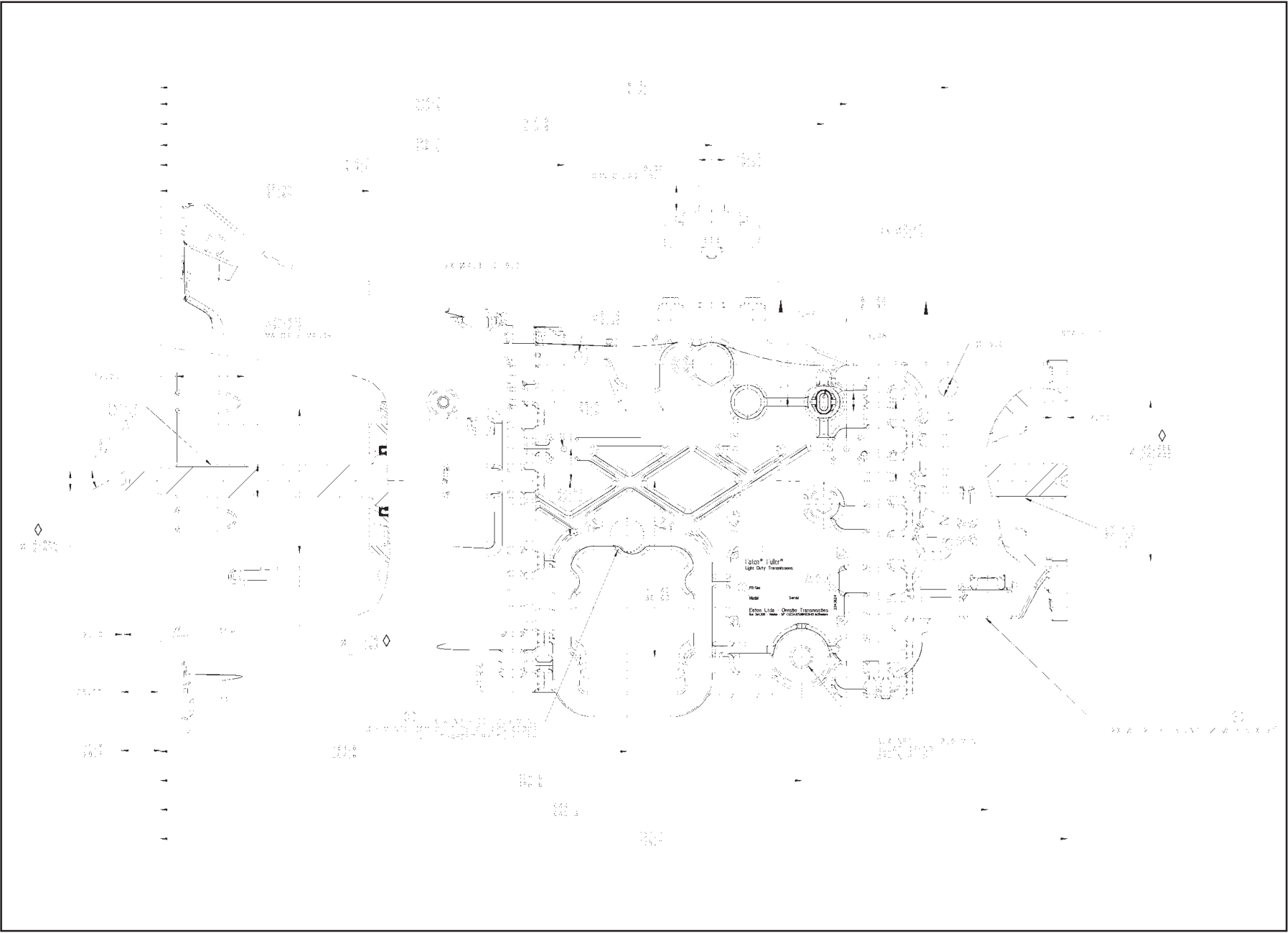
Ford Ranger 4x2



Ranger-4x2 01

Installation Reference

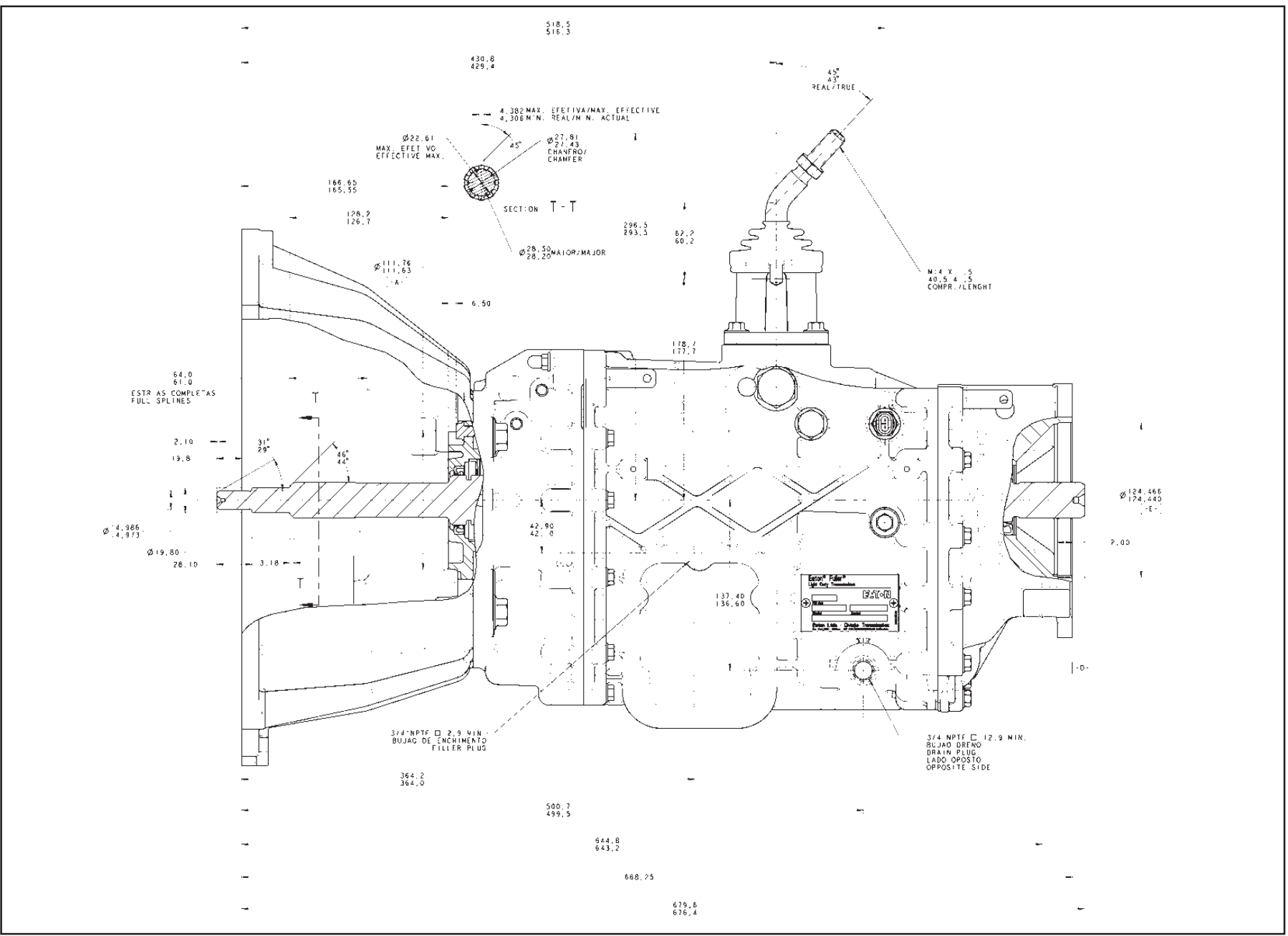
Ford Ranger 4x4



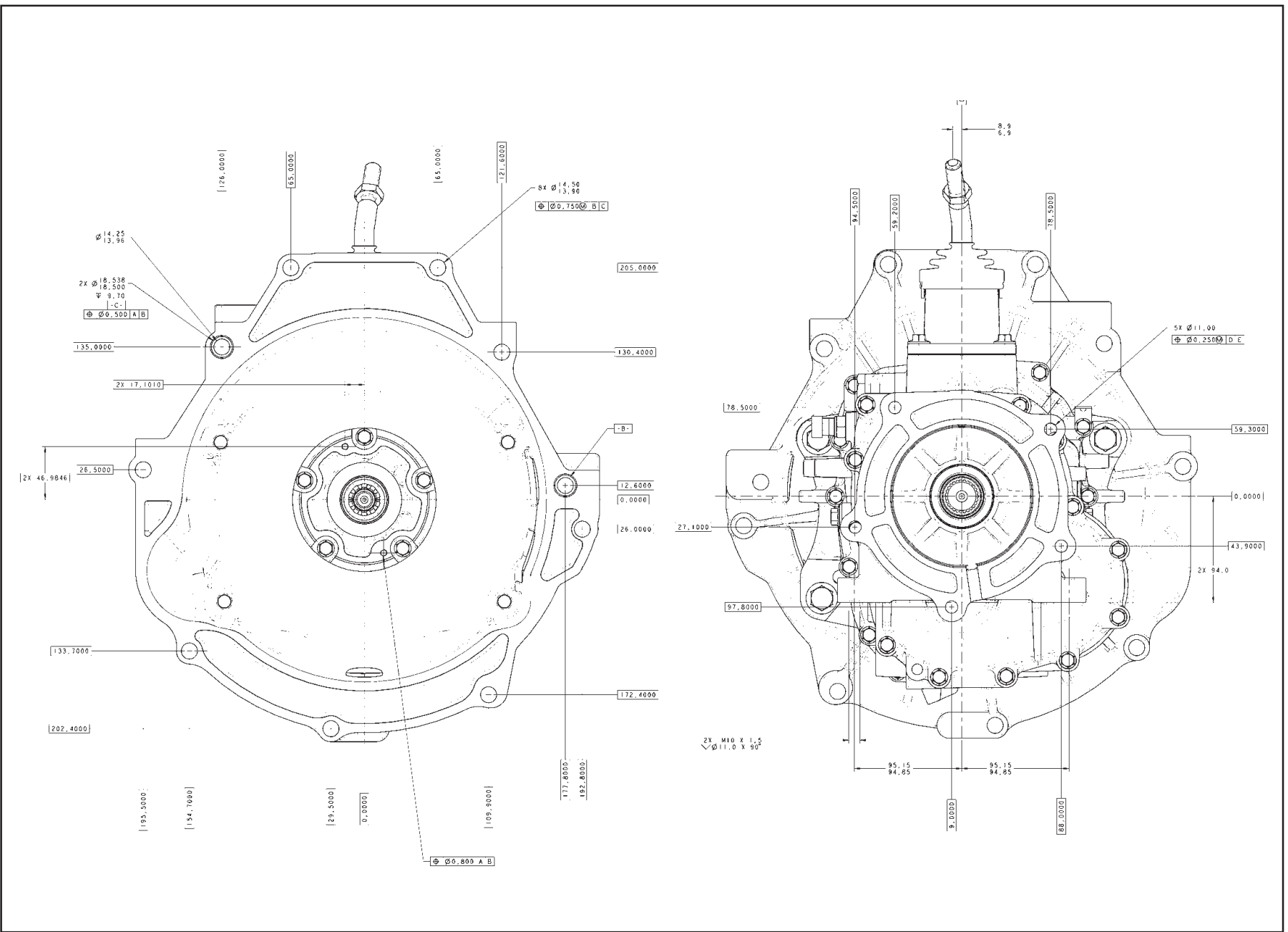
Ranger-4x4 01

Installation Reference

GM JinBei 4x4



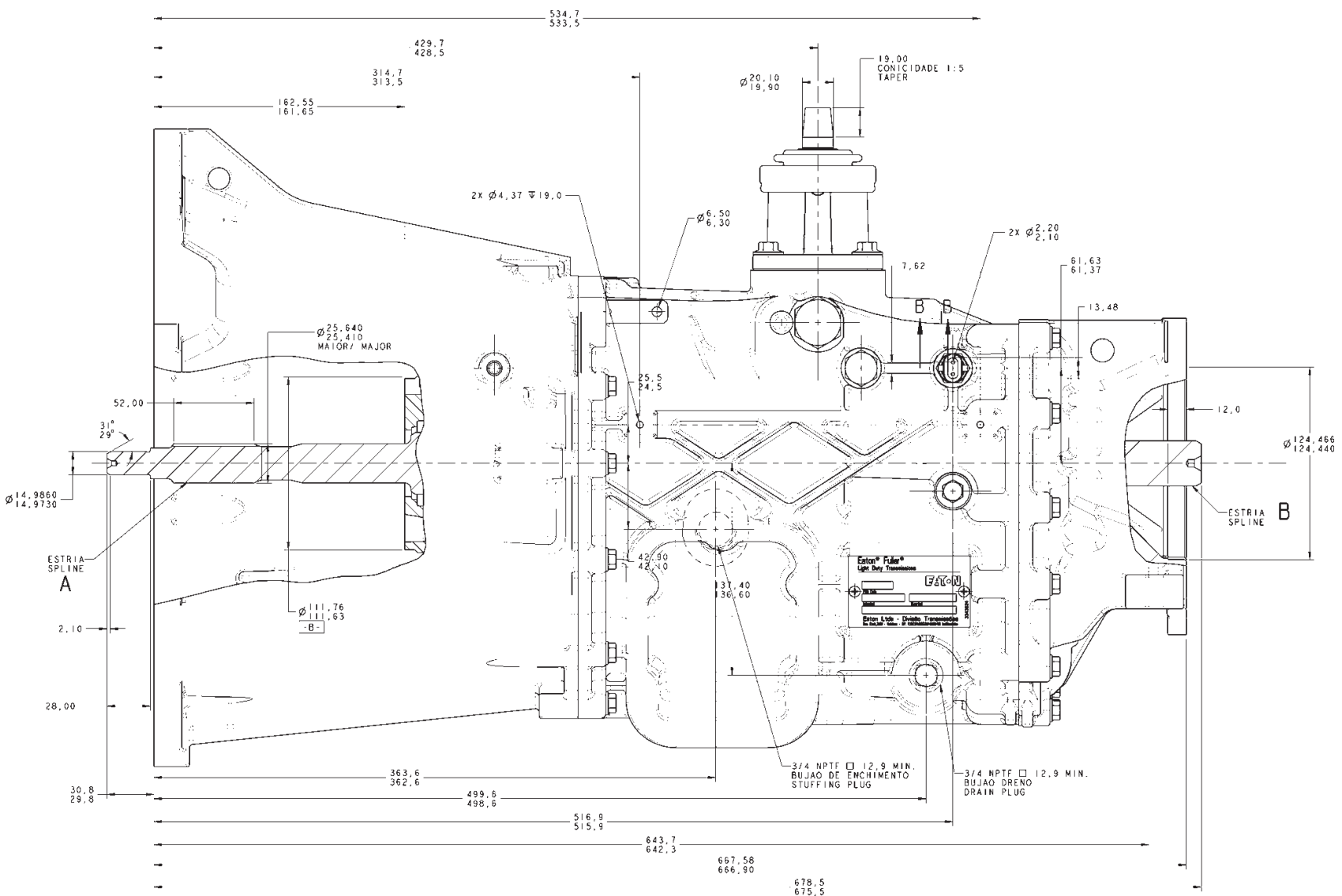
GM JinBei 4x4



Mitsubishi L200 RS 4x4

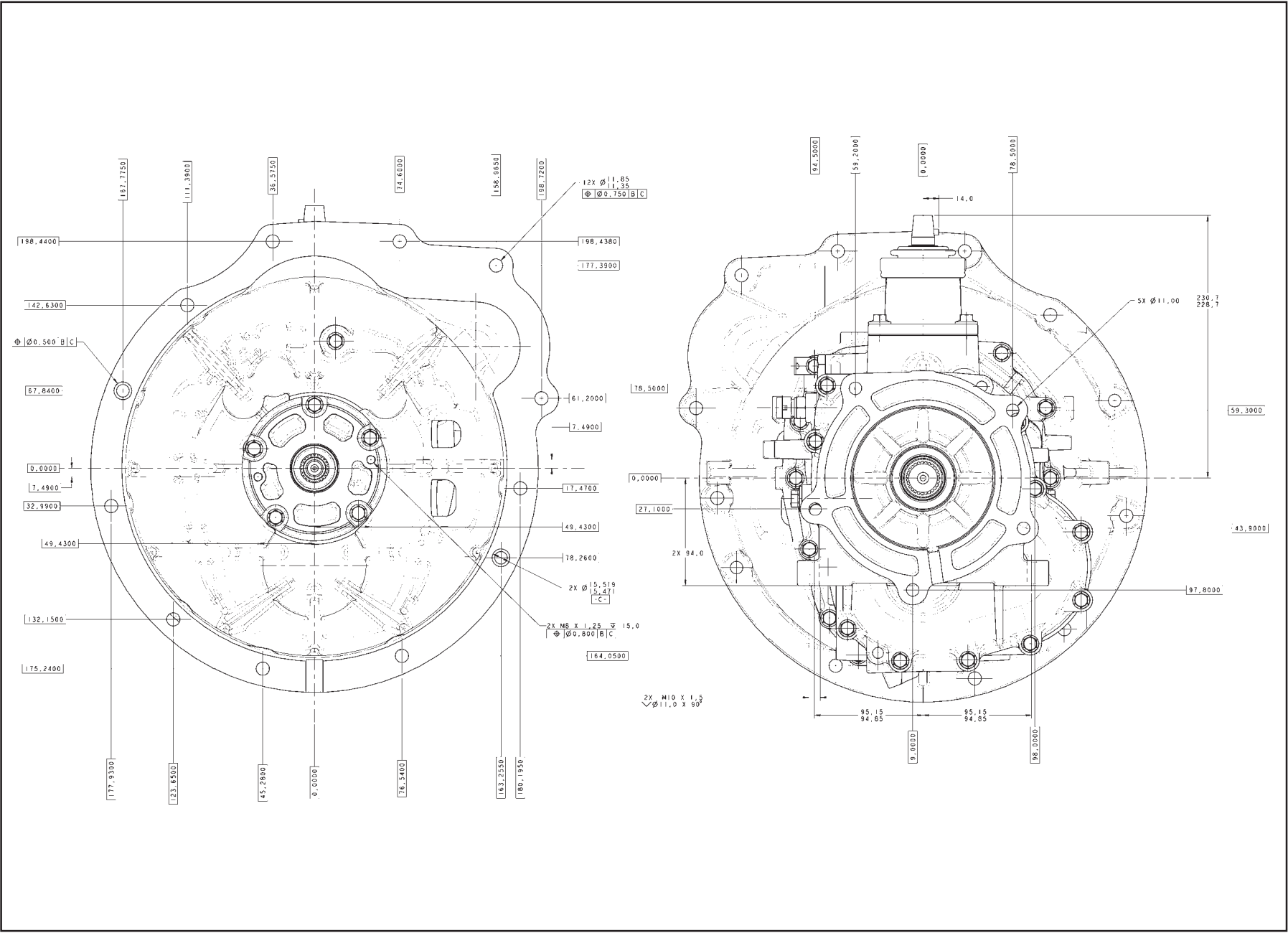


Cross Lander

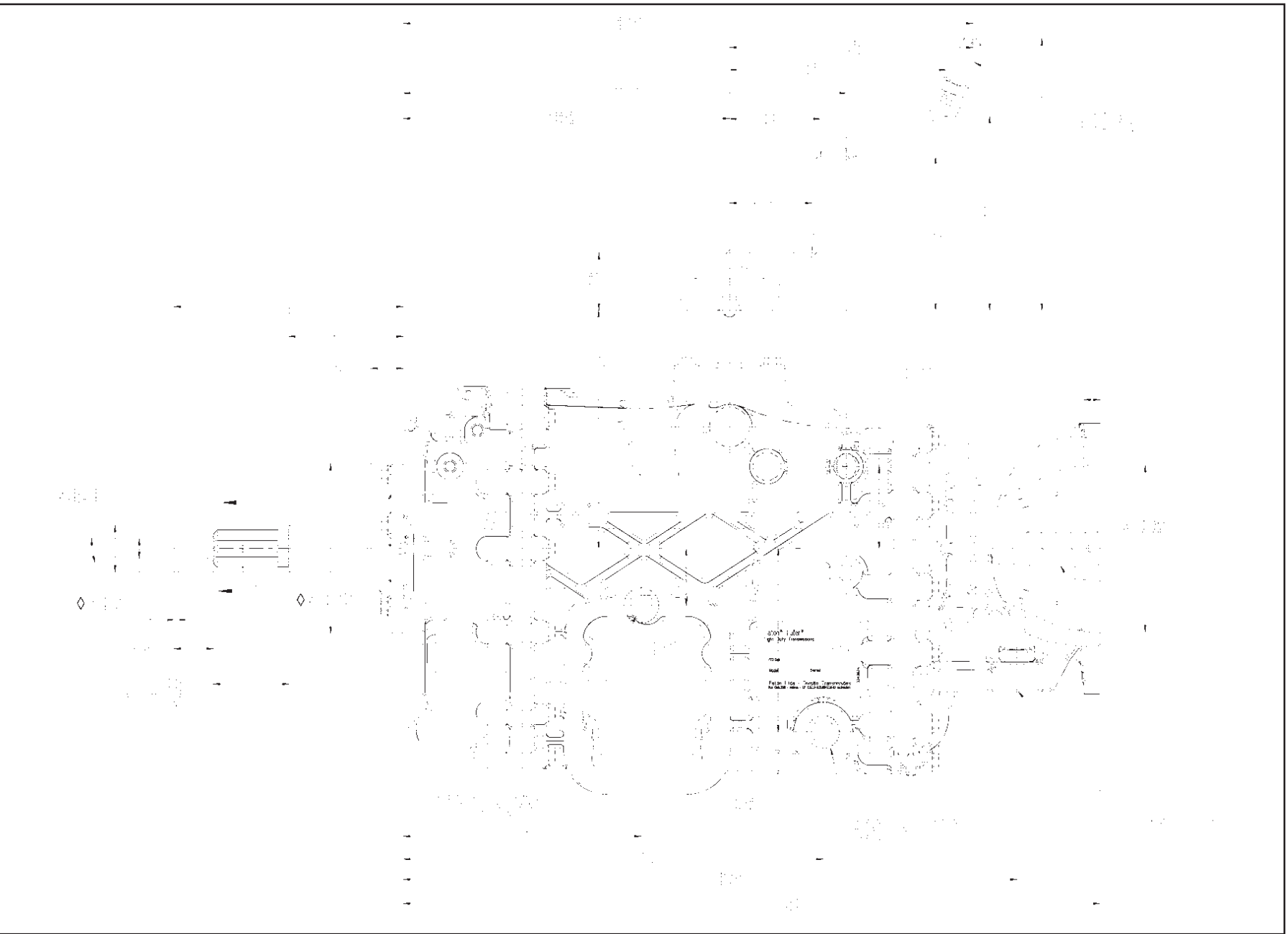


Installation Reference

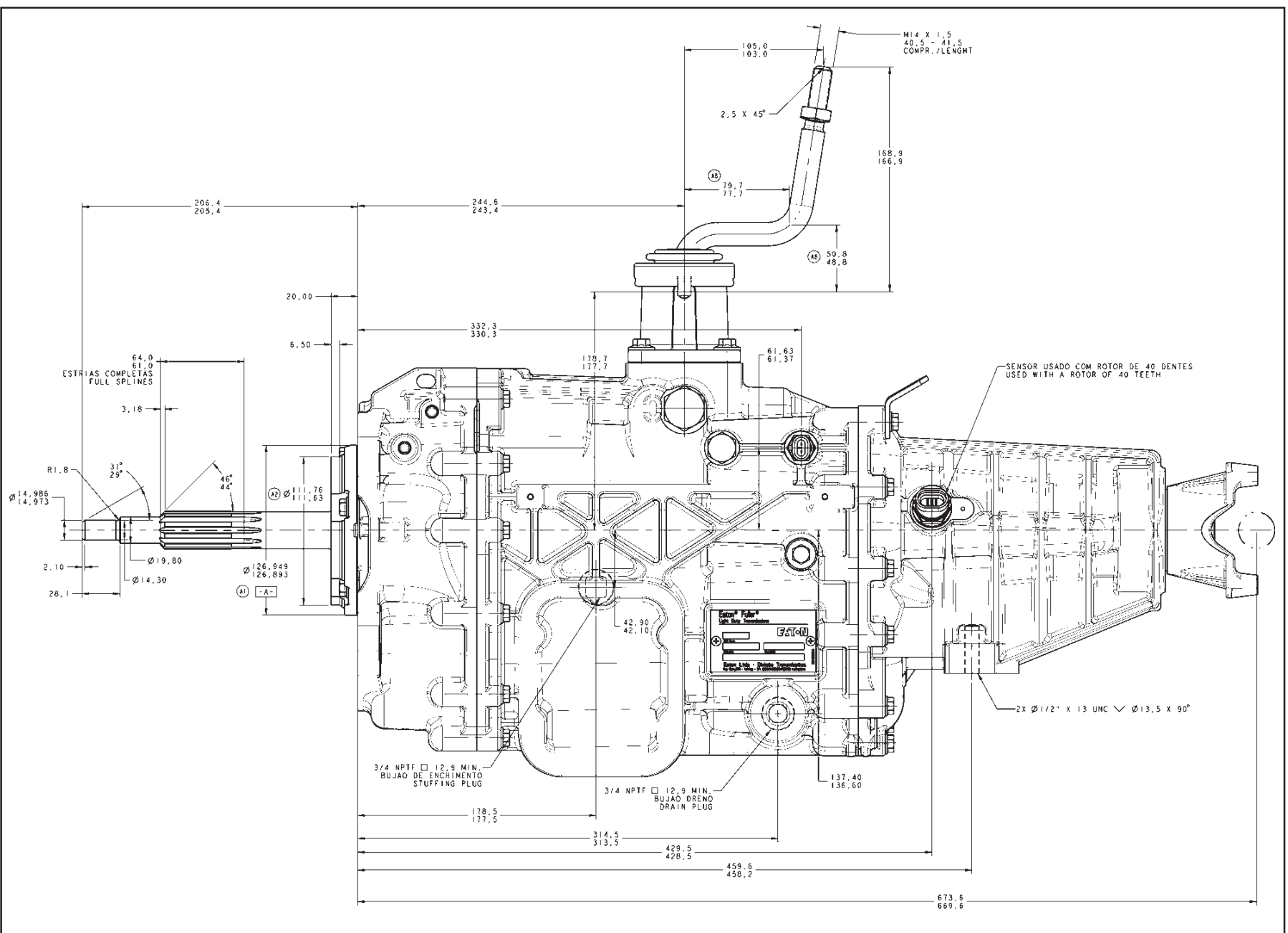
Cross Lander

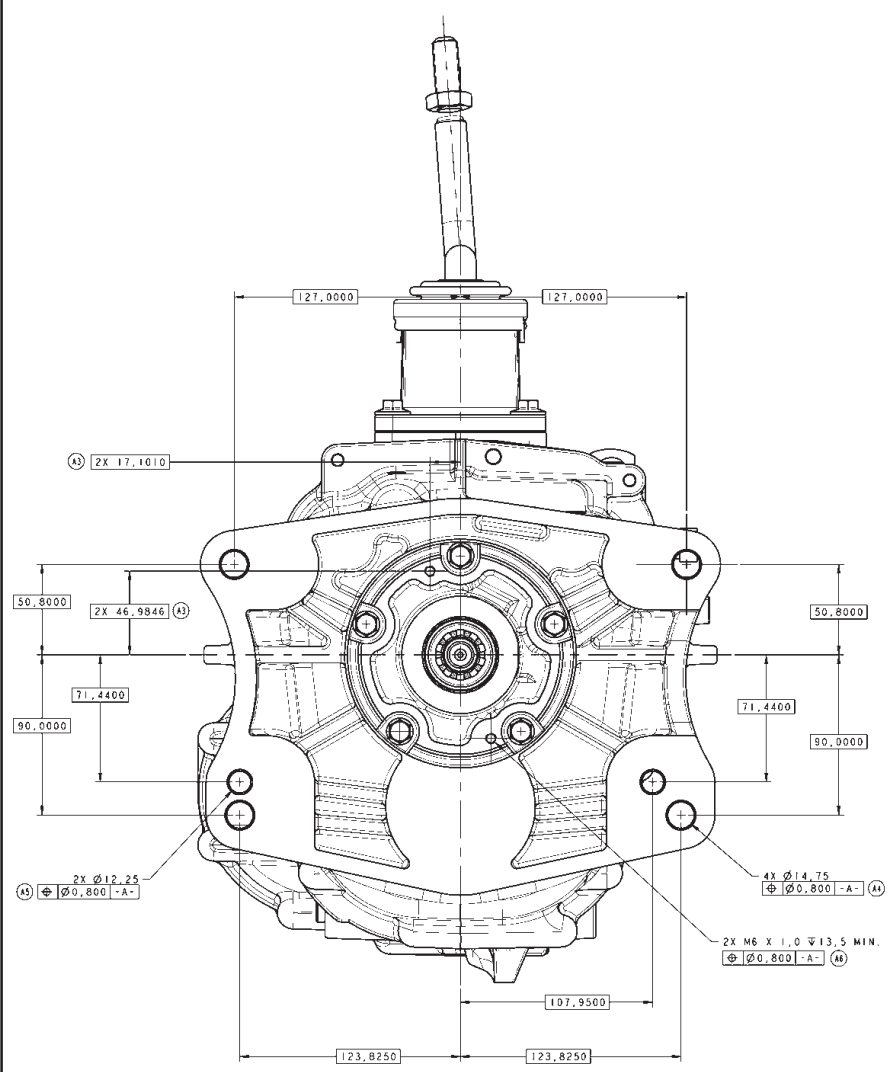
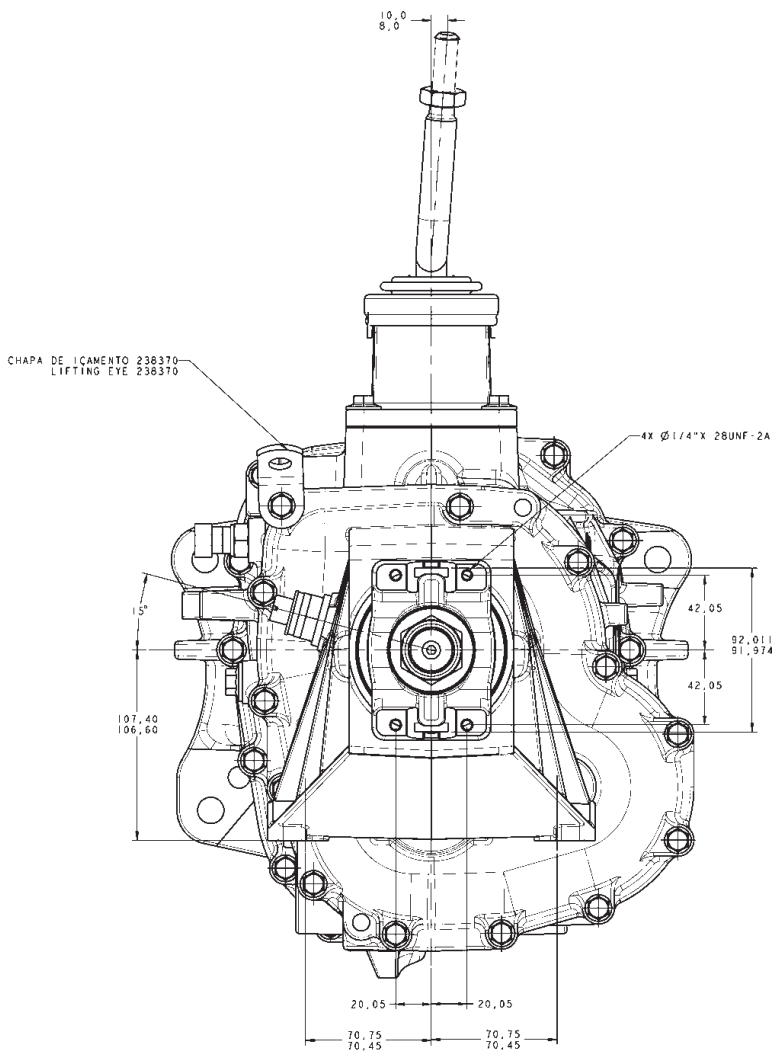


Troller Jeep 4x4



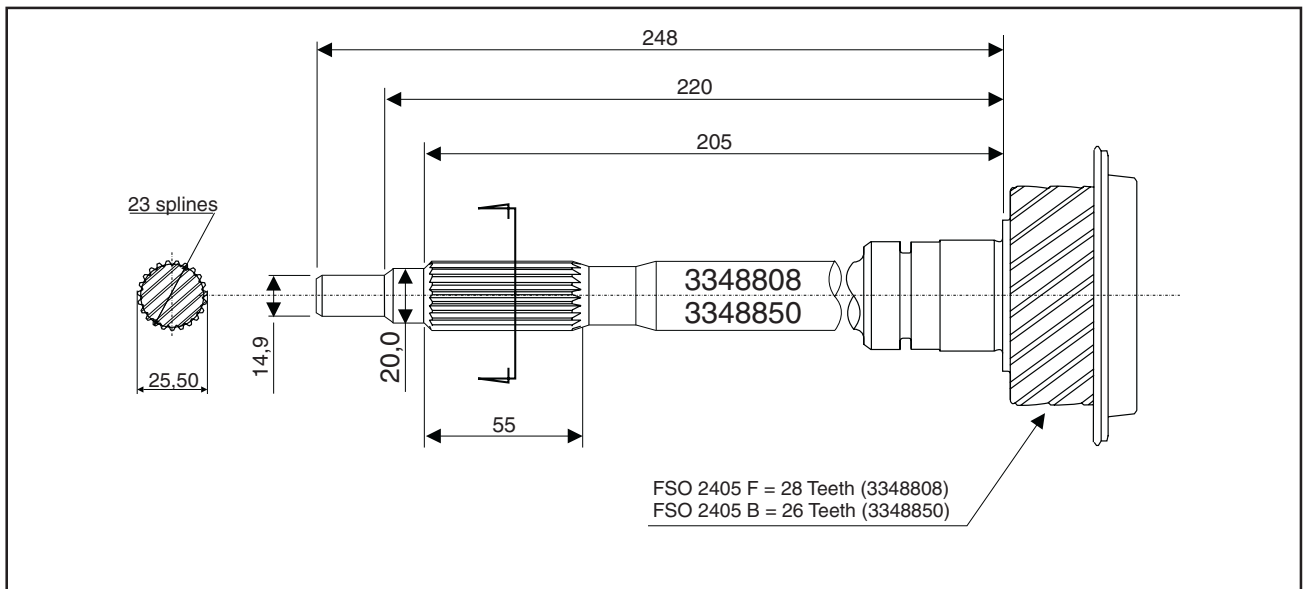
Troller 4x4





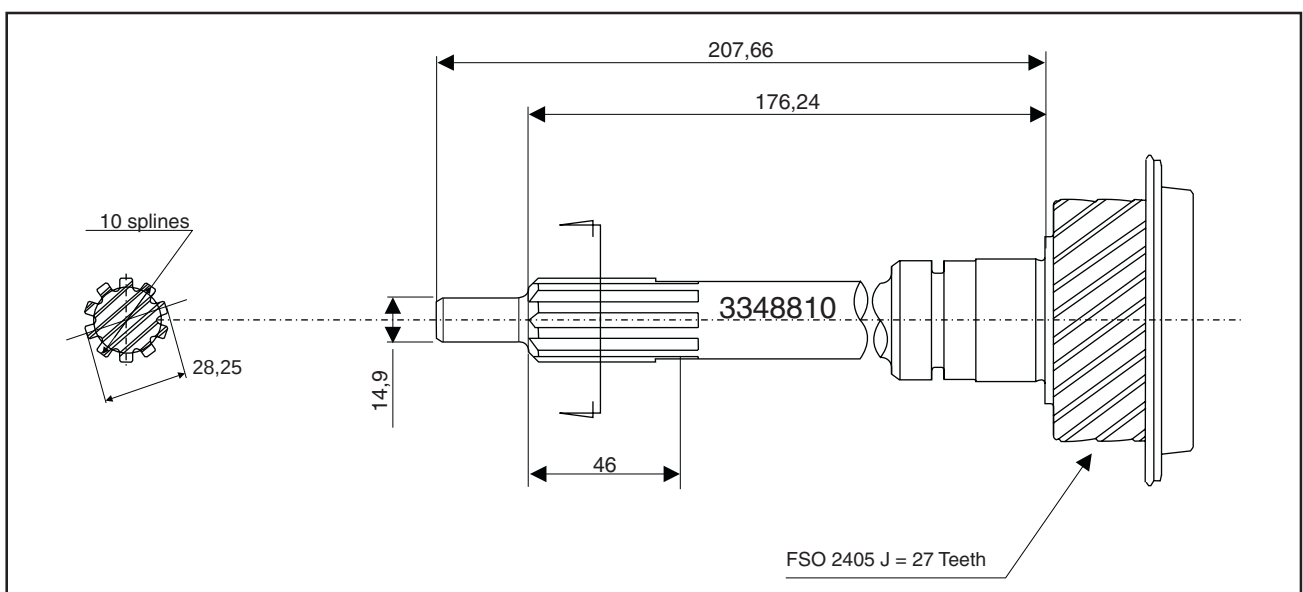
Input shaft splines and lengths

Ford Ranger 4x2 / Ford Ranger 4x4 / Cross Lander CL 224 Mx



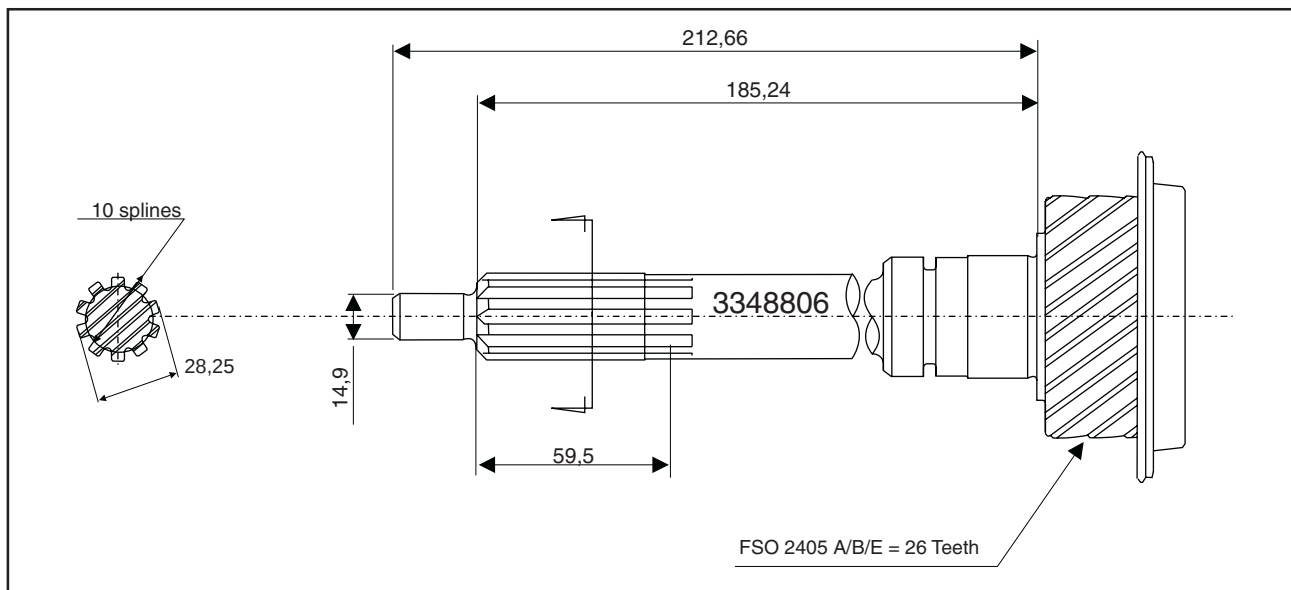
FSO-2405/157

Nissan Frontier 4x2 / Nissan Frontier 4x4



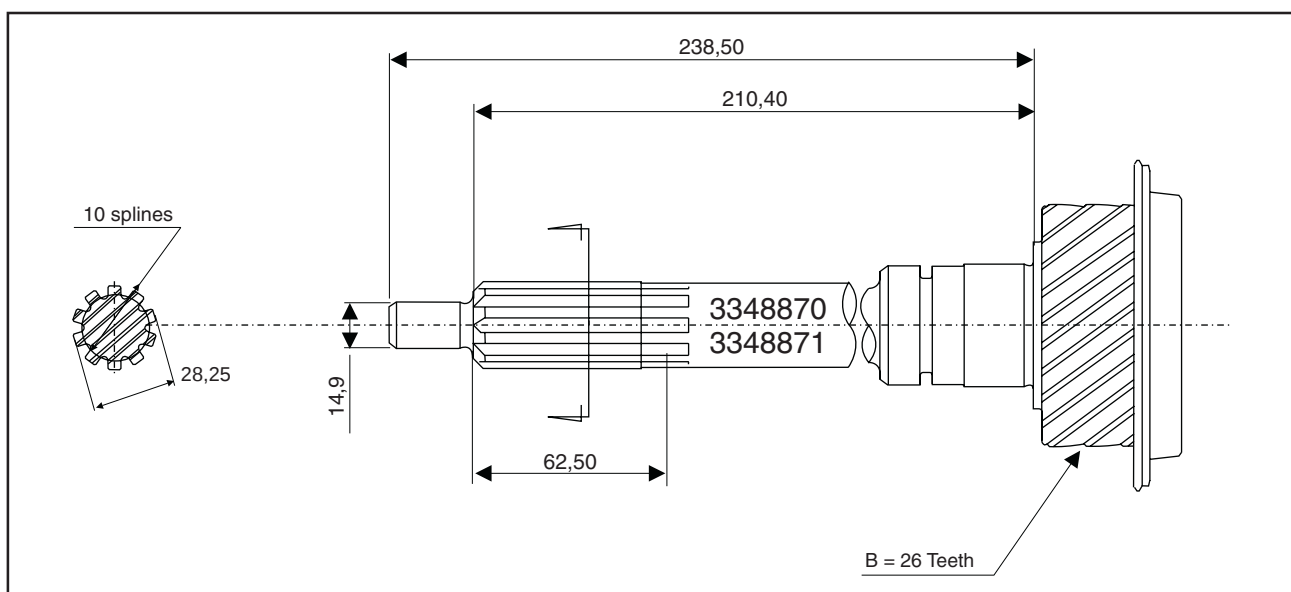
FSO-2405/158

GM S10 4x2 / GM S10 4x4 / Mitsubishi L200 RS 4x4



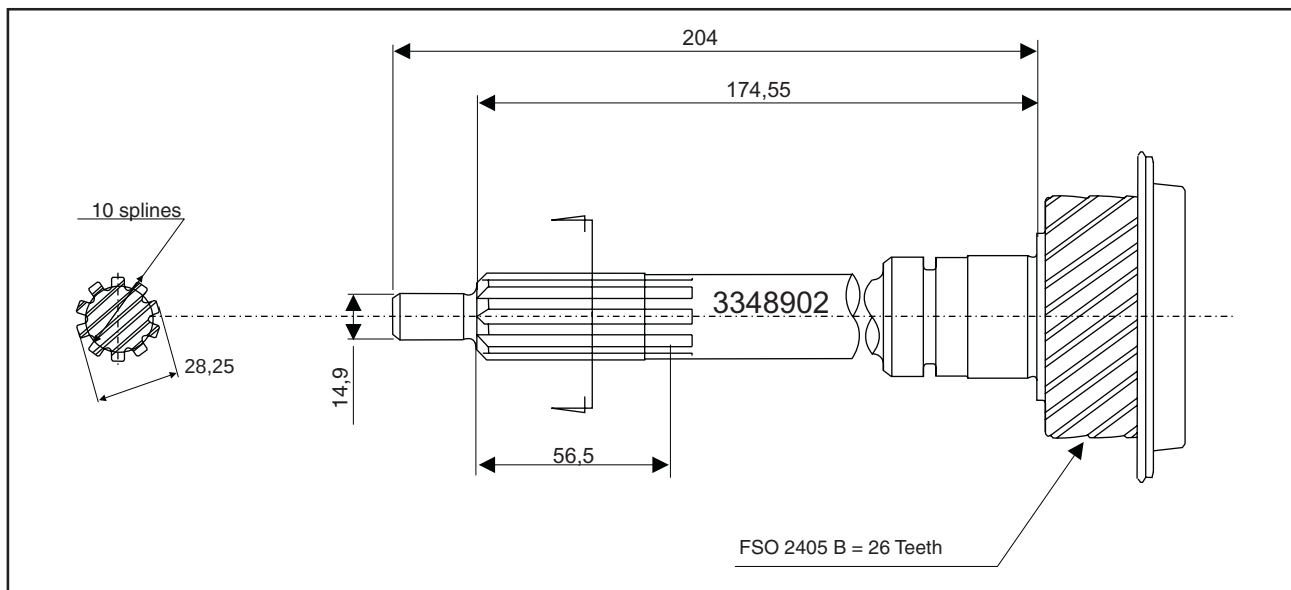
FSO-2405/159

GM Jinbei Pickup Lw9 / VM Motori



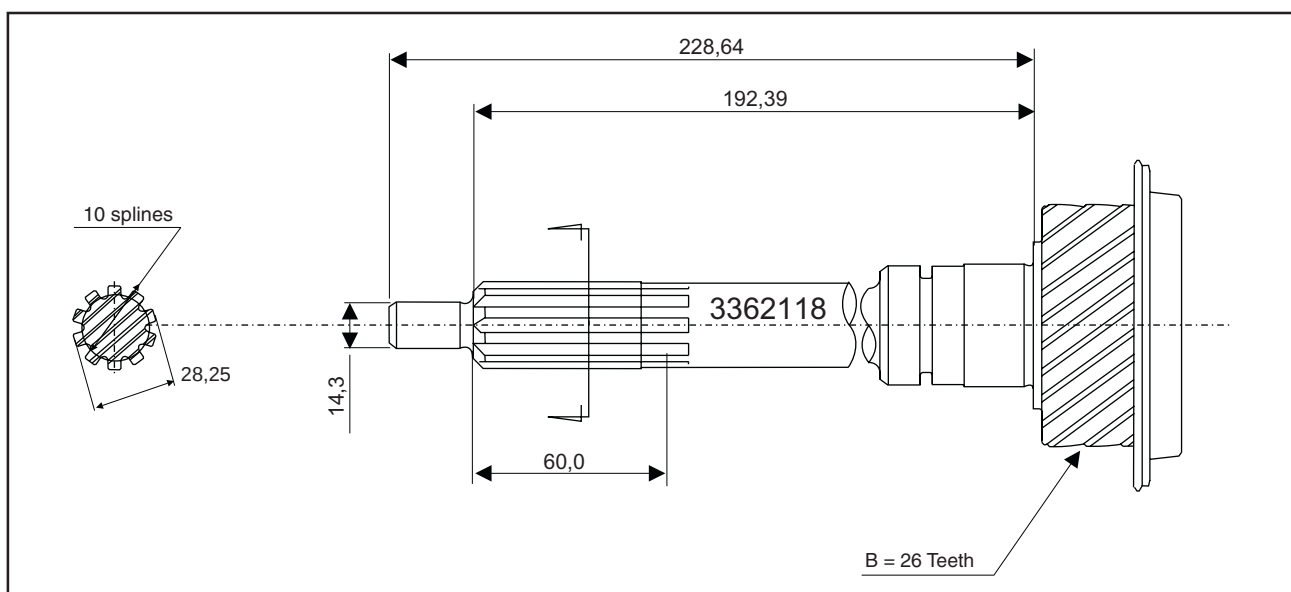
FSO-2405/160

Troller Jeep 4x4



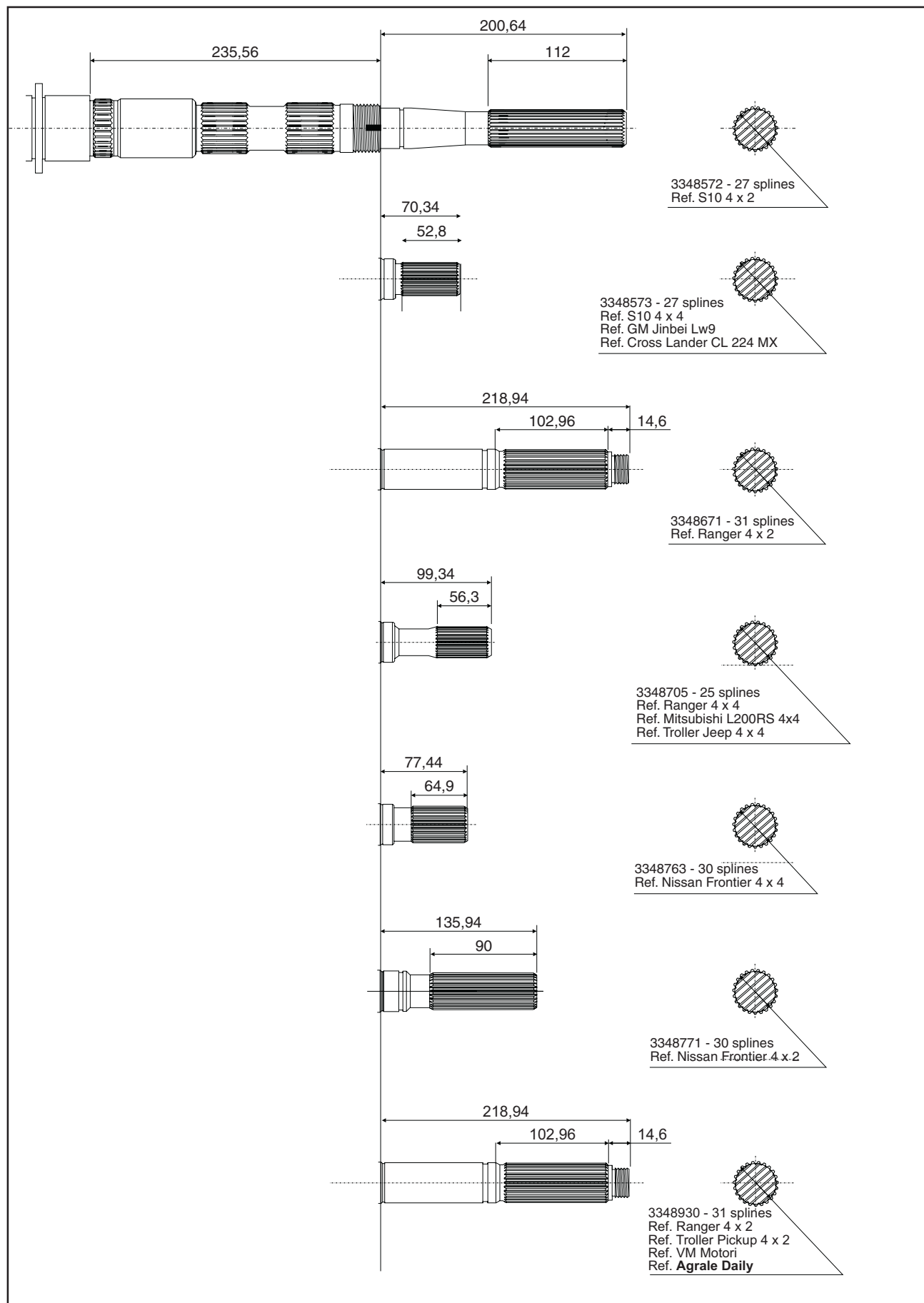
FSO-2405/159

Agrale Daily



FSO-2405/160

Mainshaft splines and lengths

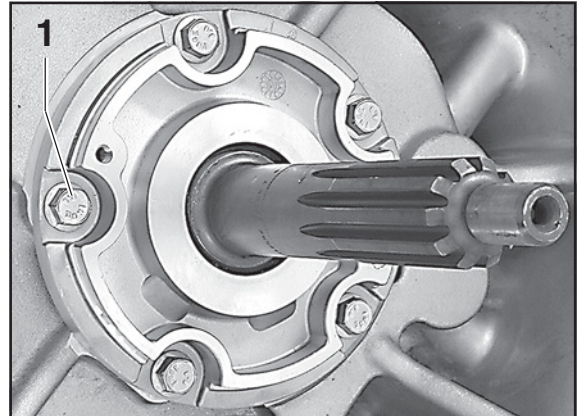


Input Shaft Bearing Cover

Removal 87

Installation 88

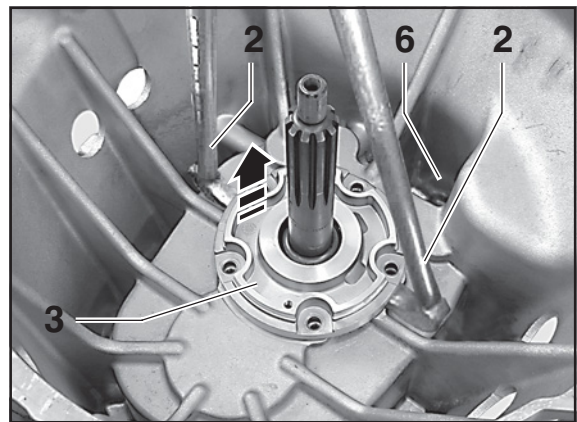
1. Remove the five retaining capscrews from the input shaft bearing cover.



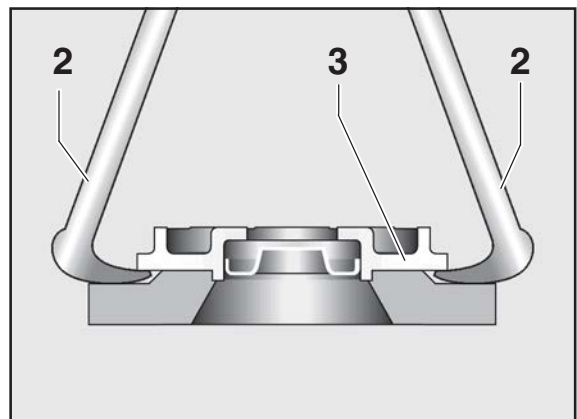
FSO-2405/50

2. Place two pry bars under the input shaft bearing cover by using the existing slots.
3. By forcing the pry bars, remove the input shaft bearing cover.
4. Remove the oil baffle.
5. If necessary, remove oil seal.

6. *NOTE: When disassembling the transmission, remove the capscrew that attach the front housing from inside it to the intermediate housing (see "Front Section Disassembly").*



FSO-2405/51



FSO-2405/52

2

Input Shaft Bearing Cover Installation



1. If previously removed, install the new oil seal with the installer.

NOTE: See “Special Tools”, Ref. E001021, E001013.

2. Install the oil baffle, observing its correct position.
3. Apply sealant to the mounting surface of input shaft bearing cover.

NOTE: Apply Eaton E680 sealant to the cover.

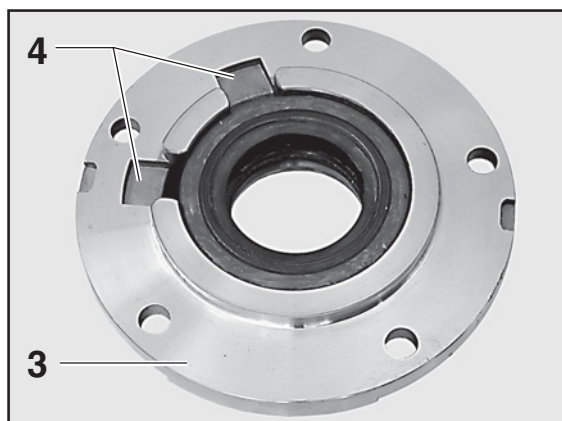
4. Align the lubrication slots of both input shaft cover and front housing and install the cover. If necessary, carefully hit the cover with a plastic hammer to seat it.



FSO-2405/150



FSO-2405/151

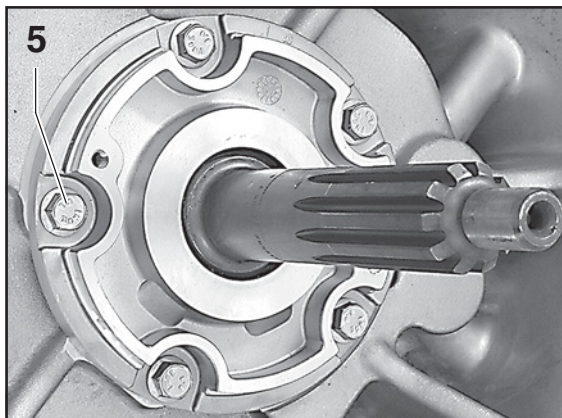


FSO-2405/53

5. Apply sealant to the cover's retaining capscrews, install them and tighten to the proper torque.

NOTE: Apply Eaton E677 sealant to the capscrews.

Torque = 10-16 N.m (7-12 lb.ft)



FSO-2405/50

2

Rear Section

Output Sleeve, Yoke and 4x4
Transmission Differences 91

Rear Section Disassembly 92

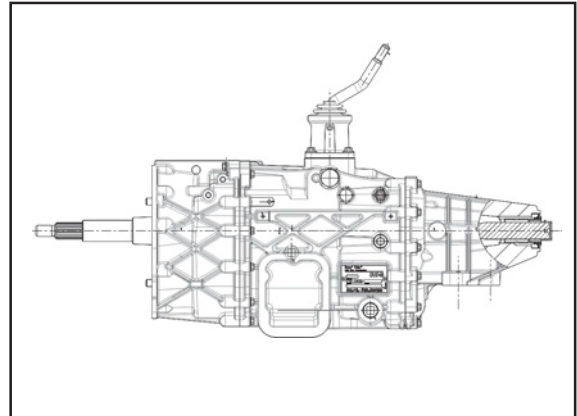
Oil Seal Replacement 100

Rear Section Assembly 101



Transmission with Output Sleeve (used in this manual)

With the exception of some rear section parts, the remaining transmission configuration is the same for all other models.



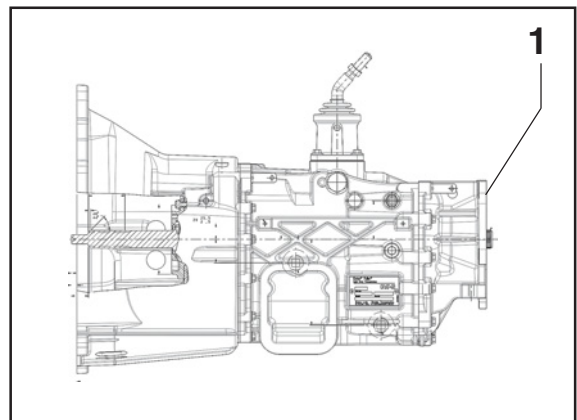
FSO-2405/142

4x4 Transmission

This transmission model has a shorter mainshaft and there is neither the speedometer sensor nor the rotor, whose functions are not performed by the transmission itself.

The rear housing is shorter and has a mounting surface with holes for attaching a transfer box (4x4).

- 1- Companion flange for attaching the transfer box

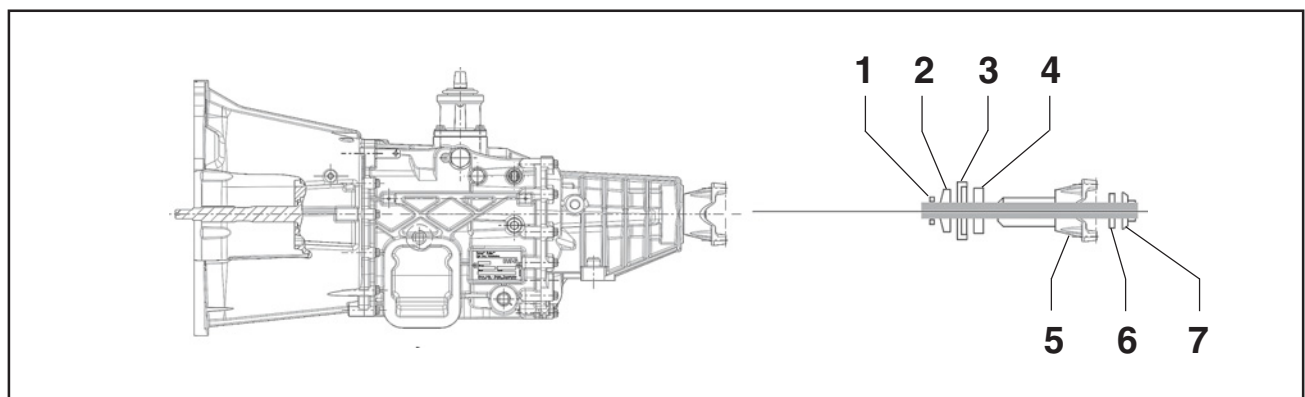


FSO-2405/143

Transmission with Universal Joint Yoke

This transmission model has an output yoke at the mainshaft end for coupling the drive shaft. Both the speedometer sensor and rotor might or not be provided, depending on the vehicle equipped with this transmission.

- | | | | |
|------------------|-------------------|-------------------------|--------|
| 1- Snap ring | 3- Retaining ring | 5- Universal joint yoke | 7- Nut |
| 2- Thrust washer | 4- Rubber washer | 6- Rubber washer | |

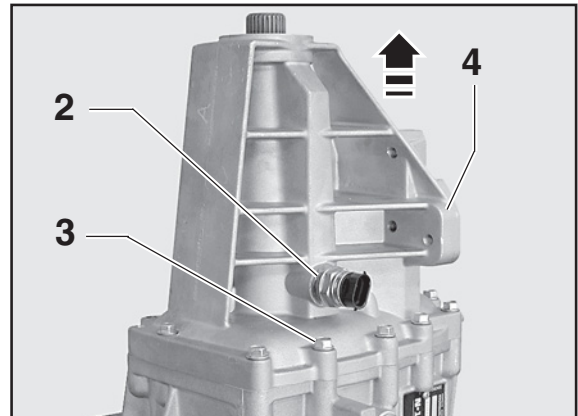


FSO-2405/144

Rear Section Disassembly

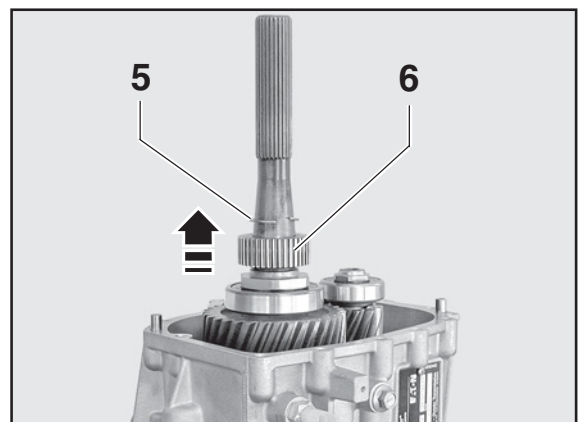


1. Place transmission with the rear cover facing up.
2. Remove speedometer sensor.
3. Remove the thirteen retaining capscrews of rear case to the intermediate housing.
4. Use a rubber or plastic hammer to break gasket seal and detach the rear cover. Remove the rear cover by pulling it upwards.



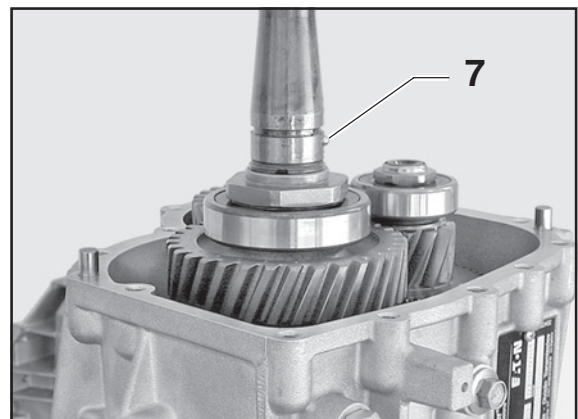
FSO-2405/1

5. Remove the speedometer rotor snap ring.
6. Remove the speedometer rotor.



FSO-2405/2

7. Remove the rotor retaining ball from the mainshaft.



FSO-2405/3

8. Place the wrench to loosen the mainshaft rear nut.

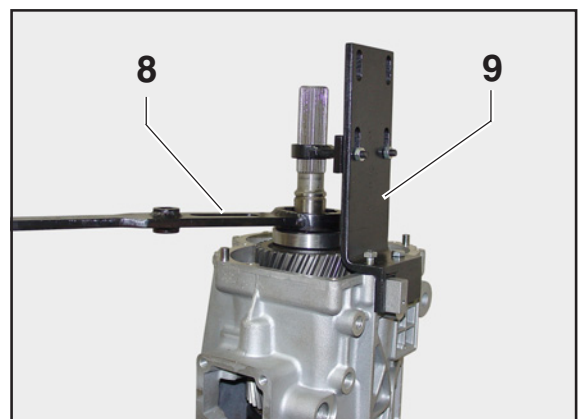
NOTE: See "Special Tools", Ref. E006006.

NOTE: As an option, the tool # E006004 or # E006005 may be used for removing the mainshaft rear nut, locking the mainshaft with the tool # E006003. See "Special Tools, Using the Eaton tool # E006003".

9. Place the special tool and lock the mainshaft. Loosen the rear nut.

NOTE: See "Special Tools", Ref. E014010.

10. Remove tools and the mainshaft nut.



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11. Lock the mainshaft again with the special tool and shift transmission into the 1st gear.

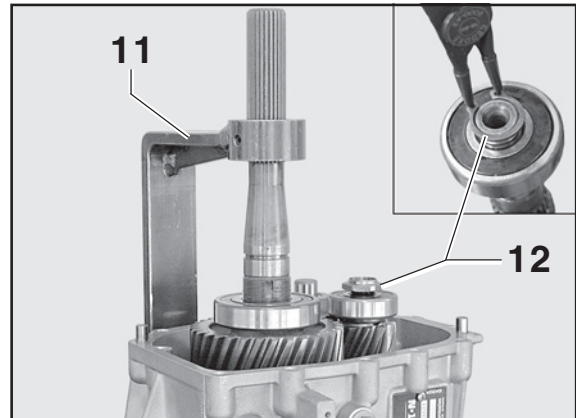
NOTE: See "Special Tools", Ref. E014010.

NOTE: As an option, the tool # E006003 may be used for locking the mainshaft. See "Special Tools, Using the Eaton tool # E006003".

12. Remove the countershaft rear nut (or snap ring).

NOTE: On 2006, the nut was replaced by a snap ring in some applications.

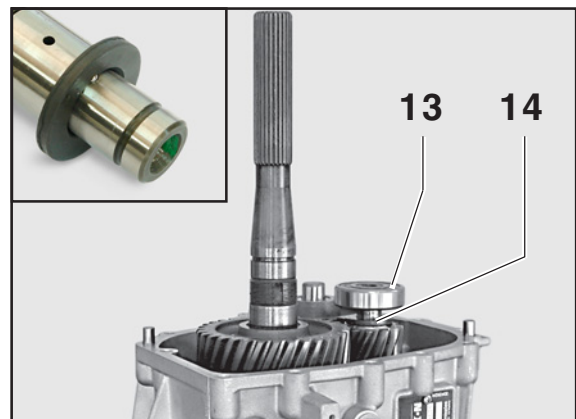
NOTE: See "Special Tools", Ref. E006002.



FSO-2405/5

13. Remove the countershaft ball bearing.
14. Remove the bearing thrust washer.

NOTE: On countershaft with threadless end, which uses a snap ring instead of the nut, the thrust washer has a retaining ball (see detail), which should also be removed.



FSO-2405/138

15. Remove the reverse gear and the ball bearing together from the mainshaft by pulling them off.

NOTE: See "Special Tools" - Ref. E012001, E012002.

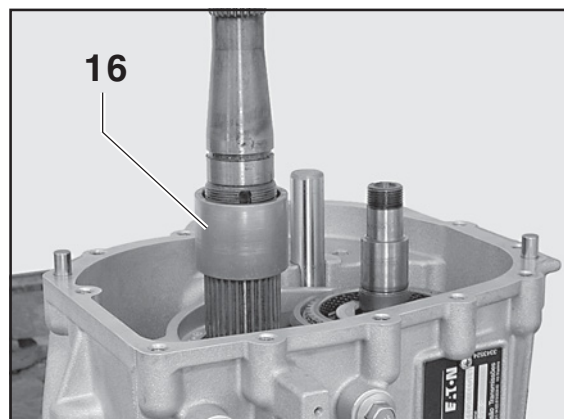


FSO-2405/153

Rear Section Disassembly

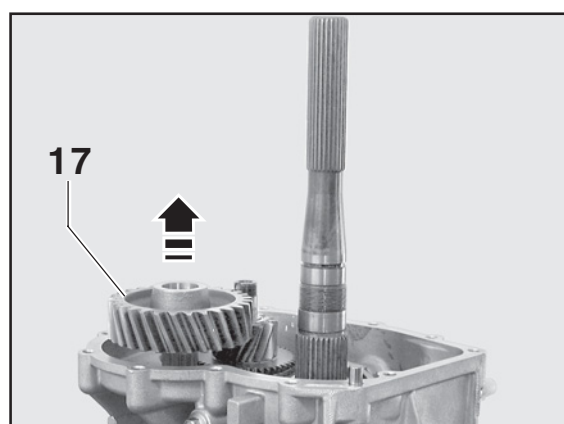


16. Remove the reverse gear spacer bushing from the mainshaft.



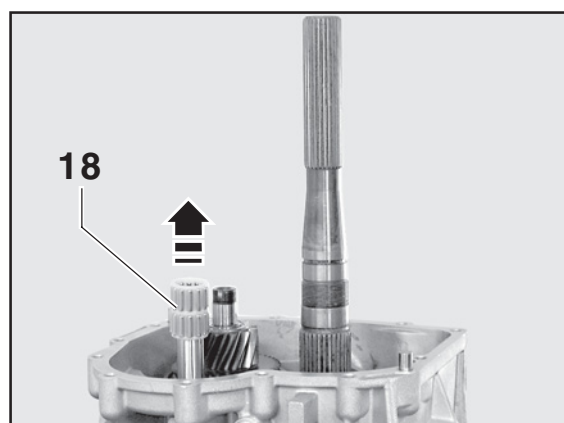
FSO-2405/9

17. Remove the reverse idler gear.



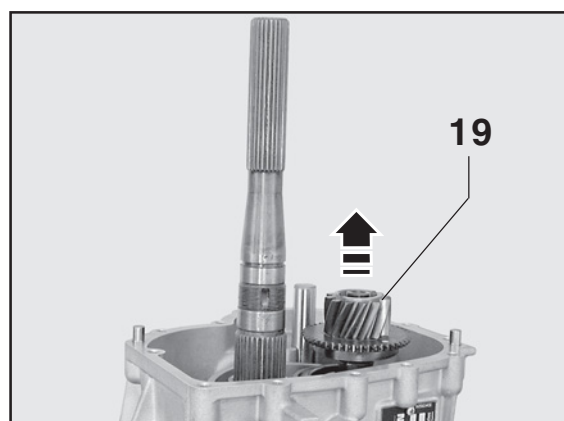
FSO-2405/10

18. Remove the reverse idler gear needle bearing.



FSO-2405/11

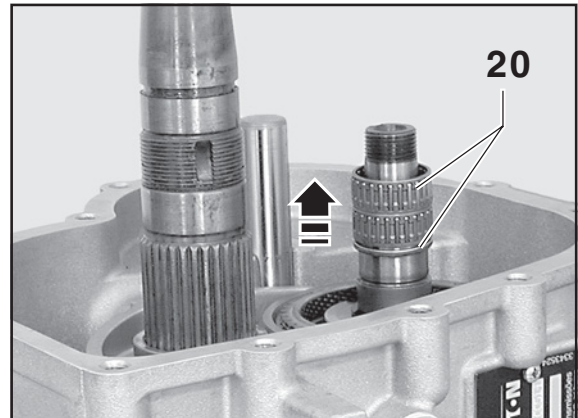
19. Remove the reverse gear from the countershaft.



FSO-2405/12

21. Remove the two needle bearings and the reverse gear spacer from the countershaft.

NOTE: The reverse gear needle bearing on the countershaft was updated. When servicing the unit, if older, replace both bearings (p/n 3342286) and spacer (p/n 3342287) by the new lone bearing (p/n 3348906).



FSO-2405/13

Old part

2 (two) bearings - Eaton P/N 3342286

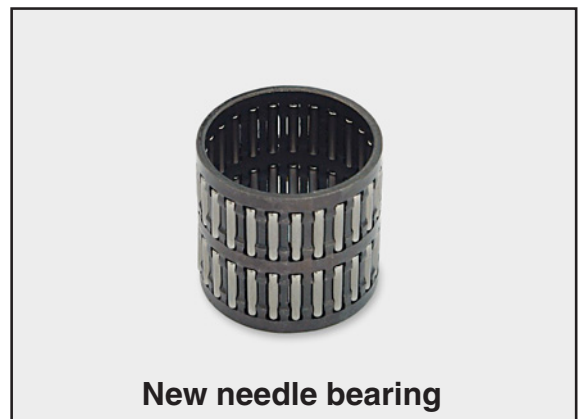
1 (one) spacer - Eaton P/N 3342287



FSO-2405/154

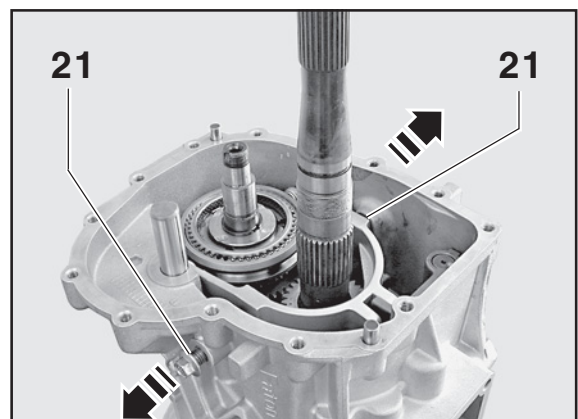
New part

1 (one) bearing - Eaton P/N 3348906



FSO-2405/155

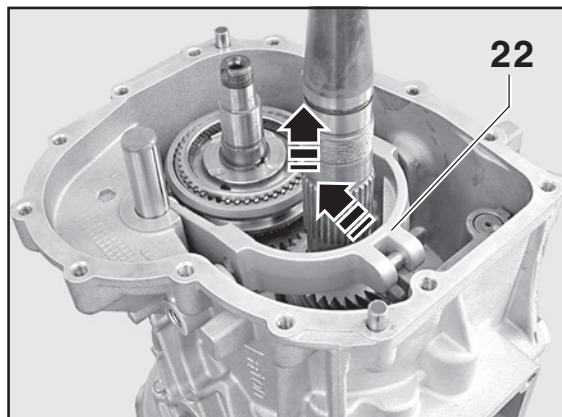
21. Remove the two pivot threaded pins of 5th/ reverse shift yoke.



FSO-2405/14

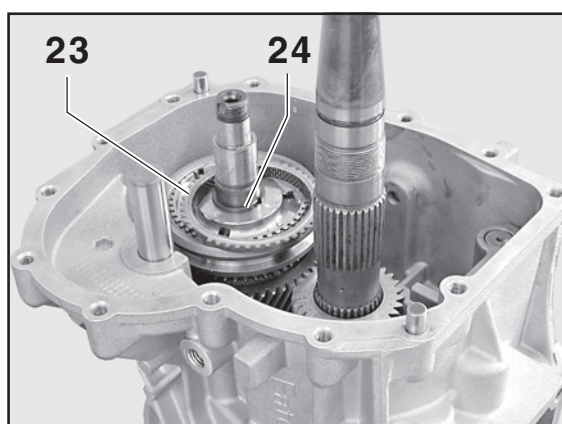
Rear Section Disassembly

22. Push the 5th/reverse shift yoke towards the synchronizer in order to loosen it from the linked shift block. Lift the yoke end and remove by pulling the yoke upwards.



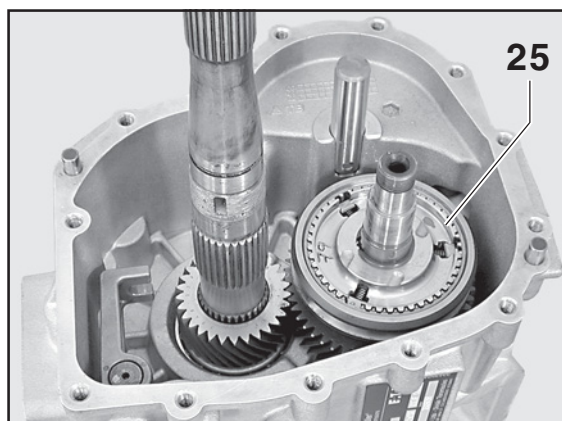
FSO-2405/15

23. Remove the reverse speed synchronizer ring.
24. Remove the 5th/reverse synchronizer hub snap ring from the countershaft.



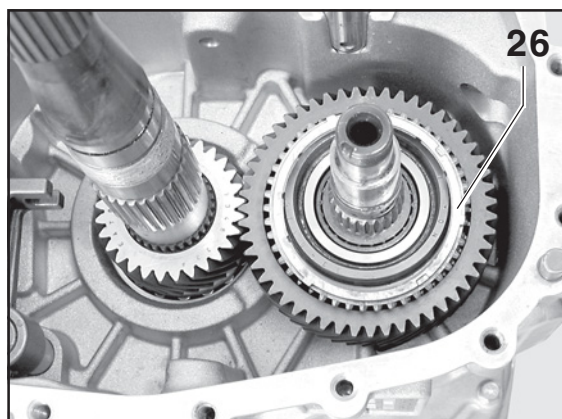
FSO-2405/16

25. Remove the 5th/reverse synchronizer assembly.



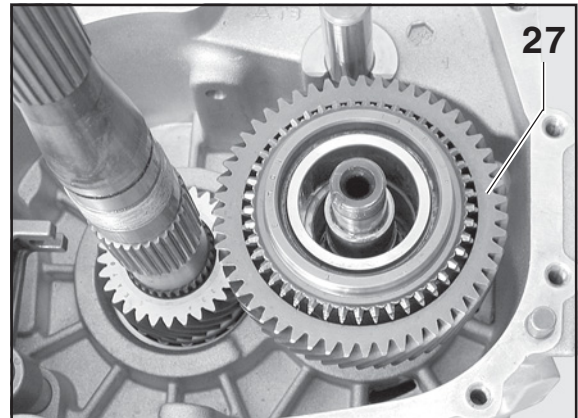
FSO-2405/17

26. Remove the 5th speed synchronizer ring.



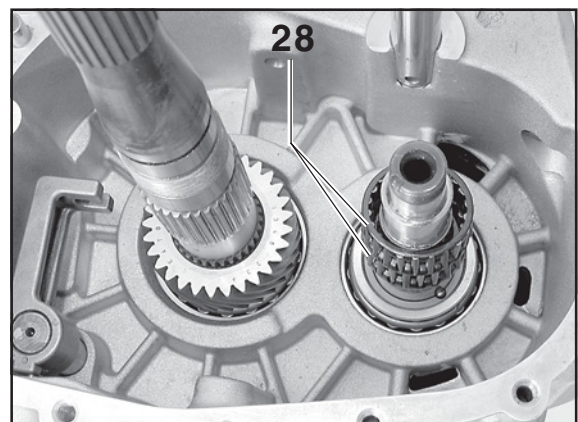
FSO-2405/18

27. Remove the 5th speed gear from the countershaft.



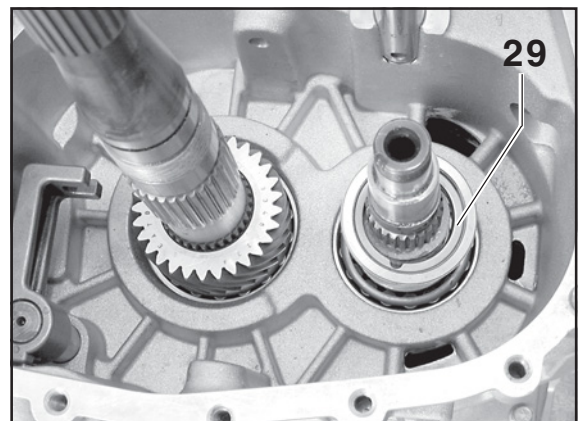
FSO-2405/19

28. Remove the two needle bearings of 5th speed gear from the countershaft.



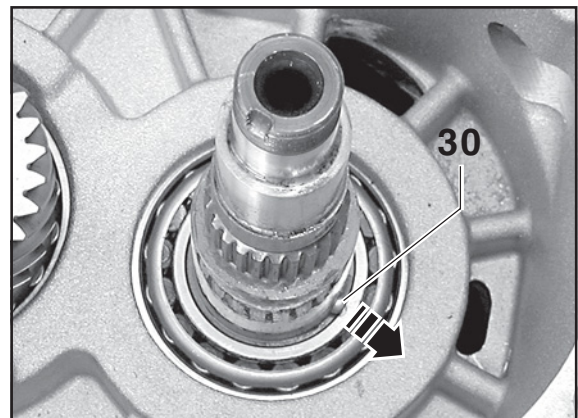
FSO-2405/20

29. Remove the 5th speed gear thrust washer from the countershaft.



FSO-2405/21

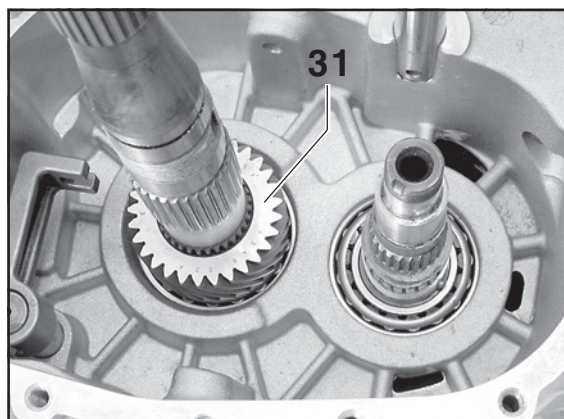
30. Remove the retaining ball of the 5th speed gear thrust washer from the countershaft.



FSO-2405/22

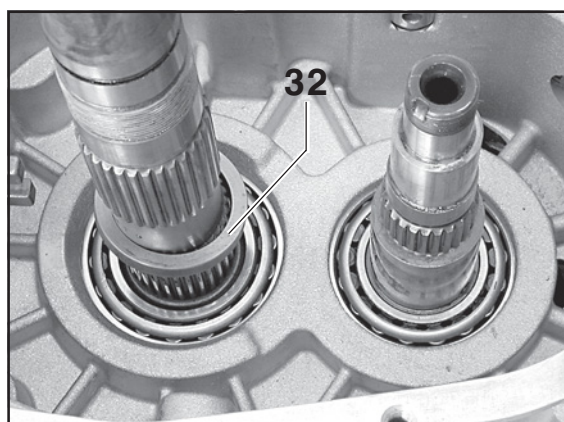
Rear Section Disassembly

31. Remove the 5th speed gear from the mainshaft.



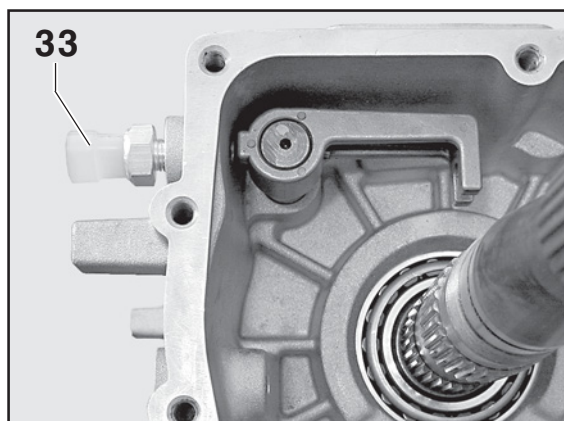
FSO-2405/23

32. Remove the 5th speed gear thrust washer from the mainshaft.



FSO-2405/24

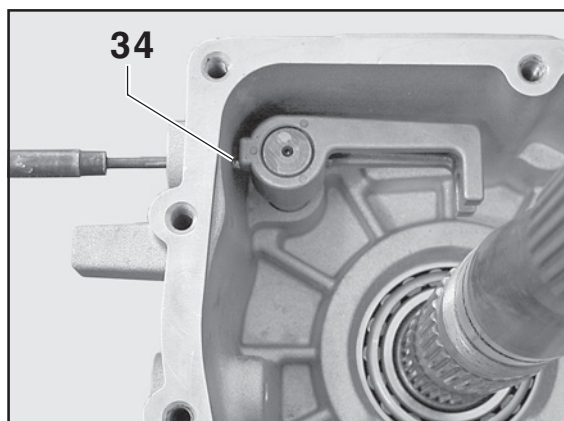
33. Remove the reverse light switch.



FSO-2405/25

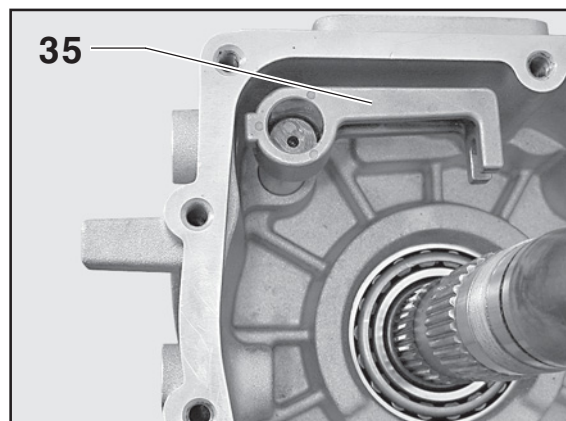
34. Remove the 5th/reverse linked shift block retaining roll pin.

NOTE: Use a 4 mm diameter pin punch.



FSO-2405/26

35. Remove the 5th/reverse linked shift block.

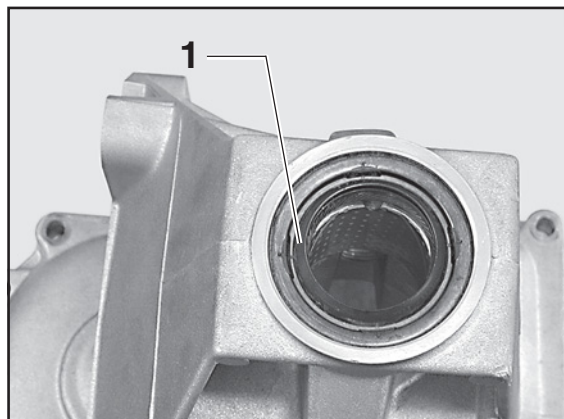


FSO-2405/27

Removal

1. Use pry bars or screwdriver to remove the oil seal.

NOTE: The removed oil seal should not be reused.



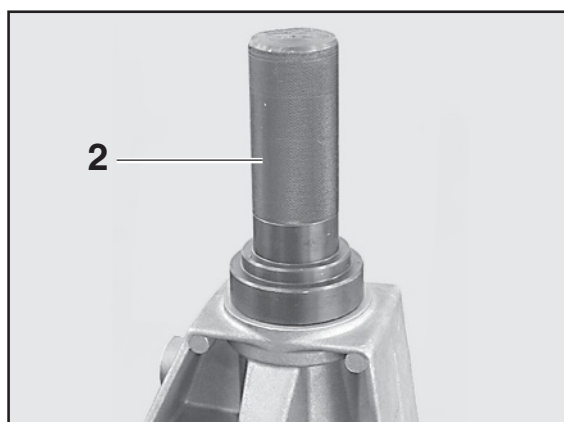
FSO-2405/70

Installation

NOTE: If removed, always replace the oil seal.

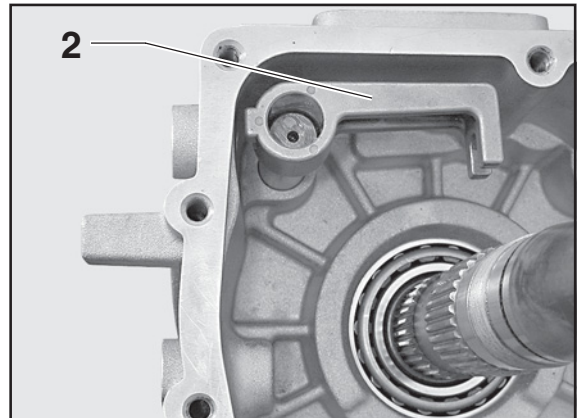
1. Coat the new seal lips with the recommended grease.
2. Position the seal on the rear cover and install it in the bore using the proper tool.

NOTE: See "Special Tools" - use the proper device for the transmission.



FSO-2405/71

1. Place transmission with the rear section facing up.
2. Install the 5th/reverse linked shift block.

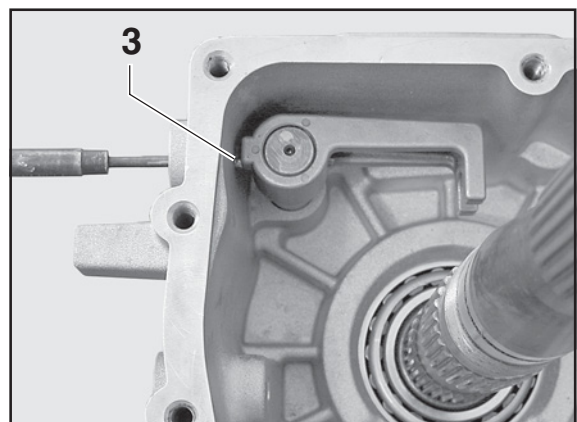


FSO-2405/27

3. Install the 5th/reverse linked shift block retaining roll pin.

NOTE: Use a 4 mm diameter pin punch.

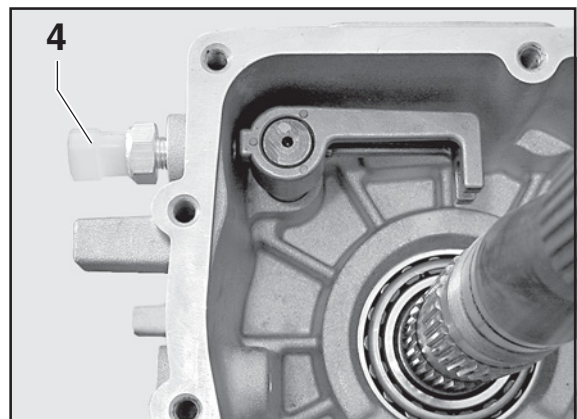
NOTE: Replace the roll pin by a new one.



FSO-2405/26

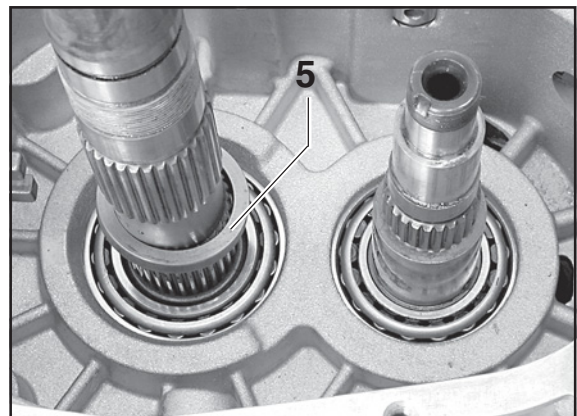
4. Install the reverse light switch.

NOTE: Apply Eaton E680 or Eaton E679 sealant to the switch threads.



FSO-2405/25

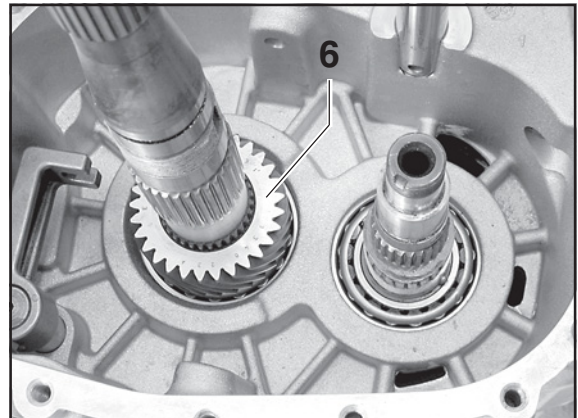
5. Install the 5th speed gear thrust washer on the mainshaft.



FSO-2405/24

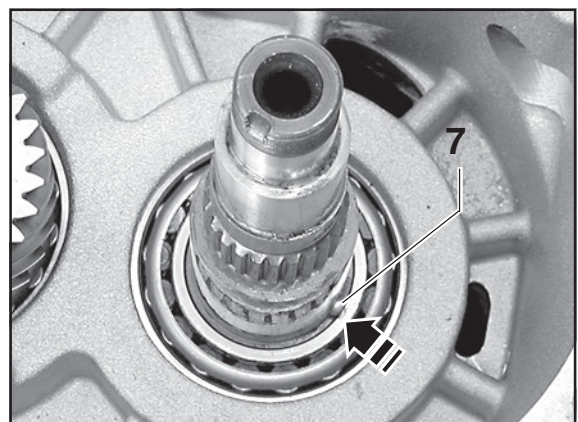
Rear Section Assembly

6. Install the 5th speed gear on the mainshaft.



FSO-2405/23

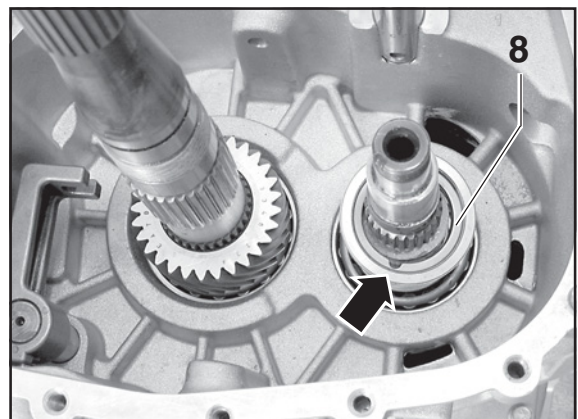
7. Install the retaining ball of the countershaft 5th speed gear thrust washer on the countershaft. Apply grease to hold the ball in place.



FSO-2405/22

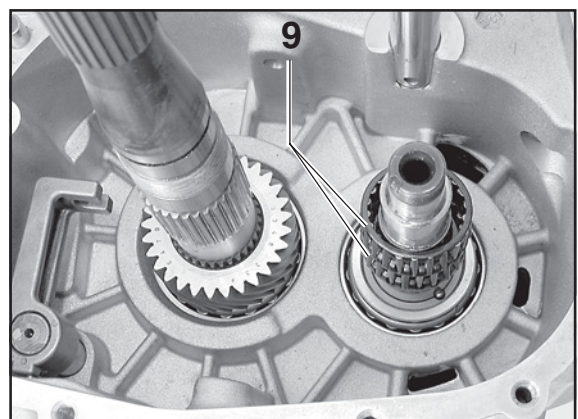
8. Install the 5th speed gear thrust washer on the countershaft. Make sure to set correctly the retaining ball into the washer slot.

NOTE: Install the thrust washer counterbore side up (facing the needle bearing).



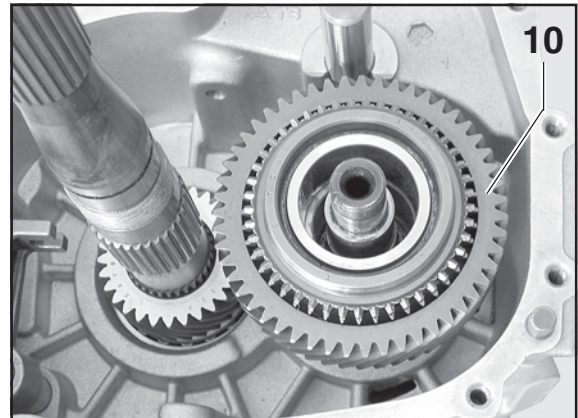
FSO-2405/21

9. Install the two needle bearings of 5th speed gear on the countershaft.



FSO-2405/20

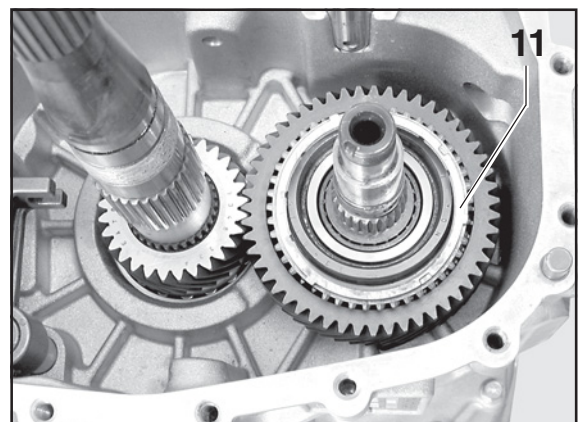
10. Install the 5th speed gear on the countershaft.



FSO-2405/19

11. Install the 5th speed ring synchronizer on the countershaft.

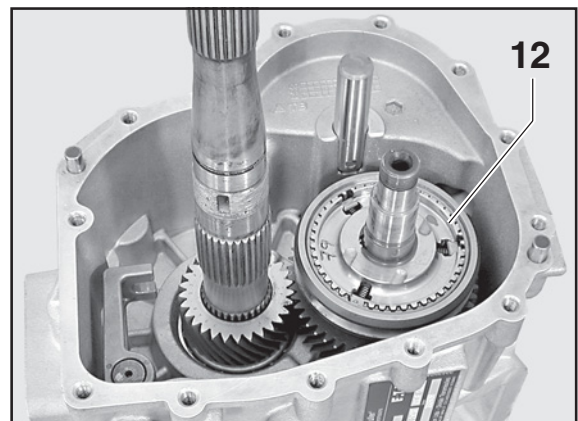
NOTE: The 5th speed synchronizer ring is not coated with EFM II and is smaller than the other rings.



FSO-2405/18

12. Install the 5th/reverse synchronizer assembly on the countershaft. Make sure it is installed in the proper position.

WARNING! Both the synchronizer sleeve sharp end and the hub anti-escape relief should be installed facing the 5th speed gear (see “Synchronizer Assemblies”). Make sure to slide the synchronizer ring lugs into the hub key slots.

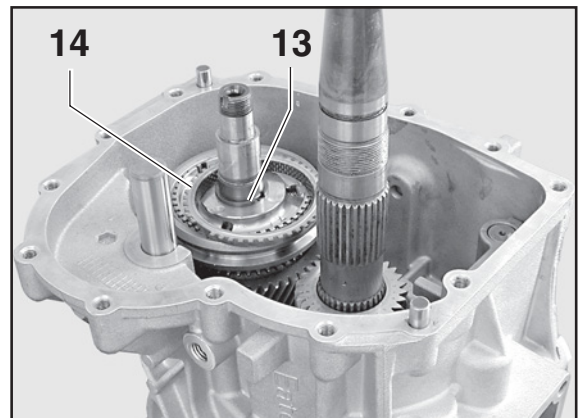


FSO-2405/17

13. Install the 5th/reverse synchronizer hub snap ring on the countershaft.

14. Install the reverse synchronizer ring.

NOTE: The reverse synchronizer ring is coated with EFM II and is smaller than the other rings.

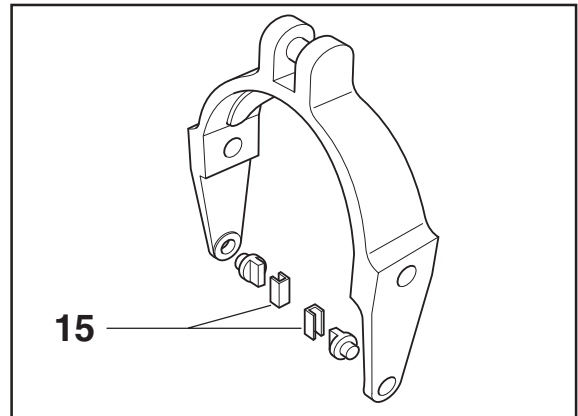


FSO-2405/16

Rear Section Assembly

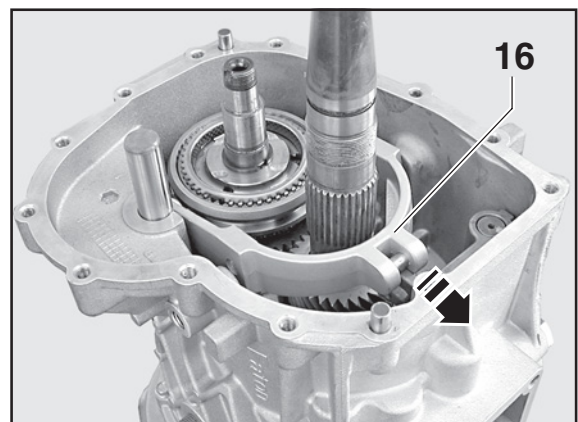


15. If necessary, replace the 5th/reverse shift yoke nylon pads.



FSO-2405/99

16. Install the 5th/reverse shift yoke in synchronizer sleeve groove. Pull the yoke backwards until engaging with the linked shift block.



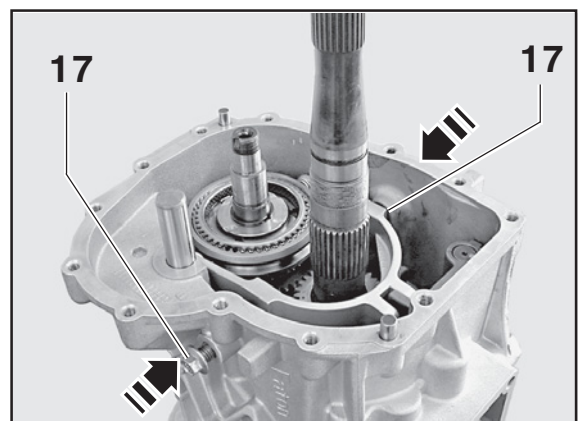
FSO-2405/15

17. Install the two pivot threaded pins of 5th/reverse shift yoke.

NOTE: Apply Eaton E677 sealant to the pin threads.

Torque = 10-16 N.m (7-12 Lb.ft)

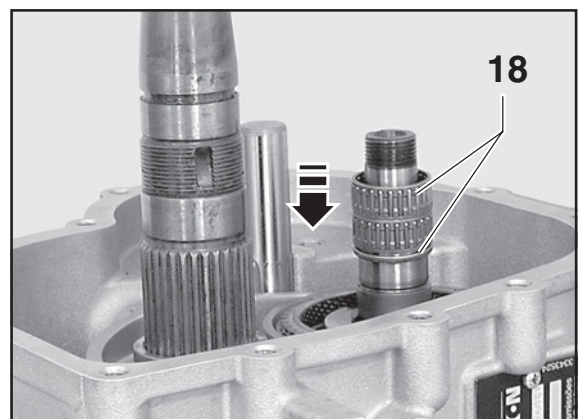
NOTE: See "Special Tools", Ref. E001044.



FSO-2405/14

18. Install the reverse gear spacer and the two needle bearings on the countershaft.

NOTE: The reverse gear needle bearing on the countershaft was updated. When servicing the unit, if older, replace both bearings (p/n 3342286) and spacer (p/n 3342287) by the new lone bearing (p/n 3348906).



FSO-2405/13

Old part

2 (two) bearings - Eaton P/N 3342286

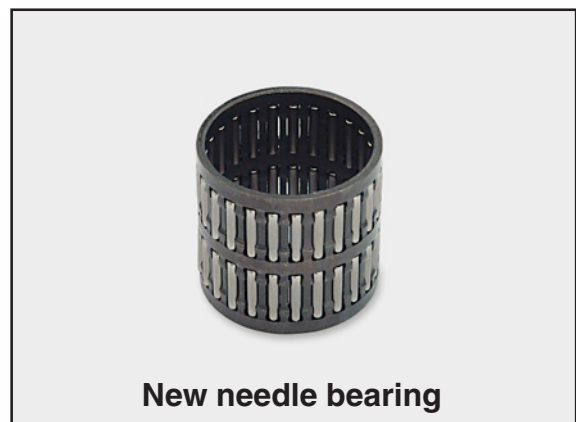
1 (one) spacer - Eaton P/N 3342287



FSO-2405/154

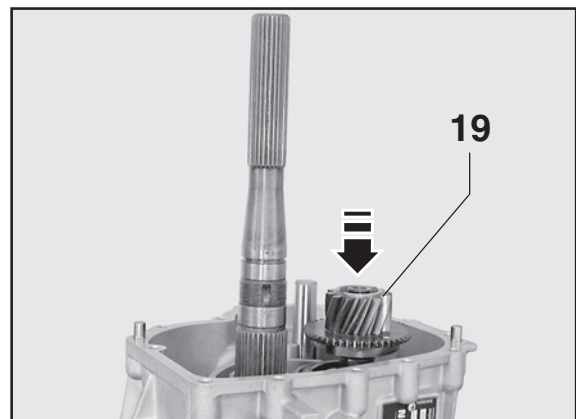
New part

1 (one) bearing - Eaton P/N 3348906



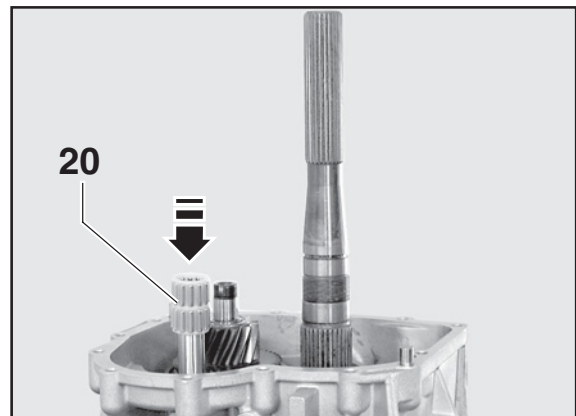
FSO-2405/155

19. Install the reverse gear on the countershaft.



FSO-2405/12

20. Install the reverse idler gear needle bearing on the idler shaft.

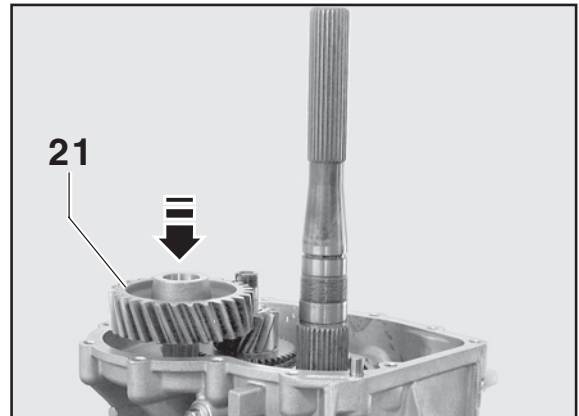


FSO-2405/11

Rear Section Assembly

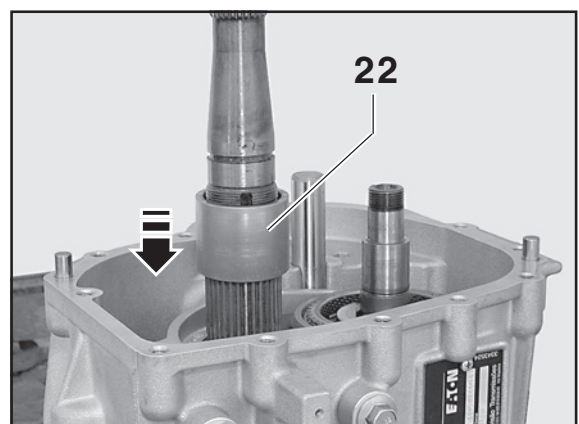


21. Install the reverse idler gear on the shaft with the prominent side facing the housing outside.



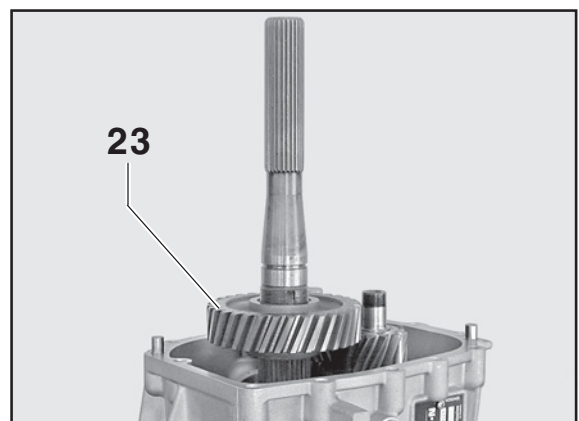
FSO-2405/10

22. Install the reverse gear spacer bushing on the mainshaft.



FSO-2405/9

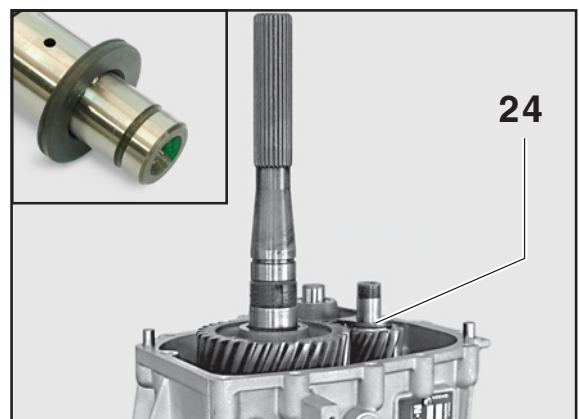
23. Install the reverse gear on the mainshaft with the hub prominent side facing the housing inside.



FSO-2405/8

24. Install the rear bearing thrust washer on the countershaft.

NOTE: On countershaft with threadless end, which uses a snap ring instead of the nut, the thrust washer has a retaining ball (see detail), which should also be installed.

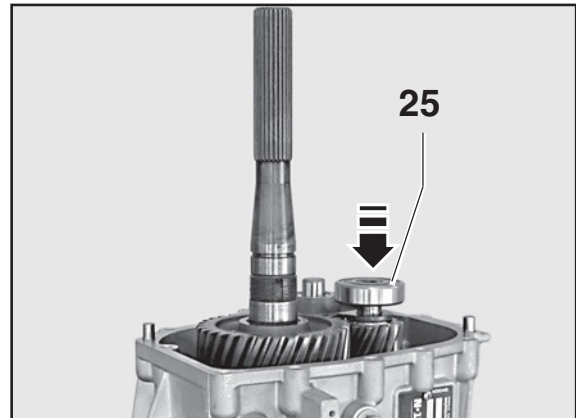


FSO-2405/7

3

25. Use the recommended tool and install the rear ball bearing on the countershaft.

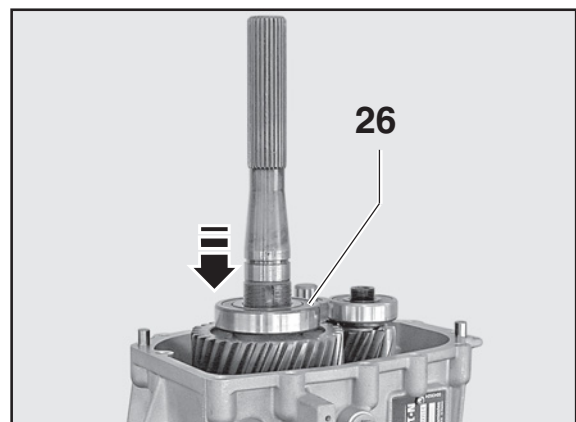
NOTE: See "Special Tools", Ref. E010001.



FSO-2405/138

26. Use the recommended tool and install the rear ball bearing on the mainshaft.

NOTE: See "Special Tools", Ref. E010002.



FSO-2405/141

27. Lock the mainshaft with the special tool and shift transmission into the 1st gear.

NOTE: See "Special Tools", Ref. E014010.

NOTE: As an option, the tool # E006003 may be used for locking the mainshaft. See "Special Tools, Using the Eaton tool # E006003".

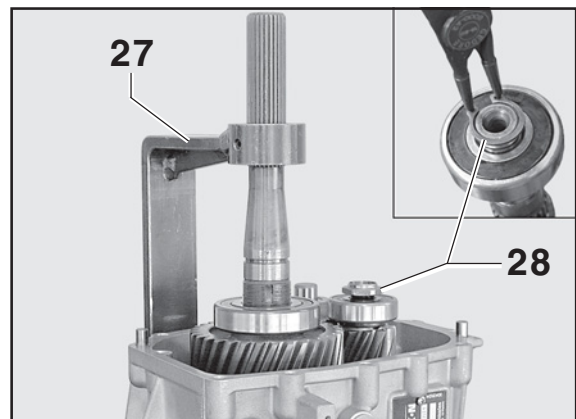
28. Install the rear nut (or snap ring) on countershaft and tighten to the proper torque.

NOTE: On 2006, the nut was replaced by a snap ring in some applications.

NOTE: See "Special Tools", Ref. E006002.

Torque = 108-122 N.m (80-90 lb.ft)

NOTE: When installing the nut (or the snap ring), replace the used nut (or used snap ring) by a new one.



FSO-2405/5

Rear Section Assembly



29. Remove the special tool from the mainshaft.

30. Install the rear nut on the mainshaft.

NOTE: When installing the nut, replace the used nut by a new one.

31. Place the tool to tighten the mainshaft rear nut.

NOTE: See "Special Tools", Ref. E006006.

NOTE: As an option, the tool # E006004 or # E006005 may be used for installing the mainshaft rear nut, locking the mainshaft with the tool # E006003. See "Special Tools, Using the Eaton tool # E006003".

32. Place the special tool and lock the mainshaft.

NOTE: See "Special Tools", Ref. E014010.

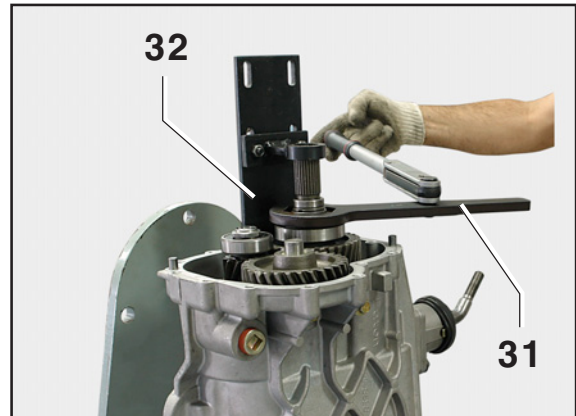
33. Tighten the mainshaft rear nut to the proper torque.

NOTE: Torque = 217-270 N.m (160-200 lb.ft)

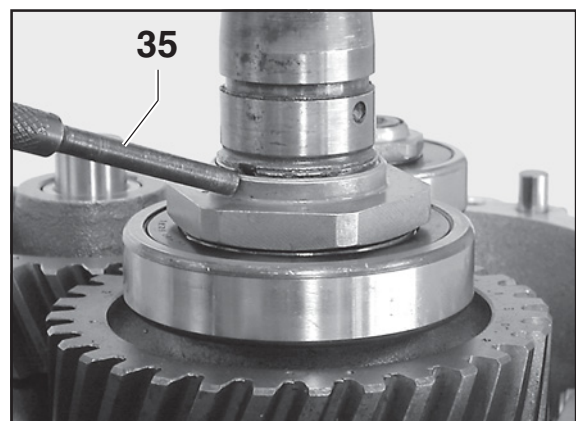
34. Remove the tools.

35. Use a punch and lock both the mainshaft and countershaft rear nuts.

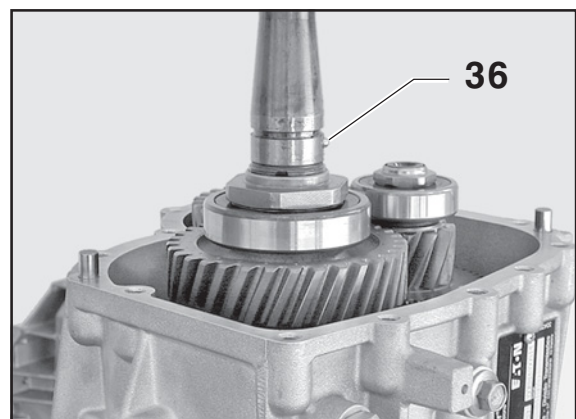
36. Install the retaining ball that locks the speedometer rotor in the mainshaft. Apply grease to hold the ball in place.



FSO-2405/156

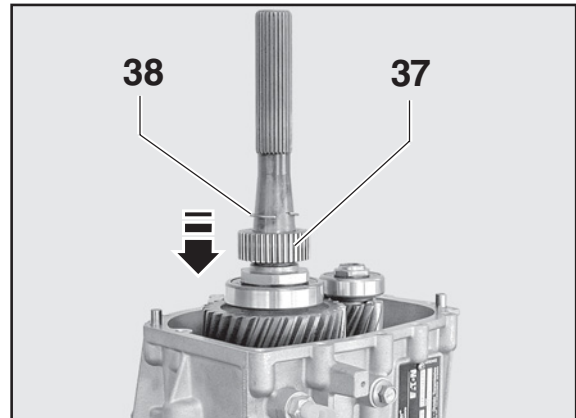


FSO-2405/100



FSO-2405/3

- 37. Install the speedometer rotor.
- 38. Install the rotor retaining snap ring.



FSO-2405/2

- 39. Apply sealant compound gasket to the rear cover mounting surface with the intermediate housing.

NOTE: Apply Eaton E680 sealant to the mounting surface.

- 40. Install the rear cover.
- 41. Install the thirteen retaining capscrews of rear case to the intermediate housing. Tighten the capscrews crosswise to the proper torque.

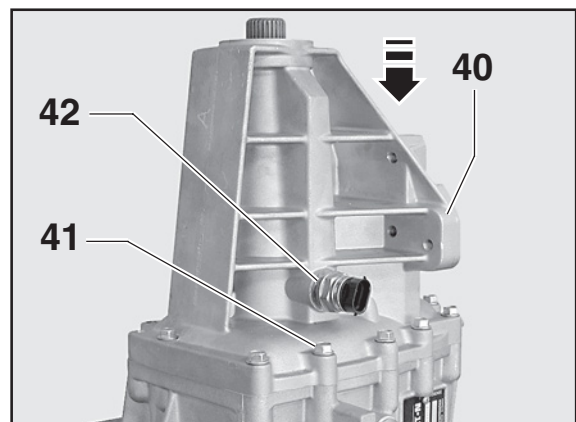
NOTE: Apply Eaton E677 sealant to the capscrews.

Torque = 19-25 N.m (14-19 lb.ft)

- 42. Install the speedometer sensor.

NOTE: Apply Eaton E680 or Eaton E679 sealant to the sensor thread.

Torque = 10-16 N.m (7-12 lb.ft)



FSO-2405/1

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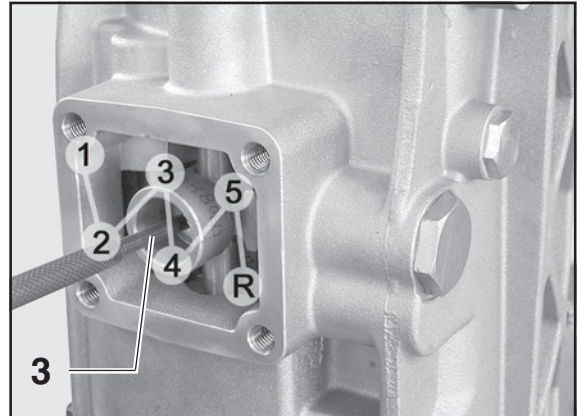
 Adjusting Shims 150

1. Disassemble the rear section (see "Rear Section Disassembly").
2. Shift the 1st speed gear.

WARNING! Remove the shift lug roll pin BEFORE removing the threaded actuator of shifting cam.

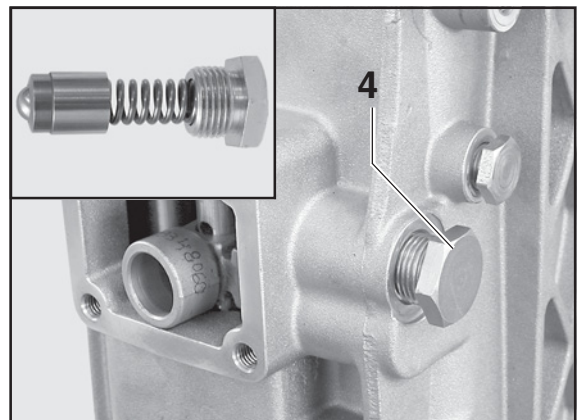
3. Remove the shift lug roll pin by pushing it forward into the housing.

NOTE: Use a 6 mm diameter pin punch.



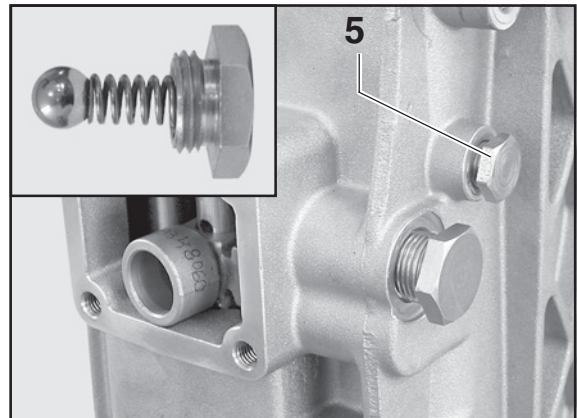
FSO-2405/28

4. Remove the plug, spring and spherical actuator pin of the cam threaded actuator.



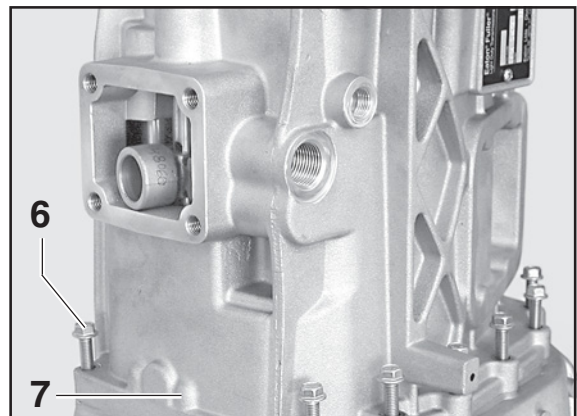
FSO-2405/29

5. Remove the shift positioning plug, spring and ball.



FSO-2405/30

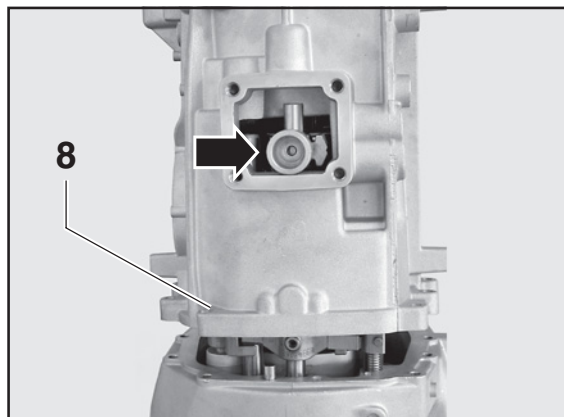
6. Remove the thirteen capscrews that attach the intermediate housing to the front housing.
7. From inside the front housing, remove the capscrew that attach the front housing to the intermediate housing.



FSO-2405/31

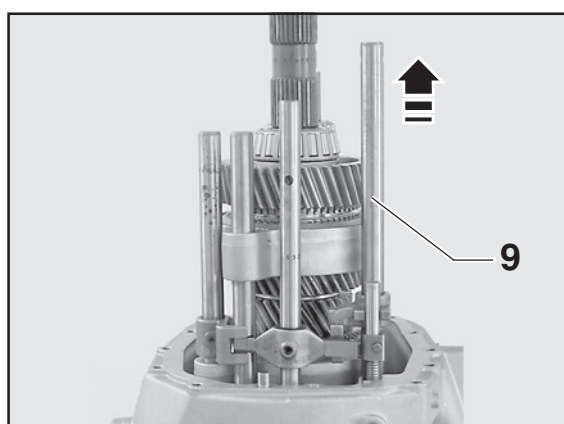
8. Remove the intermediate housing together with the shift lug.

NOTE: Carefully hit the housing's capscrews area with a rubber or plastic hammer to brake the gasket seal and detach the housing.



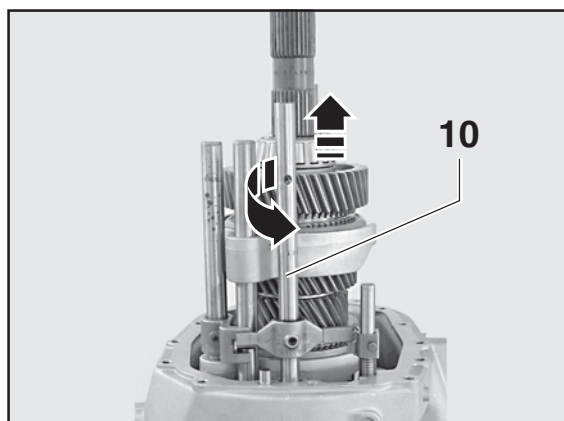
FSO-2405/32

9. Pull the 5th/reverse yoke bar (the longest) upwards and remove it.



FSO-2405/33

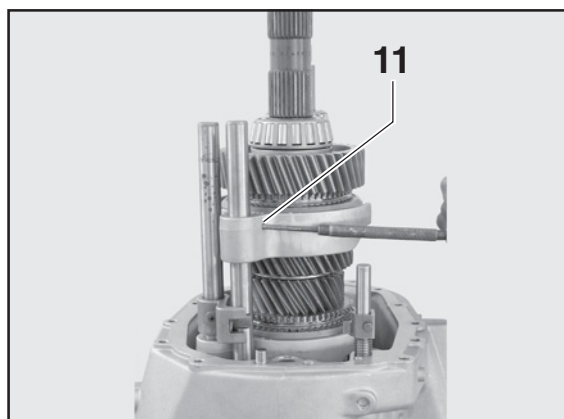
10. Rotate the shift selecting bar counterclockwise and remove it pulling the bar upwards.



FSO-2405/34

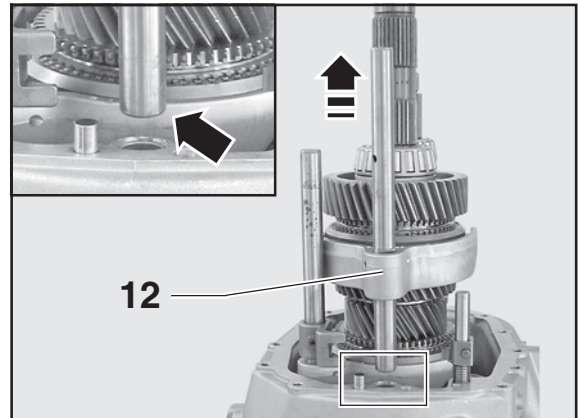
11. Remove the 1st/2nd shift yoke roll pin.

NOTE: Use a 4 mm diameter pin punch.



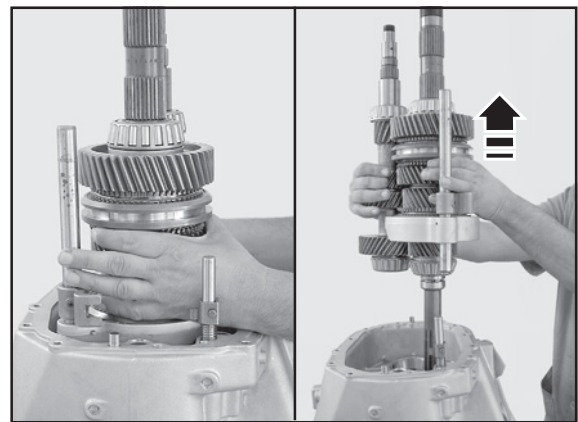
FSO-2405/35

12. Hold the 1st/2nd shift yoke in its place on synchronizer groove and pull the yoke bar upwards. When the bar lower end rises over the housing surface (see detail), remove the bar and shift yoke assembly.



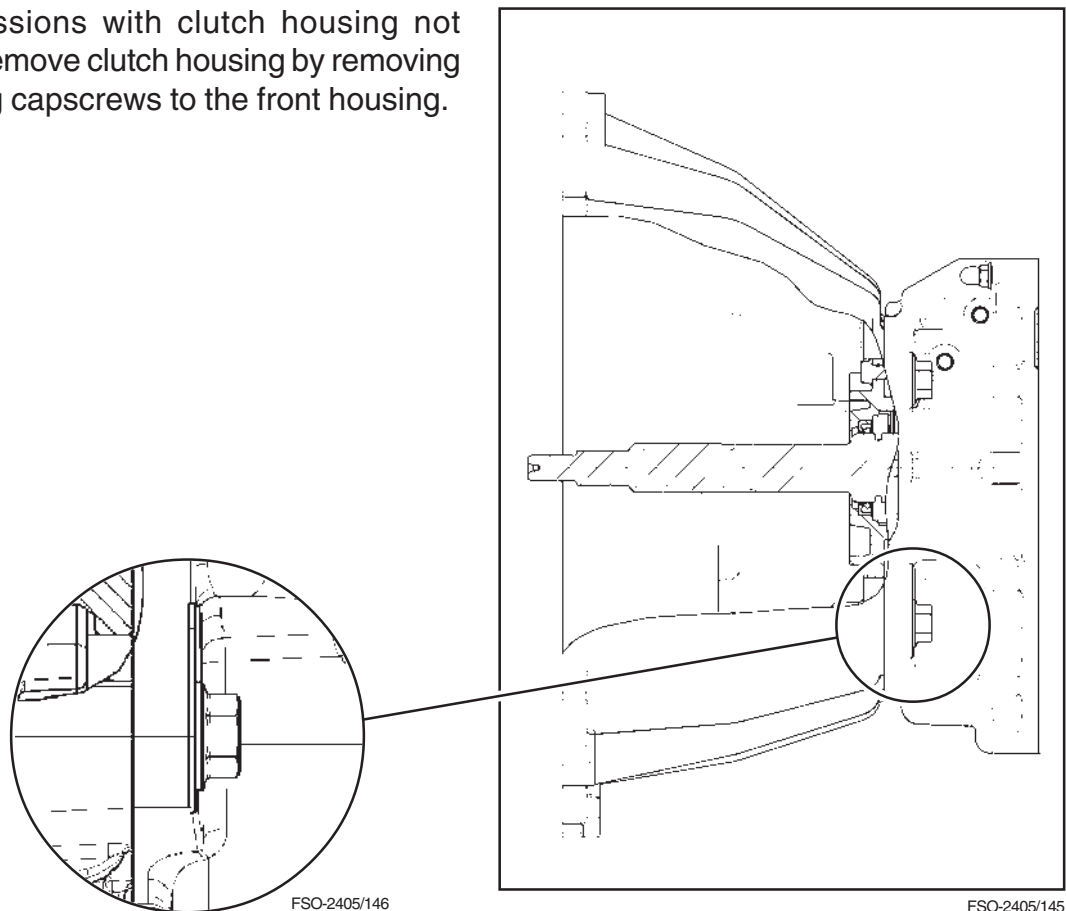
FSO-2405/36

13. Simultaneously, remove from the housing the remaining assemblies of mainshaft, countershaft, 3rd/4th bar and shift yoke and input shaft, while grasping them all together and pulling them upwards.
14. Take the assemblies apart.



FSO-2405/37

15. On transmissions with clutch housing not integrated, remove clutch housing by removing the fastening capscrews to the front housing.



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FSO-2405/145

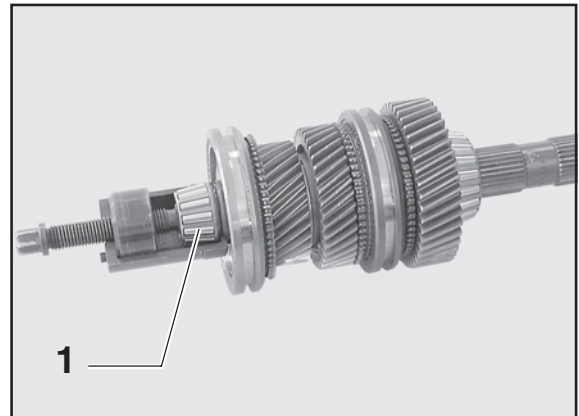
Front Section Disassembly

Mainshaft

Disassembly

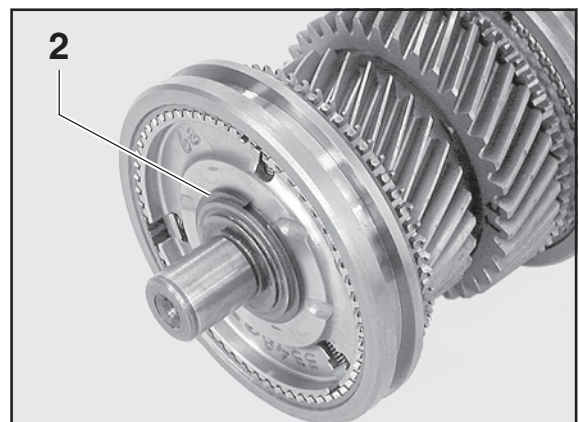
1. Use the bearing puller and remove the front bearing cone from mainshaft.

NOTE: See "Special Tools", Ref. E005003.



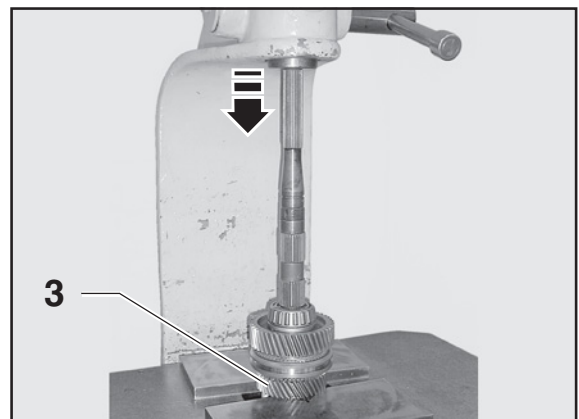
FSO-2405/38

2. Remove the 3rd/4th synchronizer hub retaining snap ring.



FSO-2405/39

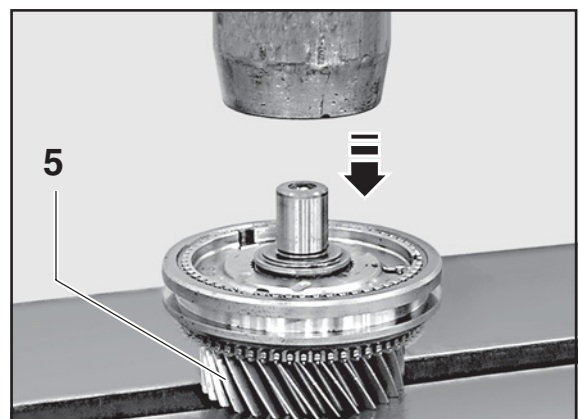
3. Place the mainshaft in the press, using the 2nd speed gear as a base.
4. Press the mainshaft through and remove the set of components up to the rear bearing cone.



FSO-2405/40

WARNING! Be careful NOT to use mainshaft flange as a pressing base when using the 3rd speed gear.

5. Turn the mainshaft over in the press and use the 3rd speed gear as a base.
6. Press the mainshaft and remove the 3rd/4th synchronizer assembly, 3rd speed gear and the needle bearing.



FSO-2405/41

Mainshaft

Assembly

1. Install the 2nd speed gear needle bearing.

NOTE: The 2nd speed gear needle bearing was modified. When servicing the unit, replace the old needle bearing by the new one.

Old part: 239818 / New part: 3348857
They are interchangeable.

2. Install the 2nd speed gear.
3. Install the 2nd speed synchronizer ring.

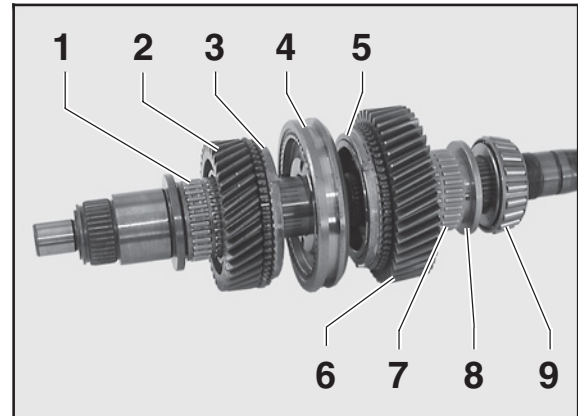
NOTE: The 1st, 2nd, 3rd and 4th speed have equal synchronizer rings and they are all EFM II coated.

4. Install the 1st/2nd speed synchronizer assembly. Make sure it is installed in the proper position.

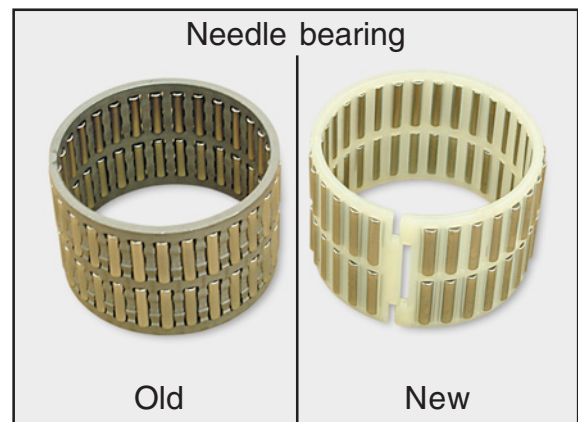
WARNING! Both the 1st/2nd synchronizer sleeve largest chamfer and the hub most prominent side must face the 1st speed gear (see “Synchroizer Assemblies”).

The 1st/2nd synchronizer hub does not have the anti-escape relief (see “Synchroizer Assemblies”).

5. Install the 1st speed synchronizer ring.
6. Install the 1st speed gear.
7. Install the 1st speed gear needle bearing.
8. Install the 1st speed gear bushing.
9. Install the rear bearing cone on the mainshaft.



FSO-2405/101



FSO-2405/163

Front Section Disassembly

Mainshaft

10. Use two tubular tools and press the late installed set of components of the mainshaft. Make sure to align the synchronizer ring lugs with hub key slots.

WARNING! Apply force to bearing inner race. NEVER apply force to the bearing cage.

Do NOT use the shaft flange as a pressing base.

NOTE: See "Special Tools", Ref. E010001, E010002.

11. Make sure the pressing procedure was successfully: disengage the synchronizer and position it between the 1st and 2nd speed gears. In this condition, the gears should run free.

12. Turn the mainshaft over and install the 3rd speed gear needle bearing.

NOTE: The 3rd speed gear needle bearing was modified. When servicing the unit, replace the old needle bearing by the new one.

Old part: 239818 / New part: 3348857
They are interchangeable.

13. Install the 3rd speed gear.

14. Install the 3rd speed synchronizer ring.

NOTE: The 1st, 2nd, 3rd and 4th speed have equal synchronizer rings and they are all EFM II coated.

15. Install the 3rd/4th speed synchronizer assembly. Make sure it is installed in the proper position.

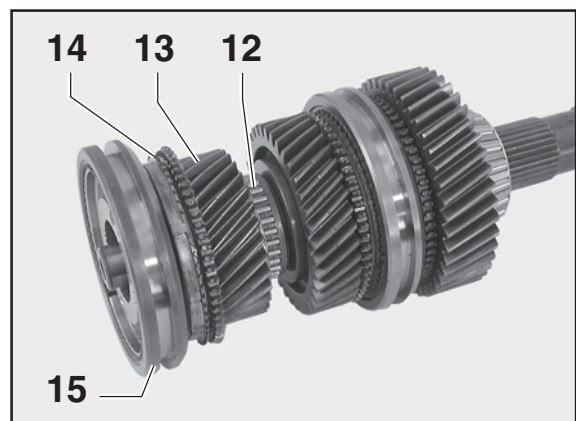
WARNING! Both the 3rd/4th synchronizer sleeve largest chamfer and the hub most prominent side must face the 3rd speed gear (see "Synchronizer Assemblies"). The 1st/2nd synchronizer hub does have the anti-escape relief, which must face the 3rd speed gear (see "Synchronizer Assemblies").



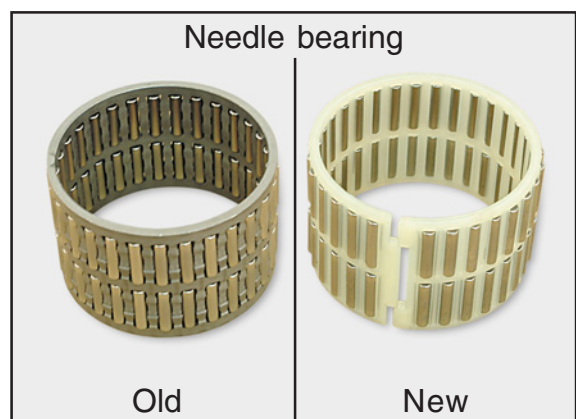
FSO-2405/165



FSO-2405/166



FSO-2405/103



FSO-2405/163

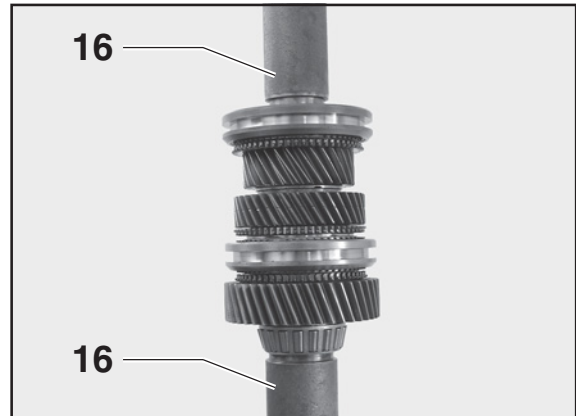
Manishaft

16. Use two tubular tools and press the late installed set of components of the mainshaft. Make sure to align the synchronizer ring lugs with hub key slots.

WARNING! Apply force to bearing inner race. NEVER apply force to the bearing cage.

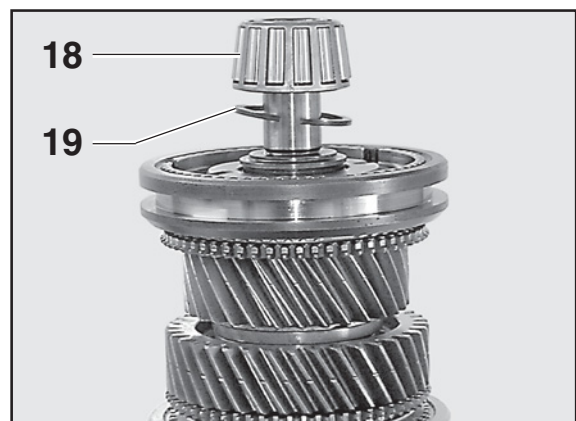
NOTE: See "Special Tools", Ref. E010001, E010002.

17. Make sure the pressing procedure was successfully: disengage the synchronizer and position it between the 3rd and 4th speed gears. In this condition, the gears should run free.



FSO-2405/104

18. Install the 3rd/4th synchronizer hub retaining snap ring.
19. Position the front bearing cone on the mainshaft.

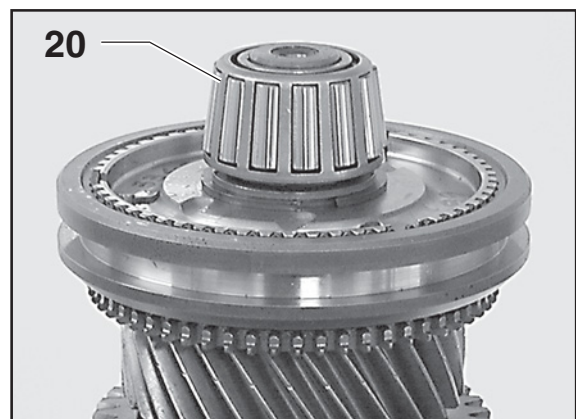


FSO-2405/105

20. Press the front bearing cone.

WARNING! Apply force to bearing inner race. NEVER apply force to the bearing cage.

NOTE: See "Special Tools", Ref. E010001.



FSO-2405/106

Front Section Disassembly

Countershaft

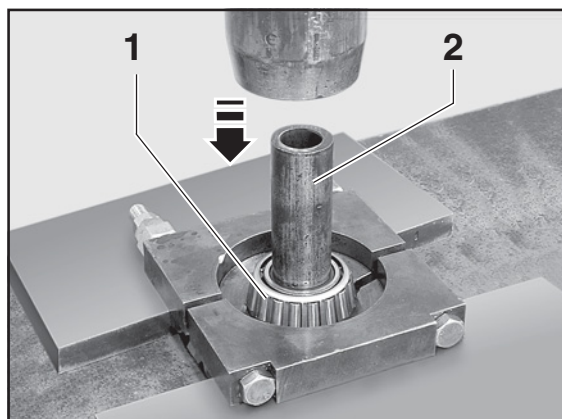
Disassembly

WARNING! Do NOT use the bearing roller cage as a pressing base.

1. Place the countershaft in the press with the front bearing facing up. Use the bearing inner race as a base by using the proper support.

NOTE: See "Special Tools", Ref. E007008.

2. Use a tubular tool and press the countershaft through the front bearing to remove the bearing.

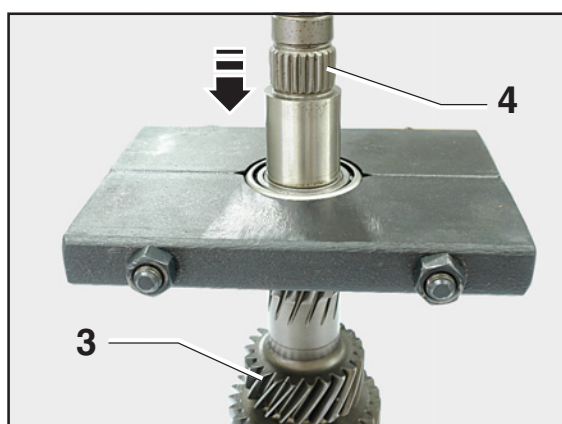


FSO-2405/43

3. Turn the countershaft over and use the 1st speed gear teeth as a pressing base by using the special device.

NOTE: See "Special Tools", Ref. E007001.

4. Press the countershaft through the rear bearing and remove the bearing.



FSO-2405/167

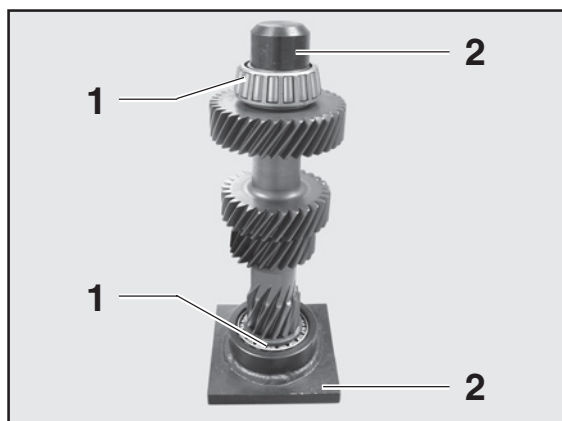
Assembly

1. Position both the front and rear bearing cones on the countershaft.
2. Use two tubular tools and place the countershaft in the press, using the inner races of those two bearings as a base.

WARNING! NEVER use the bearing roller cage as a pressing base.

NOTE: See "Special Tools", Ref. E001043.

3. Press both bearings until they rest against the shaft stops.



FSO-2405/107

Input Shaft

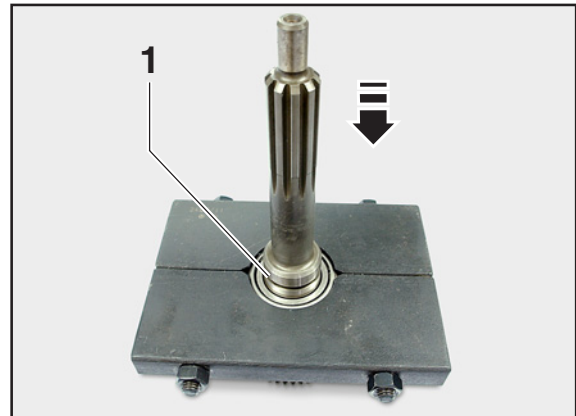
Disassembly

WARNING! Do NOT use the bearing roller cage as a pressing base.

1. Place the input shaft in the press with bearing facing up. Use the bearing inner race as a base by using the proper support.

NOTE: See “Special Tools”, Ref. E007002.

2. Press the input shaft through the bearing and remove the bearing.



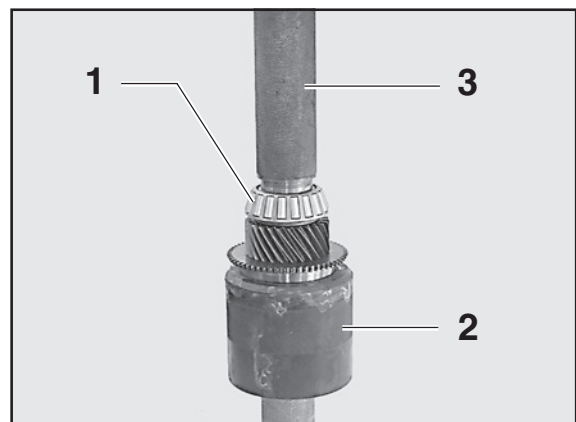
E007002

Assembly

1. Position the bearing cone on the input shaft.
2. With the synchronizer side down, place the input shaft on a base. Be careful not to damage the synchronizer cone.
3. Using the bearing inner race as a base, press the bearing assembly with the proper tubular tool, until the race shoulder be against the shaft face.

WARNING! Apply force to bearing inner race. NEVER apply force to the bearing cage.

NOTE: See “Special Tools”, Ref. E010003.



FSO-2405/108

Front Section Disassembly

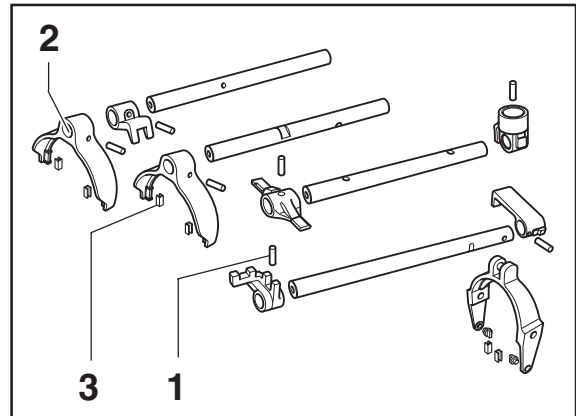
Shift Yoke Bars

Disassembly

1. Remove the retaining roll pins and remove the parts from the shift bars.

NOTE: Use a 4 mm diameter pin punch.

2. If necessary, replace the shift yoke permaglide bushing. After installing the bushing, use a punch to lock the bushing in the bushing bore. Be careful not to damage the shift yoke.
3. If necessary, replace the shift yoke nylon pads.



FSO-2405/109

1st/2nd and 3rd/4th Speed Yoke Bar Assembly

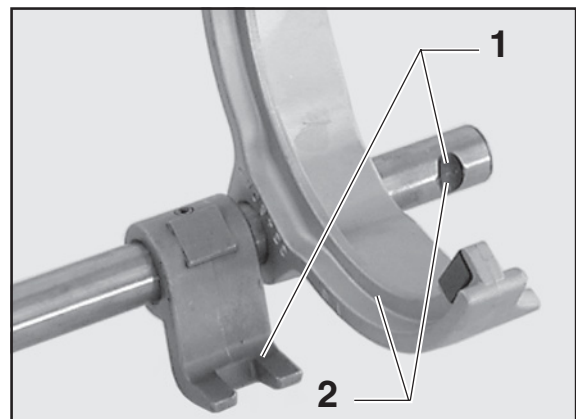
1. Make sure the shift block is properly positioned regarding the notch at the yoke bar end and install the shift block on the yoke bar.
2. Make sure the 3rd/4th speed shift yoke is properly positioned regarding the notch at the yoke bar end and install the shift yoke on the yoke bar.
3. Align the shift yoke with the yoke bar matching the roll pin holes and install the retaining roll pin. Push the roll pin until it is flush with yoke hub.

NOTE: See "Special Tools", Ref. E001044.

4. Align the shift block with the yoke bar matching the roll pin holes and install the retaining roll pin. Push the roll pin until it is flush with shift block hub.

NOTE: See "Special Tools", Ref. E001044.

NOTE: Replace the roll pin by a new one.

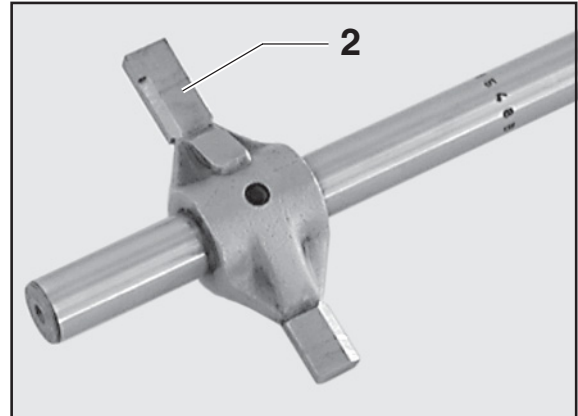


FSO-2405/110

Shift Yoke Bars

Shift Selecting Bar Assembly

1. The shift selecting bar has two holes simmetrically positioned to the bar center to install retaining roll pins. Thus, the shift selecting block can be assembled on any bar end.
2. Install the shift selecting block on the shift bar.
3. Align the shift block with the shift bar matching the roll pin holes and install the retaining roll pin. Push the roll pin until it is flush with shift block hub.



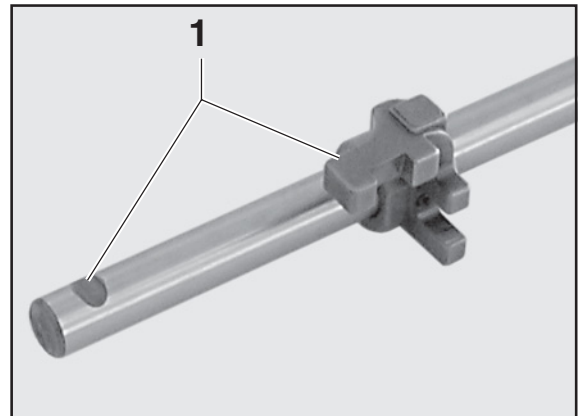
FSO-2405/111

NOTE: See “Special Tools”, Ref. E001045.

NOTE: Replace the roll pin by a new one.

5th/reverse Yoke Bar Assembly

1. Make sure the shift block is properly positioned regarding the notch at the yoke bar end and install the shift block on the yoke bar. Notice that the opposite bar end also has a notch, shifted 180° from the other, and a hole.
2. Align the shift block with the shift bar matching the roll pin holes and install the retaining roll pin. Push the roll pin until it is flush with shift block hub.



FSO-2405/112

NOTE: See “Special Tools”, Ref. E001045.

NOTE: Replace the roll pin by a new one.

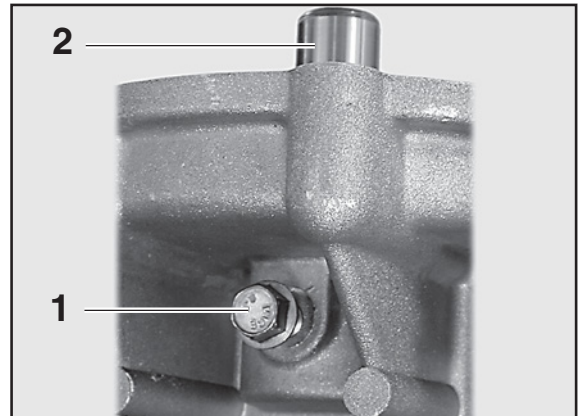
Front Section Disassembly



Reverse Idler Gear Shaft

Removal

1. In the intermediate housing, locate the reverse idler gear shaft retaining capscrew and remove it.
2. Remove the idler shaft.

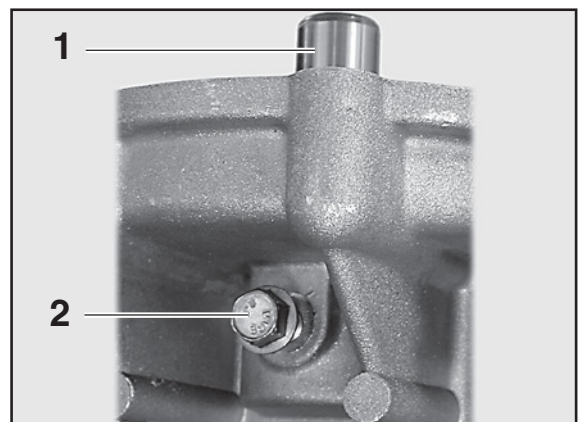


FSO-2405/69

Installation

1. Align the shaft hole with the housing hole and install the idler shaft into the shaft bore.
2. Tighten the retaining capscrew to the proper torque.

NOTE: Torque = 14-19 N.m (19-26 Lb.ft)



FSO-2405/69

Expansive Plugs

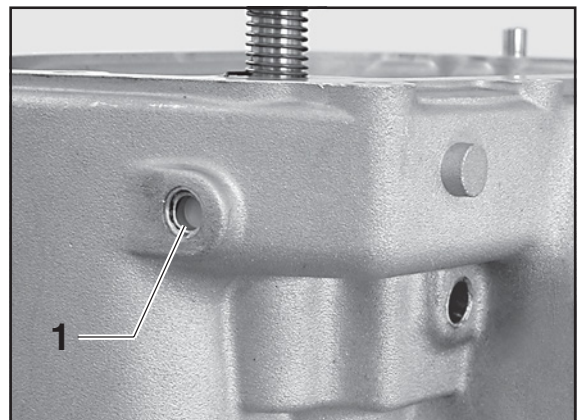
Some through holes in housings are drilled for machining purpose only and must be blocked later by using expansive metallic plugs.

During the transmission life, it is possible to happens that those plugs should be removed and reinstalled when servicing the unit.

Removal

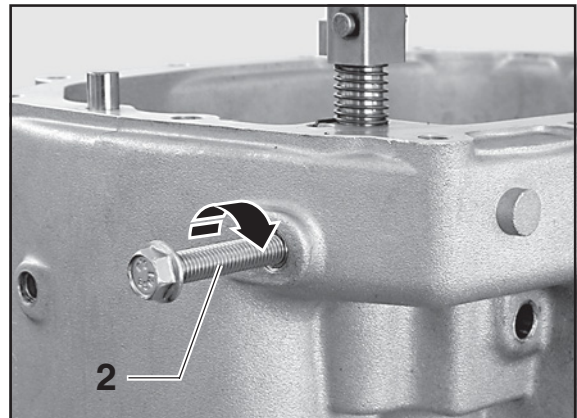
1. In the housing, locate the plug that should be removed. Use the special device and make a thread in the plug.

NOTE: See "Special Tools", Ref. E005005.



FSO-2405/45

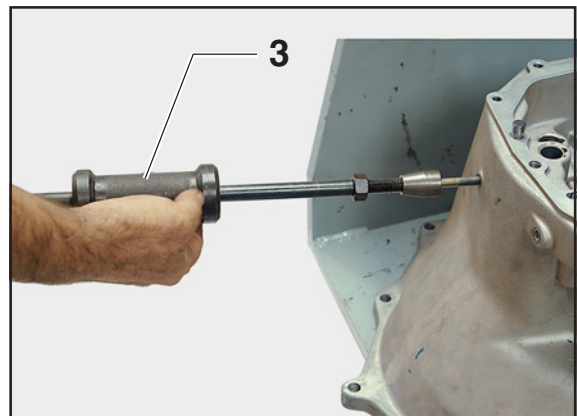
2. Use one retaining capscrew removed from the housing and insert it into the plug, threading it until it stays firmly in place.



FSO-2405/46

3. Use an impact puller to remove the capscrew and the plug comes along.

NOTE: See "Special Tools", Ref. E003001, E004002



FSO-2405/169

Front Section Disassembly



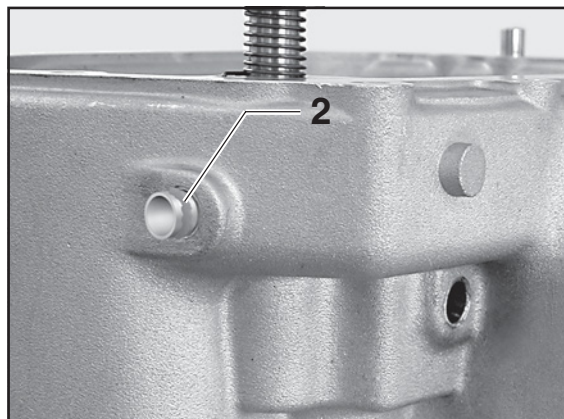
Expansive Plugs

Installation

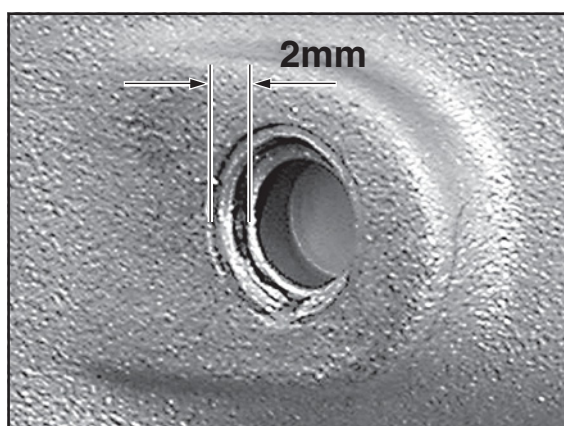
WARNING! Always replace the removed plug to prevent leaks.

1. With a clean rag and solvent, clean the plug hole and remove any remaining sealant compound. Do not use sand paper.
2. Apply sealant to the new plug and insert it into the hole using the hands to guide the plug.

NOTE: Apply Eaton E677 to plugs.



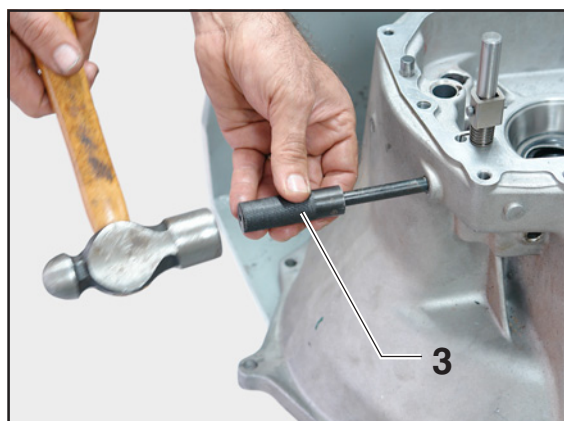
FSO-2405/48



FSO-2405/49

3. Use the proper tool and a hammer to force the plug into the plug bore. The proper depth is when the plug is 2 mm below the plug bore top.

NOTE: See "Special Tools", Ref. E001020.



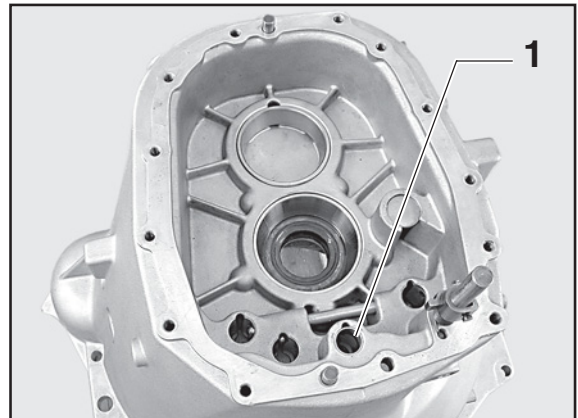
FSO-2405/170

Permaglide Bushing

Removal

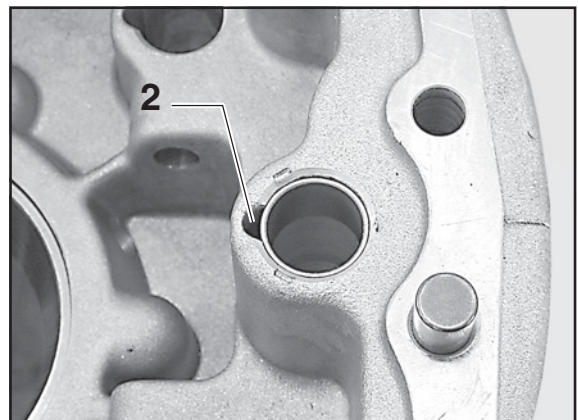
1. Inspect bushing and replace if worn.

NOTE: Inspect other transmission bushing too. The pictures here show only the front housing bushing, however the procedure is the same for all other transmission permaglide bushing.



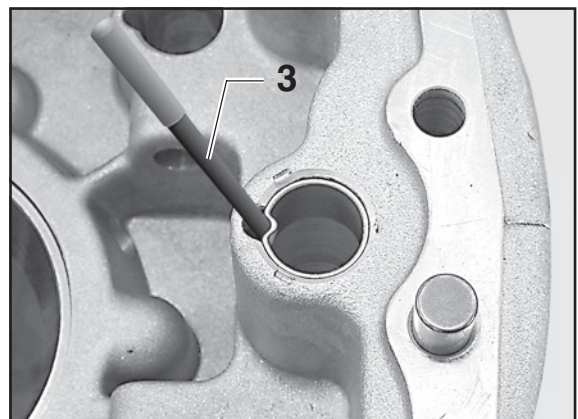
FSO-2405/54

2. Use the lubrication hole to place a punch against the bushing outer diameter.



FSO-2405/55

3. Hit the punch and deform the bushing as shown.
4. Use pliers and pull the bushing out from the bushing bore.



FSO-2405/56

Front Section Disassembly

Permaglide Bushing

Installation

1. Place the bushing on the proper tool.

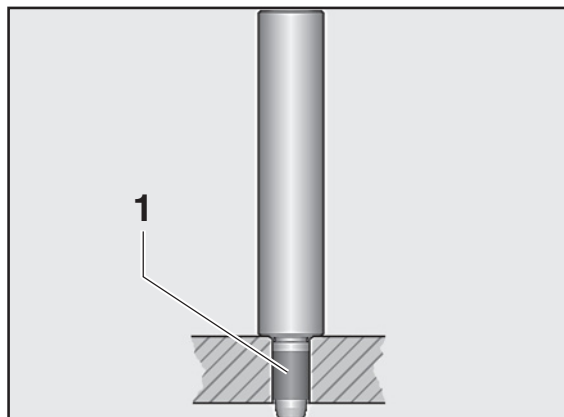
NOTE: See "Special Tools", Ref. E001010.

2. Position the bushing in the bushing bore and install the bushing by hitting the tool until it rest against the housing. This condition gives the proper bushing depth.

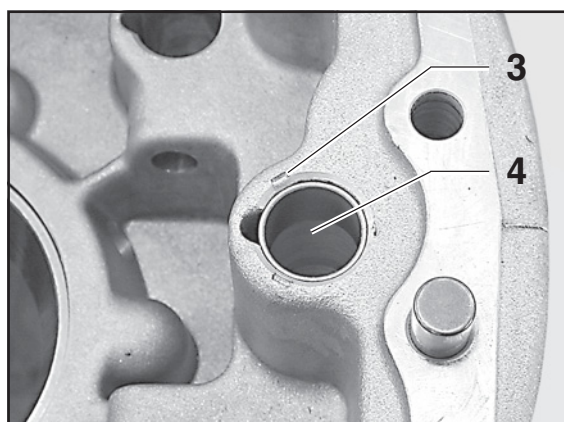
3. Use a punch and lock the bushing by punching the housing material in four positions around the bushing bore.

WARNING! When locking the bushing, be careful not to damage the bushing itself.

4. Apply a thin coating of recommended grease to the bushing inner diameter.



FSO-2405/57



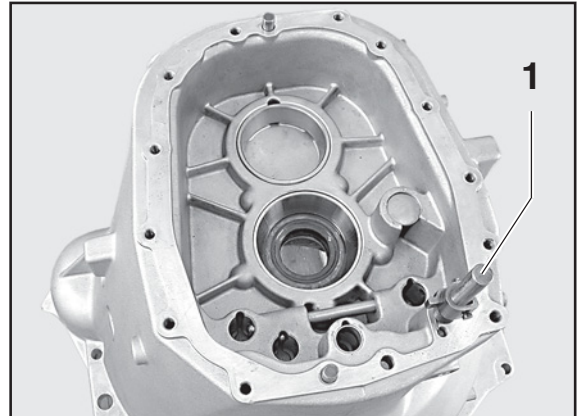
FSO-2405/55

Reverse Shifting Interlocking System

Description

The reverse shifting interlocking mechanism prevents the driver from shifting accidentally into reverse speed when downshifting from 5th to 4th speed.

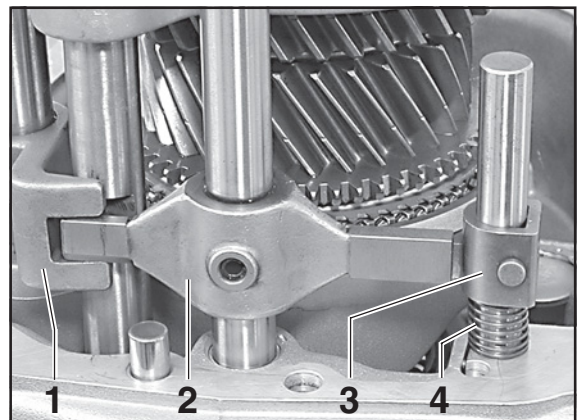
1. Reverse shifting interlocking mechanism.



FSO-2405/58

The mechanism comprises a lock device working together with the shift selecting bar. When the 5th/reverse yoke bar is positioned in 5th, the lock mechanism is actuated by the spring and then prevents the reverse speed from being straight shifted. To deactivate the locking mechanism, just gearshift to neutral and then to reverse speed.

1. 3rd/4th yoke bar
2. Shift selecting bar
3. Lock
4. Spring



FSO-2405/59

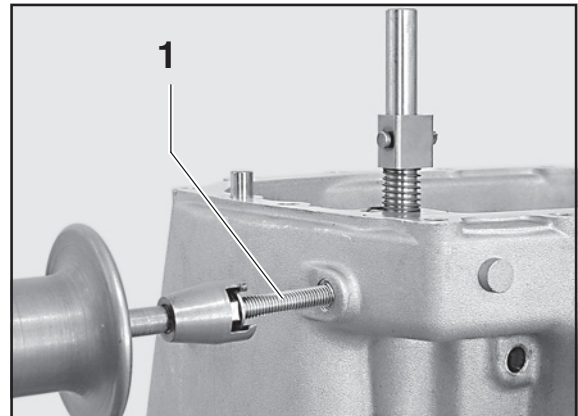
Front Section Disassembly

Reverse Shifting Interlocking System

Disassembly

1. Remove the expansive plug from housing hole where is located the interlocking mechanism retaining roll pin.

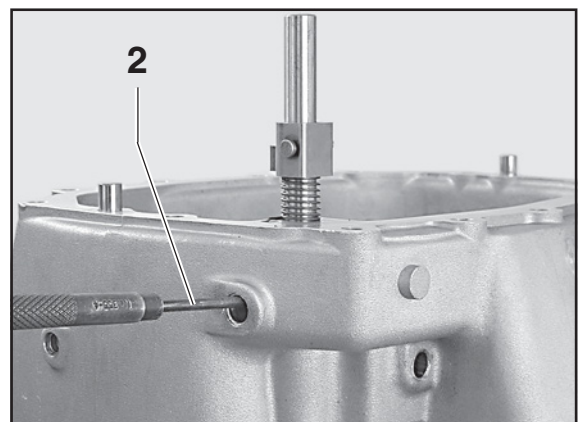
NOTE: See "Expansive Plugs" for instructions.



FSO-2405/60

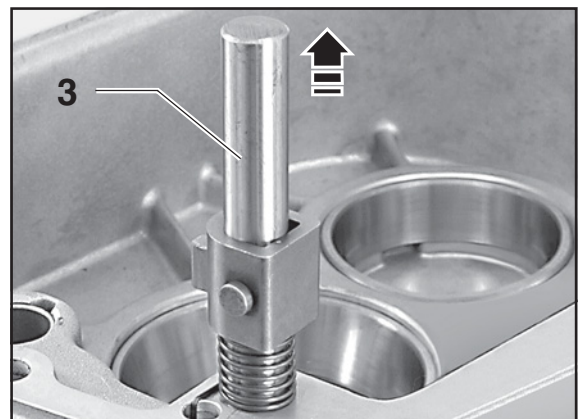
2. Through the housing hole, remove the roll pin.

NOTE: Use a 4 mm diameter pin punch.



FSO-2405/61

3. Pull the interlock pin upwards and remove the mechanism assembly.

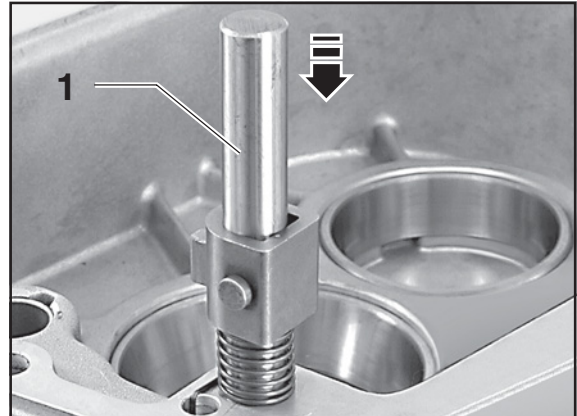


FSO-2405/62

Reverse Shifting Interlocking System

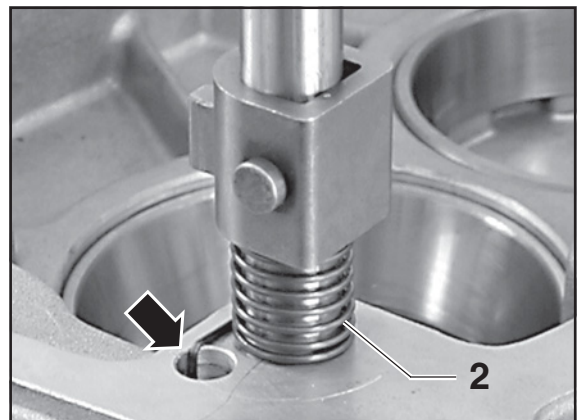
Assembly

1. Align the interlok pin hole with the housing hole and install the interlocking mechanism into the pin bore.



FSO-2405/62

2. Give the spring as much as the tension you can by winding the spring on the pin and then set its free end in the housing hole.

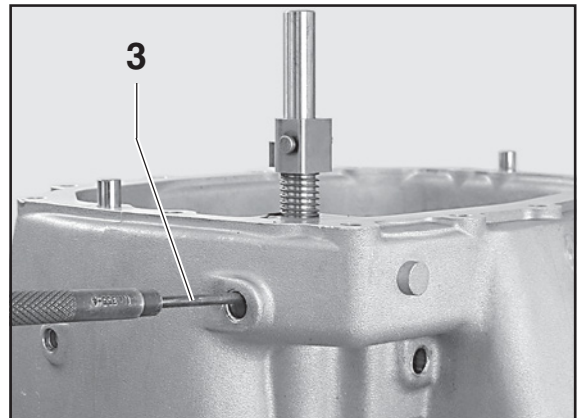


FSO-2405/63

3. Install a new roll pin.

NOTE: Use a 4 mm diameter pin punch.

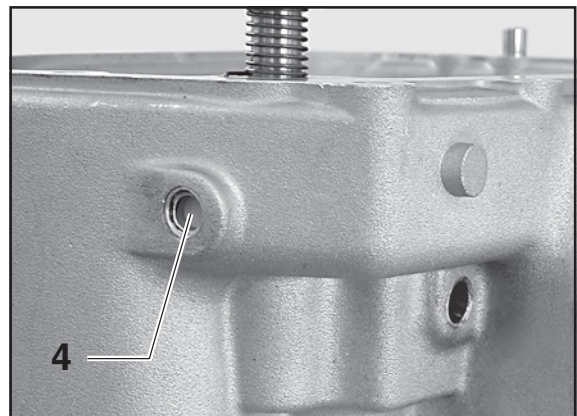
NOTE: Replace the roll pin by a new one.



FSO-2405/61

4. Install a new expansive plug in the housing hole.

NOTE: See "Expansive Plugs" for instructions.



FSO-2405/45

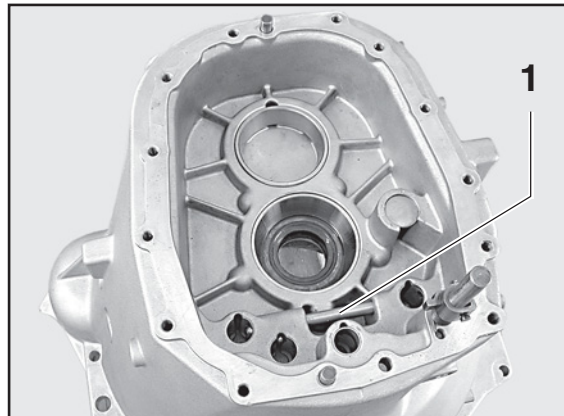
Front Section Disassembly

Double Gear Shifting Interlocking System

Description

The double gear shifting interlocking mechanism prevents shifting into two gears at the same time.

1. Double gear shifting interlocking mechanism

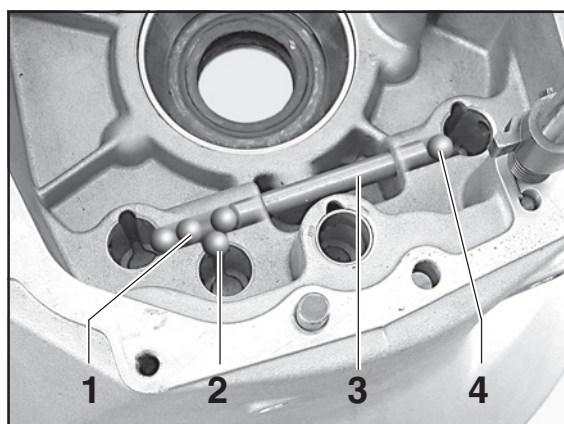


FSO-2405/58

Such mechanism comprises one interlock pin and five interlock balls.

NOTE: One interlock ball has a 8,0 mm diameter while the other four interlock balls have a 9,5 mm diameter. A larger ball does not install into the smallest interlock bore.

When shifting any of the speed gears, the yoke bar of this specific speed push away the corresponding ball, displacing the remaining balls and locking the other yoke bars into the neutral position.



FSO-2405/64

1. Three balls (9,5 mm diameter) aligned from the 3rd/4th yoke bar bore.
2. One ball (8,0 mm diameter) located on the 1st/2nd yoke bar bore.
3. Interlock pin
4. One ball (9,5 mm diameter) located on the 5th/reverse yoke bar bore.

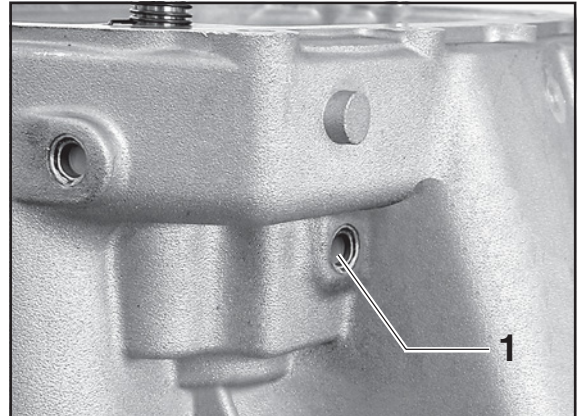
WARNING! Be careful when removing the yoke bars. Interlock balls may drop into the bar bores. Keep a close watch on the interlock balls when disassembling and assembling the transmission.

Double Gear Shifting Interlocking System

Disassembly

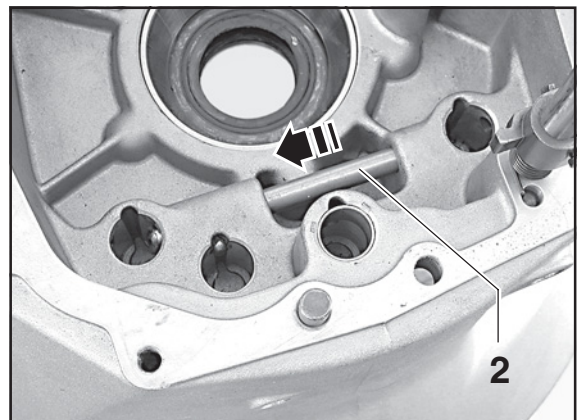
1. Remove the expansive plug near to the 5th/ reverse yoke bar.

NOTE: See "Expansive Plugs" for instructions.



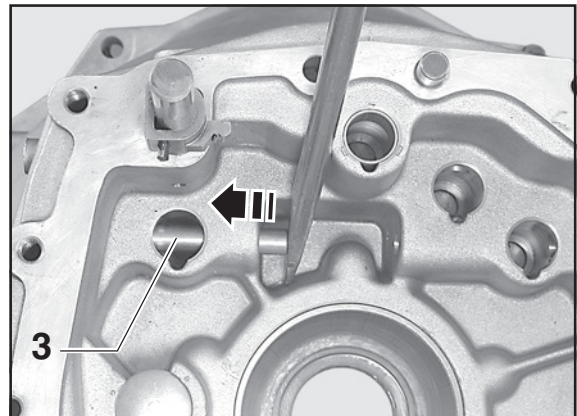
FSO-2405/83

2. Push the interlock pin to the opposite side in order the interlock balls drop from their bores.



FSO-2405/65

3. Displace the interlock pin towards the removed expansive plug hole and remove the pin through the housing hole.



FSO-2405/66

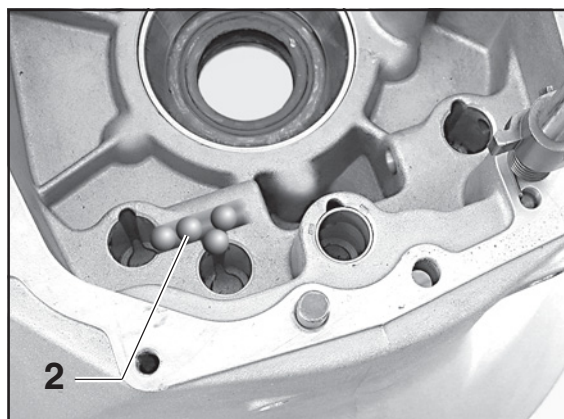
Front Section Disassembly



Double Gear Shifting Interlocking System

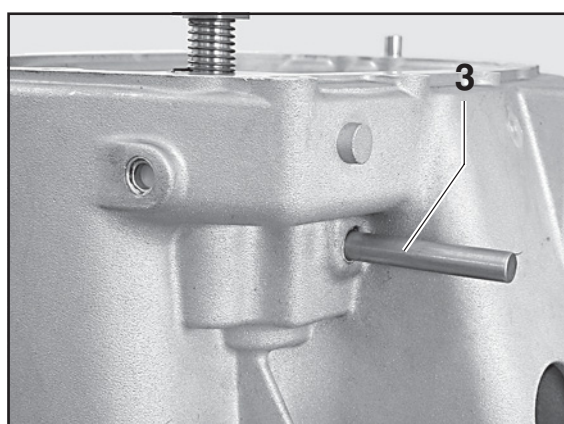
Assembly

1. Apply grease to interlock bores to keep the balls in place.
2. Install the three interlock balls aligned from the 3rd/4th yoke bar bore and install the smallest ball (8,0 mm diameter) located on the 1st/2nd yoke bar bore.



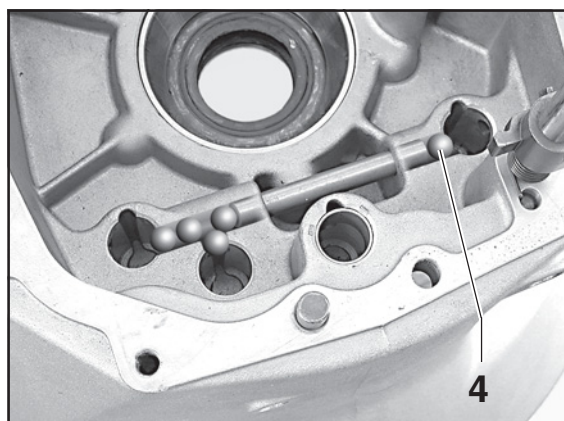
FSO-2405/84

3. Install the interlock pin through the housing hole whose expansive plug was removed before.



FSO-2405/67

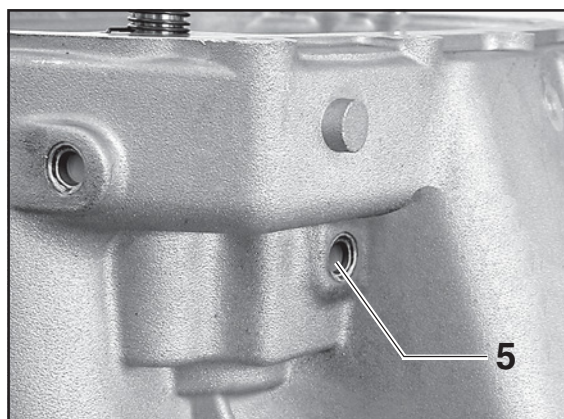
4. Install the interlock ball located on the 5th/ reverse yoke bar bore.



FSO-2405/64

5. Install a new expansive plug in the housing hole.

NOTE: See “Expansive Plugs” for instructions.



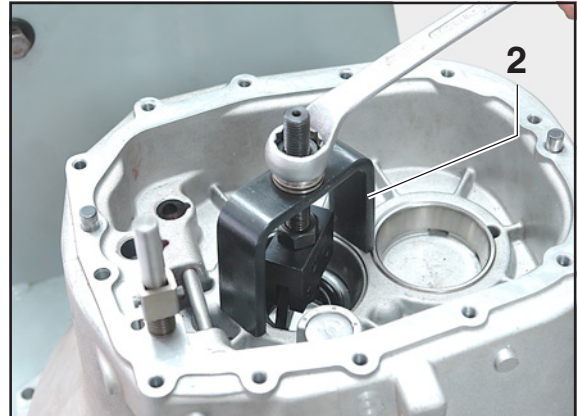
FSO-2405/83

Input Shaft Bearing Cup

Removal

1. Place the front housing properly supported with the input shaft bearing cup removing side down.
2. Use the bearing cup puller and remove the bearing cup from the bearing bore.

NOTE: See "Special Tools", Ref. E012004.

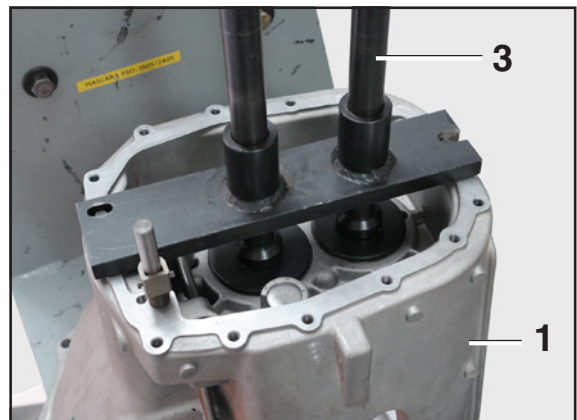


FSO-2405/171

Installation

1. Support properly the front housing with bearing cup installing side up.
2. Prior installing the bearing cup, carefully clean bearing cup and bore.
3. Use the proper tool and drive the bearing cup into the bearing bore, just until the cup be guided by the bore.

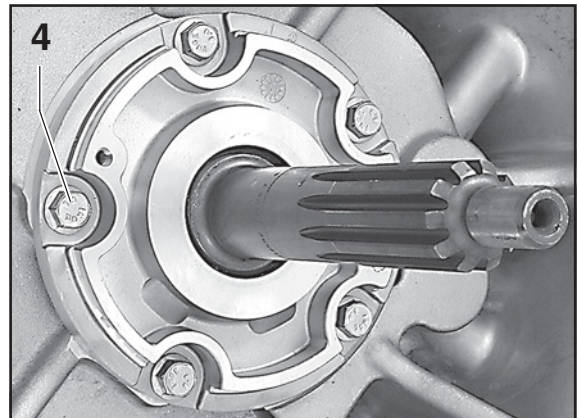
NOTE: See "Special Tools", Ref. E001033, E001037, E001039



FSO-2405/183

4. Install the input shaft bearing cover and tighten the cover retaining capscrews to the proper torque (see "Input Shaft Bearing Cover - Installation").

NOTE: Torque = 10-16 N.m (7-12 lb.ft)



FSO-2405/50

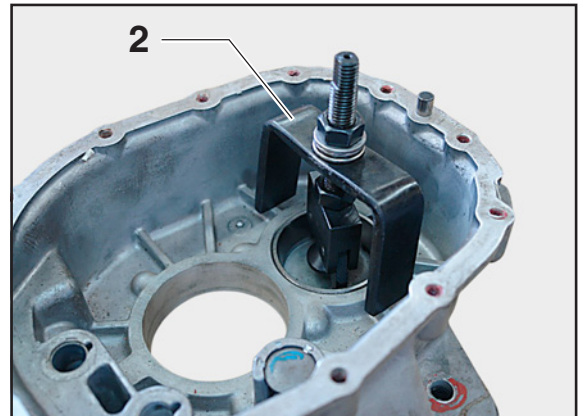
Front Section Disassembly

Countershaft Front Bearing Cup

Removal

1. Place the front housing properly supported with the countershaft bearing bore side up.
2. Use the proper tool placed under the bearing cup counterbore at the cup bottom and remove the bearing cup.

NOTE: See "Special Tools", Ref. E011001.

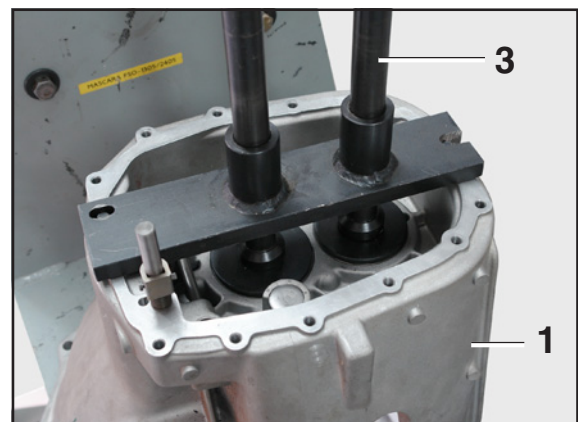


FSO-2405/172

Installation

1. Support properly the front housing with bearing bore side up.
2. Prior to installing the bearing cup, carefully clean both bearing bore and cup.
3. Use the proper tool and drive the bearing cup into the bearing bore until it is completely seated on the bottom.

NOTE: See "Special Tools", Ref. E001033, E001037, E001039.



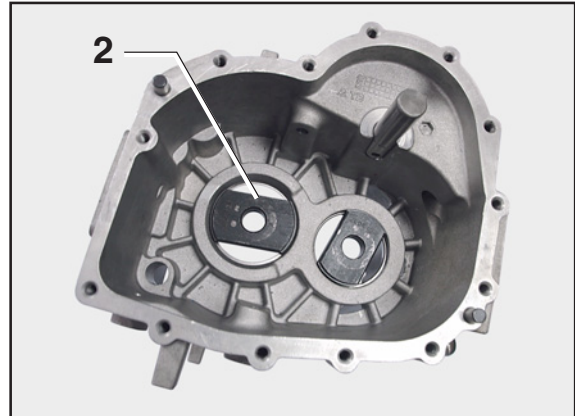
FSO-2405/183

Mainshaft and Countershaft Rear Bearing Cups

Removal

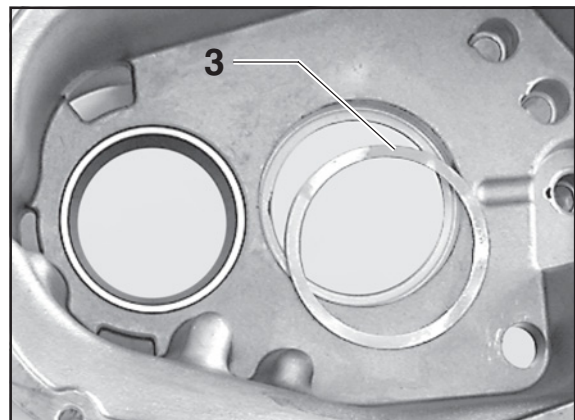
1. Place the intermediate housing properly supported with the bearing cup removing side down.
2. Use the proper device along with the support and remove the mainshaft and countershaft rear bearing cups from the bearing bore.

NOTE: See "Special Tools", Ref. E001035, E001036. Used with E001037.



FSO-2405/173

3. Remove all the existing shims from the bearing bore.



FSO-2405/124

Installation

1. Support properly the intermediate housing with bearing bore side up.
2. Prior to installing the bearing cup, carefully clean both bearing bore and cup.

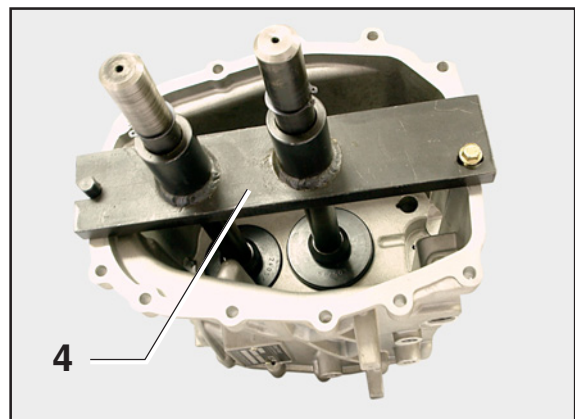
WARNING! Dirt between the bearing cup and the bearing bore can lead to axial clearance (end play) adjustment error.

3. Install the bearing cups without any shim before adjusting the transmission end play.

WARNING! See topic "End Play Adjustment".

4. Along with the support, use the proper tool to install the mainshaft and countershaft rear bearing cups and drive the bearing cup into the bearing bore until it is completely seated on the bottom.

NOTE: See "Special Tools", Ref. E001038, E001039. Used with E001037.



FSO-2405/174

Front Section Disassembly

Synchronizer Assemblies

Description

Synchronizers and synchronizer rings together are responsible for engaging the transmission gears.

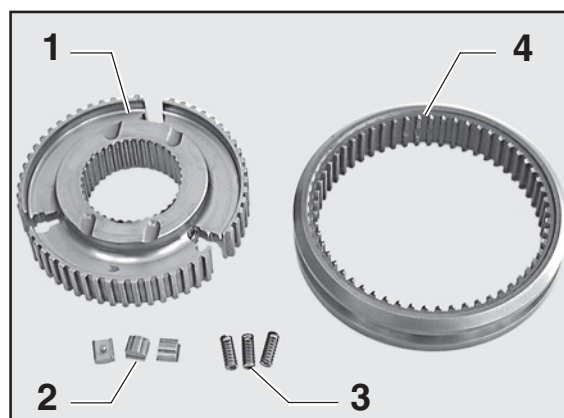
There are three synchronizer assemblies in this transmission model:

- 1st/2nd speed synchronizer
- 3rd/4th speed synchronizer
- 5th/reverse speed synchronizer

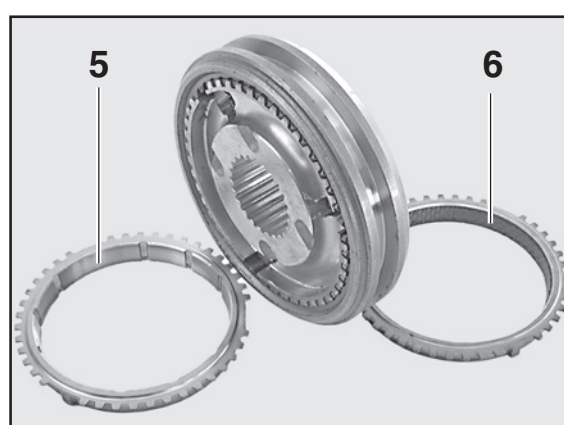
NOTE: When repairing synchronizer assemblies, do not replace a single part only. Always replace the assembly. If would be necessary to replace one synchronizer ring, always replace the transmission synchronizer ring set.

1. Synchronizer hub
2. Key (3x)
3. Spring (3x)
4. Synchronizer sleeve
5. Synchronizer ring with EFM II coating
6. Synchronizer ring without EFM II coating

NOTE: The EFM II is a special coating used in some synchronizer rings to increase its lifetime.



FSO-2405/72

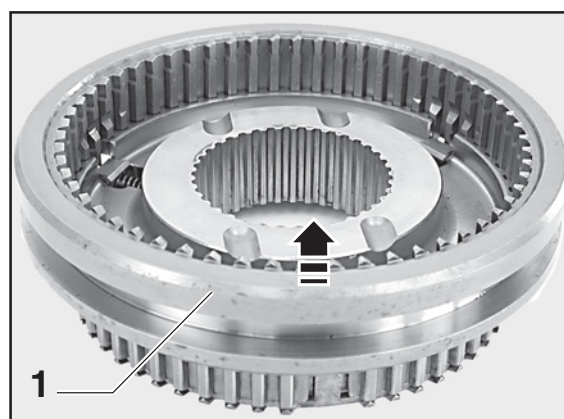


FSO-2405/73

4

Disassembly

1. With the hands, remove the synchronizer sleeve from the hub.



FSO-2405/75

Synchronizer Assemblies

- Slide the keys and springs out from the synchronizer hub slots and remove them.



FSO-2405/74

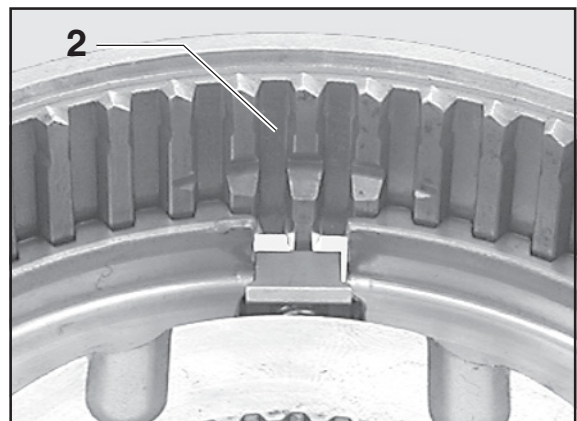
Assembly

- Place the spring inside the key hole, depress the spring and slide spring and key together into the synchronizer hub. Repeat this procedure for the three keys.



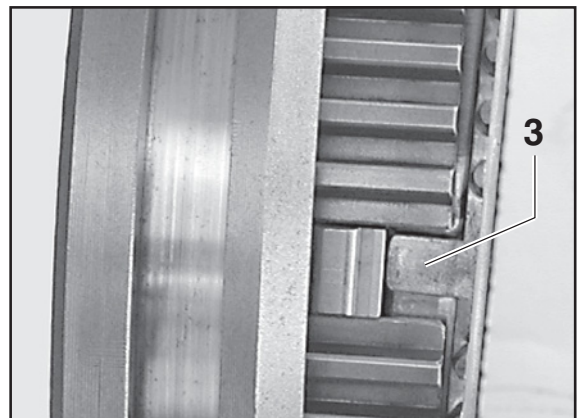
FSO-2405/74

- The center of the key must coincide with the center of synchronizer sleeve spline relief, in the three positions. With that in mind, align the synchronizer sleeve with the synchronizer hub.



FSO-2405/76

- To help when assembling, position a synchronizer ring at the sleeve opposite side and insert the ring lugs into the synchronizer hub key slots.

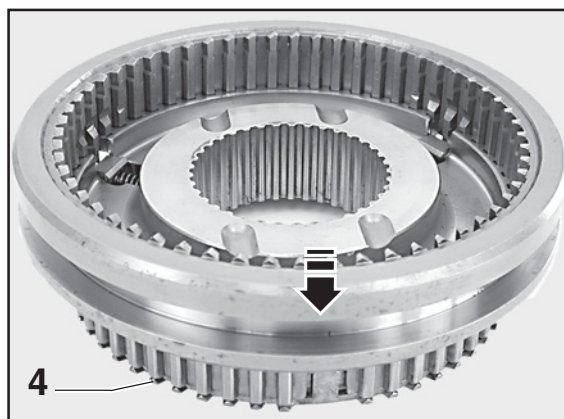


FSO-2405/77

Front Section Disassembly

Synchronizer Assemblies

4. Place the assembly on the bench with the synchronizer ring facing down.
5. With the hands, install the synchronizer sleeve on the synchronizer hub by forcing the sleeve downwards.



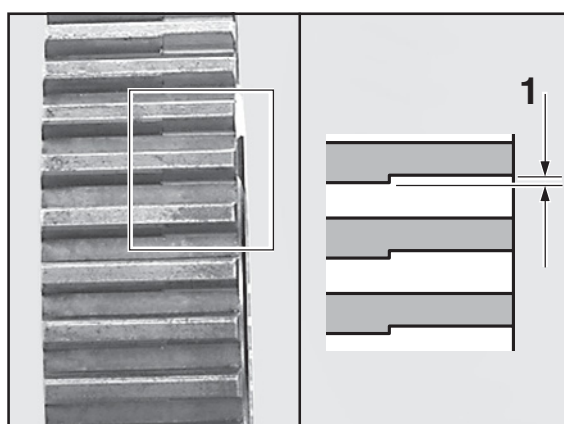
FSO-2405/75

Installation

WARNING! Before installing synchronizer assemblies on shafts is very important to be acquainted with their design features and be able to identify themselves as well.

1st/2nd and 3rd/4th Speed Synchronizer

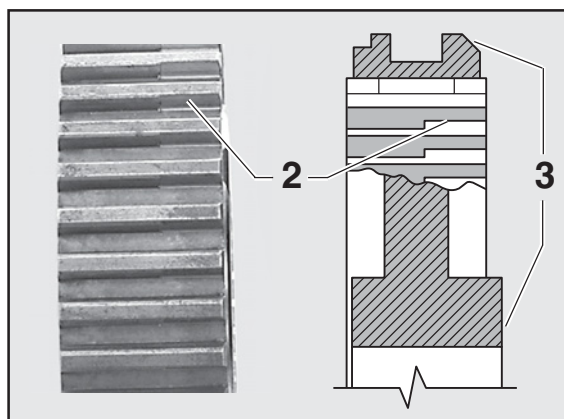
1. They look exactly alike, having as the only difference an anti-escape relief existing on the 3rd/4th speed synchronizer hub splines, not present on the 1st/2nd synchronizer.



FSO-2405/78

WARNING! Identify the anti-escape relief on the 3rd/4th speed synchronizer hub in order to prevent from swapping when installing. This misassembling can cause 3rd speed to slip out of gear.

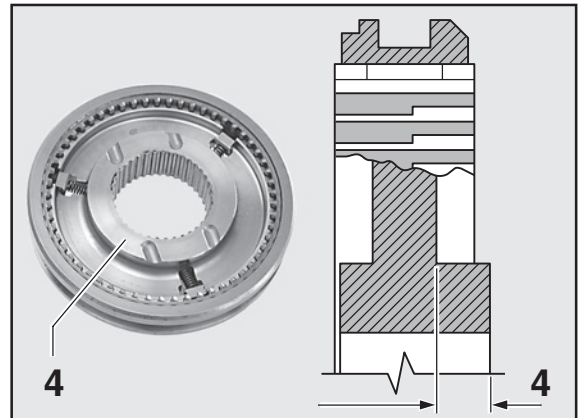
2. Install the 3rd/4th speed synchronizer assembly with the hub anti-escape relief side facing the 3rd speed gear.
3. The synchronizer hub most prominent side should face the sleeve chamfer side.



FSO-2405/79

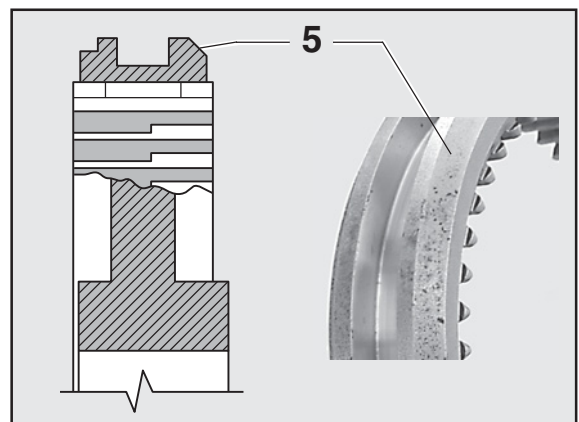
Synchronizer Assemblies

4. Install the synchronizer assemblies with the hub most prominent side facing the odd speed gear (either 1st or 3rd depending on the assembly).



FSO-2405/81

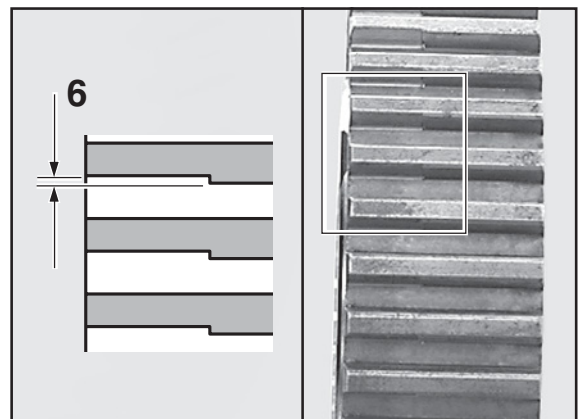
5. Install the synchronizer assemblies with the sleeve largest chamfer side facing the odd speed gear (either 1st or 3rd depending on the assembly).



FSO-2405/80

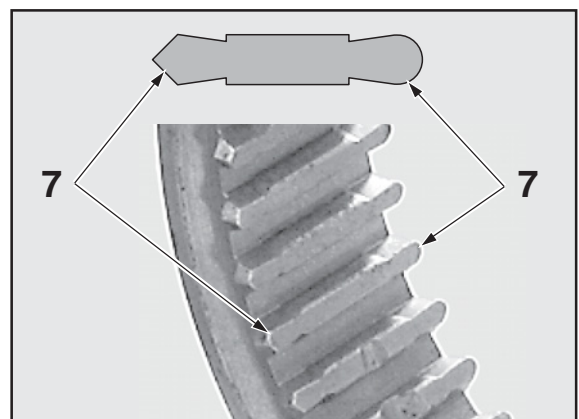
5th/reverse Speed Synchronizer

6. The 5th/reverse synchronizer hub has an anti-escape relief on the splines and must be installed with that relief side facing the 5th speed gear.



FSO-2405/78

7. The 5th/reverse synchronizer sleeve spline ends have one side rounded and the other side sharp ended. Install the 5th/reverse synchronizer assembly with the sleeve spline rounded end facing the reverse gear and the sharp end facing the 5th speed gear.



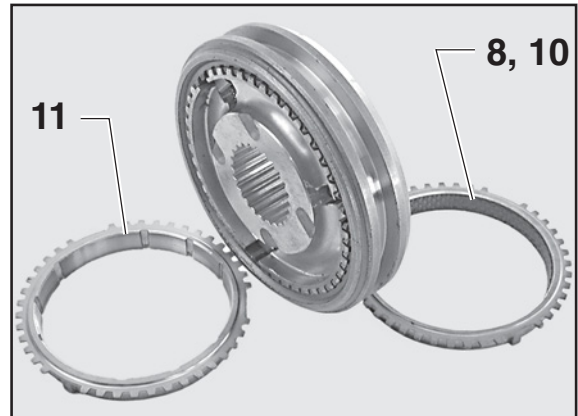
FSO-2405/82

Front Section Disassembly

Synchronizer Assemblies

Synchronizer Rings

- 8. The 1st, 2nd, 3rd and 4th speed synchronizer rings are the same and all coated with EFM II.
- 9. The 5th and reverse speed synchronizer rings are smaller than the others.
- 10. The reverse synchronizer ring is coated with EFM II.
- 11. The 5th speed synchronizer ring is not coated with EFM II.

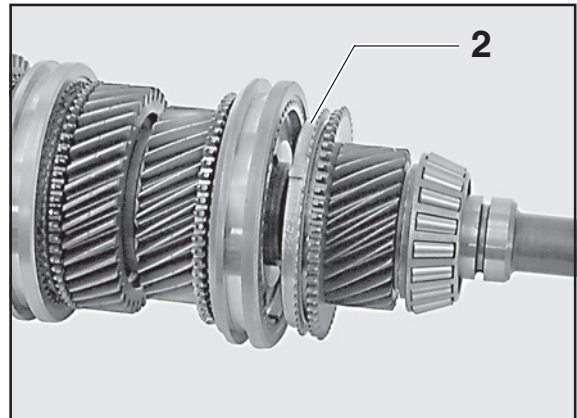


FSO-2405/73

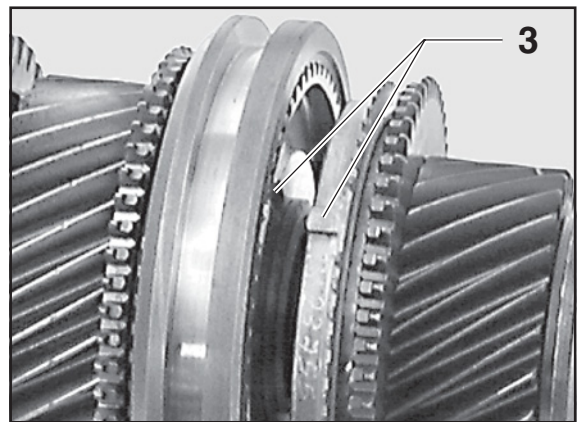
1. Place the front housing with input shaft and countershaft bearing cups side facing up.
2. Position the 4th speed synchronizer ring on the input shaft.

NOTE: The 1st, 2nd, 3rd and 4th speed synchronizer rings are the same and all coated with EFM II.

3. Install the input shaft with the positioned ring in the mainshaft front bearing cone. The synchronizer ring lugs must slide into the synchronizer hub key slots.

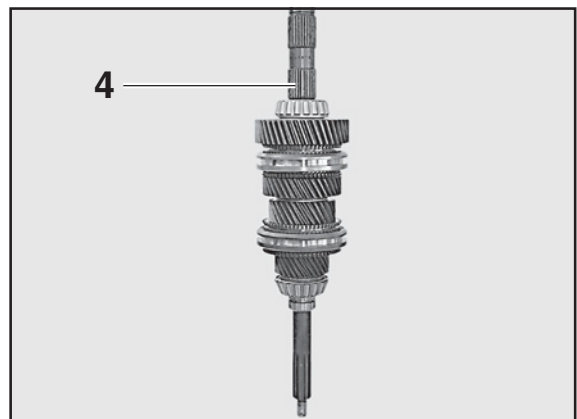


FSO-2405/113



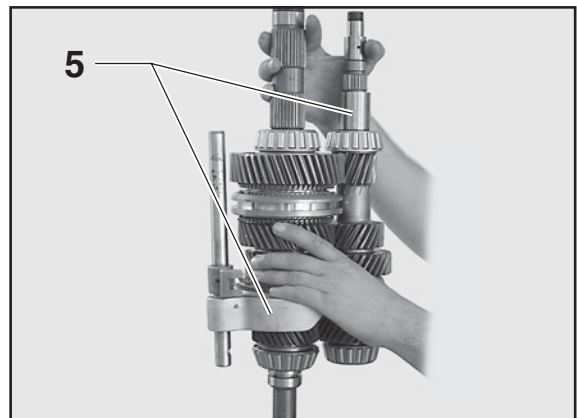
FSO-2405/114

4. With the input shaft down, position the input shaft and mainshaft assembly on the front housing.



FSO-2405/115

5. Position the 3rd/4th speed shift yoke and bar and the countershaft on the mainshaft assembly, holding the whole assembly with the hands.

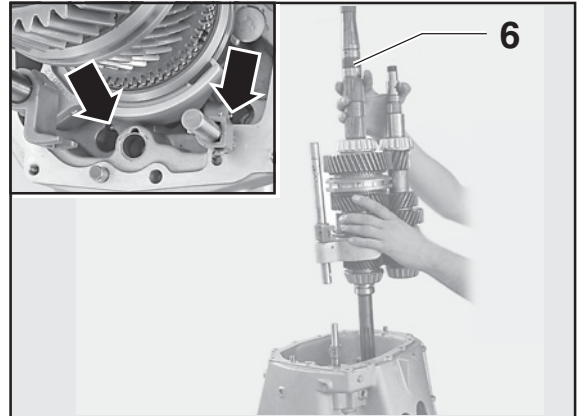


FSO-2405/116

Front Section Assembly

6. Align the whole assembly, as set before, with the input shaft bearing cup, with the countershaft bearing cup and with the 3rd/4th yoke bar bore, and install the assembly in the front housing.

NOTE: Be careful to keep the double shifting interlock balls in place.



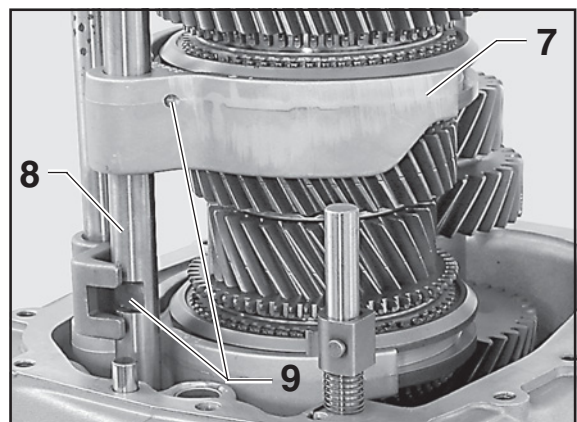
FSO-2405/117

7. Install the 1st/2nd shift yoke in the proper synchronizer sleeve groove.
8. Install the 1st/2nd yoke bar in the bar bore. The bar notch must be at the lower side.

NOTE: Be careful to keep the double shifting interlock balls in place.

9. Align the shift yoke with the yoke bar matching the roll pin holes and install the retaining roll pin. The 1st/2nd yoke bar notch should be aligned with the 3rd/4th shift block groove, formerly installed.

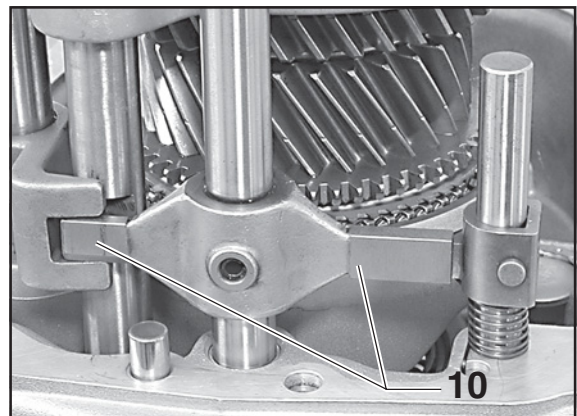
NOTE: Use a 4 mm diameter pin punch.



FSO-2405/118

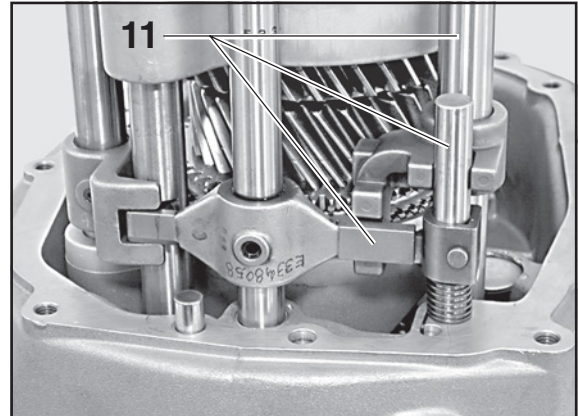
10. Install the shift selecting bar in the bar bore, positioning the selecting block shortest arm between the 1st/2nd yoke bar notch and the 3rd/4th shift block groove. The longest arm must be ahead the reverse shifting interlocking mechanism. To do this, rotate the interlocking mechanism by hand while positioning the shift selecting bar.

NOTE: Be careful to keep the double shifting interlock balls in place.



FSO-2405/59

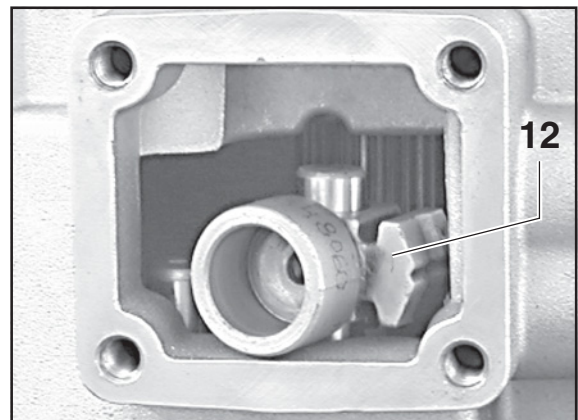
11. Align the 5th/reverse yoke bar with the bar bore, with the selecting block longest arm and with the reverse shifting interlock pin, and install the yoke bar.



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WARNING! Do not apply sealant to both housing and retaining capscrews by now! Prior to finishing the transmission assembly is necessary to check the end play.

12. Position the shift lug in the gear shift control tower opening in the intermediate housing, and install the intermediate housing on the front housing. The shift lug should be installed on the shift selecting bar with the cam side facing right as shown in the picture.



FSO-2405/120

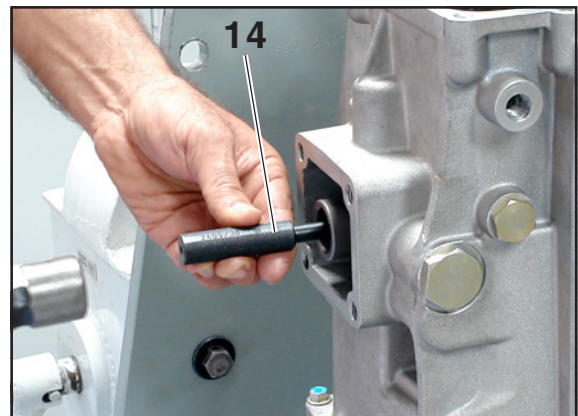
NOTE: If necessary, carefully hit the housing's capscrews area with a plastic hammer to match the housings.

13. Install the intermediate housing retaining capscrews. Tighten the capscrews crosswise to the recommended torque.

NOTE: Torque = 19-25 N.m (14-19 Lb.ft)

14. Align the shift lug with the shift selecting bar matching the roll pin holes and install the retaining roll pin.

NOTE: See "Special Tools", Ref. E001045.



E001045

Front Section Assembly



End Play Adjustment

WARNING! Before measuring and adjusting the transmission axial clearance (end play), remove **ALL** existing adjusting shims under both the mainshaft and countershaft rear bearing cups (see “Mainshaft and Countershaft Rear Bearing Cups - Removal and Installation”).

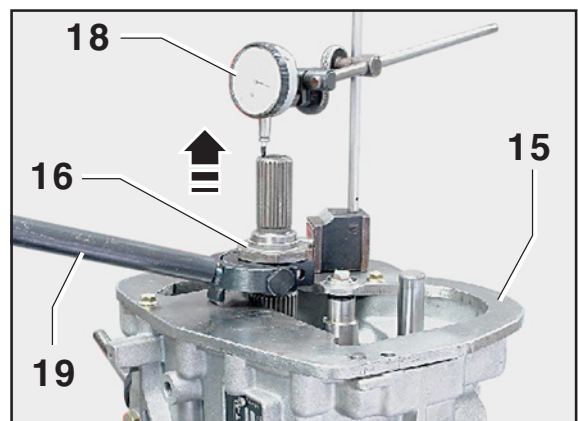
The bearing cups must have been installed in the bearing bores completely clean and perfectly seated on the bearing bore bottom.

NOTE: Special tools used for measuring the end play: see “Special Tools”, Ref. E008001, E009001.

Mainshaft End Play Measurement

WARNING! Prior this procedure make sure the input shaft bearing cover is installed (see “Input Shaft Bearing Cover”).

15. Choose one from housing threaded holes and install the special plate (tool # E009001) to support a dial indicator gauge with magnetic base.
16. Install the mainshaft rear nut just a few threads to support the pry bar (tool # E008001).
17. Rotate the mainshaft several times in both directions clockwise and counterclockwise to make sure the mainshaft is completely seated on the bearing.
18. Set the dial indicator tip against the mainshaft end. Set the pointer to zero.
19. Place the pry bar (tool # E008001) under the mainshaft nut and push the mainshaft upwards at once. Keep the mainshaft in that position while taking the dial indicator reading. Record that reading.



FSO-2405/176

4

End Play Adjustment**Countershaft End Play Measurement**

20. Choose one from housing threaded holes and install the special plate (tool # E009001) to support a dial indicator with magnetic base.
21. Install one from those removed transmission capscrews in the hole at countershaft end center. The capscrew head will be used as a base to set the dial indicator tip.
22. Install the countershaft rear nut just a few threads to support the pry bar (tool # E008001).
23. Rotate the countershaft several times in both directions clockwise and counterclockwise to make sure the countershaft is completely seated on the bearing.
24. Set the dial indicator tip against the capscrew head threaded in the countershaft end. Set the pointer to zero.
25. Place the pry bar (tool # E008001) under the countershaft nut and push the countershaft upwards at once. Keep the countershaft in that position while taking the dial indicator reading. Record that reading.

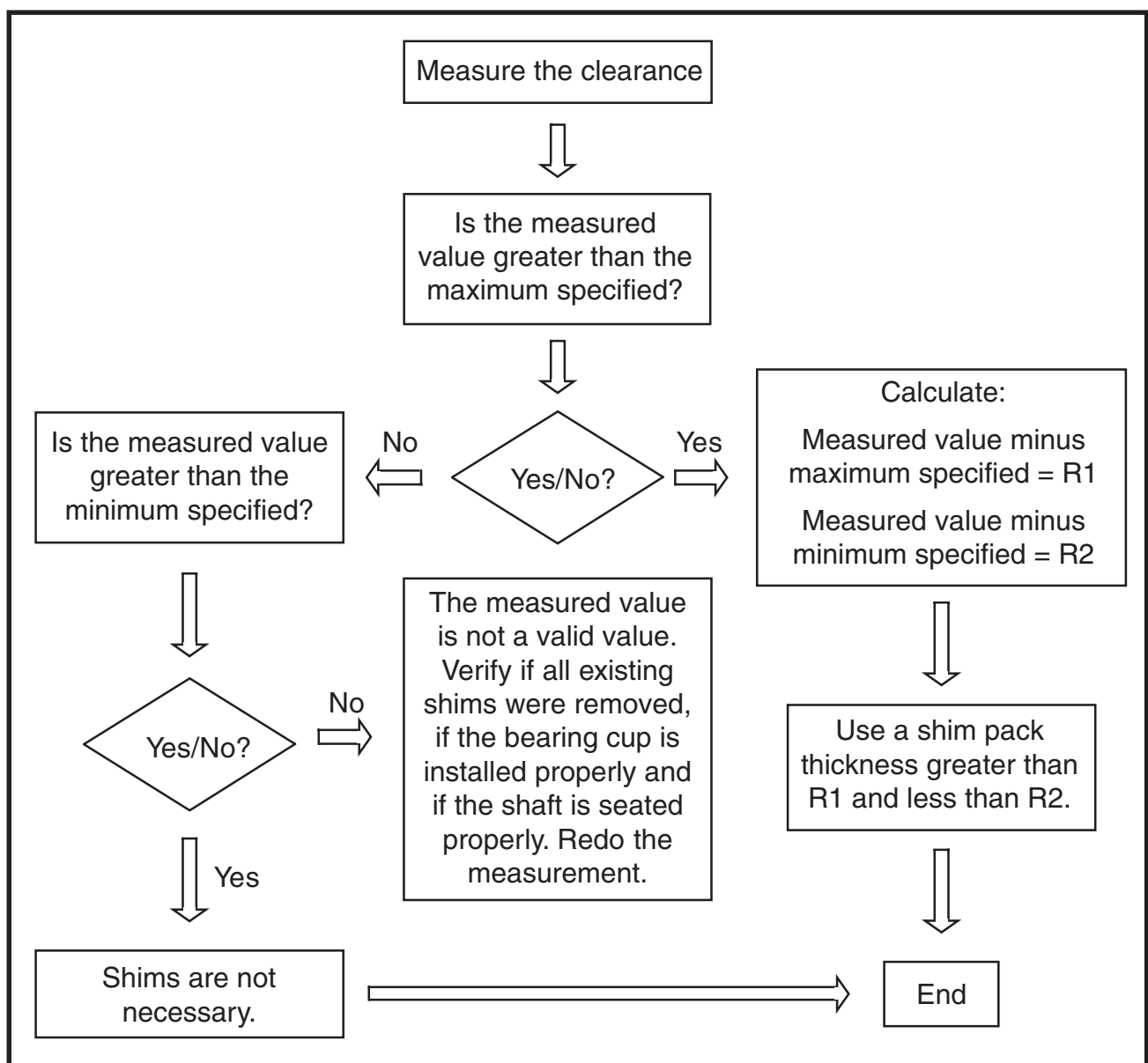
Front Section Assembly

End Play Adjustment

Determination of End Play Adjusting Shims

	Specified end play (mm)		
	Minimum	Maximum	Remarks
Countershaft	0,010	0,080	Positive clearance
Mainshaft	0,010	0,060	Positive clearance

26. Use the following flowchart and determine the shims pack thickness to adjust the transmission end play:



End Play Adjustment

Example #1: countershaft end play adjustment

Specified end play: 0,010 mm to 0,080 mm

Measured end play: 0,47 mm

As the measured value is greater than 0,080 mm (maximum specified), calculate:

$$0,470 - 0,080 = 0,390 \text{ mm (R1)}$$

$$0,470 - 0,010 = 0,460 \text{ mm (R2)}$$

The shim pack thickness must be within 0,390 mm and 0,460 mm.

Example #2: mainshaft end play adjustment

Specified end play: 0,010 mm to 0,060 mm

Measured end play: 0,15 mm

As the measured value is greater than 0,060 mm (maximum specified), calculate:

$$0,150 - 0,060 = 0,090 \text{ mm (R1)}$$

$$0,150 - 0,010 = 0,140 \text{ mm (R2)}$$

The shim pack thickness must be within 0,090 mm and 0,140 mm.

Example #3: countershaft end play adjustment

Specified end play: 0,010 mm to 0,080 mm

Measured end play: 0,005 mm

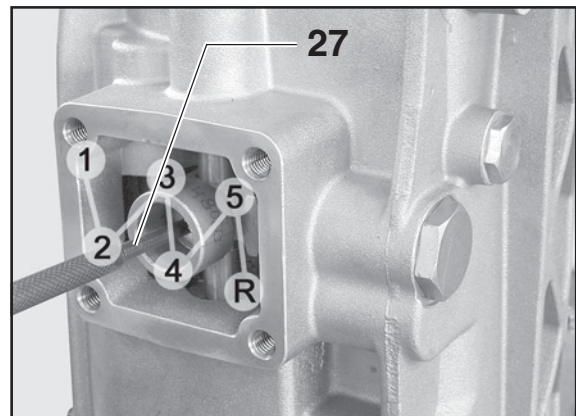
In this case, it is not possible to calculate the shim thickness, since the clearance is already less than the minimum specified. This measured value is not a valid value. So, it is necessary to redo the measurement, verifying before if all existing shims were actually removed, if the bearing cup is perfectly seated on the bearing bore and free of any kind of dirt, and if the shaft is seated properly on the bearing, by rotating the shaft in both directions clockwise and counterclockwise.

27. Shift the 1st gear and remove the retaining roll pin from the shift lug, by pushing it forward into the housing.

NOTE: Use a 6 mm diameter pin punch.

28. Remove the retaining capscrews from the intermediate housing.
29. Remove the intermediate housing.

NOTE: If necessary, carefully hit the housing's capscrews area with a plastic hammer to detach the housing.

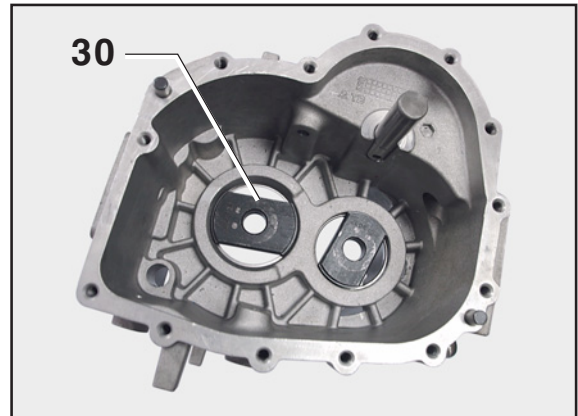


FSO-2405/28

Front Section Assembly

End Play Adjustment

30. Use the proper drive tool and remove the rear bearing cups (see “Mainshaft and Countershaft Rear Bearing Cups - Removal and Installation”).

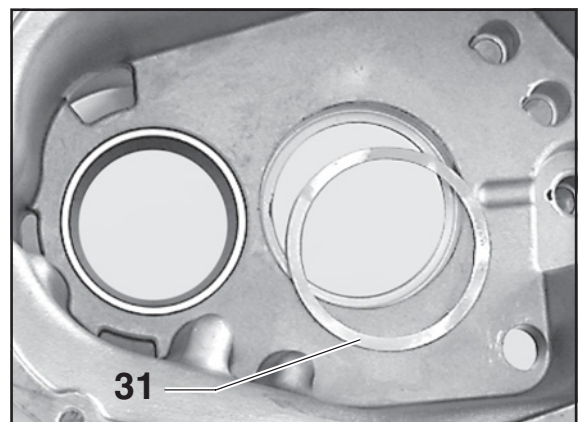


FSO-2405/173

WARNING! Be careful to not swap the adjustment shim pack between mainshaft and countershaft when installing.

31. Install the necessary shim pack thickness to adjust the mainshaft end play in the mainshaft rear bearing bore and next, install the bearing cup.

NOTE: Use the proper drive tool to install the bearing cup (see “Mainshaft and Countershaft Rear Bearing Cups - Removal and Installation”).



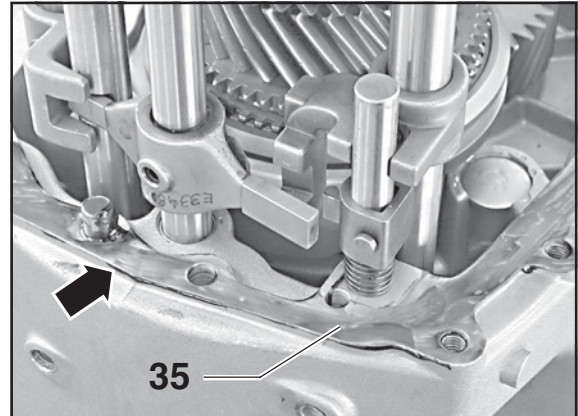
FSO-2405/124

32. Install the necessary shim pack thickness to adjust the countershaft end play in the countershaft rear bearing bore and next, install the bearing cup.

NOTE: Use the proper drive tool to install the bearing cup (see “Mainshaft and Countershaft Rear Bearing Cups - Removal and Installation”).

33. Remove any remaining sealant material from housing mounting surfaces.
34. Use either a proper tap or screw and remove any remaining sealant material from housing threaded holes.
35. Apply sealant to the front housing mounting surface. Spread the sealant properly to prevent leaks.

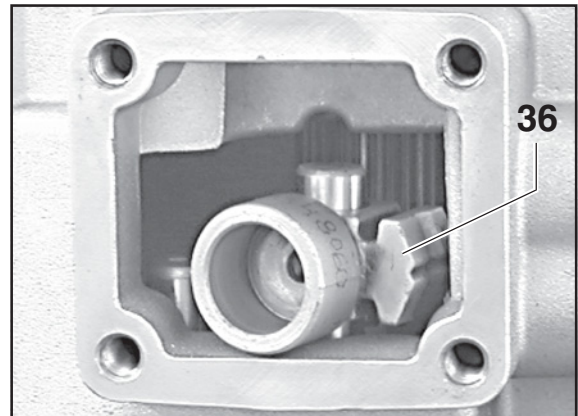
NOTE: Use Eaton E680sealant.



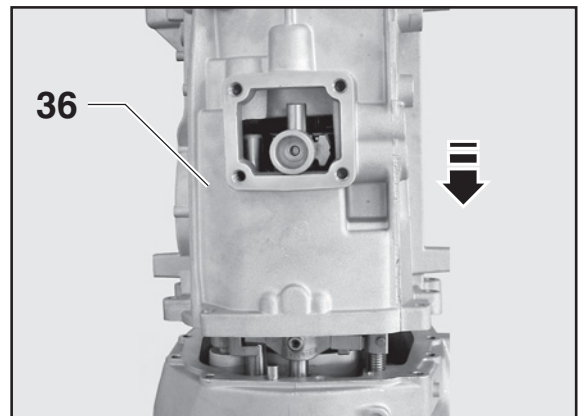
FSO-2405/125

36. Position the shift lug in the gear shift control tower opening in the intermediate housing, and install the intermediate housing on the front housing. The shift lug should be installed on the shift selecting bar with the cam side facing right as shown in the picture.

NOTE: If necessary, carefully hit the housing's capscrews area with a plastic hammer to match the housings.



FSO-2405/120



FSO-2405/32

Front Section Assembly



37. Apply sealant to the thirteen retaining capscrews that attach the intermediate housing to the front housing and install the capscrews, tightening by hand until capscrews are snug. Next, tighten capscrews crosswise to the proper torque.

NOTE: Apply Eaton E677 sealant to capscrews.

Torque = 19-25 N.m (14-19 Lb.ft)

38. From inside the front housing, install the capscrew that attach the front housing to the intermediate housing. Tighten capscrew to the proper torque.

NOTE: Apply Eaton E677 sealant to capscrews.

Torque = 19-25 N.m (14-19 Lb.ft)

39. Align the shift lug with the shift selecting bar matching the roll pin holes and install the retaining roll pin.

NOTE: See "Special Tools", Ref. E001045.

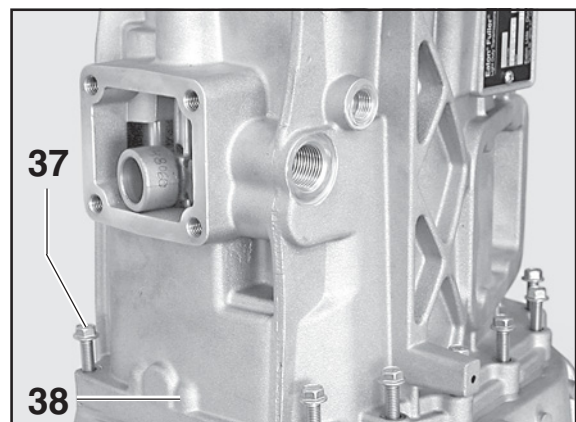
40. Install the ball, spring and shift positioning plug.

NOTE: Apply Eaton E680 or Eaton E679 sealant to plug threads.

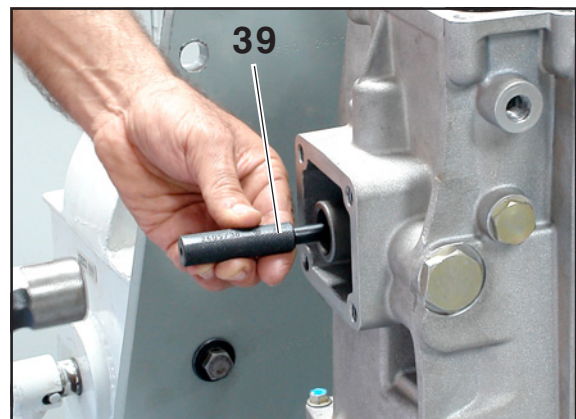
Torque = 10-16 N.m (7-12 lb.ft)



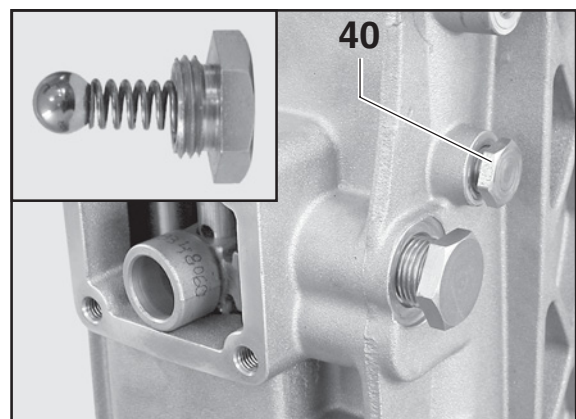
FSO-2405/126



FSO-2405/31



E001045



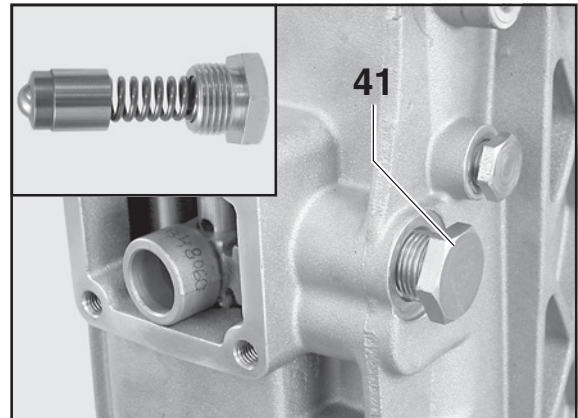
FSO-2405/30

41. Install the spherical actuator pin, spring and plug of the cam threaded actuator.

NOTE: Apply Eaton E680 or Eaton E679 sealant to plug threads.

Torque = 10-16 N.m (7-12 lb.ft)

42. Assemble the rear section (see “Rear Section - Assembly”).



FSO-2405/29

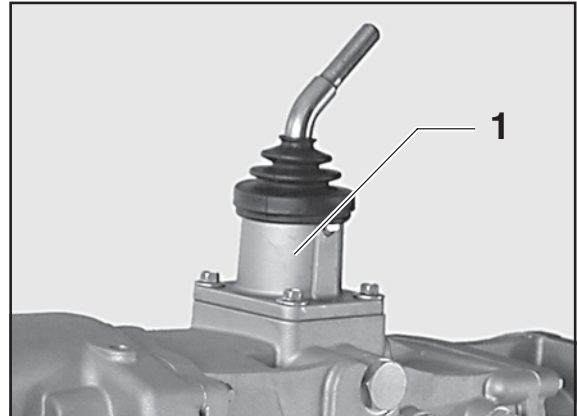
Gear Shift Lever Housing

Disassembly 159

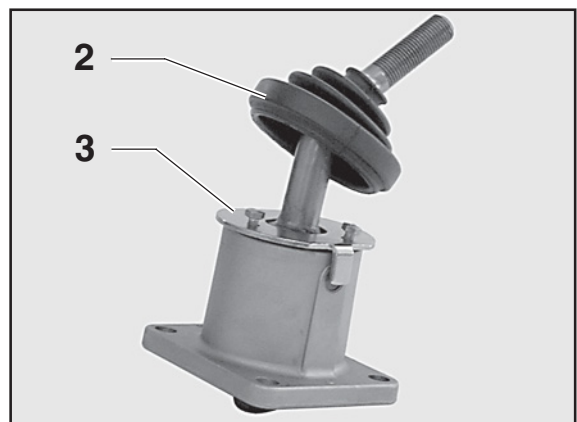
Assembly 161

Replace all internal parts, but gear shift lever. Inspect the gear shift lever and replace if worn. In case the housing should be replaced, get a complete assembly from your dealer.

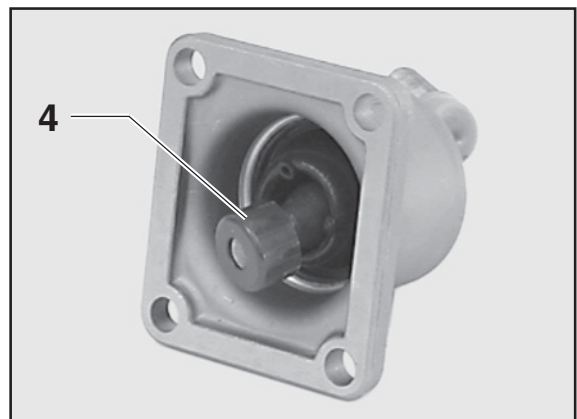
1. Remove the four retaining capscrews from the gear shift lever housing and remove the gear shift lever housing assembly from the transmission.
2. Remove the boot.
3. From the housing cover, remove the three retaining capscrews and the cover.
4. Use a screwdriver and remove the gear shift lever end bushing.
5. Pull the lever with the hands and remove the lever and the upper bushing.



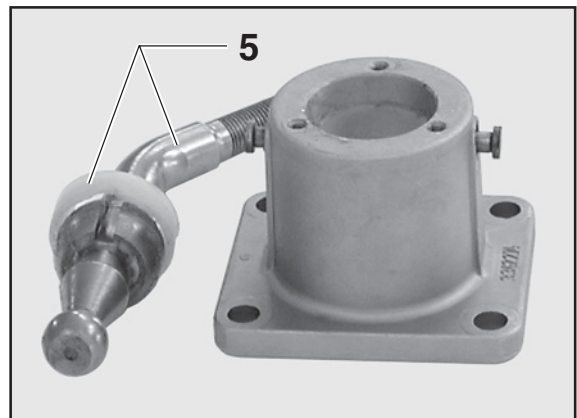
FSO-2405/127



FSO-2405/128

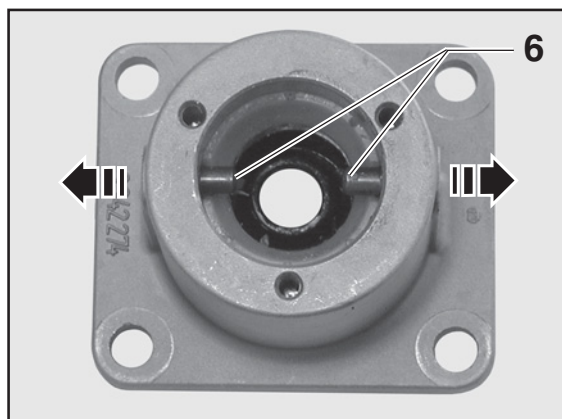


FSO-2405/129



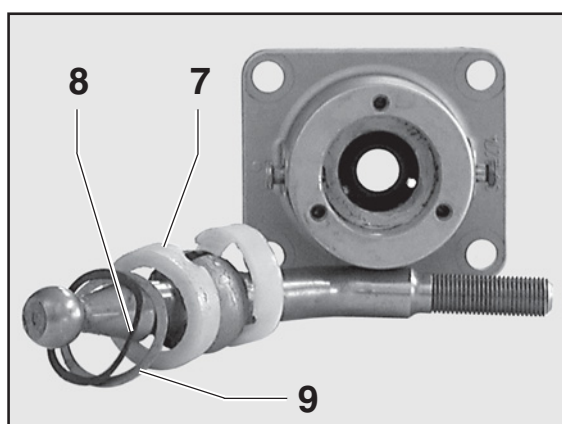
FSO-2405/130

6. Use a pin punch and remove the two spade pins from the housing tower bores by punching the pins from inside outwards.



FSO-2405/131

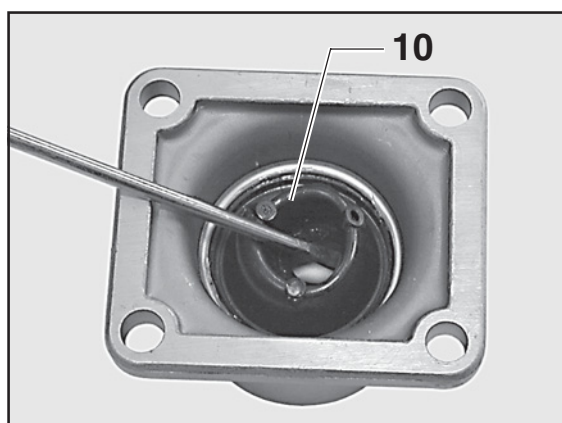
7. Remove the lower bushing.
8. Remove the wave washer.
9. Remove the thrust washer.



FSO-2405/132

10. Turn the housing over and remove the oil baffle from the housing using a screwdriver.

NOTE: Discard and replace the oil baffle.



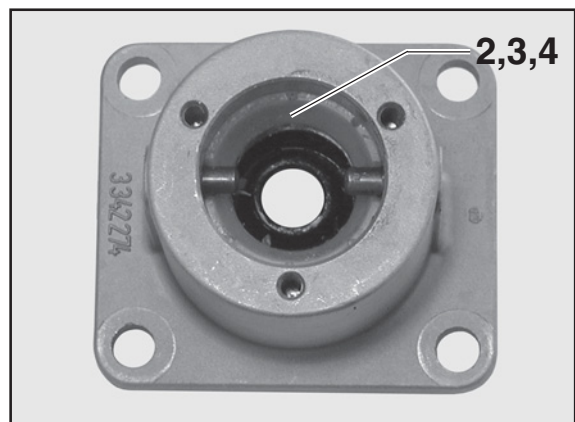
FSO-2405/133

1. Position the oil baffle on the housing and install the oil baffle using a proper drive tool.



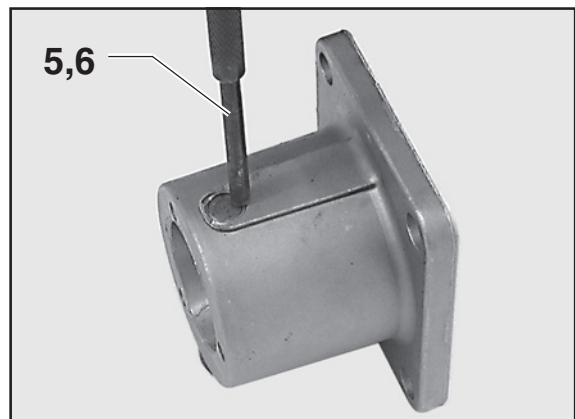
FSO-2405/134

2. Turn the housing over.
3. Install the wave washer and next, the thrust washer.
4. Install the lower bushing.



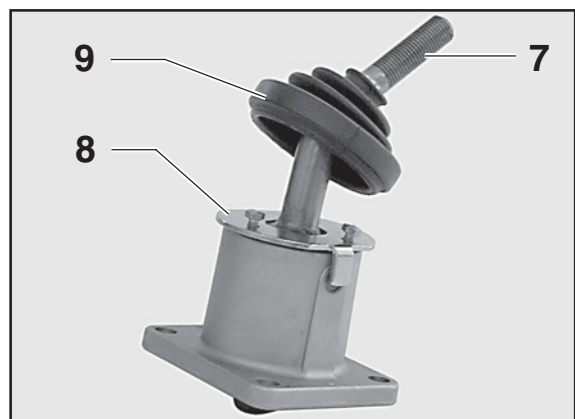
FSO-2405/131

5. Apply sealant to the spade pins and install the pins in the housing tower bores. Use a pin punch and push the spade pins inwards until they are seated on the bore bottom.
6. Use a center punch and lock the spade pins around the pin bores.



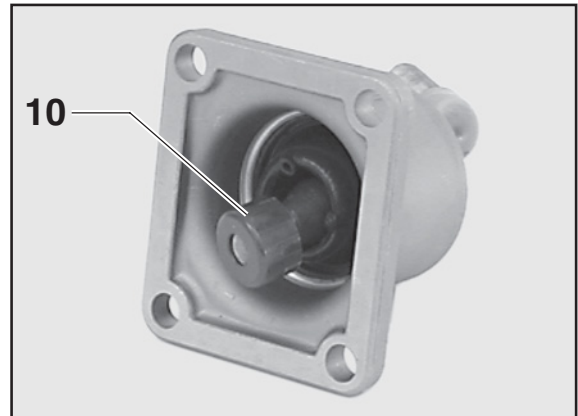
FSO-2405/135

7. Install the gear shift lever and the upper bushing.
8. Install the housing cover and install the three retaining capscrews.
9. Install the boot over the gear shift lever.



FSO-2405/128

10. Lubricate the gear shift lever end with multipurpose grease and install the end bushing by pressing the bushing with the fingers.



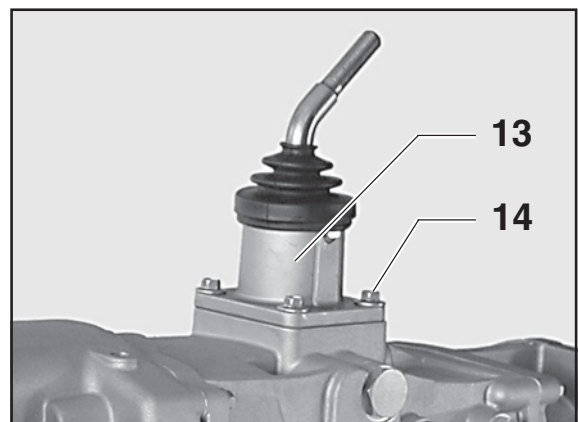
FSO-2405/129

11. Protect the gear shift lever housing opening on the transmission housing and remove any remaining sealant from the mounting surface of both transmission housing and the gear shift lever housing.
12. Apply sealant to the gear shift lever housing mounting surface. Spread the sealant properly to prevent leaks.

NOTE: Apply Eaton E680 or Eaton E679 sealant to the mounting surface.

13. Install the gear shift lever housing assembly on the transmission.
14. Install the four retaining capscrews in the gear shift lever housing and tighten to the proper torque.

*NOTE: Apply Eaton E677 sealant to each capscrew.
Torque = 19-25 N.m (14-19 Lb.ft)*



FSO-2405/127

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