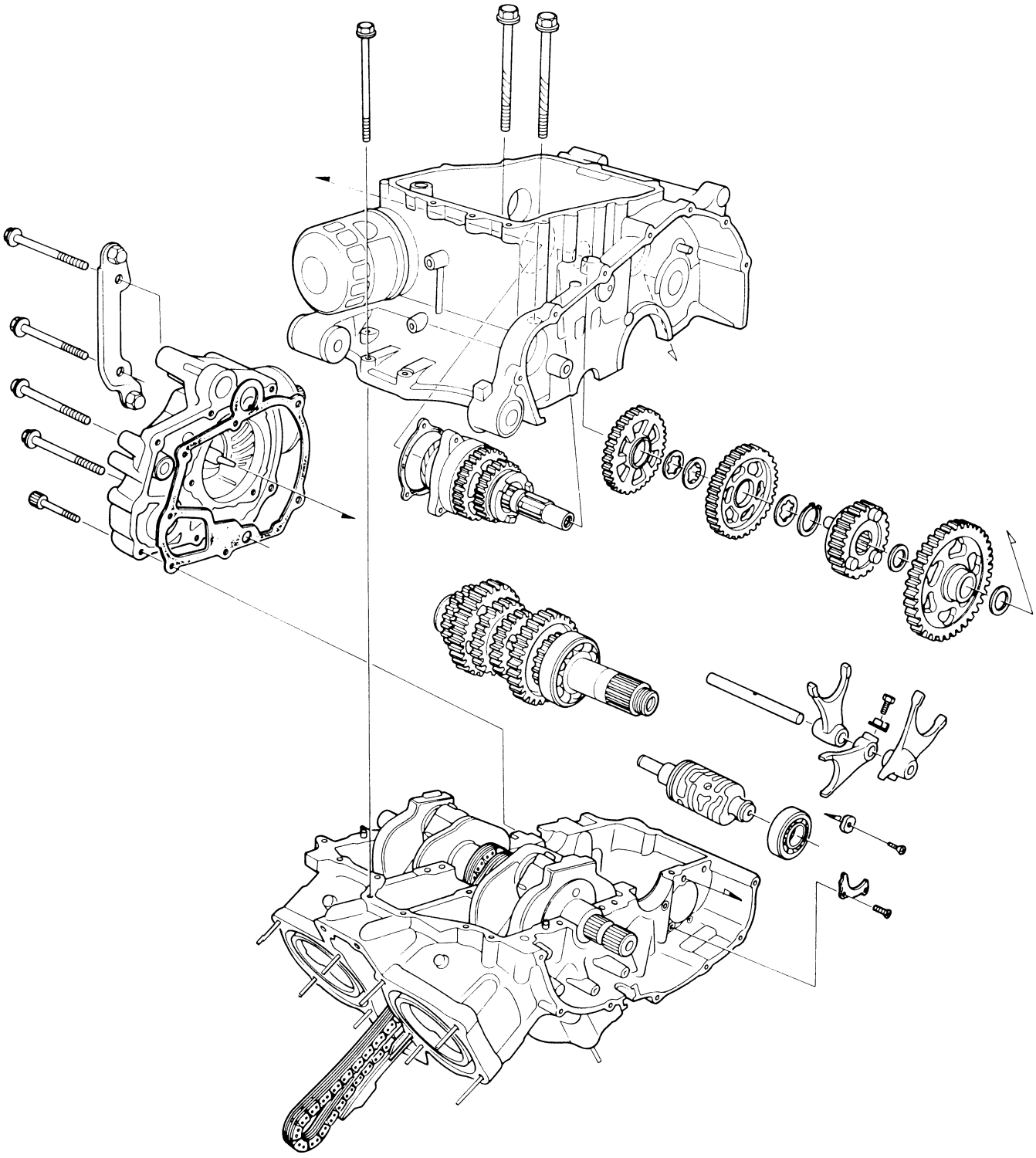


11. TRANSMISSION

SERVICE INFORMATION

GENERAL

- For internal transmission repairs, the crankcase must be separated (Section 10).
- Replace the countershaft and output driven gear as a set.
- When using the lock nut wrench, use a deflecting beam type torque wrench 14—20 inches long. The lock nut wrench increases the torque wrench's leverage, so the torque wrench reading will be less than the torque actually applied to the lock nut. Torque readings are given in both actual and indicated measurement.
- The output gear case can be removed with the engine in the frame after removing these parts:
  — rear wheel (section 14).
  — final drive case and drive shaft (section 12).

SPECIFICATIONS

ITEM			STANDARD	SERVICE LIMIT
Transmission	Gear I.D.	M5, M6, C2, C3 gear	28.000—28.021 mm (1.1024—1.1032 in)	28.04 mm (1.104 in)
		C1 gear	24.007—24.028 mm (0.9451—0.9459 in)	24.04 mm (0.946 in)
		C4 gear	29.000—29.021 mm (1.1417—1.1426 in)	29.04 mm (1.143 in)
	Gear bushing O.D.	M5, M6, C2, C3	27.959—27.980 mm (1.1007—1.1016 in)	27.94 mm (1.100 in)
		C4	28.959—28.980 mm (1.1401—1.1409 in)	28.94 mm (1.139 in)
	Gear bushing I.D.	M5	24.985—25.006 mm (0.9837—0.9845 in)	25.04 mm (0.986 in)
		C4	24.985—25.006 mm (0.9837—0.9845 in)	25.04 mm (0.986 in)
	Main shaft O.D.	at M5	24.959—24.980 mm (0.9826—0.9835 in)	24.90 mm (0.980 in)
	Countershaft O.D.	at C1	19.987—20.000 mm (0.7869—0.7874 in)	19.93 mm (0.785 in)
		at C4	24.959—24.980 mm (0.9826—0.9835 in)	24.90 mm (0.980 in)
	Gear-to-bushing or shaft clearance	M5, 6 to M5, 6 bushing	0.020—0.062 mm (0.0008—0.0024 in)	0.10 mm (0.004 in)
		M5 bushing to shaft	0.005—0.047 mm (0.0002—0.0019 in)	0.06 mm (0.002 in)
		C2 to bushing	0.020—0.062 mm (0.0008—0.0024 in)	0.10 mm (0.004 in)
		C3 to bushing	0.020—0.062 mm (0.0008—0.0024 in)	0.10 mm (0.004 in)
		C4 to bushing	0.020—0.062 mm (0.0008—0.0024 in)	0.10 mm (0.004 in)
		C4 bushing to shaft	0.005—0.047 mm (0.0002—0.0019 in)	0.06 mm (0.002 in)
Shift fork	Claw thickness		6.43—6.50 mm (0.253—0.256 in)	6.1 mm (0.24 in)
	I.D.	Left and right	14.016—14.034 mm (0.5518—0.5525 in)	14.04 mm (0.553 in)
Fork shaft	O.D.		13.973—13.984 mm (0.5501—0.5505 in)	13.90 mm (0.547 in)

TORQUE VALUES

Output gear case bearing holder	30 – 34 N·m (3.0 3.4 kg m, 22 25 ft lb)
Output gear case 8 mm	21 – 25 N·m (2.1 – 2.5 kg-m, 14 – 18 ft-lb)
6 mm	10 – 14 N·m (1.0 – 1.4 kg-m, 7 – 10 ft-lb)
Output gear bearing lock nut (outer)	90 – 110 N·m (9.0 – 11.0 kg-m, 65 – 80 ft-lb)
Countershaft lock nut (inner)	70 – 80 N·m (7.0 – 8.0 kg-m, 51 – 58 ft-lb)
Shift fork center bolt	16 – 20 N·m (1.6 – 2.0 kg-m, 12 – 14 ft-lb)
Mainshaft bearing holder bolt/screw	7 – 11 N·m (0.7 – 1.1 kg-m, 5 – 8 ft-lb) ┐
Shift drum set plate bolt/screw	7 – 11 N·m (0.7 – 1.1 kg-m, 5 – 8 ft-lb) ┘ Apply locking agent to the threads.

TOOLS

Special

Lock nut wrench, 30 x 64 mm	07916 – MB00000
Shaft holder	07923 – 6890101
Ring gear dis/assembly tool	07965 – 3710101 or 07965 – 3710100
Race driver attachment	07945 – 3330300
Bearing remover, 17 mm	07936 – 3710300
Remover handle	07936 – 3710100
Remover weight	07936 – 3710200 or 07741 – 0010201

Common

Driver	07749 – 0010000
Pilot, 30 mm	07746 – 0040700
Attachment, 42 x 47 mm	07746 – 0010300
Attachment, 52 x 55 mm	07746 – 0010400
Pilot, 17 mm	07746 – 0040400
Driver	07746 – 0030100 ┐ or driver 07945 – 3710200
Attachment, 25 mm I.D.	07746 – 0030200 ┘
Bearing puller	Commercially available

TROUBLESHOOTING

Hard to shift

- Faulty clutch system (Clutch drag).
- Bent shift fork.
- Bent shift shaft.
- Bent shift claw.
- Damaged shift drum cam grooves.
- Sticking shift drum stopper.

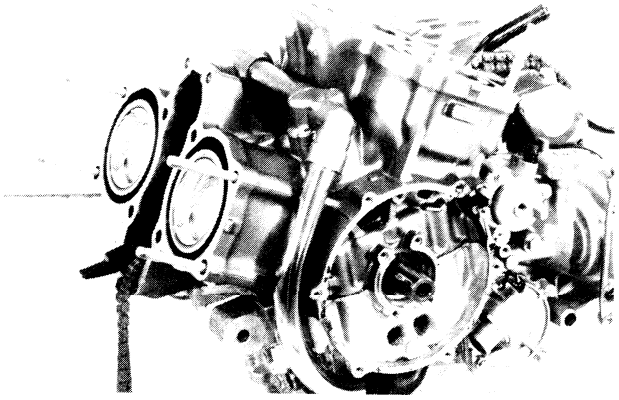
Transmission jumps out of gear

- Gear dogs worn or damage.
- Bent shift shaft.
- Broken shift drum stopper.
- Worn shift forks.
- Broken shift linkage return spring.

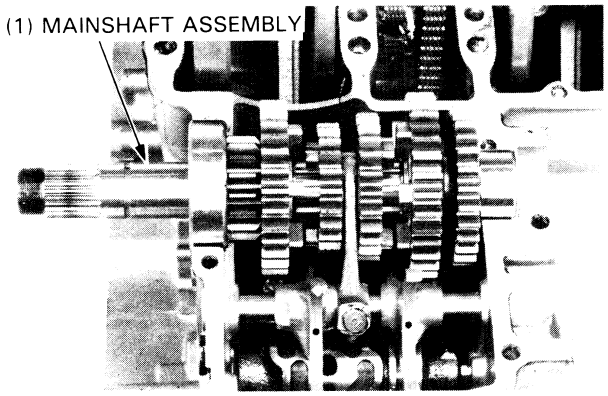
TRANSMISSION

REMOVAL

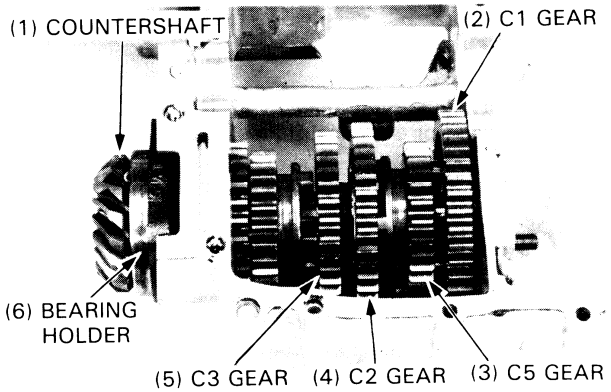
Separate the crankcase (Section 10).



Remove the mainshaft assembly from the upper crankcase.



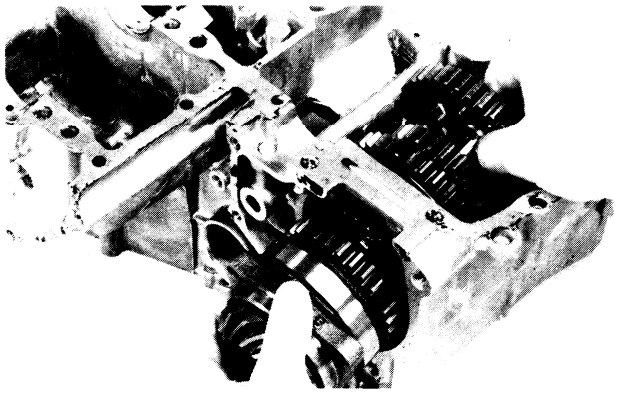
Index the gear case countershaft bearing holder to the output gear case, for ease of reassembly.



Pull the countershaft assembly out of the crankcase, and then remove the C1, C5 gears, washers and C1 gear bushing.

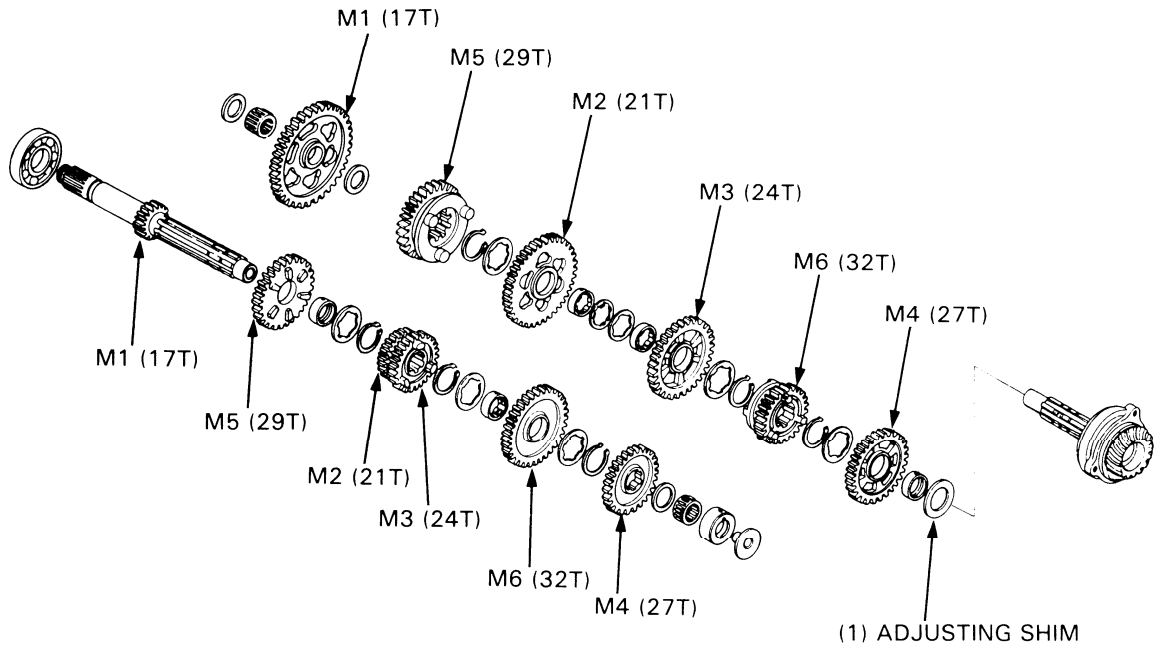
Remove the circlip, then remove the spline washers, C2 gear and bushing.

Remove the countershaft assembly from the crankcase.



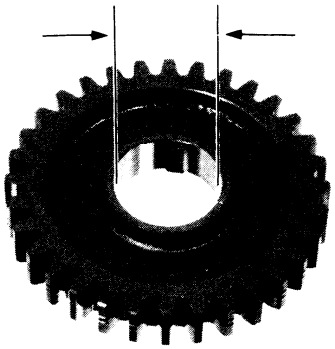
DISASSEMBLY

Disassemble the mainshaft and countershaft.



INSPECTION

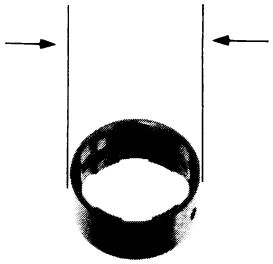
Transmission Gears
Check gear dogs, dog holes and teeth for excessive or abnormal wear, or evidence of insufficient lubrication.



Measure the I.D. of each gear.

SERVICE LIMITS:
- **M5 gear: 28.04 mm (1.104 in)**
- **M6 gear: 28.04 mm (1.104 in)**
- **C1 gear: 24.04 mm (0.946 in)**
- **C2 gear: 28.04 mm (1.104 in)**
- **C3 gear: 28.04 mm (1.104 in)**
- **C4 gear: 29.04 mm (1.143 in)**

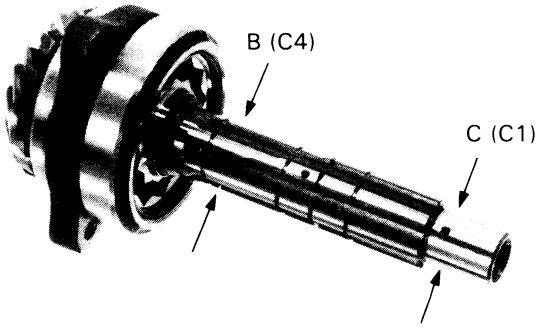
Bushings
Measure the I.D. and O.D. of the gear bushings.



SERVICE LIMITS:
- **M5 O.D.: 27.94 mm (1.100 in)**
- **M6 O.D.: 27.94 mm (1.100 in)**
- **C1 O.D.: 23.94 mm (0.943 in)**
- **C2 O.D.: 27.94 mm (1.100 in)**
- **C3 O.D.: 27.94 mm (1.100 in)**
- **C4 O.D.: 28.94 mm (1.139 in)**
- **M5 I.D.: 25.04 mm (0.986 in)**
- **C1 I.D.: 20.40 mm (0.803 in)**
- **C4 I.D.: 25.04 mm (0.986 in)**

Mainshaft/Countershaft

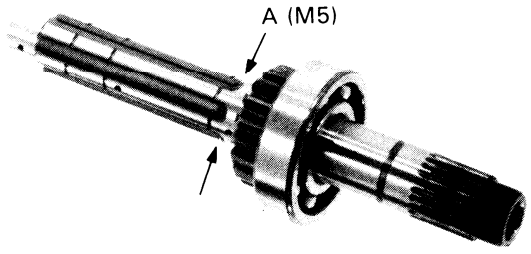
Measure the O.D. of the mainshaft and countershaft.



SERVICE LIMITS:

A (at M5 bushing): 24.90 mm (0.980 in)
B (at C1 bushing): 19.92 mm (0.785 in)
C (at C4 bushing): 24.90 mm (0.980 in)

Calculate the clearance between the gear and gear shaft or bushing.



SERVICE LIMITS:

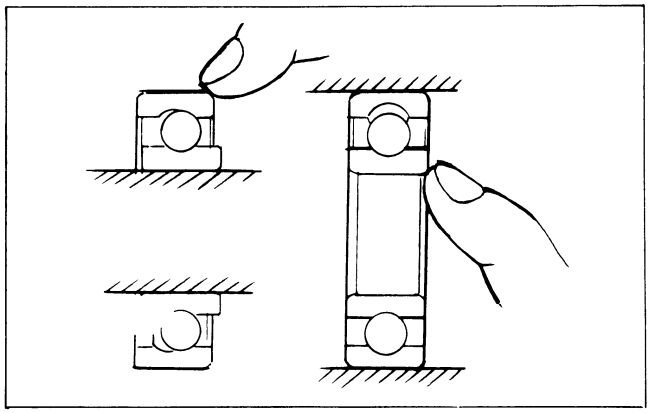
M5, 6 gear to M5, 6 bushing:	**0.10 mm (0.004 in)**
M5 bushing to M5 (A) shaft:	**0.06 mm (0.002 in)**
C1 gear to C1 bushing:	**0.10 mm (0.004 in)**
C1 bushing to C1 (C) shaft:	**0.10 mm (0.004 in)**
C2 gear to C2 bushing:	**0.10 mm (0.004 in)**
C3 gear to C3 bushing:	**0.10 mm (0.004 in)**
C4 gear to C4 bushing:	**0.10 mm (0.004 in)**
C4 bushing to C4 (B) shaft:	**0.06 mm (0.002 in)**

Bearing

Turn the race of each bearing with your finger. The bearings should turn smoothly and quietly. Also check that the bearing outer race fits tightly in the crankcase.

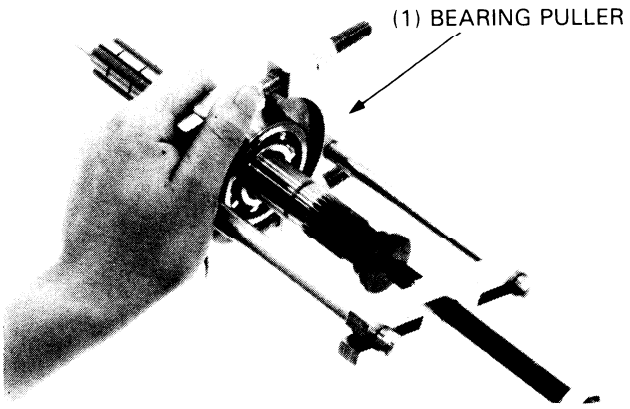
Remove and discard the bearings if the races do not turn smoothly, quietly, or if they fit loosely in the crankcase (below).

Pack new bearings with grease and install them with the special tool (page 11-5 to 11-6).



MAINSHAFT BEARING REPLACEMENT

Remove the mainshaft bearing with a bearing puller.



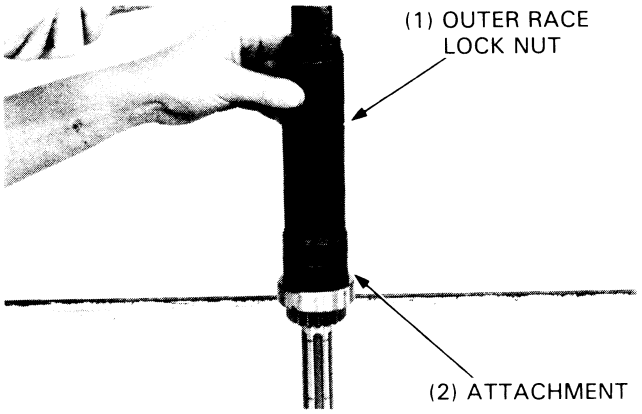
TOOL:

BEARING PULLER **(COMMERCIALLY AVAILABLE)**

Drive a new bearing onto the mainshaft.

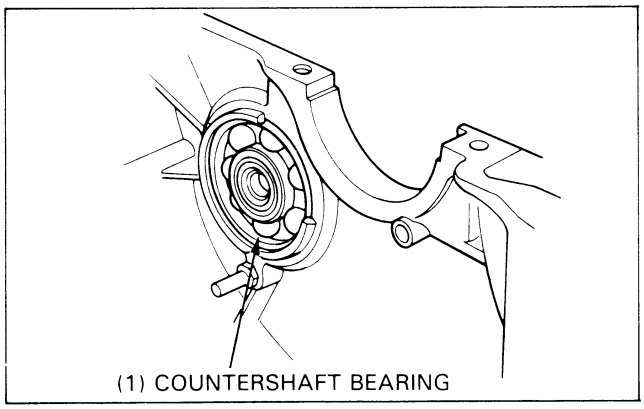
TOOLS:

DRIVER	**07746–0030100**
ATTACHMENT, 25 mm	**07746–0030200**



CRANKCASE BEARING REPLACEMENT

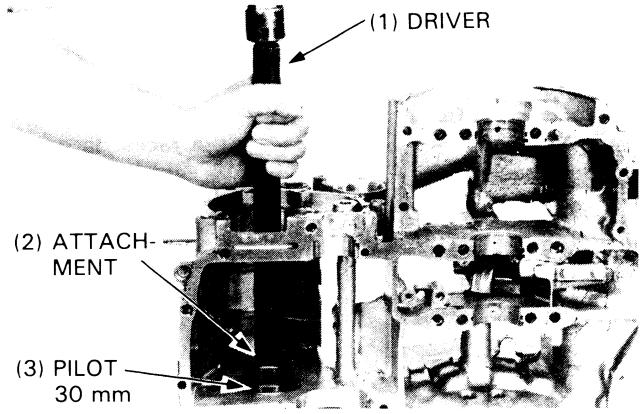
Drive the countershaft bearing out of the case.



Drive the countershaft bearing into the crankcase.

TOOLS:

DRIVER	**07949–0010000**
ATTACHMENT	**07746–0010300**
PILOT, 30 mm	**07746–0040700**



DRIVE GEAR REMOVAL FROM THE OUTPUT GEAR CASE

Remove the dowel pin and O-ring.
Install the countershaft onto the gear case.

Place the output gear case in a vise with soft jaws, being careful not to distort it.

Place the shaft holder tool on the output driven gear shaft wedging it against the vise to lock the shaft.

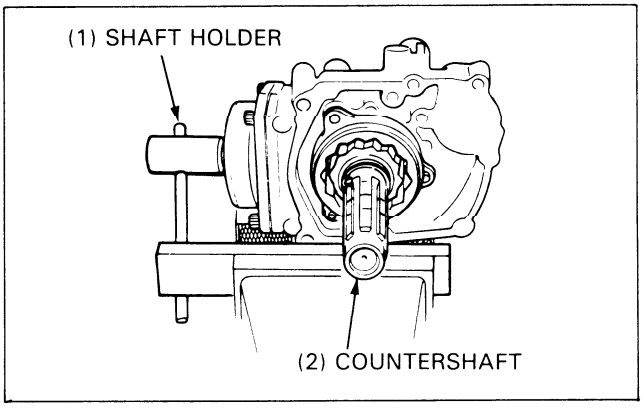
TOOL:

SHAFT HOLDER	**07923–6890101**

Unstake the inner bearing race lock nut with a drill or driver. Be careful that metal particles do not enter the bearing and the threads on the shaft are not damaged.

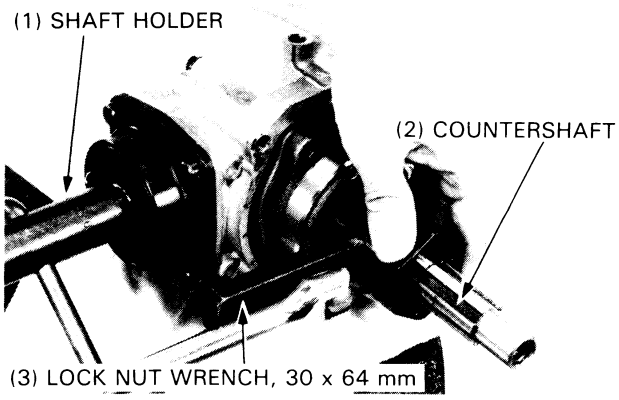
TOOL:

SHAFT HOLDER	**07923–6890101**

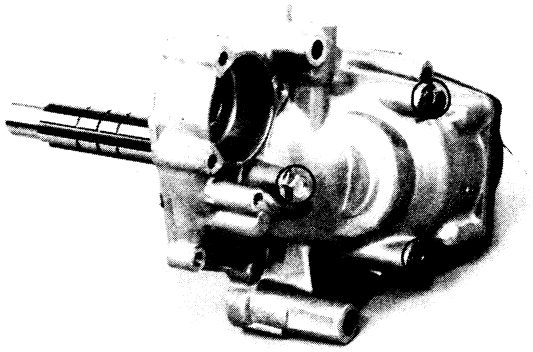


Remove the inner bearing race lock nut with a special tool. Discard the lock nuts.

TOOLS:
SHAFT HOLDER 07923—6890101
LOCK NUT WRENCH 30 x 64 mm 07916—MB00000



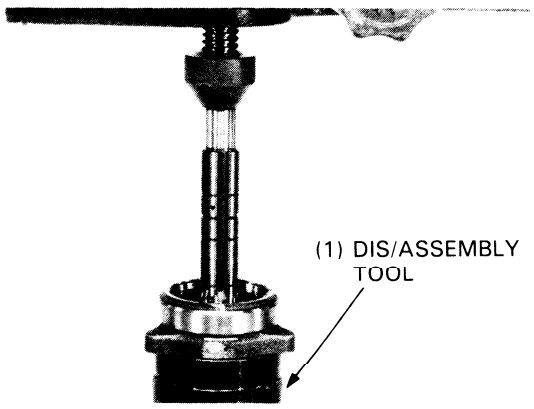
Remove the countershaft bearing holder bolts and countershaft/holder from the output gear case.



Place the countershaft/holder and a disassembly tool in a press.

Press the countershaft out of the bearing holder.

TOOL:
DIS/ASSEMBLY TOOL 07965—3710101 OR 07965—3710100



COUNTERSHAFT BEARING REPLACEMENT

NOTE

- The countershaft must be removed before replacing the bearing.

Place the bearing holder in a vise with soft jaws or shop towel.

NOTE

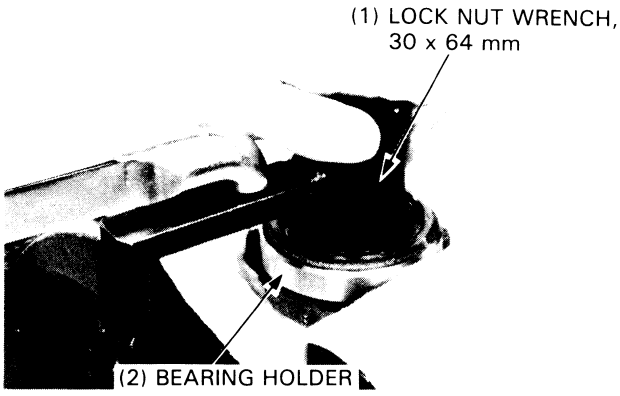
- Do not damage the bearing holder, especially the mating surface with the crankcase.

Unstake the outer race lock nut with a drill or driver.

Be careful that metal particles do not enter the bearing and the theads on the shaft are not damage.

Remove the bearing outer race lock nut with a special tool. Discard the lock nut.

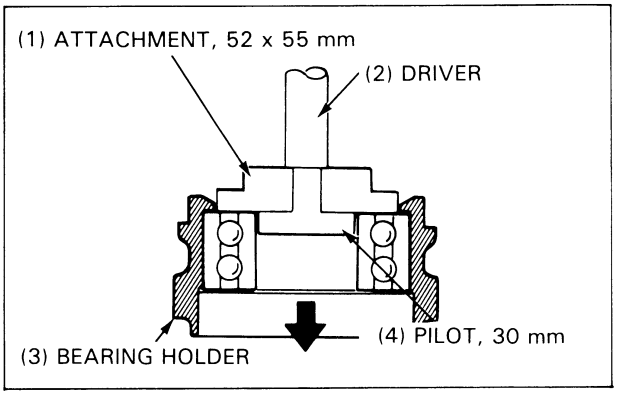
TOOL:
LOCK NUT WRENCH 30 x 64 mm 07916—MB00000



Drive the bearing holder in a press and remove the bearing.

TOOLS:

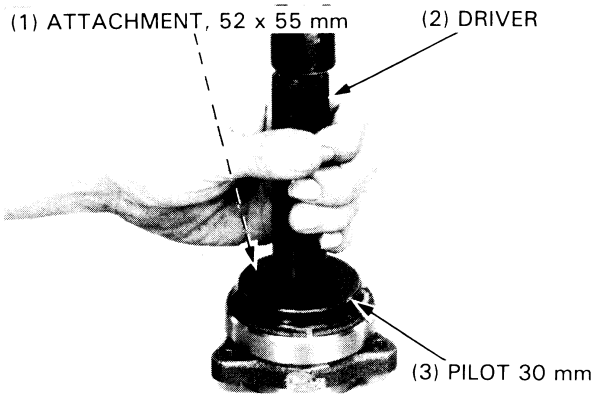
ATTACHMENT, 52 x 55 mm	**07746—0010400**
DRIVER	**07749—0010000**
PILOT, 30 mm	**07746—0040700**



Drive a new bearing into the bearing holder.

TOOLS:

ATTACHMENT 52 x 55 mm	**07746—0010400**
DRIVER	**07749—0010000**
PILOT, 30 mm	**07746—0040700**



COUNTERSHAFT INSTALLATION

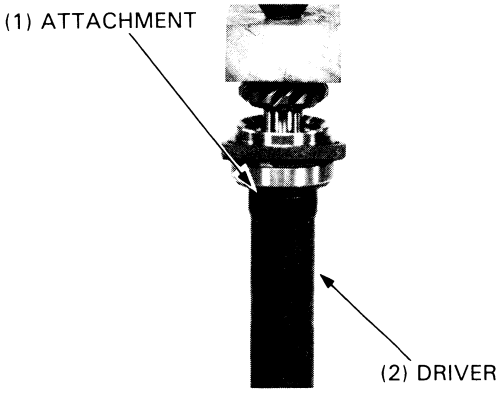
NOTE

- The countershaft and driven gear must be replaced as a set.

Place the tools in the press and mount the attachment correctly on the bearing inner race.
Press the countershaft into the bearing.

TOOLS:

ATTACHMENT	**07746—0030200**
DRIVER	**07746—0030100**



NOTE

- Place the threaded end of the pilot into the countershaft.

Place the adjustment shim over the bearing holder.

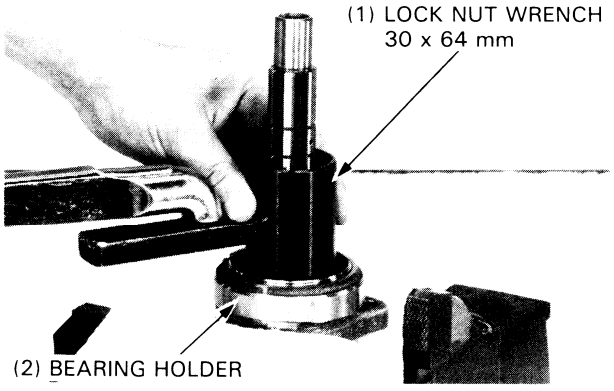
NOTE

- If the countershaft/driven gear, bearing or gear case are replaced, a new adjustment shim must be selected (page 11-15 Backlash inspection).

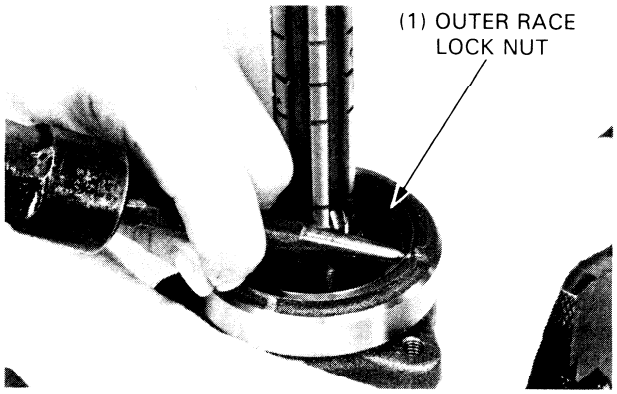
Place the bearing holder in a vise with soft jaws and install and tighten a new outer race lock nut to the specified torque value.

TOOL:
LOCK NUT WRENCH, 30 x 64 mm 07916—MB00000

TORQUE:
Actual: 90—110 N·m (9.0—11.0 kg-m, 65—80 ft-lb)
Indicated: 80—100 N·m (8.0—10.0 kg-m, 58—73 ft-lb)

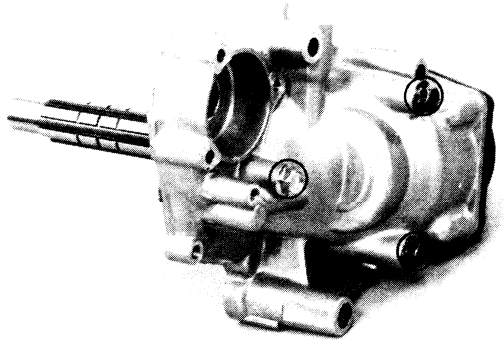


Stake the outer race lock nut with a punch.



Place the countershaft/bearing holder and correct shim into the output gear case.
Install the bolts and sealing washers with the cover bracket. Tighten the bolts in a crisscross pattern until the drive gear bearing holder seats against the case, then tighten to the specified torque.

TORQUE: 30—34 N·m (3.0—3.4 kg-m, 22—25 ft-lb)



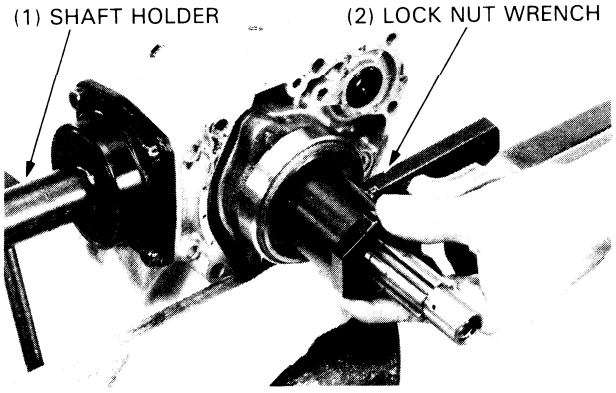
Place the case into a vise with soft jaws.

Place the shaft holder tool on the output driven gear shaft wedging it against the vise to lock the shaft.

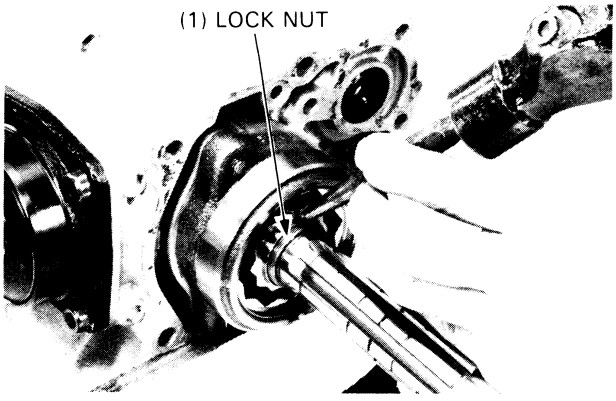
Install and tighten a new countershaft nut to the specified torque.

TOOLS:
SHAFT HOLDER 07923—6890101
LOCK NUT WRENCH, 30 x 64 mm 07916—MB00000

TORQUE:
Actual: 70—80 N·m (7.0—8.0 kg-m, 51—58 ft-lb)
Indicated: 64—73 N·m (6.4—7.3 kg-m, 46—53 ft-lb)



Stake the countershaft locknut with a punch.
Remove the countershaft bearing holder bolts and holder from the output gear case.

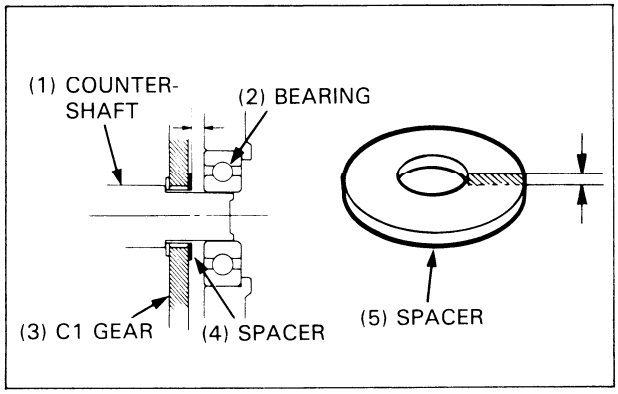


COUNTERSHAFT INSPECTION

NOTE

Countershaft spacer selection should be performed whenever you replace any of the following parts:
- Crankcase
- Countershaft bearing
- Countershaft

Install the output gear case assembly and new gasket onto the lower case.
Assemble the transmission with the original spacer.



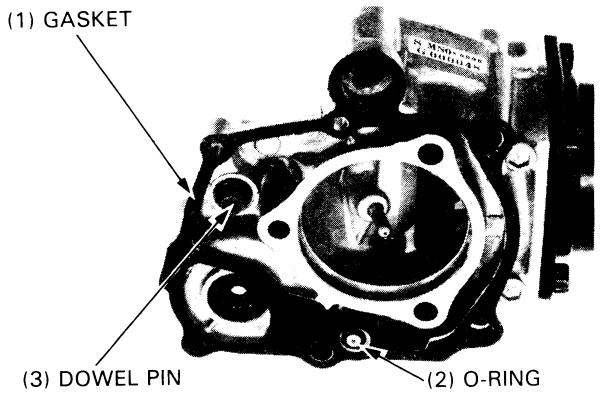
Measure the clearance between the bearing and spacer with a feeler gauge.

CLEARANCE: 0.3—0.4 mm (0.012—0.016 in)

If the clearance exceeds the limit, select a spacer to obtain the correct clearance.

SPACER THICKNESS:

A: 1.05 mm (0.041 in)	**C: 0.90 mm (0.035 in)**
B: 0.95 mm (0.037 in)	**D: 0.85 mm (0.033 in)**

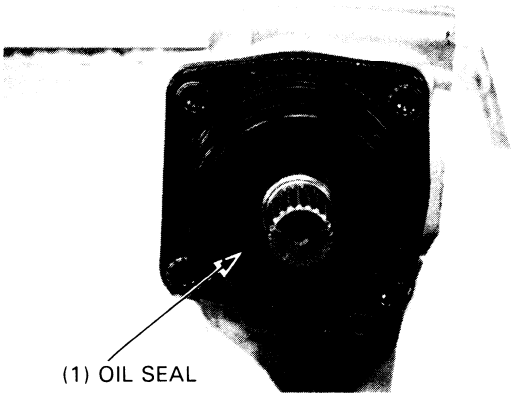


OUTPUT DRIVEN GEAR

REMOVAL

Remove the output driven gear from the crankcase (Section 10).
Remove the dowel pin and O-ring.
Remove the output driven gear case gasket.

Remove the output driven gear oil seal from the case.
Place the output gear case in a vise at the shift shaft spindle boss.

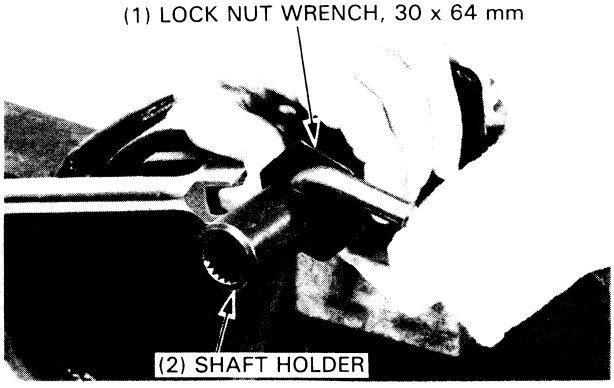


Place the shaft holder tool on the output driven gear shaft wedging it against the vise to look the shaft.

Unstake and loosen the output driven gear bearing inner race lock nut.

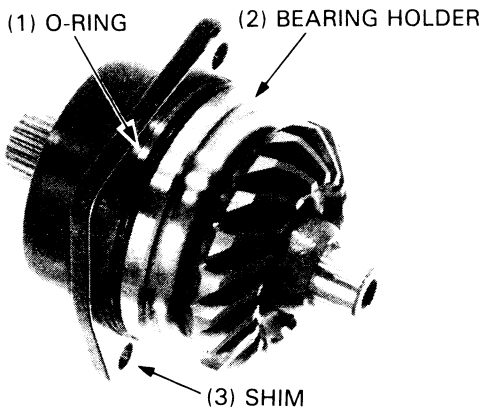
TOOLS:

LOCK NUT WRENCH, 30 x 64 mm	**07916—MB00000**
SHAFT HOLDER	**07916—6890101**

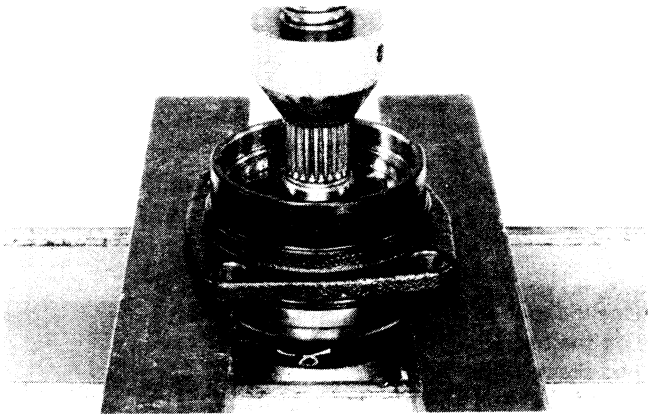


Remove the driven gear bearing holder mounting bolts and remove the gear and holder from the case.

Remove the shim and O-ring from the bearing holder.



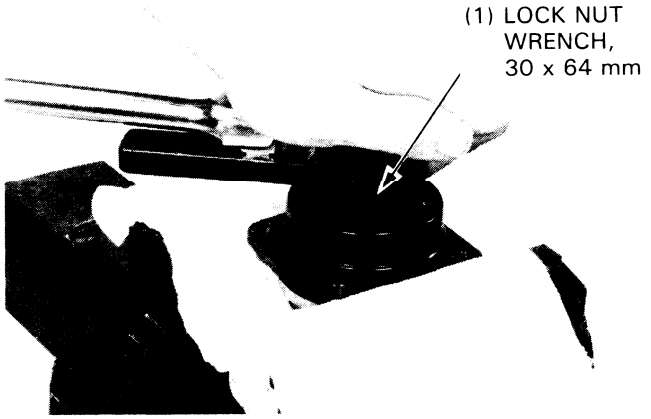
Press the output driven gear from the holder.



BEARING REPLACEMENT

Clamp the output driven gear bearing holder in a vise with soft jaws. Unstake and remove the output driven gear bearing outer race lock nut from the holder.

TOOL:
LOCK NUT WRENCH, 30 x 64 mm 07916—MB00000



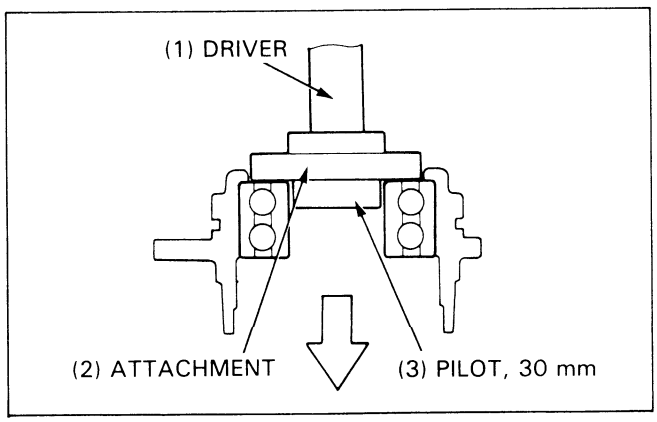
Place the bearing holder in a press with the special tools shown and press the bearing out.

NOTE

- Be careful not to damage the bearing holder gear case mating surface.

TOOLS:

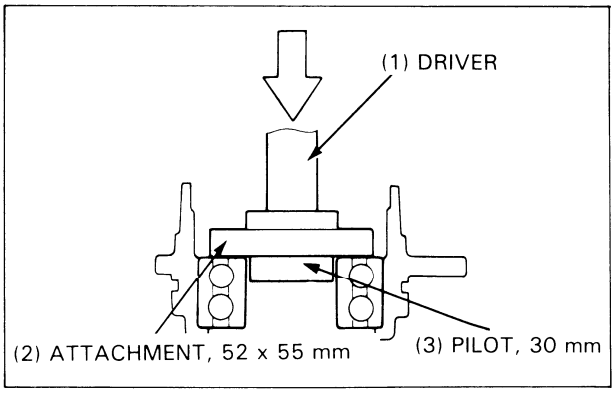
DRIVER	**07749—0010000**
PILOT, 30 mm	**07746 0040700**
ATTACHMENT, 52 x 55 mm	**07746—0010400**



Drive the new bearing into the bearing holder and make sure it rotates freely.

TOOLS:

DRIVER	**07749—0010000**
PILOT, 30 mm	**07746—0040700**
ATTACHMENT, 52 x 55 mm	**07746—0010400**

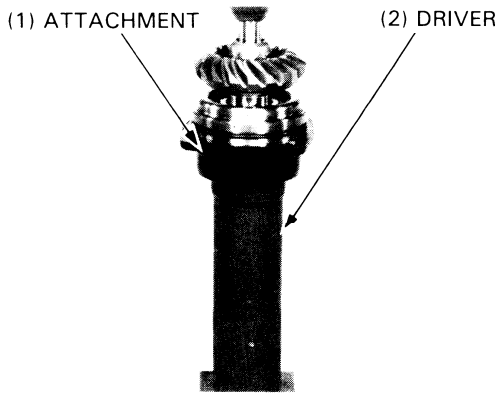


INSTALLATION

NOTE

- Remove the center guide from the dis/assembly tool before using.
- When the gear set, driven gear bearing and/or gear case has been replaced, use a shim 0.30 mm (0.012 in) thick for initial reference.

Place the tools in the press and mount the attachment correctly on the bearing inner race.
Then press in the output driven gear.
Install the O-ring and correct shim.



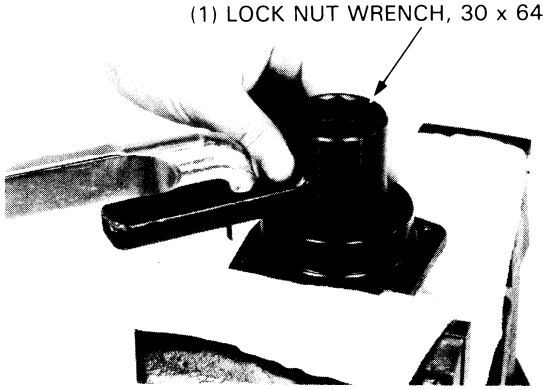
TOOLS:

ATTACHMENT, 25 mm	**07746—0030200**
DRIVER	**07746—0030100**

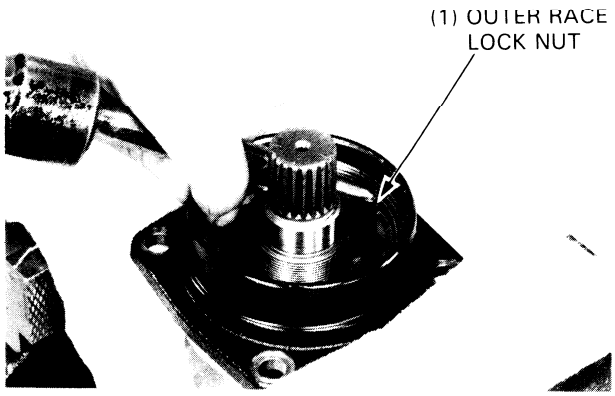
Clamp the bearing holder in a vise with soft jaws.
Install and tighten a new bearing outer race lock nut to the specified torque value.

TOOL:
LOCK NUT WRENCH, 30 x 64 mm 07916—MB00000

TORQUE:
Actual: 90—110 N·m (9.0—10.0 kg-m, 65—80 ft-lb)
Indicated: 80—110 N·m (8.0—11.0 kg-m, 58—80 ft-lb)



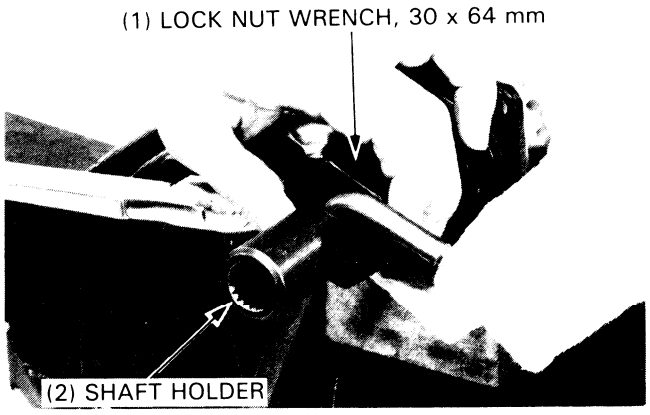
Stake the outer race lock nut with a punch.



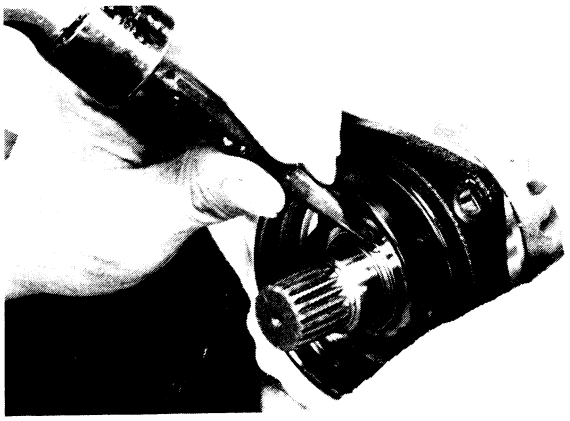
Install a new bearing inner race lock nut and tighten it to the specified torque.

TOOLS:
LOCK NUT WRENCH, 30 x 64 mm 07916—MB00000
SHAFT HOLDER 07916—6890101

TORQUE:
Actual: 70—80 N·m (7.0—8.0 kg-m, 51—58 ft-lb)
Indicated: 64—73 N·m (6.4—7.3 kg-m, 46—53 ft-lb)

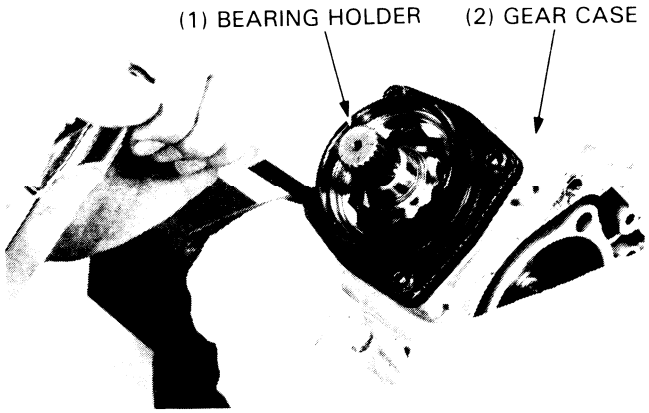


Stake the inner race lock nut with a punch.

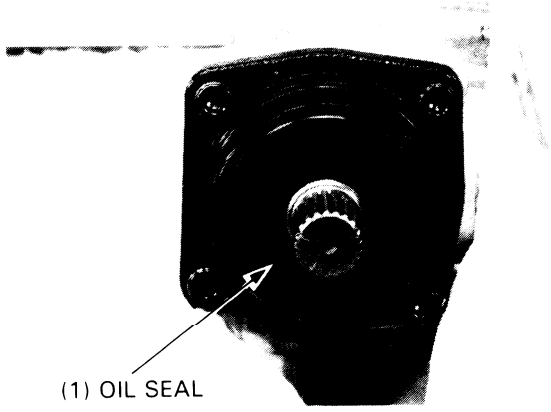


Attach the bearing holder to the gear case with the four hex bolts. Tighten the bolts in a crisscross pattern in two or more steps.

TORQUE: 30—34 N·m (3.0—3.4 kg-m, 22—25 ft-lb)



Install a new oil seal.

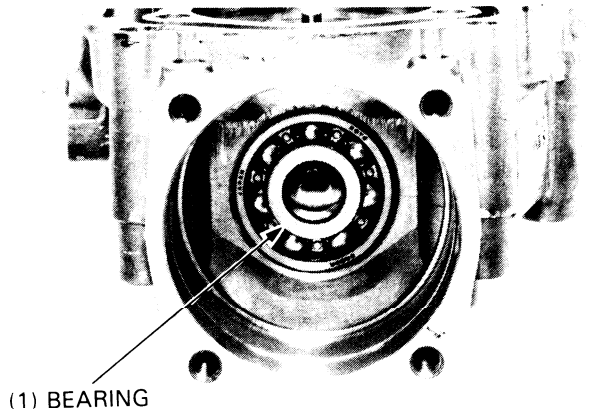


GEAR CASE BEARING REPLACEMENT

Remove the four hex bolts and output driven gear.
Heat the output gear case around the bearing to 80°C (176°F).

CAUTION

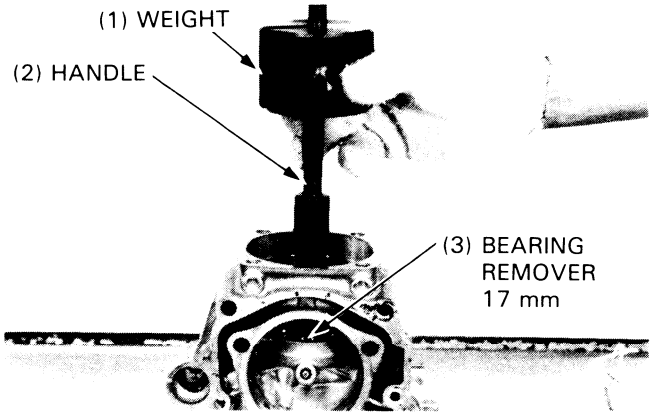
- *Always wear gloves when handling a heated gear case.*



Remove the bearing with the bearing remover.

TOOLS:

WEIGHT	**07936—3710200**
HANDLE	**07936—3710100**
BEARING REMOVER, 17 mm	**07936—3710300**

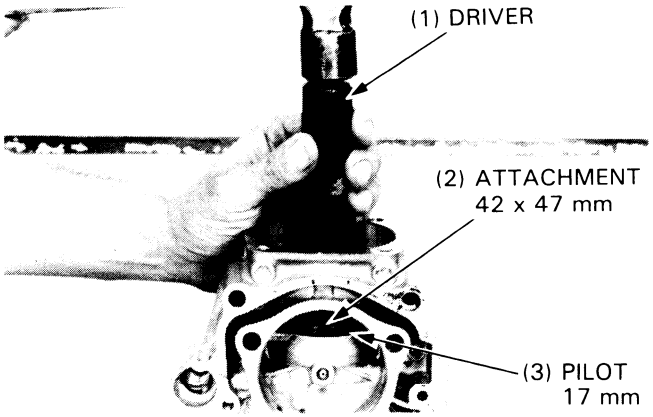


Drive a new bearing into the output gear case.

TOOLS:

DRIVER	**07749—0010000**
ATTACHMENT, 42 x 47 mm	**07746—0010300**
PILOT, 17 mm	**07746—0040400**

Install the bearing holder in the reverse order of removal.

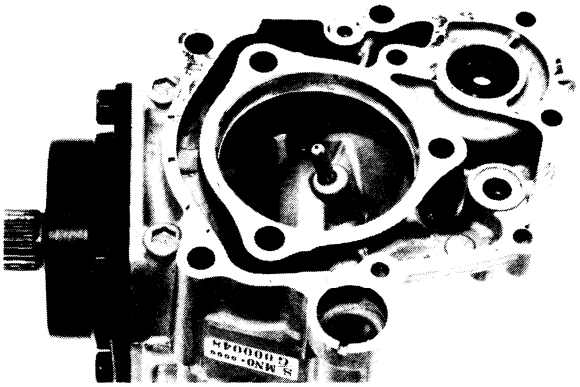


GEAR TOOTH CONTACT PATTERN CHECK

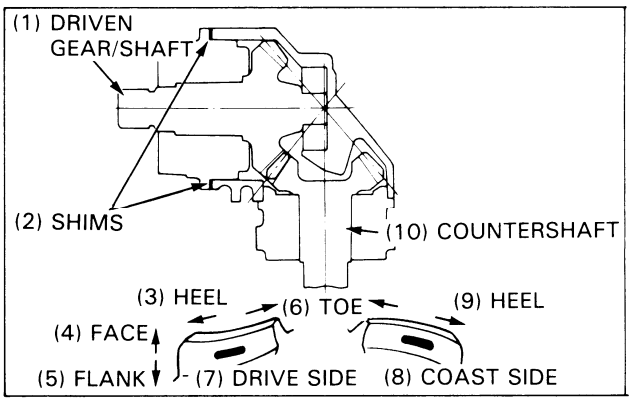
Remove the drive and driven gears (page 11-6).
Apply Prussian Blue to the driven gear teeth.

Install the drive and driven gears with the standard shims.

Rotate the drive gear several times in the normal direction of rotation.
Check the gear tooth contact pattern after removing the drive gear.



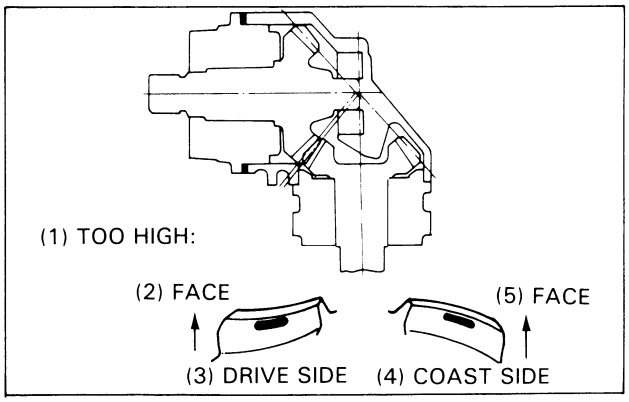
Contact is normal if Prussian Blue is transfered to the approximate center of each tooth and slightly to the side.



If the pattern is not correct, remove and replace the driven gear adjustment shim.
Replace the shim with a thinner one if the contact pattern is too high.

Replace the driven gear adjustment shim with a thicker one if the contact is too low.

The pattern will shift about 1.5—2.0 mm (0.06—0.08 in) when the thickness of the shim is changed by 0.10 mm (0.04 in).

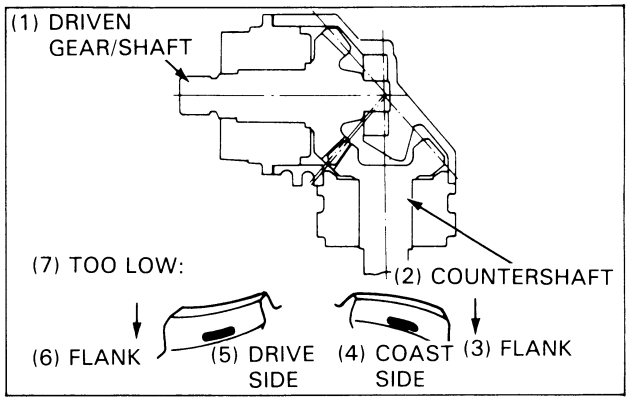


OUTPUT DRIVEN GEAR ADJUSTMENT SHIMS
- **A: 0.40 mm (0.016 in)**
- **B: 0.45 mm (0.018 in)**
- **C: 0.50 mm (0.020 in) STANDARD**
- **D: 0.55 mm (0.022 in)**
- **E: 0.60 mm (0.024 in)**

BACKLASH INSPECTION

Clamp the output gear case in a vise that has soft jaws or use a shop towel.

Set a horizontal type dial indicator on the countershaft as shown.
Hold the driven gear with the shaft holder and rotate the countershaft by hand until gear slack is taken up.

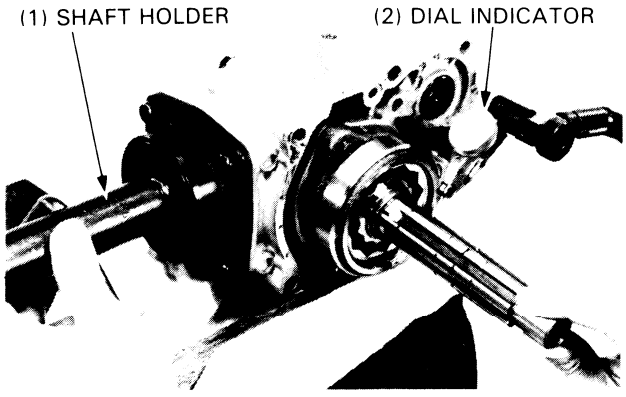


TOOL:
SHAFT HOLDER **07923—6890101**

Turn the countershaft back and forth to read backlash.

STANDARD: 0.08—0.23 mm (0.003—0.009 in)

SERVICE LIMIT: 0.40 mm (0.016 in)



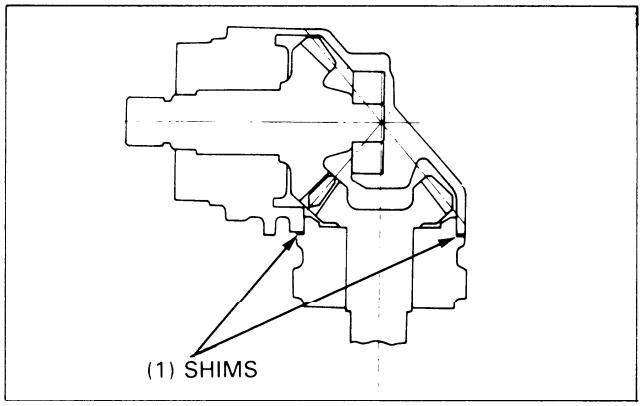
Remove the dial indicator. Turn the countershaft 120° and measure backlash. Repeat this procedure once more.
Compare the difference of the three measurements.

DIFFERENCE OF MEASUREMENTS SERVICE LIMIT:
0.10 mm (0.004 in)

If the difference in measurements exceeds the limit, if indicates that the bearing is not installed squarely. Inspect the bearings and reinstall if necessary.

If backlash is excessive, replace the countershaft gear adjustment shim with a thinner one.
If the backlash is too small, replace the countershaft shim with a thicker one.

Backlash is changed by about 0.06—0.07 mm (0.002—0.003 in) when the thickness of the shim is changed by 0.10 mm (0.004 in).



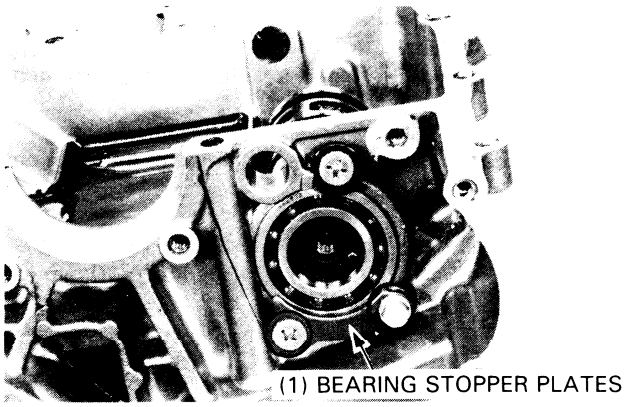
COUNTERSHAFT/OUTPUT DRIVE GEAR ADJUSTMENT SHIMS:

A: 0.40 mm (0.016 in)
B: 0.45 mm (0.018 in)
C: 0.50 mm (0.020 in) STANDARD
D: 0.55 mm (0.022 in)
E: 0.60 mm (0.024 in)

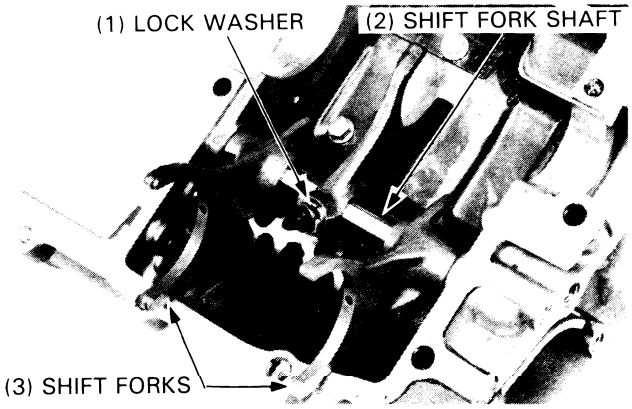
SHIFT FORK AND SHIFT DRUM

REMOVAL

Separate the crankcase (Section 10).
Remove the mainshaft assembly.
Remove the bearing stopper plates.

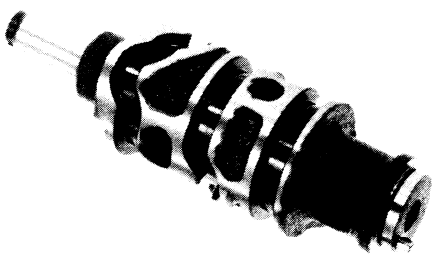


Bend the lock washer tab down and remove the center fork mounting bolt.
Remove the shift fork shaft and shift forks.
Remove the shift drum.

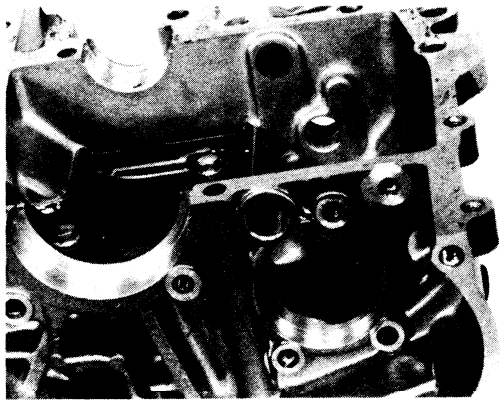


INSPECTION

Gear Shift Drum
Inspect the shift drum for scoring, scratches, or evidence of insufficient lubrication.
Check the shift drum grooves for damage.



Inspect the shift drum hole and shift fork shaft hole for scoring or scratches.

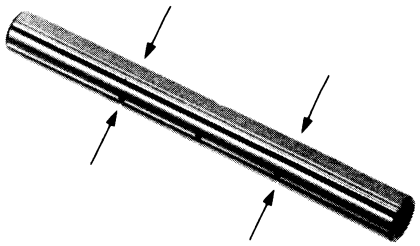


Shift Fork Shaft

Measure the shift fork shaft O.D. at the right and left shift fork surfaces.

Chcek for scratches, scoring or evidence of insufficient lubrication.

SERVICE LIMIT: 13.90 mm (0.547 in)



Shift Fork

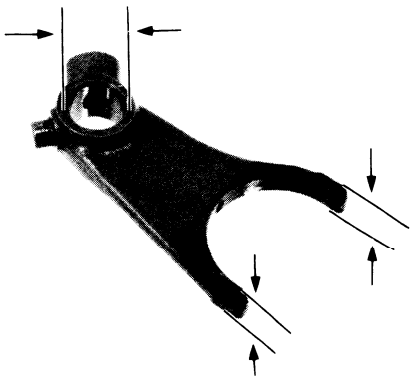
Measure the right and left shift fork I.D.

Measure the shift fork claw thickness.

SERVICE LIMITS:

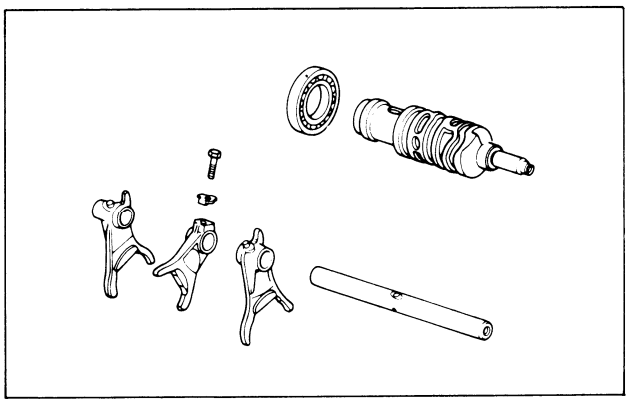
I.D. (right and left forks): 14.04 mm (0.553 in)

CLAW THICKNESS: 6.1 mm (0.24 in)



INSTALLATION

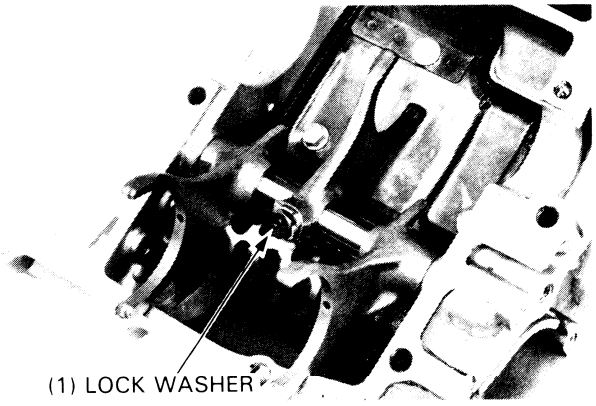
Install the shift drum and shift fork.



Install the lock washer and tighten the center fork bolt.

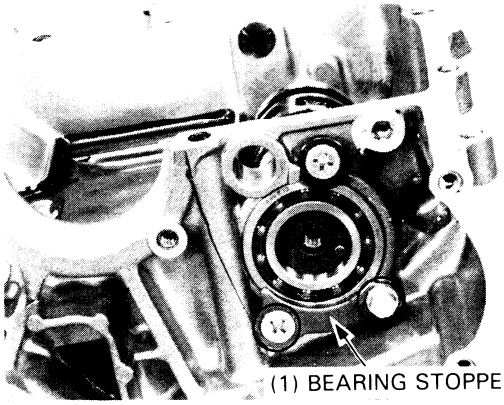
TORQUE: 16—20 N·m (1.6—2.0 kg-m, 12—14 ft-lb)

Bend the lock washer tabs up.



Apply a locking agent to the screw threads and install the bearing stopper plates.
Tighten the screwsfirst, then tighten the bolt.

TORQUE: 7—11 N·m (0.7—1.1 kg-m, 5—8 ft-lb)



TRANSMISSION ASSEMBLY

Clean all parts in solvent and dip them in clean engine oil.

NOTE

- Align the circlip end gaps with the shaft grooves. Note the installation direction.

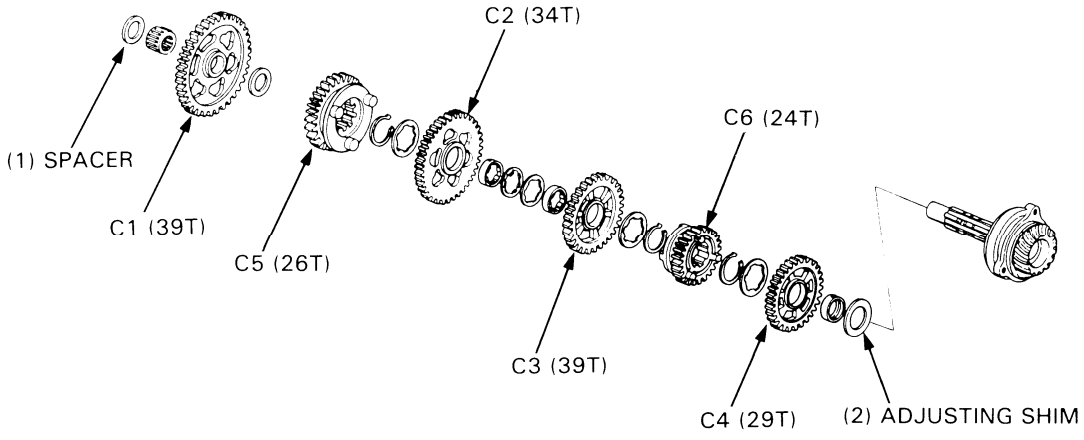
CAUTION

- *Align the oil holes in the splined bushings with the oil holes in the shaft.*

COUNTERSHAFT

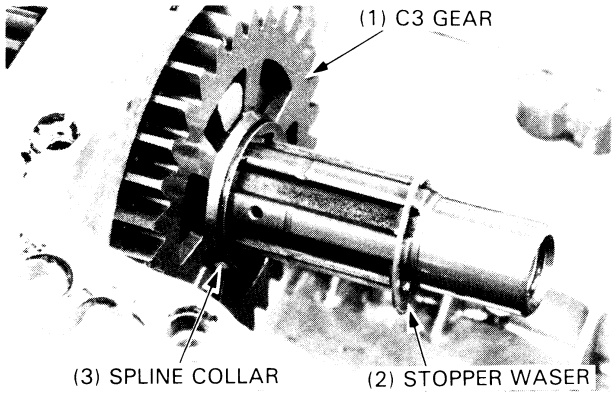
Before installing the countershaft in the crankcase, install the C4 and C6 with the snap rings.

Align the hole in the C3 gear bushing with the hole in the countershaft.

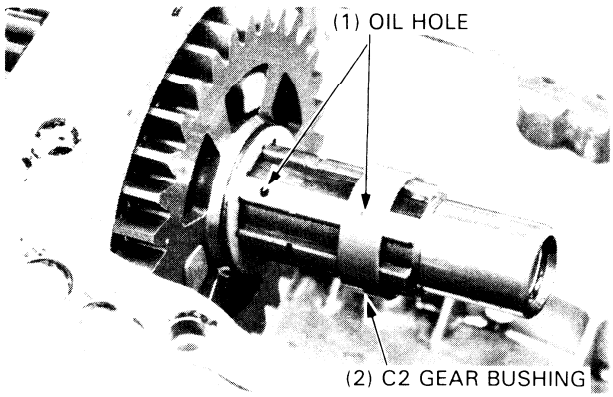


Clean the oil passages and orifice with compressed air.

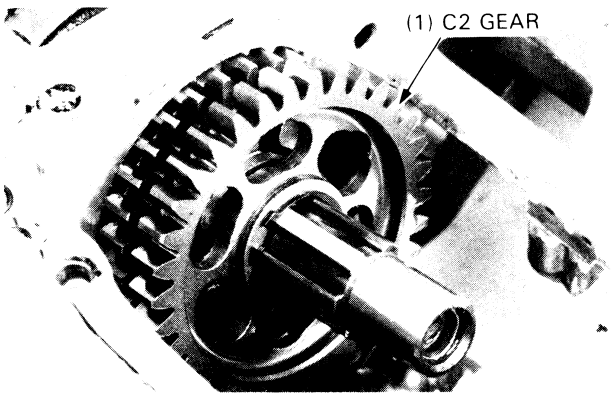
Install the C3 gear and spline collar.
Install the stopper washer while aligning its tab with the groove in the spline collar.



Align the oil hole in the C2 gear bushing with the oil hole in the countershaft.



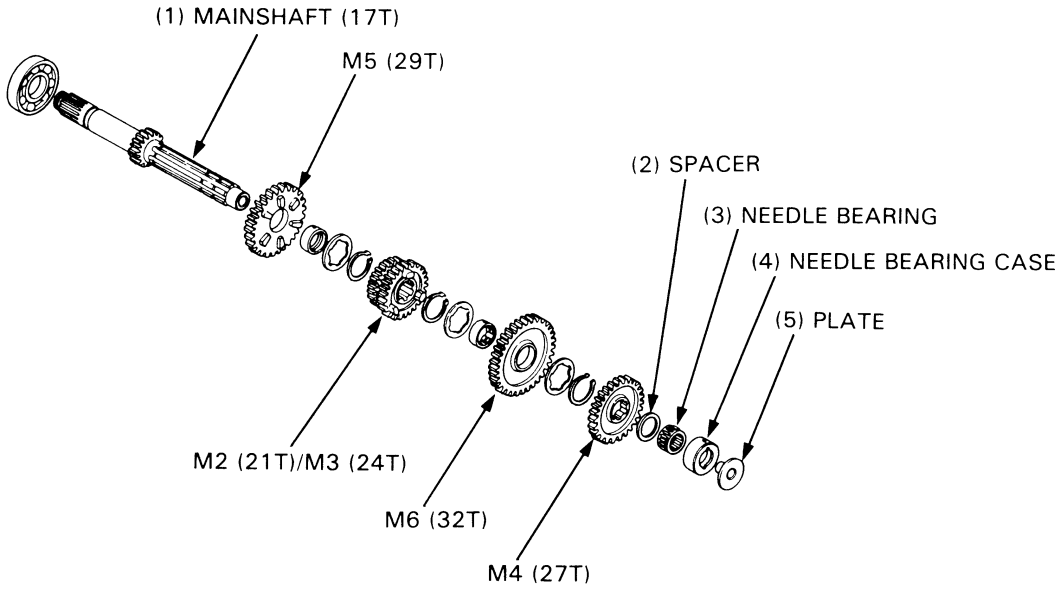
Install the C2 gear and spline collar with the snap ring.
Assemble the C5 and C1 gears, washer and collars.



MAINSHAFT

Assemble the mainshaft as shown.

Check the gears for freedom of movement and rotation on the shaft.
Check that the snap rings are seated in the grooves.



Align the hole in the M6 gear bushing with the hole in the mainshaft.