Chapter Eleven

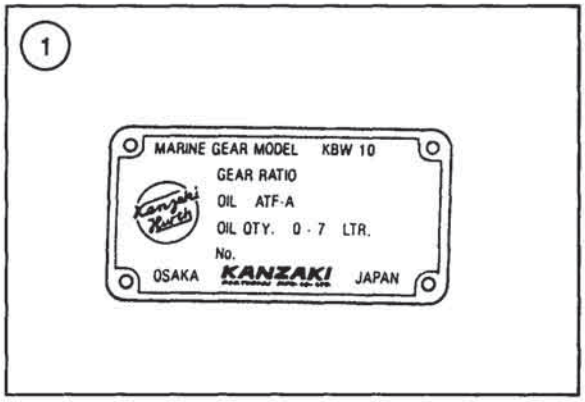
Transmission—KBW Series

This chapter covers the Kanzaki Hurth KBW10D and KBW10E marine transmissions that are attached to Yanmar 3GM, 3HM and 3HM35 engines. Refer to **Table 1** for a cross-reference of engine and transmission models. The identification plate (**Figure 1**) located on the transmission case specifies the transmission model.

The KBW10 series transmissions covered in this chapter are inline transmissions that provide forward and reverse direction. All gears are constant mesh. A plate-type clutch engages the gears to transmit power to the output shaft. Oil contained in the transmission case lubricates the internal transmission components.

Refer to Chapter Three for maintenance information.

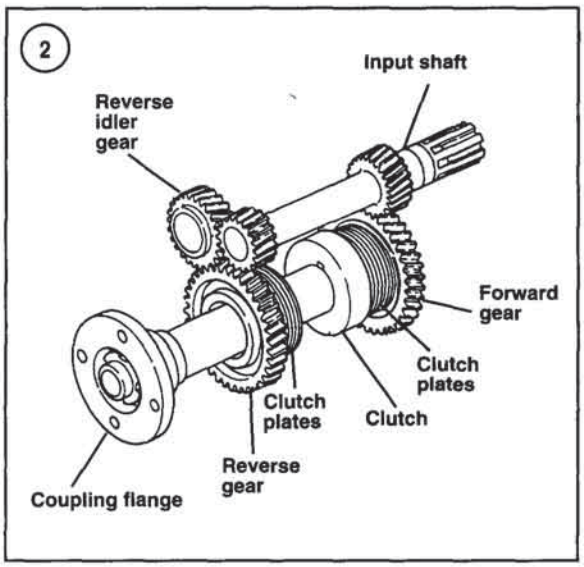
Tables 1-3 are located at the end of this chapter.



OPERATION

The input shaft on the transmission engages the drive disc attached to the engine flywheel. Because this is a constant-mesh transmission, engine power is transmitted to all gears. Power flows to the output shaft when the clutch engages either the forward gear or the reverse gear. The clutch contacts a clutch pack of several discs adjacent to the forward and reverse gears. In **Figure 2**, the clutch is shown engaged with the forward gear. Because power flows from the input shaft gear through the reverse idler gear to the reverse gear, the reverse gear rotates in the opposite direction of the forward gear. When the clutch engages the reverse gear, the output shaft rotates in reverse.

Moving the shift lever rotates the shift shaft. When the shift shaft rotates, the shifter fork slides the shift ring into engagement with the forward or reverse gear clutch. The drive hub on the output shaft transfers power from the selected clutch to the output shaft.



REMOVAL/INSTALLATION

The following procedure addresses units that are accessible. In some cases, it may be necessary to remove the engine and transmission as a unit before removing the transmission from the engine. Refer to Chapter Six if engine removal is necessary.

1. If not previously disconnected, disconnect the remote control cable from the transmission shift lever.
2. If not previously disconnected, disconnect the drive coupling from the transmission drive flange.
3. Remove the bolts that secure the transmission to the engine bellhousing.
4. Remove the transmission from the engine.
5. Reinstall the transmission by reversing the removal procedure. Make sure to align the splines on the transmission input shaft and the drive disc during installation. Tighten the transmission retaining bolts to the torque specified in **Table 2**.

OVERHAUL

Refer to **Figure 3**.

NOTE

Overhaul of the KBW transmission requires special tools, which can be obtained from Yanmar or fabricated. If the special tools are not available, have a Yanmar dealership overhaul the transmission.

Disassembly

1. Remove the drain plug and drain the transmission oil.
2. Position the transmission in a vise with soft jaws so the input shaft is held by the vise jaws.
3. The output flange retaining nut is staked. Use a chisel to cut away the staked portion so the nut will rotate.
4. Install a tool that will prevent rotation of the output flange.
5. Unscrew the output flange retaining nut.
6. Remove the oil dipstick.
7. Make match marks on the shifter cover and the transmission case so the shifter can be installed in its original position.
8. Remove the shifter retaining bolts and remove the shifter assembly.
9. Remove the transmission from the vise.
10. Using an 8 mm Allen wrench, remove the shift bar retaining plug (68, **Figure 3**) in the rear of the case.
11. Install a 10 mm bolt into the end of the shift bar, then pull the shift bar (58, **Figure 3**) out of the case while also removing the shift fork (57).
12. Remove the transmission mounting flange retaining bolts.

NOTE

In Step 13, position the transmission so the transmission input shaft is up when removing the mounting flange so the transmission shafts will not fall out.

13. Tap on the mounting flange using a soft-faced hammer to dislodge the flange. Position the transmission with the input shaft up, then remove the flange from the transmission case.
14. Remove the output shaft assembly from the transmission case and set aside for disassembly.
15. Remove the intermediate shaft assembly from the transmission case and set aside for disassembly.
16. Remove the input shaft assembly from the transmission case and set aside for disassembly.
17. Using a large screwdriver, pry out the oil seal in the transmission case. Be careful not to damage the case or the adjacent bearing race.
18. Using a large screwdriver, pry out the oil seal in the transmission mounting flange. Be careful not to damage the case or the adjacent bearing race.
19. If inspection indicates additional disassembly is necessary, refer to the following sections.

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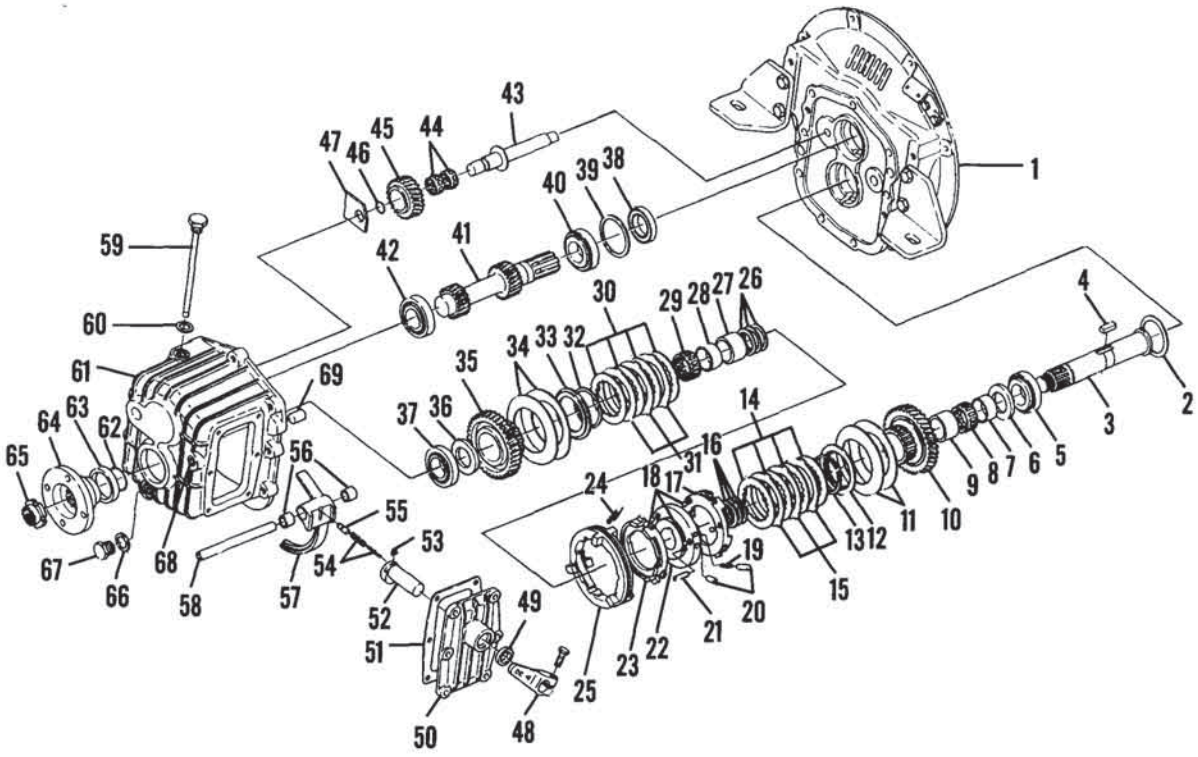
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TRANSMISSION

1. Mounting flange
2. Shim
3. Output shaft
4. Key
5. Bearing
6. Thrust washer
7. Bearing inner race
8. Bearing
9. Spacer
10. Forward gear
11. Belleville springs
12. Retainer
13. Snap ring
14. Friction plates
15. Steel plates
16. Shims
17. Pressure plate
18. Balls (3)
19. Spring
20. Detent pins
21. Alignment pin
22. Driving plate
23. Pressure plate
24. Return spring
25. Shift ring
26. Shims
27. Spacer
28. Inner bearing race
29. Bearing
30. Friction plates
31. Steel plates
32. Snap ring
33. Retainer
34. Belleville washers
35. Reverse gear
36. Thrust washer
37. Bearing
38. Seal
39. Shim
40. Bearing
41. Input shaft
42. Bearing
43. Intermediate shaft
44. Roller bearings
45. Idle gear
46. O-ring
47. Thrust washer
48. Shift lever
49. Seal
50. Shifter cover
51. Gasket
52. Shift shaft
53. Snap ring
54. Springs
55. Detent pin
56. Bearings
57. Shift fork
58. Shift bar
59. Oil dipstick
60. Gasket
61. Case
62. O-ring
63. Seal
64. Flange
65. Nut
66. Gasket
67. Drain plug
68. Plug
69. Dowel pin

Input shaft

1. Check the gear teeth for excessive wear, corrosion or rust and mechanical damage. Check the teeth for galling, chips, cracks, missing pieces, distortion or discoloration from overheating. Replace the input shaft if the gears are damaged.
2. Inspect the input shaft bearings and seal surfaces for excessive wear, grooves, metal transfer and discoloration from overheating. Use a press to remove damaged bearings and to install new bearings.

NOTE

*Shims (39, **Figure 3**) behind the outer bearing race in the mounting flange determine bearing preload for the input shaft bearings. Save the shims and reinstall them if reusing the original parts.*

3. Inspect the input shaft bearing outer races in the transmission case and mounting flange. If either race is damaged or excessively worn, remove it using a suitable puller.

Intermediate shaft

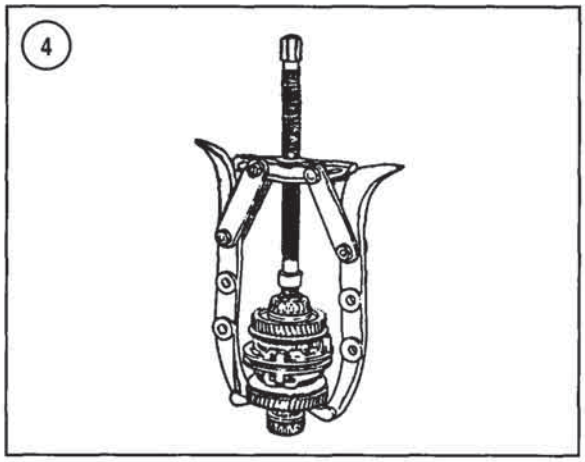
1. Remove and discard the O-ring (46, **Figure 3**) at the end of the shaft.
2. Remove the thrust washer (47, **Figure 3**), idle gear (45) and roller bearings (44).
3. Inspect the bearings, shaft and reverse idler gear inside diameter for excessive wear, grooves, metal transfer and discoloration from overheating. If necessary, replace the shaft, gear and bearings.
4. Check the idler gear teeth for excessive wear, corrosion or rust and mechanical damage. Check the teeth for galling, chips, cracks, missing pieces, distortion or discoloration from overheating. If necessary, replace the gear.
5. Reassemble the intermediate shaft. Install a new O-ring on the shaft. Check that the idler rotates freely on the shaft.

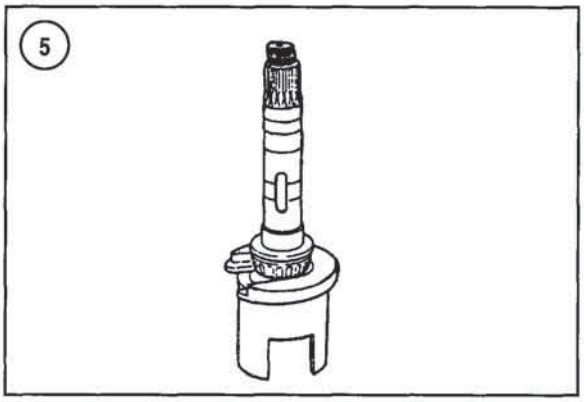
Output shaft

NOTE

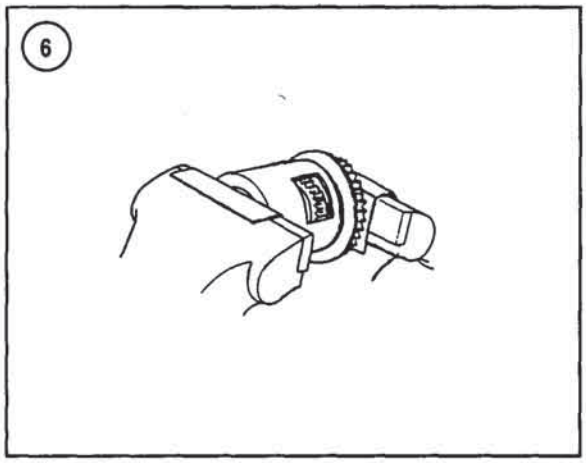
Exercise care when using the puller in Step 1. Make sure the threads on the output shaft are not damaged.

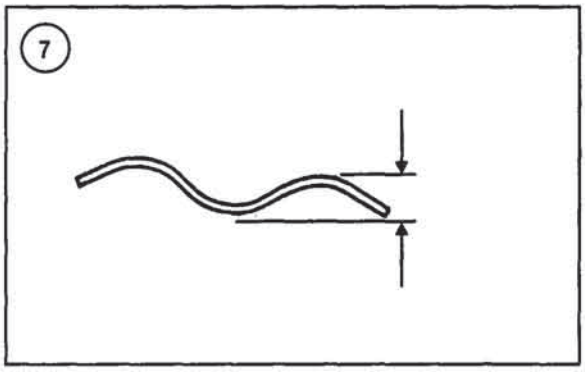
1. Using a suitable puller, remove the output shaft from the forward and reverse gear assemblies as shown in **Figure 4**. Do not mix the forward gear parts and reverse gear parts.





2. Remove the spacer (9, **Figure 3**) and the bearing inner race (7) from the output shaft.
3. Hold the threaded end of the output shaft so the threads are protected.
4. Place the outer race onto the front bearing inner race. Using a suitable bearing driver, gently drive the inner bearing race away from the shaft collar approximately 10 mm.
5. Place a pulling support plate (such as Yanmar special tool 17099-09030) between the collar of the output shaft and bearing.
6. Use Yanmar special tool 17095-09070, or a suitable equivalent tool, to press the bearing off the shaft, as shown in **Figure 5**.
7. Remove the clutch friction plates (14, **Figure 3**) and steel plates (15) from the forward gear (10).
8. Use Yanmar special tool 17095-09070, or an equivalent tool, to compress the Belleville springs (11, **Figure 3**) and remove the snap ring from the forward gear, as shown in **Figure 6**.





9. Refer to Steps 7 and 8 and disassemble the clutch components on the reverse gear.
10. Lay the shift ring and pressure plate assembly flat.
11. Remove the pressure plate return springs (24, **Figure 3**), then lift off the top pressure plate (17) and remove the steel balls (18).
12. Lift the shift ring (25, **Figure 3**) and driving plate (22) off the bottom pressure plate and remove the three remaining balls.
13. Slip the shift ring (25, **Figure 3**) off the driving plate (22).
14. Remove the alignment pins (21, **Figure 3**) and detent pins (20) with springs (19) from the driving plate (22).

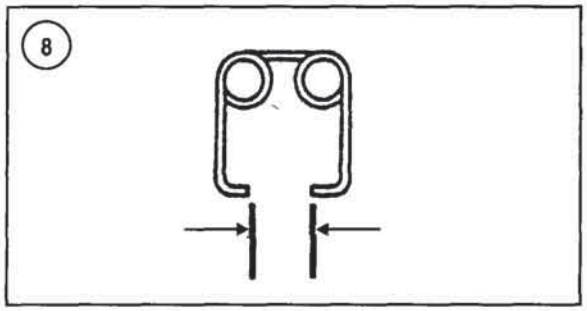
Inspection

1. Check the gear teeth for excessive wear, corrosion or rust and mechanical damage. Check the teeth for galling, chips, cracks, missing pieces, distortion or discoloration from overheating. Check the splines for excessive wear or damage. Replace the gears if damaged.
2. Inspect the output shaft bearings and seal surfaces for excessive wear, grooving, metal transfer and discoloration from overheating.
3. Inspect the key and output shaft keyway for damage.

NOTE

Shims behind the outer bearing race in the mounting flange determine bearing preload for the output shaft bearings. Save the shims and reinstall them if reusing the original parts.

4. Inspect the input shaft bearing outer races in the transmission case and mounting flange. If either race is damaged or excessively worn, remove it using a suitable puller.
5. Measure steel plate warpage as shown in **Figure 7** and compare the result with the specification in **Table 3**.
6. Measure the width of the steel plates tangs and compare the result with the specification in **Table 3**.
7. Measure the width of the grooves in the pressure plates and compare the result with the specification in **Table 3**. The clearance between the tangs and the grooves should be 0-0.6 mm (0-0.024 in.).
8. Measure the width of the friction plates and compare with the specification in **Table 3**. Both sides of friction plates have a 0.35 mm (0.014 in.) copper sintered layer. Replace the friction plates when the copper layer is worn more than 0.2 mm (0.008 in.) on one side.
9. Measure four friction plates. The sum of wear of four friction plates (forward or reverse) must not exceed 0.8 mm (0.031 in.). If wear exceeds 0.8 mm (0.031 in.), replace all friction plates (forward or reverse).
10. Assemble each set of steel and friction plates. Compress the plates to remove steel plate warp. Measure the assembled plates. The assembled thickness must exceed 10.0 mm (0.394 in.).
11. Measure the backlash between the teeth on the friction plates and the gear splines. The backlash must not exceed 0.9 mm (0.035 in.).
12. Lay the shift ring and pressure plate assembly flat and remove the pressure plate return springs (24, **Figure 3**). Lift off the top pressure plate (17) and remove the steel balls (18).
13. Lift the shift ring (25, **Figure 3**) and driving plate (22) off the bottom pressure plate and remove the three remaining steel balls. Slip the shift ring (25) off the driving plate (22), remove the alignment pins (21) and detent pins (20) with the springs (19) from the driving plate (22).
14. Inspect the pressure plate (17 and 23, **Figure 3**) ball grooves for wear and renew the plate if wear is noticeable.
15. Measure the pressure plate thickness and compare the result with the specification in **Table 3**.



16. Measure the return spring end gap (**Figure 8**) and compare the result with the specification in **Table 3**.

17. Check the driving plate ball grooves (**Figure 9**), detent pin bores, detent pins (A) and keyway (B) for any noticeable wear.

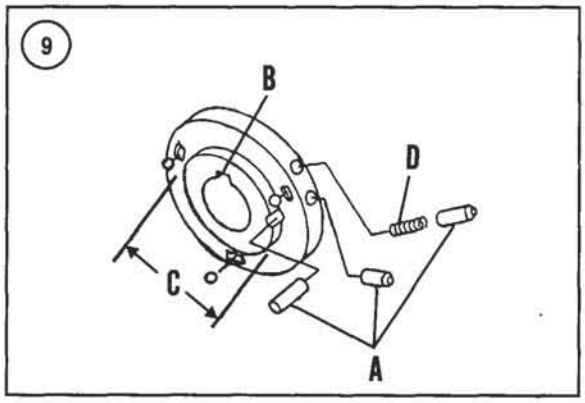
18. Measure the driving plate hub outer diameter (C, **Figure 9**) and compare it with the specification in **Table 3**.

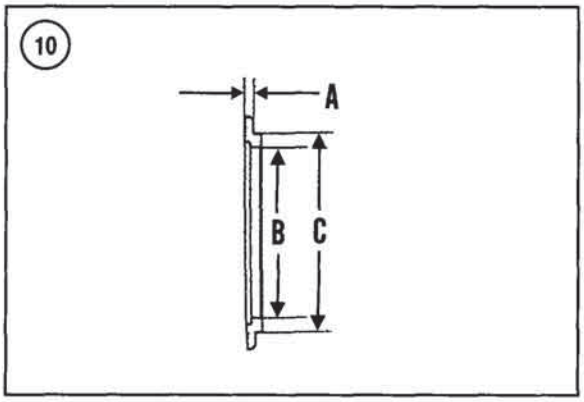
19. Measure detent pin spring (D, **Figure 9**) free length and compare it with the specification in **Table 3**.

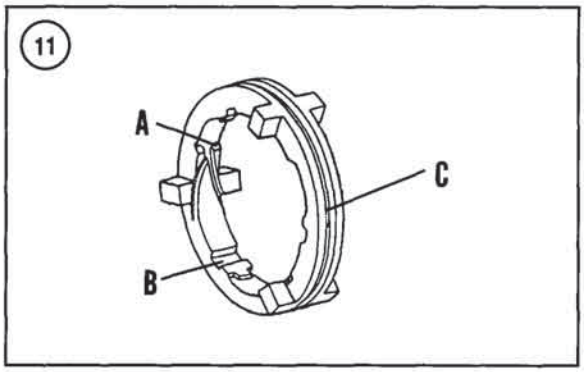
20. Measure the plate spring retainer thickness (A, **Figure 10**) and compare the result with the specification in **Table 3**. Measure the plate spring inside diameter (B) and compare with the specification in **Table 3**. Measure the plate spring shoulder diameter (C) and compare the result with the specification in **Table 3**.

21. Measure the free width of the Belleville springs and compare it with the specification in **Table 3**.

22. Inspect the shift ring pressure grooves (A, **Figure 11**) and pin contact grooves (B) for any signs of excessive wear. Measure the width of the circumferential groove (C) and compare the result with the specification in **Table 3**.







Reassembly

1. Install the Belleville springs on the forward gear so the concave sides face each other as shown in **Figure 12**. Position the retainer (12, **Figure 3**) over the Belleville springs and slide the snap ring onto the spline of the forward gear. Using Yanmar special tool 177095-09070, or a suitable equivalent tool, compress the forward gear assembly in a vise and engage the snap ring in the groove around the forward gear splines.

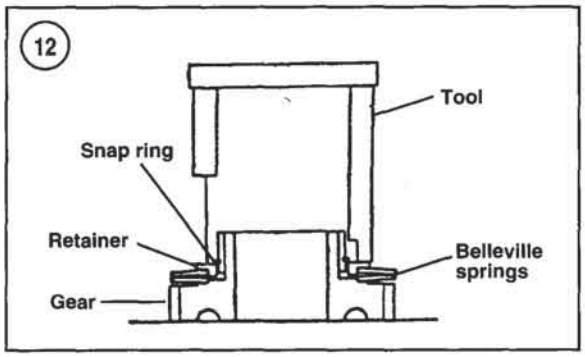
2. Refer to Step 1 and assemble the reverse gear, Belleville springs, retainer and snap ring.

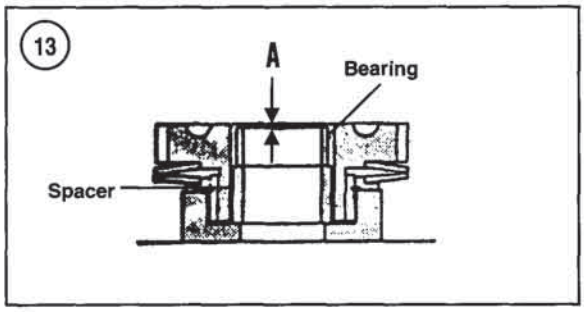
3. To determine the correct thickness of shims (16 and 26, **Figure 3**), install the inner bearing race and spacer in their respective gears. Measure the depth (A, **Figure 13**) of the bearing race from the end of the gear as shown in **Figure 13**. Install shims equal to the depth.

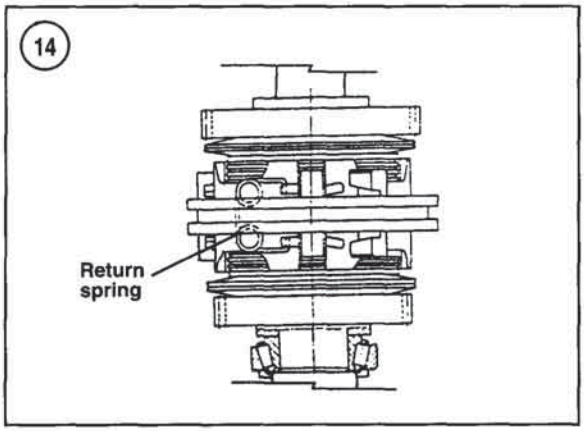
4. Alternately install four friction plates (14, **Figure 3**) and three steel plates (15) on the forward gear (10) splines starting with a friction plate.

5. Refer to Step 4 and assemble the reverse gear, steel plates and friction plates.

6. Using a suitable bearing driver, install the output shaft front bearing onto the shaft. Be sure the bearing inner race contacts the collar on the end of the output shaft.







7. Install the thrust washer on the output shaft with the sintered copper surface facing away from the bearing.

8. Using a suitable bearing driver, install the needle bearing inner race on the output shaft. Be sure the race bottoms against the thrust washer.

9. Install the needle bearing, spacer and shim on the output shaft.

10. Install the forward gear assembly on the output shaft and align the steel plate tangs.

11. Fit the key (4, **Figure 3**) into the slot on the output shaft so the fillet side of the key faces the threaded end of the output shaft.

12. Install the pressure plate, with the ball slots facing up, so the steel plate tangs fit into the three slots in the pressure plate. Make sure the pawls of all three steel plates engage the pressure plate.

13. Install three steel balls into the slots on the pressure plate. Install the drive plate onto the output shaft so the side of the drive plate with concentric groove is facing the forward gear assembly. Make sure all three steel balls remain in place and the grooves of the pressure plate and the drive plate match when the drive plate is installed.

14. Insert both locating pins into the drive plate so they engage the torque limiter slots of the pressure plate.

15. Install the shim, spacer and inner needle bearing race on the ouput shaft using a suitable bearing driver.

16. Insert the detent pins and springs into the drive plate. Install the shift ring over the drive plate so the three legs with grooves are facing the forward gear and the detent pins in the drive plate properly engage the pin slots of the inside diameter of the shift ring.

17. Install three steel balls in the slots of the drive plate and place the pressure plate over the drive plate. Make sure the steel balls remain in position and the slots of both plates match.

18. Install the pressure plate return springs between the shift ring and the drive plate. Attach the spring ends to the small holes inside the pressure plates as shown in **Figure 14**.

19. Install the reverse gear assembly so the tangs of all three steel plates properly engage the slots in the pressure plate.

20. Install the needle bearing and thrust washer with the copper sintered side of the washer facing the reverse gear.

21. Using a suitable bearing driver install the rear output shaft inner race onto the output shaft. Make sure the race bottoms against the thrust washer.

22. Check for smooth rotation of both the forward and reverse gears. Check for correct operation of the shift ring.

Shifter

Refer to **Figure 3**.

NOTE

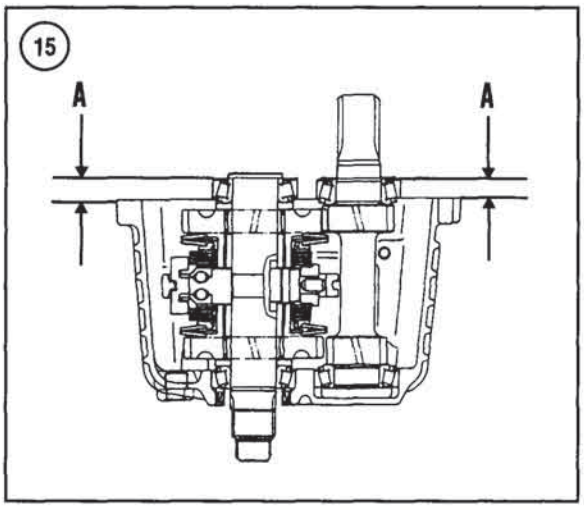
Make alignment marks on the shift lever and shift shaft so the shift lever can be reinstalled in its original position.

1. Loosen the clamp bolt and remove the shift lever.
2. Remove the shift cam.

3. Push in the detent pin, remove the snap ring and remove the pin and springs.
4. Use a screwdriver or suitable tool to pry out the seal.
5. Inspect the shift ring. Check the detent notch for excessive wear that will allow poor clutch engagement.
6. Inspect the detent pin. Replace the pin if it is damaged or excessively worn.
7. The shift ring contact surface of the shift fork is plated with molybdenum. Renew the shift fork if the plating is peeled or the shift fork base metal is exposed.
8. Reassemble the shifter by reversing the disassembly procedure. Install the shift lever so the triangle mark on the lever is out.

Reassembly

1. If removed, install the outer bearing races into the transmission case and mounting flange.
2. Apply sealer to the periphery of the oil seals and install them into the transmission case and mounting flange with the open side to the inside.
3. Install the input shaft into the transmission case.
4. Install the intermediate shaft assembly into the transmission case. Position the thrust washer so the beveled corner is toward the input shaft. Install a new O-ring on the intermediate shaft. Use a soft-faced hammer to tap the shaft into the case.
5. While holding the input shaft out of the way, insert the output shaft assembly into the transmission case. Move the gears into mesh on the intermediate shaft, input shaft and output shaft while installing the output shaft.
6. If the following components have been replaced, refer to the *Bearing Adjustment* section: input shaft, input shaft bearings, output shaft, drive plate, spacer, thrust washers and output shaft bearings. After adjusting the bearings, continue to reassemble the transmission as described in the following steps. If the preceding components have not been replaced, bearing adjustment is not necessary and the orginal shims may be reused. Proceed to the following step.
7. Install the input shaft oil seal.
8. Coat the case mating surface with RTV sealer.
9. Install the mounting flange and tighten bolts evenly.
10. Place the shift ring in neutral position and install the shift fork through the side opening.
11. Insert the shift bar through the hole in the rear of the case while installing the shift fork onto the shift bar.
12. Install the shift bar plug. Make sure the threaded end of the shift bar is installed toward the rear of the case.
13. Install the shifter assembly. Align the marks made during disassembly and tighten the retaining bolts securely. Loosen the shift lever clamp bolt and position the lever so it points up at a 45° angle toward the rear of the transmission. Retighten the clamp bolt.

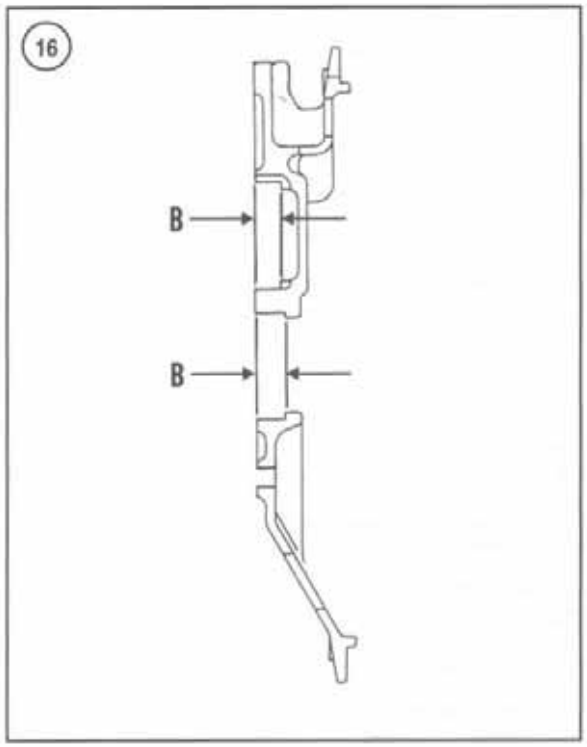


14. Check the operation of the transmission. A click should be audible when the gears are properly engaged. If the gears do not engage, loosen the shifter retaining bolts and reposition the shifter. If improper engagement continues, remove the shifter and check for improper assembly of the shifting components.
15. Install the O-ring on the output shaft.
16. If not previously installed, install the oil seal into the case.
17. Install the coupling flange onto the output shaft. Tighten the retaining nut to the torque specified in **Table 2**.
18. Install the drain plug and oil dipstick.
19. Fill the transmission with the recommended transmission fluid. Refer to Chapter Three.

BEARING ADJUSTMENT

Perform the following procedure if the following components have been replaced: input shaft, input shaft bearings, output shaft, drive plate, spacer, thrust washers and output shaft bearings. This procedure determines the thickness of shims that must be installed so the tapered roller bearings properly contact the bearing outer races.

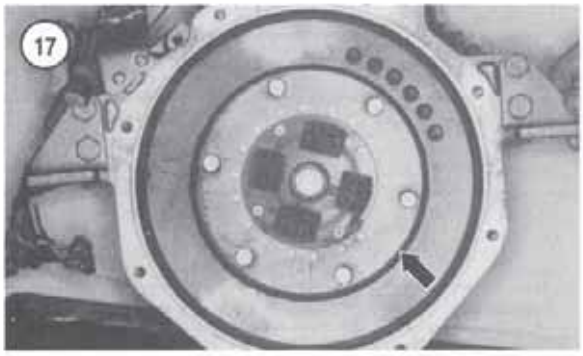
1. Install the input shaft, intermediate shaft and output shafts as described in the *Reassembly* section.
2. Position the transmission case so the open end is up and no pressure is being applied to the splined end of the output shaft.
3. Install the outer bearing races on the input and output shaft tapered bearings.

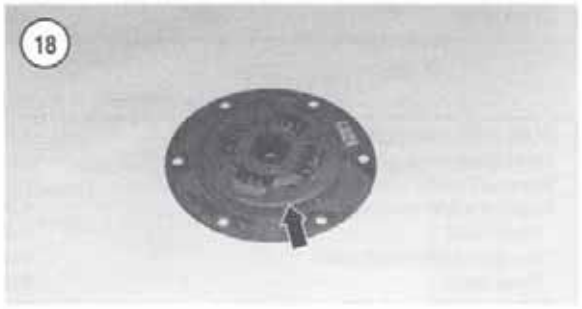


4. Measure the distance (A, **Figure 15**) in millimeters from the mounting flange mating surface on the case to the top of each bearing race. Record the measurements.
5. Measure the distance (B, **Figure 16**) from the mounting flange mating surface to the bottom of the bearing race bore for both the input and output shaft bearings.
6. Subtract the A measurement from the B measurement for each shaft.
7A. Input shaft—From the result obtained in Step 6, subtract 0.0-0.05 mm. This result equals the thickness of the shim(s) that must be installed in the bearing bore in the mounting flange.
7B. Output shaft—From the result obtained in Step 6, subtract 0.0-0.1 mm. This result equals the thickness of the shim(s) that must be installed in the bearing bore in the mounting flange.
8. Install the shim(s) in the bearing bore in the mounting flange, then press the bearing outer race into the mounting flange on top of the shims. Be sure the race is bottomed.

DRIVE DISC

The drive disc attached to the engine flywheel transmits power from the engine flywheel to the transmission input shaft. Bolts secure the disc to the flywheel while the transmission input shaft engages the splined hub on the drive disc. The drive disc incorporates springs that dampen driveline shocks between the engine and transmission.





Removal/Installation

1. Remove the engine from the boat.
2. Remove the transmission.
3. Remove the drive disc (**Figure 17,** typical).
4. Install the drive disc by reversing the removal procedure. Install the drive disc so the side marked FLYWHEEL SIDE (**Figure 18**) is toward the flywheel. Tighten drive disc retaining bolts to the torque specified in **Table 2**.

Inspection

Replace the drive disc if any of the following conditions exist:
1. Broken spring.
2. Worn or damaged splines in hub.
3. Damaged disc.
4. Damaged pins.

Table 1 ENGINE/TRANSMISSION MODELS

Model	Transmission	Transmission ratio (forward gear)
3GM	KBW10D	2.14, 2.63 or 2.83
3HM	KBW10E	2.14 or 2.83
3HM35	KBW10E	2.14 or 2.83

Table 2 TIGHTENING TORQUES

Fastener	N•m	ft.-lb.
Transmission mounting flange	20-25	15-18
Output shaft nut	85-115	63-85
Output flange nut	85-115	63-85
Drive disc	25	18

Table 3 CLUTCH SPECIFICATIONS

Steel plate warpage	1.4-1.7 mm (0.055-0.067 in.)
Steel plate tang width	11.8-12.0 mm (0.464-0.472 in.)
Pressure plate groove width	12.0-12.1 mm (0.472-0.476 in.)
Friction plate thickness	1.70-1.75 mm (0.067-0.069 in.)
Wear limit	1.5 mm (0.059 in.)
Pressure plate thickness	6.4-6.6 mm (0.252-0.260 in.)
Wear limit	6.3 mm (0.248 in.)
Return spring end gap	16.5-17.5 mm (0.650-0.690 in.)
Driving plate hub outer diameter-min.	58.8 mm (2.315 in.)
Detent pin spring free length	32.00-32.85 mm (1.260-1.293 in.)
Plate spring retainer thickness	2.72-2.80 mm (0.107-1.110 in.)
Wear limit	2.60 mm (0.102 in.)
Plate spring retainer inner diameter	65.9-66.0 mm (2.594-2.598 in.)
Wear limit	65.7 mm (2.587 in.)
Plate spring retainer shoulder diameter	57.56-57.606 mm (2.266-2.268 in.)
Wear limit	57.8 mm (2.276 in.)
Belleville spring width	6.15-6.35 mm (0.242-0.250 in.)
Min. width	6.0 mm (0.236 in.)
Shift ring circumferential groove width	6.0-6.1 mm (0.236-0.240 in.)
Wear limit	6.3 mm (0.248 in.)