

SPECIFICATIONS (Continued)

CRANKSHAFT AND FLYWHEEL (Cont'd)

| Crankshaft Diameter | Main Bearing Journal Diameter | Main Bearing Journal Out-of-Round Maximum | Main Bearing Thrust Face Runout TIR Maximum | Main Bearing Journal Taper Maximum per Inch | Thrust Bearing Journal Width | Main and Rod Bearing Journal Finish RMS Maximum | Main Bearing Thrust Face Finish RMS Maximum |
|---------------------|---|---|---|---|---|---|---|
| 0.020 Undersize | 78.811-78.831 mm (3.1028-3.1036 In.) | 0.0056 mm (0.00022 In.) | 0.025 mm (0.001 In.) | 0.0038 mm (0.00015 In.) | 31.509-31.585 mm (1.2405-1.2435 In.) | 10 | 20 |
| 0.030 Undersize | 78.557-78.577 mm (3.0928-3.0936 In.) | 0.0056 mm (0.00022 In.) | 0.025 mm (0.001 In.) | 0.0038 mm (0.00015 In.) | 31.509-31.585 mm (1.2405-1.2435 In.) | 10 | 20 |

CRANKSHAFT AND FLYWHEEL (Continued)

| Crankshaft Diameter | Connecting Rod Journal Diameter ^a | Connecting Rod Journal Taper per Inch Maximum | Crankshaft End Play ^b | Flywheel and Ring Gear Runout | Flywheel and Ring Gear Concentricity |
|---------------------|--|---|---------------------------------------|-------------------------------|--------------------------------------|
| Standard | 63.45-63.47 mm (2.4980-2.4990 In.) | 0.0066 mm (.00026 In.) | 0.063-0.216 mm (0.0025-0.0085 In.) | 0.203 mm (0.008 In.) | 0.203 mm (0.008 In.) |
| 0.010 Undersize | 63.20-63.22 mm (2.488-2.489 In.) | 0.0066 mm (.00026 In.) | 0.063-0.216 mm (0.0025-0.0085 In.) | 0.203 mm (0.008 In.) | 0.203 mm (0.008 In.) |
| 0.020 Undersize | 62.94-62.96 mm (2.478-2.479 In.) | 0.0066 mm (.00026 In.) | 0.063-0.216 mm (0.0025-0.0085 In.) | 0.203 mm (0.008 In.) | 0.203 mm (0.008 In.) |
| 0.030 Undersize | 62.69-62.71 mm (2.468-2.469 In.) | 0.0066 mm (.00026 In.) | 0.063-0.216 mm (0.0025-0.0085 In.) | 0.203 mm (0.008 In.) | 0.203 mm (0.008 In.) |

a Maximum out-of-round — 0.0056 mm (0.00022 in.).

b Service limit — 0.51 mm (0.020 in.).

CRANKSHAFT BEARINGS

| Connecting Rod Bearing to Crankshaft Clearance | | Main Bearing to Crankshaft Clearance | |
|--|---------------------------------------|--|---------------------------------------|
| Desired | Allowable | Desired | Allowable |
| 0.038-0.114 mm (0.0015-0.0045 In.) | 0.028-0.091 mm (0.0011-0.0036 In.) | 0.046-0.0914 mm (0.0018-0.0036 In.) | 0.046-0.117 mm (0.0018-0.0046 In.) |

CONNECTING ROD

| Rod Bearing I.D. ^{ab} | Rod Length Center to Center | Connecting Rod Alignment Maximum Total Difference | | Rod to Crankshaft Assembled Side Clearance |
|---|-----------------------------|---|----------------------|--|
| | | Twist/Inch | Bend/Inch | |
| 63.513-63.564 mm (2.5005-2.5025 In.) | 181.10 mm (7.130 In.) | 0.05 mm (0.002 In.) | 0.025 mm (0.001 In.) | 0.30-0.61 mm (0.012-0.024 In.) |

a Connecting rod bearing bore maximum out-of-round — 0.0005, and maximum bore taper — 0.0005.

b With bearing caps tightened in place.

CONNECTING ROD (Continued)

| Piston Pin Bushing Bore I.D. | Crankpin Bearing Bore Diameter | Bearing Bore | |
|-------------------------------------|---|--------------------------|--------------------------|
| | | Max. Out-of-Round | Max. Taper per Inch |
| 36.37-36.41 mm (1.432-1.433 In.) | 68.339-68.364 mm (2.6905 In.-2.6915 In.) | 0.013 mm (0.0005 In.) | 0.013 mm (0.0005 In.) |

SPECIFICATIONS (Continued)

VALVES (Continued)

| Minimum Valve Face Margin — Intake Valves | Minimum Valve Face Margin — Exhaust Valves | Valve Stem Diameter | Valve Head Recession Relative to Deck Surface | |
|---|--|---|---|-----------------------------------|
| | | | Intake | Exhaust |
| 1.67 mm (0.066 In.) | 1.37 mm (0.054 In.) | 7.921-7.939 mm (0.31185-0.31255 In.) | 1.17-1.47 mm (0.046-0.058 In.) | 1.32-1.63 mm (0.052-0.064 In.) |

CAMSHAFT

| End Play | Camshaft Journal to Bearing Clearance | Intake — Lobe Lift | Exhaust — Lobe Lift | Camshaft Thrust Plate Thickness | |
|-------------------------------------|---------------------------------------|---------------------------------|---------------------------------|-------------------------------------|-------------------------------------|
| | | | | Thrust Area | Outside of Thrust Area |
| 0.051-0.203 mm (0.002-0.008 In.) | 0.051-0.165 mm (0.002-0.006 In.) | 6.44 mm (0.2535 In.) Max. | 6.43 mm (0.2531 In.) Max. | 3.910-3.961 mm (0.154-0.156 In.) | 3.784-3.987 mm (0.149-0.157 In.) |

CAMSHAFT DRIVE

| Camshaft Bearing Inside Diameter ^a | | | | | Camshaft Front Bearing Location ^b | Gear Backlash |
|---|-------------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|--|--------------------------------------|
| No. 1 | No. 2 | No. 3 | No. 4 | No. 5 | | |
| 53.39-53.48 mm (2.102-2.105 In.) | 53.39-53.48 mm (2.102-2.105 In.) | 53.39-53.48 mm (2.102-2.105 In.) | 53.39-53.48 mm (2.102-2.105 In.) | 53.39-53.48 mm (2.102-2.105 In.) | 0.020-0.050 Inch | 0.140-0.256 mm (0.0055-0.010 In.) |

a All camshaft journals are 53.31-53.34 mm (2.099-2.100 In.).

b Distance in inches that front edge of the bearing is installed below the front face of the cylinder block.

CYLINDER BLOCK

| Cylinder Bore Diameter ^a | Main Bearing Inside Diameter ^b | Head Gasket Surface Flatness | Head Gasket Surface Finish | Bore Size |
|-------------------------------------|---|---|----------------------------|---|
| Standard | 84.206-84.231 mm (3.3152-3.3162 In.) | 0.003 In. in any 6 In. 0.006 In. Overall | RMS 63-125 | 104.384-104.402 mm (4.1096-4.1103 In.) |
| 0.010 Oversize | 84.206-84.231 mm (3.3152-3.3162 In.) | 0.003 In. in any 6 In. 0.006 In. Overall | RMS 63-125 | 104.502 mm (4.11425 In.) |
| 0.020 Oversize | 84.206-84.231 mm (3.3152-3.3162 In.) | 0.003 In. in any 6 In. 0.006 In. Overall | RMS 63-125 | 104.756 mm (4.12425 In.) |
| 0.030 Oversize | 84.206-84.231 mm (3.3152-3.3162 In.) | 0.003 In. in any 6 In. 0.006 In. Overall | RMS 63-125 | 105.010 mm (4.13425 In.) |

a Maximum out-of-round — 0.013 mm (0.0005 In.); maximum taper — 0.013 mm (0.0005 In.); cylinder bore surface finish — RMS 15-30.

b With bearing caps tightened in place.

CRANKSHAFT AND FLYWHEEL

| Crankshaft Diameter | Main Bearing Journal Diameter | Main Bearing Journal Out-of-Round Maximum | Main Bearing Thrust Face Runout TIR Maximum | Main Bearing Journal Taper Maximum per Inch | Thrust Bearing Journal Width | Main and Rod Bearing Journal Finish RMS Maximum | Main Bearing Thrust Face Finish RMS Maximum |
|---------------------|---|---|---|---|---|---|---|
| Standard | 79.139-79.340 mm (3.1228-3.1236 In.) | 0.0056 mm (0.00022 In.) | 0.025 mm (0.001 In.) | 0.0038 mm (0.00015 In.) | 31.509-31.585 mm (1.2405-1.2435 In.) | 10 | 20 |
| 0.010 Undersize | 79.065-79.085 mm (3.1128-3.1136 In.) | 0.0056 mm (0.00022 In.) | 0.025 mm (0.001 In.) | 0.0038 mm (0.00015 In.) | 31.509-31.585 mm (1.2405-1.2435 In.) | 10 | 20 |

(Continued)

REMOVAL AND INSTALLATION (Continued)

| Item | Part Number | Description |
|------|--------------|---------------------------|
| 3 | F4AZ-19562-B | Silicone Rubber |
| 4 | 6019 | Engine Front Cover |
| 5 | F4AZ-19562-B | Silicone Rubber |
| 6 | 6020 | Engine Front Cover Gasket |

2. Install the engine front cover and the four retaining bolts finger-tight.
3. Install the water pump.
4. Tighten the four engine front cover bolts to 20 N·m (15 lb-ft).
5. Install the oil pan and oil pump screen cover and tube.
6. Install the crankshaft vibration damper.
7. Install the engine.

Crankshaft Gear

The crankshaft gear is not serviced separately from the crankshaft (6303). Do not attempt to remove the crankshaft gear or damage to the crankshaft and crankshaft gear will occur.

Camshaft Drive Gear and Thrust Plate**Removal**

1. Remove the engine (6007).
2. Remove the camshaft (6250). Refer to Camshaft in the Removal and Installation portion of this section.
3. Use a press to remove the camshaft gear from the camshaft.
4. Remove the camshaft thrust plate (6269).
5. Remove the camshaft gear from the camshaft.
6. Visually inspect the camshaft gear. Refer to Drive Gears in the Cleaning and Inspection portion of this section.
7. Visually inspect the camshaft thrust plate for wear, cracks or distortion. Use a micrometer to measure camshaft thrust plate thickness. Refer to Specifications for correct value. Replace the camshaft thrust plate if not within specification, or if any wear or damage is found during inspection.

Installation

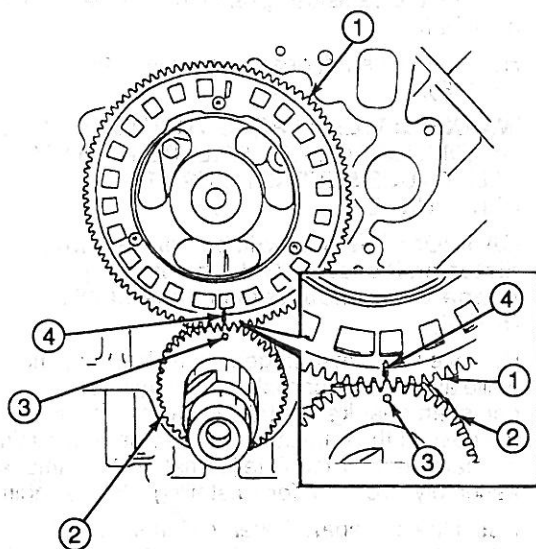
1. Clean the nose of the camshaft and install the camshaft thrust plate onto the camshaft.
2. Position the camshaft gear in the keyway on the camshaft.
3. Heat the camshaft gear in an oven to 260°C (500°F).
4. **WARNING: WEAR PROTECTIVE GLOVES TO HANDLE HOT GEARS. FAILURE TO DO SO WILL CAUSE SEVERE INJURY TO PERSONNEL.**
CAUTION: The gear will be permanently distorted if overheated. The oven temperature should never exceed 260°C (500°F).
Remove the camshaft gear from the oven and, while aligning the sprocket keyway with the camshaft gear key install the camshaft gear over the nose of the camshaft until fully seated against the camshaft thrust plate journal. Allow camshaft assembly to cool before installing into the engine.
5. Install the camshaft. Refer to Camshaft Installation in the Removal and Installation portion of this section.
6. Install the engine.

Camshaft**Removal**

1. Remove the engine (6007).
2. **NOTE:** The camshaft (6250) can be removed without removing the cylinder heads (6049) and valve tappets (6500) if desired. Remove the rocker arms and push rods (6565) making sure to keep them in order for assembly. Rotate the engine on the engine stand until in the vertical position, tipped slightly back so the valve tappets will slide away from the camshaft. Rotate the camshaft three or four times to push the valve tappets away from the camshaft lobes.
Before removing the camshaft, inspect camshaft sprocket backlash. Refer to Drive Gear Backlash (All Gears) in the Service Procedures portion of this section. Inspect camshaft sprocket end play. Refer to Section 03-00.
3. Remove the engine front cover (6019).
4. Remove the valve tappets.

REMOVAL AND INSTALLATION (Continued)

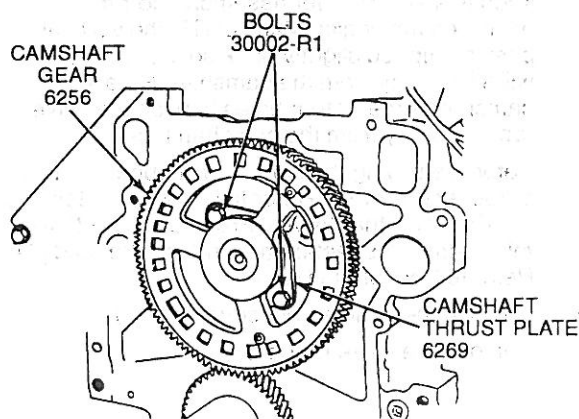
5. Rotate the crankshaft (6303) to align the camshaft sprocket and crankshaft sprocket timing marks.



A23343-A

| Item | Part Number | Description |
|------|-------------|--|
| 1 | 6256 | Camshaft Gear |
| 2 | 6306 | Crankshaft Gear |
| 3 | — | Crankshaft Gear Timing Mark (Part of 6306) |
| 4 | — | Camshaft Gear Timing Mark (Part of 6256) |

6. Remove the camshaft thrust plate retaining bolts.



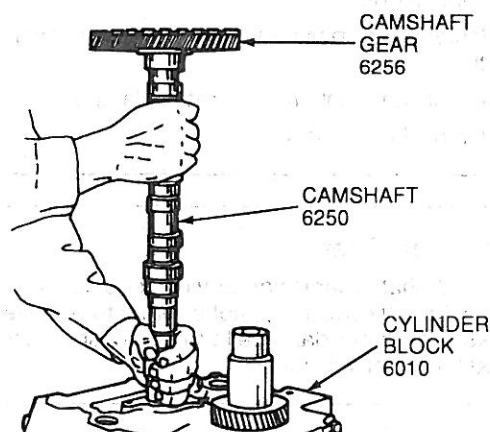
A22030-C

7. Remove the camshaft, camshaft gear and camshaft thrust plate (6269) as an assembly.
8. Inspect the camshaft lobes and journals. Refer to Section 03-00.

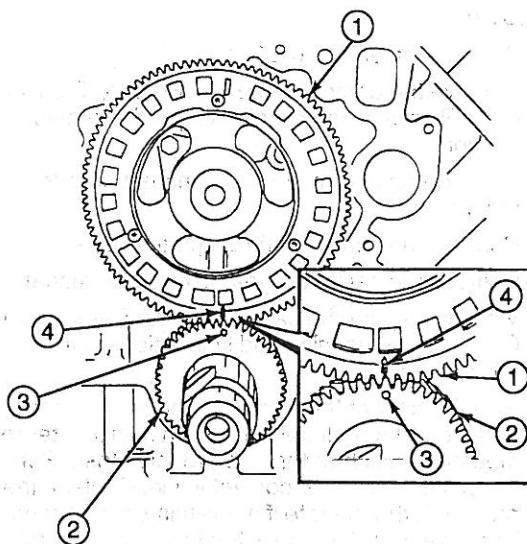
Installation

Before installing, coat the camshaft lobes with Multi-Purpose Grease DOAZ-19584-AA or equivalent meeting Ford specification ESB-M1C93-B. Lubricate the camshaft journals with diesel engine oil specified for this engine.

1. Carefully slide the camshaft, with the camshaft gear and camshaft thrust plate, down into the camshaft bearings (6A251). Make sure the camshaft gear and crankshaft gear timing marks are properly aligned after the camshaft is installed.



A22031-C



A23343-A

| Item | Part Number | Description |
|------|-------------|--|
| 1 | 6256 | Camshaft Gear |
| 2 | 6306 | Crankshaft Gear |
| 3 | — | Crankshaft Gear Timing Mark (Part of 6306) |

(Continued)

REMOVAL AND INSTALLATION (Continued)

| Item | Part Number | Description |
|------|-------------|---|
| 4 | — | Camshaft Gear Timing Mark (Part of 6256) |

2. Install the camshaft thrust plate retaining bolts. Tighten bolts to the standard torque specification listed at the end of this section.

3. NOTE: If the camshaft was removed without removing the cylinder heads and valve tappets, install the rocker arms and push rods in their original order. Refer to Rocker Arm Cover, Rocker Arm and Push Rod, Right or Left, in the Removal and Installation portion of this section.
Install the valve tappets.

4. Install the engine front cover.

5. Install the engine. Refer to Engine in the Removal and Installation portion of this section.

Camshaft Bearings

The camshaft bearings (6A251) are interchangeable from one bore to another except for the front camshaft bearing which is wider than the others.

SPECIAL SERVICE TOOL(S) REQUIRED

| Description | Tool Number |
|----------------------|-------------|
| Camshaft Bearing Set | T65L-6250-A |

Removal

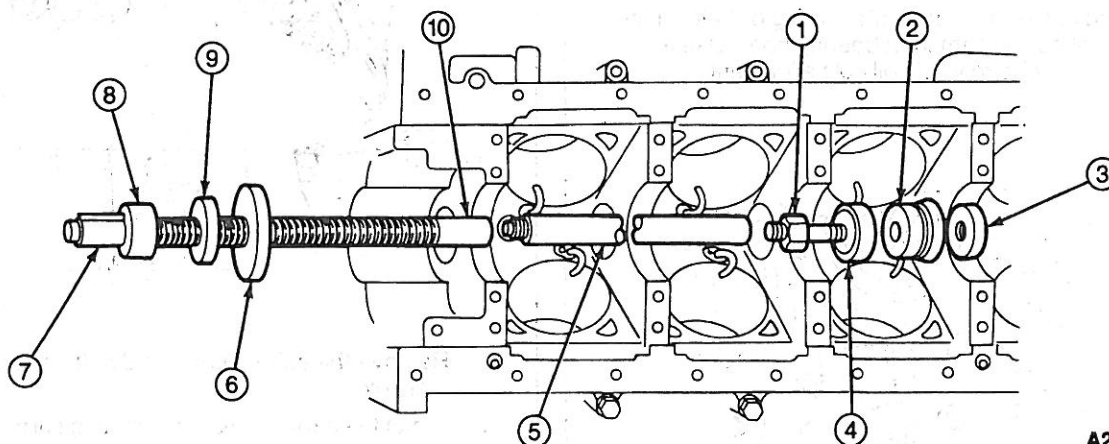
1. Remove engine from vehicle. Refer to Engine in the Removal and Installation portion of this section. Mount engine on a workstand using Rotunda Engine Mounting Brackets 014-00932 or equivalent.

2. CAUTION: Use care when pushing pistons to top of cylinders to prevent damage to piston cooling oil jets (6C327). Use connecting rod installation guides (rubber hose) or equivalent to protect connecting rod bolts (6214).

Remove camshaft (6250), flywheel and crankshaft (6303). Push pistons to top of cylinders.

3. Using Camshaft Bearing Set T65L-6250-A, select proper size expanding collet and backup nut, and assemble on expanding mandrel. With expanding collet collapsed, install collet assembly in camshaft bearing, and tighten backup nut on expanding mandrel until collet fits camshaft bearing.

Camshaft Bearing Replacement, Typical



A22032-A

| Item | Part Number | Description |
|------|-------------|--|
| 1 | — | Expanding Mandrel (Part of T65L-6250-A) |
| 2 | — | Expanding Collet (Part of T65L-6250-A) |
| 3 | — | Backup Nut (Part of T65L-6250-A) |
| 4 | 6A251 | Camshaft Bearing |

(Continued)

| Item | Part Number | Description |
|------|-------------|---|
| 5 | — | Puller Screw Extension (Part of T65L-6250-A) |
| 6 | — | Pulling Plate (Part of T65L-6250-A) |
| 7 | — | Puller Screw (Part of T65L-6250-A) |
| 8 | — | Pulling Nut (Part of T65L-6250-A) |

(Continued)

REMOVAL AND INSTALLATION (Continued)

| Item | Part Number | Description |
|------|-------------|---|
| 9 | — | Thrust Bearing (Part of T65L-6250-A) |

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| Item | Part Number | Description |
|------|-------------|---------------------------------------|
| 10 | — | Puller Screw (Part of T65L-6250-A) |

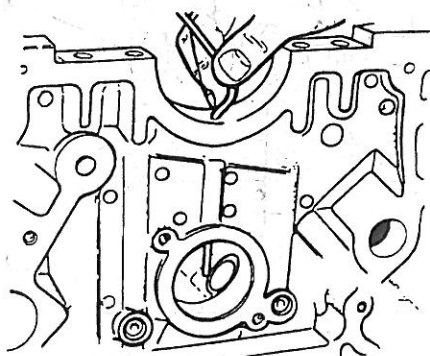
- Assemble puller screw and extension, if necessary, and install on expanding mandrel. Wrap a cloth around threads of puller screw to protect front camshaft bearing or camshaft bearing bore. Tighten pulling nut against thrust bearing and pulling plate to remove camshaft bearing. Be sure to hold wrench on end of puller screw to prevent it from turning.
- Repeat procedure for each camshaft bearing. To remove front camshaft bearing, install puller screw from rear of cylinder blocks (6010).

Installation

- CAUTION: Failure to use correct expanding collet can cause severe camshaft bearing damage. Be sure front camshaft bearing is installed the specified distance below front face of cylinder block.**

Position new camshaft bearings at camshaft bearing bores with oil holes aligned, and press in place with Camshaft Bearing Set T65L-6250-A. Be sure to center pulling plate and puller screw to avoid damage to camshaft bearing.

- Make sure each camshaft bearing oil hole aligns with oil hole in camshaft bearing bore. Use a length of wire to verify oil hole alignment.



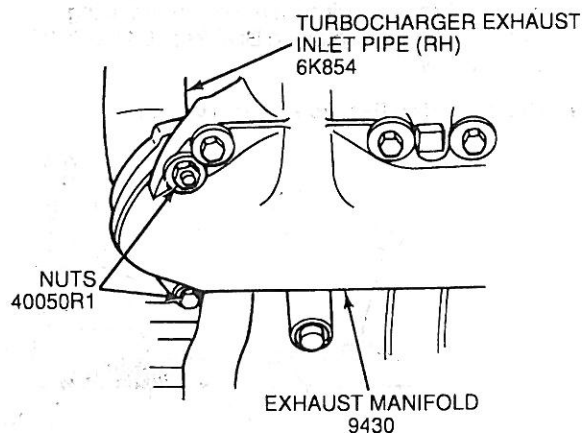
A23348-A

- Install camshaft, crankshaft and flywheel (6375). It is not necessary to check connecting rod and main bearing clearances as a part of camshaft bearing replacement.

- Install engine (6007) into vehicle.

Exhaust Manifold, Right**Removal**

- Disconnect the battery ground cable. On vehicles equipped with dual batteries, refer to Section 14-01.
- Remove the transmission fill tube bracket bolts and rotate the transmission fill tube and bracket aside.
- Raise the vehicle.
- Remove the two bolts retaining the turbocharger exhaust inlet pipe to the exhaust manifold (9430).



A22033-B

- Remove the exhaust manifold bolts and exhaust manifold.
- Clean the exhaust manifold mating surfaces.
- Check surfaces for warpage with a straightedge. Refer to Specifications in this section.

Installation

- Apply anti-seize compound to the exhaust manifold bolt threads.
- Install exhaust manifold and retaining bolts.