

INSTALLATION

1. See [Figure 3-50](#). Rotate engine so that both tappets (6), from the cylinder being serviced, will be installed on the base circle (lowest position) of the cam.
2. Apply a liberal amount of engine oil to tappet assembly, especially the roller needles, to ensure smooth initial operation.
3. Insert tappet (6) into bore in crankcase (1). Rotate tappet so that flats at upper end of tappet face the front and rear of the engine. If the tappet is installed incorrectly, pins (2) cannot be inserted.
4. Insert pins (2) in the holes in crankcase. Place **new** O-rings (3) over ends of pins. Install plate (4) using screw (5) with washer (14). Tighten screw (5) to 80-110 **in-lbs** (9.0-12.4 Nm).
5. Slide **new** seal (8) and place retainer (9), over top of push rod cover (7). Position **new** O-ring (10) at top of push rod cover. Hold cover at an angle and insert top through hole in cylinder head. Push up on cover while aligning bottom of cover with tappet bore in crankcase. Lower retainer (9) with seal (8) onto crankcase, aligning locating pin (15) with hole in retainer.
6. Insert screw (11) with washer (13) through hole in retainer (9), and thread into tapped hole in crankcase. Tighten screw (11) to 15-18 ft-lbs (20-24 Nm).
7. Install rocker covers. See [CYLINDER HEAD, INSTALLATION](#) starting on [page 3-20](#).

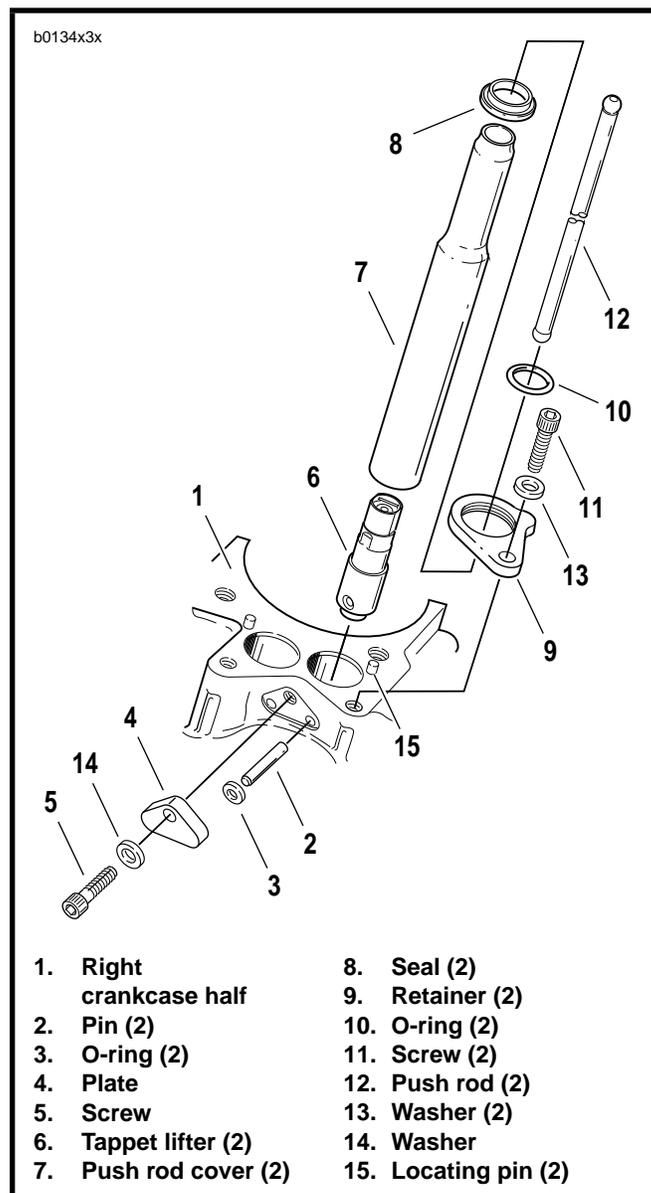


Figure 3-50. Valve Tappet Service

GEARCASE COVER AND CAM GEARS

GENERAL

Read the complete gearcase section carefully before you begin any service work.

For the gearcase components to operate at their optimum, all components must be properly fitted and matched. Changing one component can affect many others. It is important to know and understand all inspection procedures and how components interact.

REMOVAL/DISASSEMBLY

1. See [Figure 3-51](#). Thoroughly clean area around gearcase cover (17) and tappets. Blow loose dirt from crankcase with compressed air.
2. Remove any parts that will interfere with gearcase disassembly (i.e., exhaust header, footrest, air cleaner, etc.).
3. Remove push rods as described under [CYLINDER HEAD, REMOVAL](#) on [page 3-11](#).
4. Remove tappets. See [VALVE TAPPETS, REMOVAL](#) on [page 3-38](#).

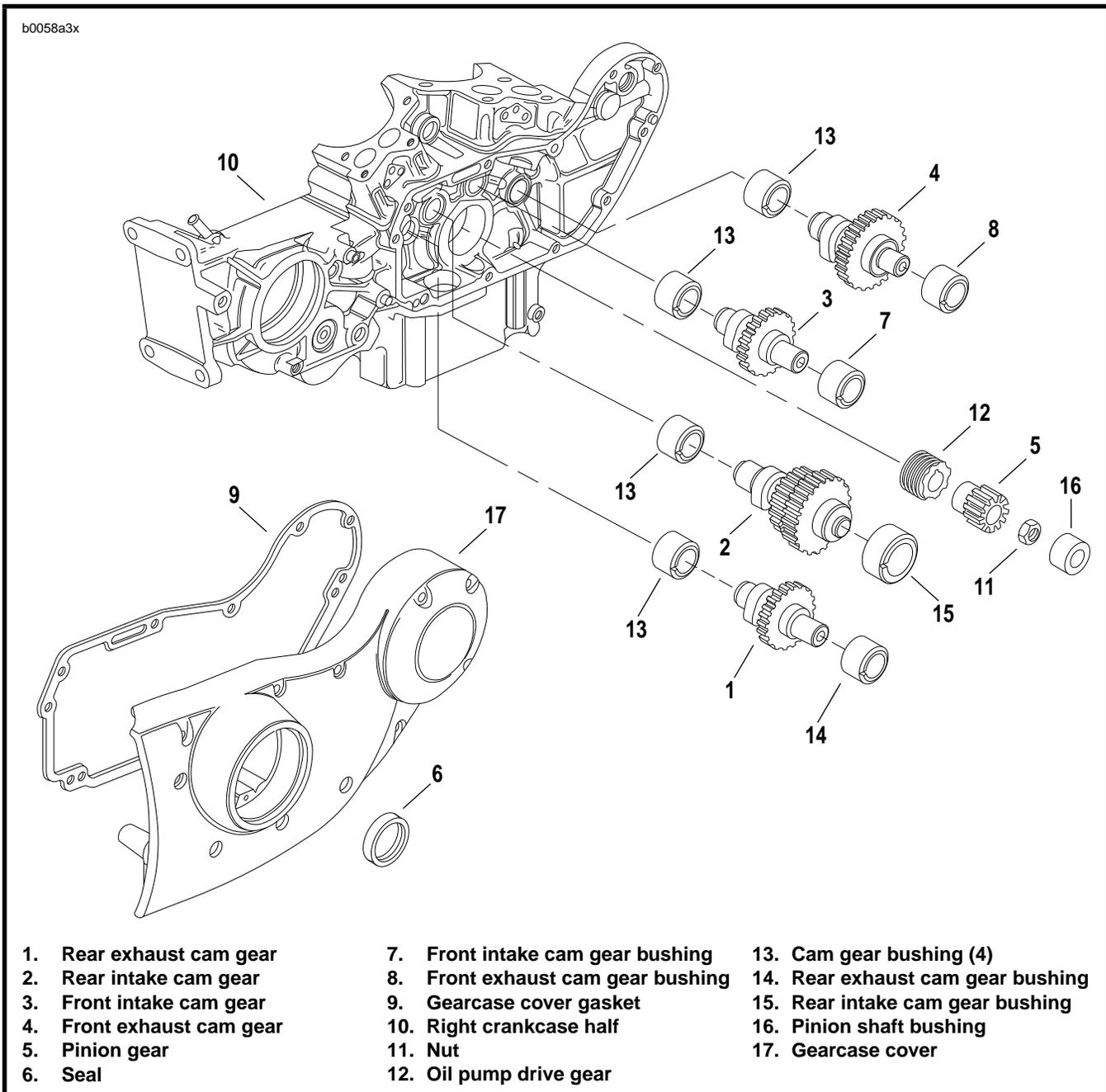


Figure 3-51. Gearcase and Valve Train Components

5. Check for minimum cam gear end play. See [page 3-46](#). Record readings.
6. Remove ignition system. See Section 7.
7. Place a pan under gearcase to collect oil. Remove cover screws. Carefully remove gearcase cover. Discard old gasket (9).

NOTE

If cover does not come loose on removal of screws, tap lightly with a plastic hammer. Never pry cover off.

8. Remove cam gears (1, 2, 3 and 4). Carefully mark each component to ensure correct installation.

NOTE

Nut (11) is secured by LOCTITE THREADLOCKER 262 (red) on the nut threads.

9. Remove nut (11). Slide pinion gear (5) and oil pump drive gear (12) off pinion shaft.

CLEANING, INSPECTION AND REPAIR

1. Thoroughly clean gearcase compartment, gearcase cover, and gears in solvent to remove oil and carbon deposits.
2. Blow out all cover oil passages and bushings with compressed air.
3. Clean old gasket material from gearcase and cover faces with cleaning solvent.

Cam and Pinion Gear Identification, Inspection, and Selection

See [Figure 3-52](#). Cam lobes are stamped with the number “15” followed by a number (1, 2, 3 or 4). The number “15” indicates model year application; the number identifies the cam location/function:

- 15-1 = rear exhaust
- 15-2 = rear intake
- 15-3 = front intake
- 15-4 = front exhaust

Use only “15” cams on 1996 models.

See [Figure 3-53](#). Measure the gear diameter with a micrometer over 0.108 in. (2.74 mm) diameter gauge pins on opposite sides of the gear. The pins are of the proper size to fit between the contacting surfaces of the gear teeth. Gear diameter should be measured in at least two places 90° apart. Use [GAUGE PIN SET \(Part No. HD-38361\)](#) when measuring pinion and cam gear sizes.

Cam and pinion gears are individually selected for each specific gear cover through sophisticated computer-aided measuring techniques in a controlled environment. Each gear is assigned an individual color code based on its diameter (measured with gauge pins). When cam and/or pinion gears are replaced, always use the same color code as found on gears being replaced to ensure that the gear operation remains as quiet as possible. For location of cam and pinion gear color codes, see [Figure 3-54](#).

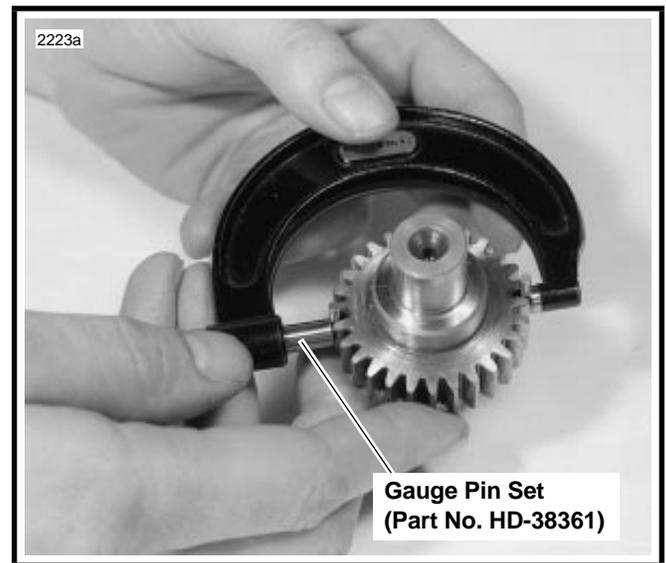


Figure 3-52. Measuring Gear Size

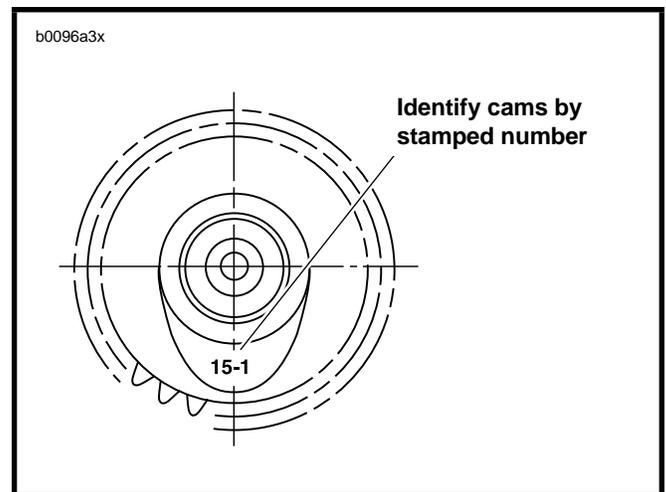
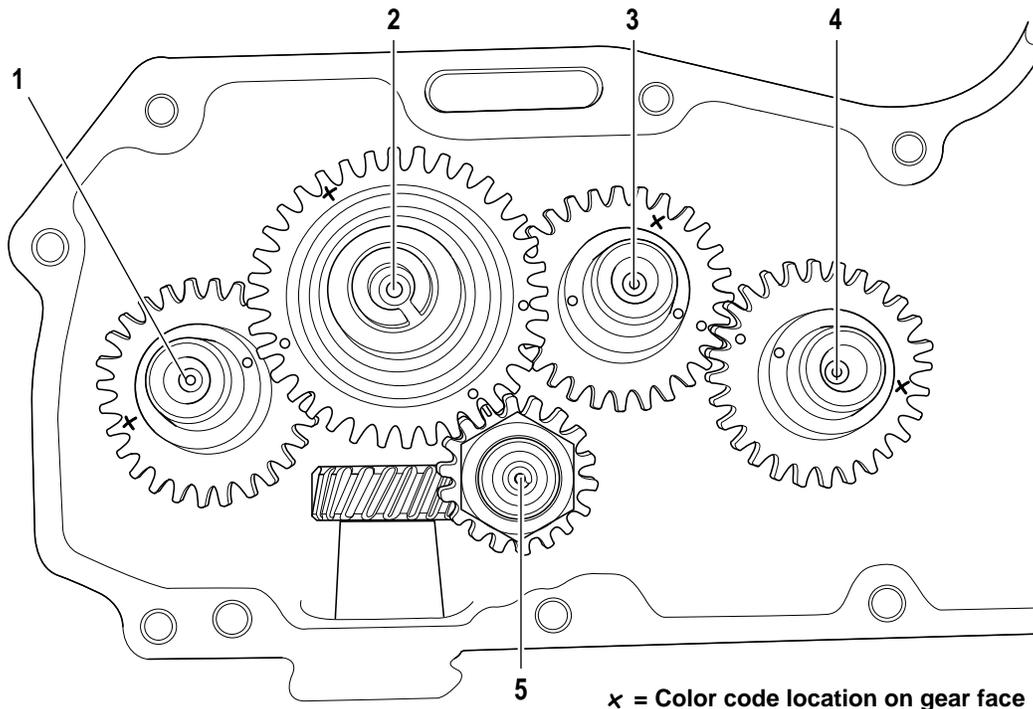


Figure 3-53. Cam Identification

NOTE

On flywheel pinion shaft, a paint dot is located on the shaft perimeter near the centerline of the keyway. This dot identifies the pinion shaft inner race size. Do not use this dot to select pinion gear size.

See [Table 3-9](#). Compare the previously measured diameter of each gear with the specifications (listed in inches) shown in the table to determine amount of wear on gear teeth.



x = Color code location on gear face

- 1. Rear exhaust cam gear (15-1)
- 2. Rear intake cam gear (15-2)
- 3. Front intake cam gear (15-3)
- 4. Front exhaust cam gear (15-4)
- 5. Pinion gear

Figure 3-54. Cam and Pinion Gear Color Code Location and Timing Mark Indexing

NOTE

Prior to changing any cam gears, check gear shaft fit within corresponding bushings. Worn bushings can cause excessive backlash.

Table 3-9. Cam and Pinion Gear Color Code and Diameter

GEAR NO. & POSITION	1	2 INBOARD	2 OUTBOARD	3	4	5
COLOR CODE (1 paint dot)	Rear Exhaust	Rear Intake	Rear Intake	Front Intake	Front Exhaust	Pinion
BROWN	1.9005-1.9009 (48.272-48.283)	1.9035-1.9039 (48.349-48.359)	2.4021-2.4025 (61.013-61.023)	1.9005-1.9009 (48.272-48.283)	1.9035-1.9039 (48.349-48.359)	1.2753-1.2756 (32.393-32.400)
BLUE	1.9010-1.9014 (48.285-48.295)	1.9030-1.9034 (48.336-48.346)	2.4026-2.4030 (61.026-61.036)	1.9010-1.9014 (48.285-48.295)	1.9030-1.9034 (48.336-48.346)	1.2749-1.2752 (32.382-32.390)
RED	1.9015-1.9019 (48.298-48.308)	1.9025-1.9029 (48.323-48.333)	2.4031-2.4035 (61.038-61.049)	1.9015-1.9019 (48.298-48.308)	1.9025-1.9029 (48.323-48.333)	1.2745-1.2748 (32.372-32.380)
WHITE	1.9020-1.9024 (48.310-48.321)	1.9020-1.9024 (48.310-48.321)	2.4036-2.4040 (61.051-61.061)	1.9020-1.9024 (48.310-48.321)	1.9020-1.9024 (48.310-48.321)	1.2741-1.2744 (32.362-32.369)
GREEN	1.9025-1.9029 (48.323-48.333)	1.9015-1.9019 (48.298-48.308)	2.4041-2.4045 (61.064-61.074)	1.9025-1.9029 (48.323-48.333)	1.9015-1.9019 (48.298-48.308)	1.2737-1.2740 (32.352-32.359)
YELLOW	1.9030-1.9034 (48.336-48.346)	1.9010-1.9014 (48.285-48.295)	2.4046-2.4050 (61.076-61.087)	1.9030-1.9034 (48.336-48.346)	1.9010-1.9014 (48.285-48.295)	1.2733-1.2736 (32.341-32.349)
BLACK	1.9035-1.9039 (48.349-48.359)	1.9005-1.9009 (48.272-48.283)	2.4051-2.4055 (61.089-61.099)	1.9035-1.9039 (48.349-48.359)	1.9005-1.9009 (48.272-48.283)	1.2729-1.2732 (32.331-32.339)

Bushing Inspection and Removal

- See [Figure 3-51](#). Bushings (7, 8, 13, 14, 15 and 16) are press fit in gearcase cover (17) and crankcase. Inspect each bushing against its corresponding cam gear shaft or pinion gear shaft. See [Table 3-10](#).

Table 3-10. Gear Shaft Specifications

GEAR SHAFT	CORRECT CLEARANCE	SERVICE WEAR LIMIT
Cam	0.0007-0.0022 in. (0.018-0.056 mm)	0.003 in. (0.08 mm)
Pinion	0.0023-0.0043 in. (0.058-0.109 mm)	0.005 (0.13 mm)

- See [Figure 3-55](#). Use a **BUSHING AND BEARING PULLER** (Part No. HD-95760-69A) to remove bushings from gearcase cover and crankcase.

Bushing Installation

NOTE

Installing and reaming crankcase and gearcase cover bushings may alter the center distances between mating gears and may result in an increase in gear noise. For quiet-running gears, the gears should be matched to the center distances.

CAM GEAR BUSHINGS IN RIGHT CRANKCASE HALF

- See [Figure 3-57](#). Each cam gear bushing (1), to be installed in right crankcase half (2), must be positioned in crankcase bore with its oiling slot at exact top of bore (12 o'clock position).
- Using an arbor press, install each bushing in its crankcase bore so that bushing shoulder contacts crankcase boss.
- After you install a **new** bushing in right crankcase half, ream the bushing to correct size. See [BUSHING REAMING](#) on [page 3-44](#).

CAM GEAR BUSHINGS (EXCEPT REAR INTAKE BUSHING) IN GEARCASE COVER

- See [Figure 3-51](#). Using an arbor press, install each bushing (7, 8 and 14) in its gearcase cover (17) bore so that bushing shoulder contacts cover boss. There is no need to orient these particular bushings in any specific position of rotation within gearcase cover bores.
- After you install a **new** bushing in gearcase cover, line-ream the bushing to correct size. See [BUSHING REAMING](#) on [page 3-44](#).

REAR INTAKE CAM GEAR BUSHING IN GEARCASE COVER.

- See [Figure 3-51](#). Rear intake cam gear bushing (15) must be installed in its gearcase cover (17) bore using an arbor press. You will need to orient the bushing in a specific position of rotation within the cover bore, and will need to drill a lubrication hole in the bushing, according to the following procedures



Figure 3-55. Removing Bushing

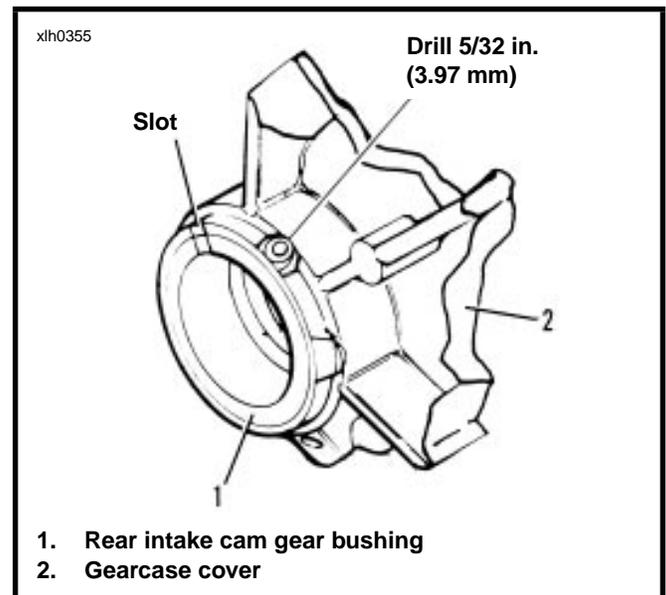


Figure 3-56. Rear Intake Cam Gear Bushing Installed in Gearcase Cover

- See [Figure 3-56](#). Position bushing (1) over bore of gearcase cover (2) with chamfered edge downward and slot upward. Align slot in bushing with slot in gearcase cover boss. Press bushing into cover bore until bushing is flush with cover boss.
- Drill a 5/32 in. (3.97 mm) diameter hole through bushing using existing hole in gearcase cover as a guide.
- After you install a **new** bushing in gearcase cover, line-ream the bushing to the correct size. See [BUSHING REAMING](#) on [page 3-44](#).

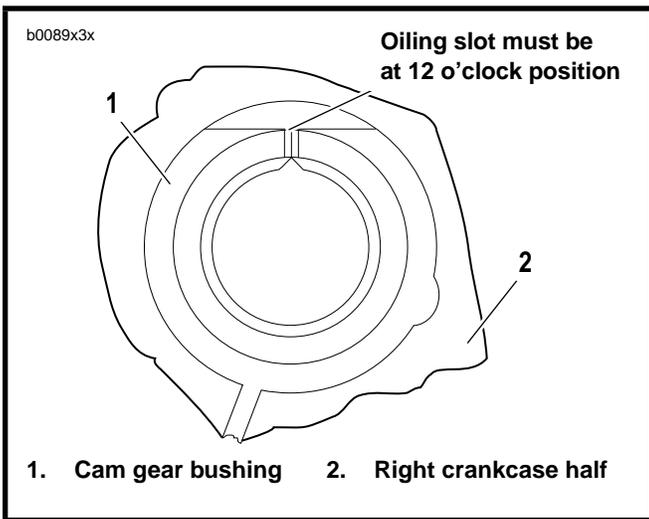


Figure 3-57. Cam Gear Bushing Installed in Crankcase

PINION SHAFT BUSHING IN GEARCASE COVER

1. See [Figure 3-51](#). Using an arbor press, install pinion shaft bushing (16) in its gearcase cover (17) so that bushing is flush with cover boss. There is no need to orient this particular bushing in any specific position of rotation within the gearcase cover bore.
2. Although the original pinion shaft bushing is not “pinned,” the replacement bushing must be secured, from possible rotation within the cover bore, by installation of a dowel pin. See [Figure 3-58](#). Drill a No. 31 hole, 0.281 in. (7.14 mm) deep, at top side of boss (side toward top of gearcase cover), centering the drill bit on the cover bore circle (hole is drilled half in bushing OD and half in cover bore ID).
3. Drive a **new** dowel pin no more than 0.20 in. (5.1 mm) below the bushing face. Carefully peen edges of hole to lock the pin in place.
4. After you install a **new** bushing in gearcase cover, line-ream the bushing to the correct size. See [BUSHING REAMING](#).

Bushing Reaming

NOTE

- *Installing and reaming crankcase and gearcase cover bushings may alter the center distances between mating gears and may result in an increase in gear noise. For quiet-running gears, the gears should be matched to the center distances.*
- *Bushings in right crankcase half serve as pilots for reaming gearcase cover bushings and must, therefore, be reamed to size first.*
- *After reaming any bushing, check shaft fit in the bushing. It may be necessary to make a second pass with reamer to attain proper fit.*

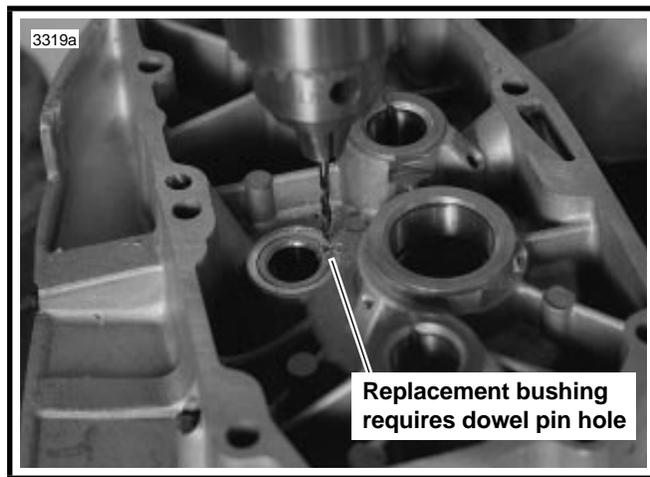


Figure 3-58. Drilling Dowel Pin Hole

CAM GEAR BUSHINGS IN RIGHT CRANKCASE HALF

1. Separate two halves of crankcase, if not already accomplished. Place right crankcase half on flat surface with gearcase side upward. Bushing to be reamed must be oriented as shown in [Figure 3-57](#).
2. See [Figure 3-59](#). Position [CAMSHAFT BUSHING REAMER PILOT \(Part No. HD-38871\)](#) onto gearcase side of crankcase half; upper right and lower left indexing holes in pilot must be placed over dowels in crankcase half. Insert two bolts (supplied with pilot) through two remaining holes in pilot, and into threaded holes of crankcase half. Tighten bolts securely.
3. Insert the 11/16 in. diameter reamer through pilot hole and into bushing while turning reamer clockwise. Continue turning reamer clockwise through bushing until smooth shank of reamer passes through hole in pilot.
4. Detach reamer from handle. Pull reamer out opposite side of crankcase half.
5. Thoroughly clean right crankcase half, removing all metal chips/shavings. Blow out all oil passages using compressed air.

CAM GEAR BUSHINGS (EXCEPT REAR INTAKE BUSHING) IN GEARCASE COVER

NOTE

Newly installed cam gear bushings in the gearcase cover must be line reamed, using the right crankcase half as a pilot for the reamer, to establish correct clearance and to ensure perfect alignment. If crankcase halves are not separated on your motorcycle, use a spare right crankcase half to perform the following line reaming procedures.

1. See [Figure 3-51](#). Bushings (7, 8 and 14) to be reamed must be installed in gearcase cover (17) as described in [BUSHING INSTALLATION](#) on [page 3-43](#). Attach gearcase cover to right crankcase half (10), which has been disassembled from left crankcase half, securing with a minimum of three mounting screws.

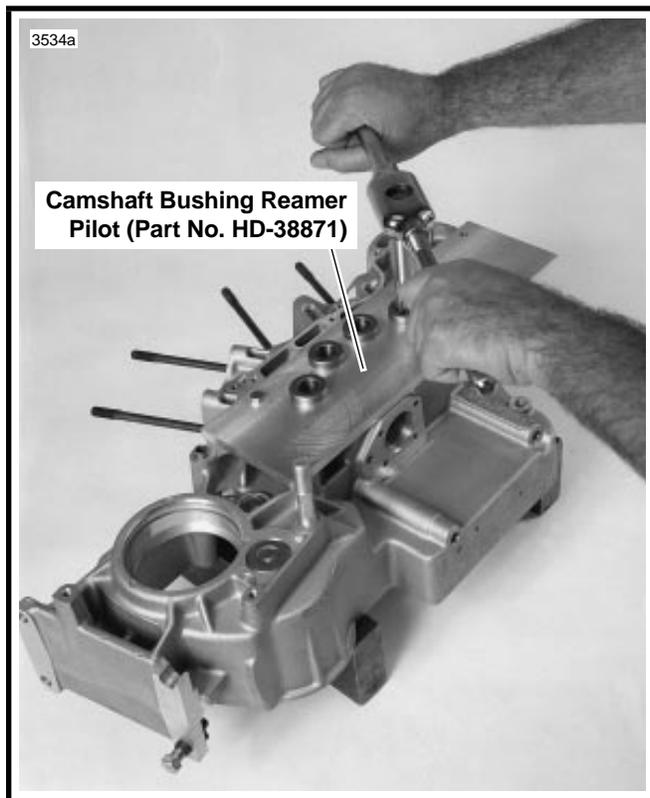


Figure 3-59. Reaming Cam Gear Bushing in Right Crankcase Half

2. Insert a standard 11/16 in. diameter reamer through the previously reamed cam gear bushing (13) in right crankcase half, which is in line with one of the bushings to be reamed in gearcase cover.
3. Turn reamer clockwise through bushing in cover until reamer bottoms. Then give reamer one complete clockwise turn to size the bushing. Continue turning reamer clockwise while extracting reamer from bushing.
4. Repeat Steps 2 and 3 for remaining two cam gear bushings (except rear intake bushing) in gearcase cover, if required.
5. Separate gearcase cover from right crankcase half. Inspect bushings for proper cam gear shaft fit. Repeat line reaming operation if necessary.
6. Thoroughly clean gearcase cover, removing all metal chips/shavings. Blow out all oil passages using compressed air.

REAR INTAKE CAM GEAR BUSHING IN GEARCASE COVER

NOTE

A newly installed rear intake cam gear bushing in the gearcase cover must be line reamed, using the right crankcase half as a pilot for the reamer, to establish correct clearance and to ensure perfect alignment. If crankcase halves are not separated on your motorcycle, use a spare right crankcase half to perform the following line reaming procedures.

1. See [Figure 3-51](#). Rear intake cam gear bushing (15) must be installed in gearcase cover (17) as described in [BUSHING INSTALLATION](#) on [page 3-43](#).
2. Identify the previously reamed rear intake cam gear bushing (13) in right crankcase half (10), which has been disassembled from left crankcase half. Insert the shank end of [REAR INTAKE CAMSHAFT BUSHING REAMER \(Part No. HD-94803-67\)](#) through gearcase side of this bushing.
3. With reamer inserted into bushing in right crankcase half, attach gearcase cover to right crankcase half, securing with a minimum of three mounting screws.
4. Turn reamer clockwise through bushing in gearcase cover until reamer bottoms. Then give reamer one complete clockwise turn to size the bushing. Continue turning reamer clockwise while extracting reamer from bushing.
5. Separate gearcase cover from right crankcase half. Inspect bushing for proper cam gear shaft fit. Repeat line reaming operation if necessary.
6. Thoroughly clean gearcase cover, removing all metal chips/shavings. Blow out all oil passages using compressed air.

PINION SHAFT BUSHING IN GEARCASE COVER

NOTE

A newly installed pinion shaft bushing in the gearcase cover must be line reamed, using both the right crankcase half and [Part No. HD-94812-87](#) as pilots for the reamer, to establish correct clearance and to ensure proper alignment. If crankcase halves are not separated on your motorcycle, use a spare right crankcase half to perform the following line reaming procedures.

1. See [Figure 3-51](#). Pinion shaft bushing (16) must be installed in gearcase cover (17) as described in [BUSHING INSTALLATION](#) on [page 3-43](#). Attach gearcase cover to right crankcase half (10), which has been disassembled from left crankcase half, securing with a minimum of three mounting screws.
2. See [Figure 3-60](#). Install [PINION SHAFT BUSHING REAMER PILOT \(Part No. HD-94812-87\)](#) into right crankcase roller race. Insert [PINION SHAFT BUSHING REAMER \(Part No. HD-94812-1\)](#) through the pilot.
3. Turn reamer clockwise through bushing in gearcase cover until reamer bottoms. Then give reamer one complete clockwise turn to size the bushing. Continue turning reamer clockwise while extracting reamer from bushing.
4. Separate gearcase cover from right crankcase half. Inspect bushing for proper pinion shaft fit. Repeat line reaming operation if necessary.
5. Remove pilot from right crankcase roller race. Thoroughly clean gearcase cover, removing all metal chips/shavings. Blow out all oil passages using compressed air.

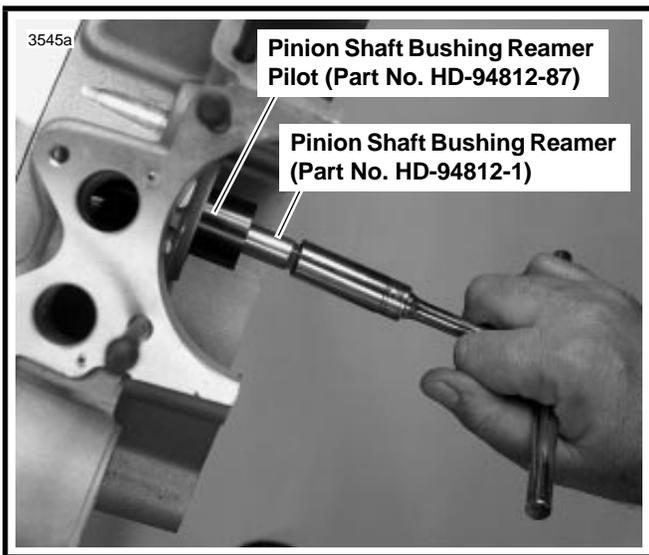


Figure 3-60. Line Reaming Pinion Shaft Bushing

ASSEMBLY/INSTALLATION

1. See Figure 3-51. Install oil pump drive gear (12) and pinion gear (5) to pinion shaft. Note that timing mark on pinion gear tooth is aligned with keyway in ID of pinion gear, as shown in Figure 3-61. See Figure 3-62. The timing mark will allow you to easily position pinion gear (1) over shaft key (2) and against oil pump drive gear (3) on pinion shaft (4).
2. See Figure 3-51. Clean pinion shaft threads and nut (11) threads. Apply several drops of LOCTITE THREAD-LOCKER 262 (red) to threads of nut. Install nut to pinion shaft, tightening to 35-45 ft-lbs (47-61 Nm).
3. See Table 3-9 and Figures 3-53 and 3-54. Liberally apply engine oil to bushings, shafts, and gears. Install all cam gears into bushings of right crankcase half, properly aligning timing marks of cam gears and pinion gear as shown in Figure 3-54.

NOTE

Because of the larger diameter additional gear (which meshes with the pinion gear) on the outboard end of the rear intake (15-2) cam gear, the rear exhaust (15-1) and front intake (15-3) cam gears must both be installed before the rear intake (15-2) cam gear is installed.

4. See Figure 3-51. Install a **new** seal (6) and **new** dry gasket (9) on gearcase cover (17).
5. Install gearcase cover over all gears and onto right crankcase half (10). Secure cover to crankcase half with 11 socket head screws. Tighten screws evenly to 80-110 **in-lbs** (9.0-12.4 Nm) according to the torque sequence shown in Figure 3-63.

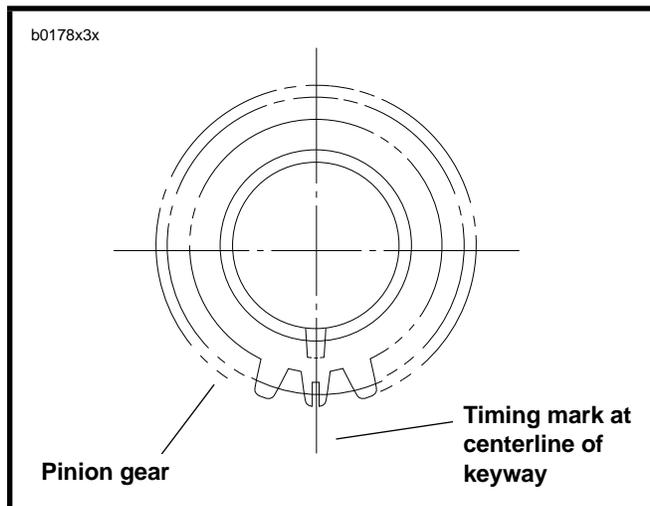


Figure 3-61. Pinion Gear Timing Mark and Keyway

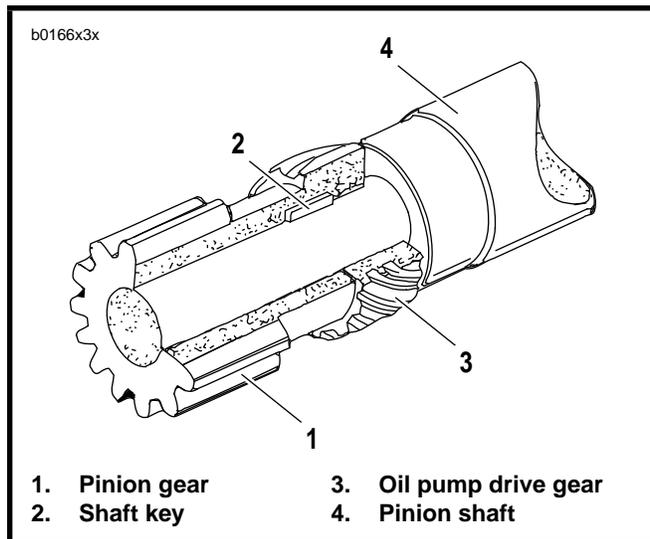


Figure 3-62. Oil Pump Drive Gear and Pinion Gear Installed on Pinion Shaft

6. Check cam gear end play for each cam gear as follows:
 - a. Turn engine over until lobe of cam gear being checked is pointing toward its respective tappet guide hole.
 - b. Using a flat blade screwdriver, gently pry the cam gear toward gearcase cover.
 - c. Using a feeler gauge, measure gap between bushing (in crankcase half) and cam gear shaft thrust face (shoulder). This is cam gear end play.
 - d. Compare your cam gear end play measurements with the SPECIFICATIONS on page 3-3. Make repairs as required if end gap is less than the minimum specified, or greater than the maximum specified (Service Wear Limits).

- 7. Install valve tappets and push rods. See [VALVE TAPPETS, INSTALLATION](#) on [page 3-39](#).
- 8. Install ignition system. See Section 7.
- 9. Install any components removed to gain access to gearcase (i.e. exhaust system components, air cleaner, etc.).

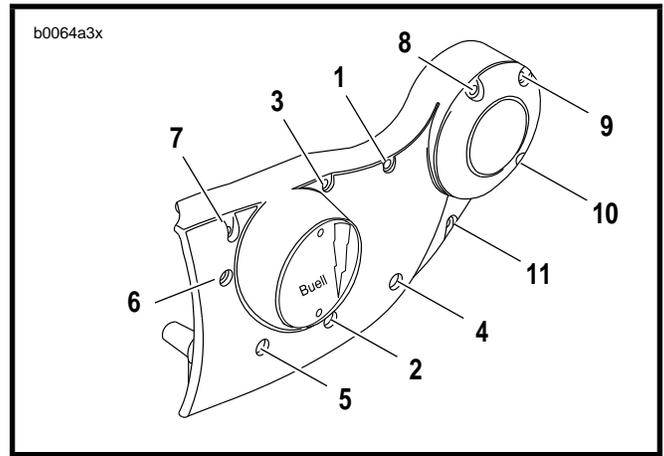


Figure 3-63. Gearcase Cover Mounting Screw Torque Sequence

CRANKCASE

GENERAL

When rod bearings, pinion shaft bearing or sprocket shaft bearing are in need of repair, the engine must be removed from the chassis. See [REMOVING ENGINE CRANKCASE OR COMPLETE ENGINE](#) on page 3-8. It is recommended procedure to check and make repairs to cylinder heads, cylinders, gearcase and transmission at the same time (perform entire engine overhaul).

⚠ CAUTION

If engine is removed from chassis, do not lay engine on primary side. Placing engine on primary side will damage clutch cable end fitting. If fitting is damaged, clutch cable must be replaced.

ADJUSTMENT/TESTING

Flywheel End Play

See [Figure 3-64](#). Before completely disassembling crankcases, check flywheel end play.

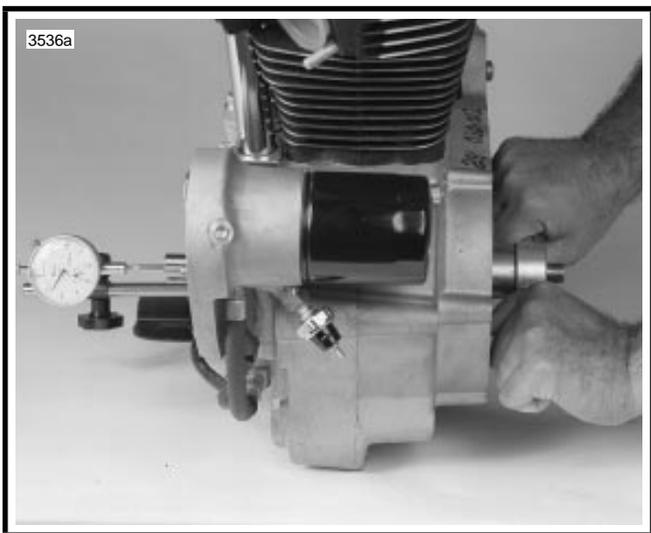


Figure 3-64. Checking Flywheel End Play

1. After engine has been removed from chassis, securely fasten it to a stand or workbench.
2. Remove gearcase cover. Attach a dial indicator to gear side crankcase with indicator stem on end of gearshaft.
3. Sprocket shaft bearings must be preloaded to obtain an accurate flywheel end play reading. A suitable tool can be made by welding two handles to an old sprocket shaft nut. Install the nut and sprocket. Tighten nut to 150-165 ft-lbs (203-224 Nm).

4. Rotate and push on sprocket shaft while reading dial indicator. Then rotate and pull on sprocket shaft while reading dial indicator. If difference (end play) in indicator readings is not 0.001-0.005 in. (0.025-0.13 mm), bearing inner spacer (shim) (item 6, [Figure 3-68](#).) must be replaced. Choose spacer from [Table 3-11](#). Use a thinner spacer for less end play; use a thicker spacer for more end play.

Table 3-11. Flywheel End Play Spacers (Shims)

PART NUMBER	THICKNESS	
	IN.	MM
9155	0.0975-0.0985	2.476-2.502
9142	0.0995 - 0.1005	2.527-2.553
9143	0.1015-0.1025	2.578-2.603
9144	0.1035 - 0.1045	2.629-2.654
9145	0.1055 - 0.1065	2.680-2.705
9146	0.1075 - 0.1085	2.730-2.756
9147	0.1095 - 0.1105	2.781-2.807
9148	0.1115 - 0.1125	2.832-2.857
9149	0.1135 - 0.1145	2.883-2.908

DISASSEMBLY

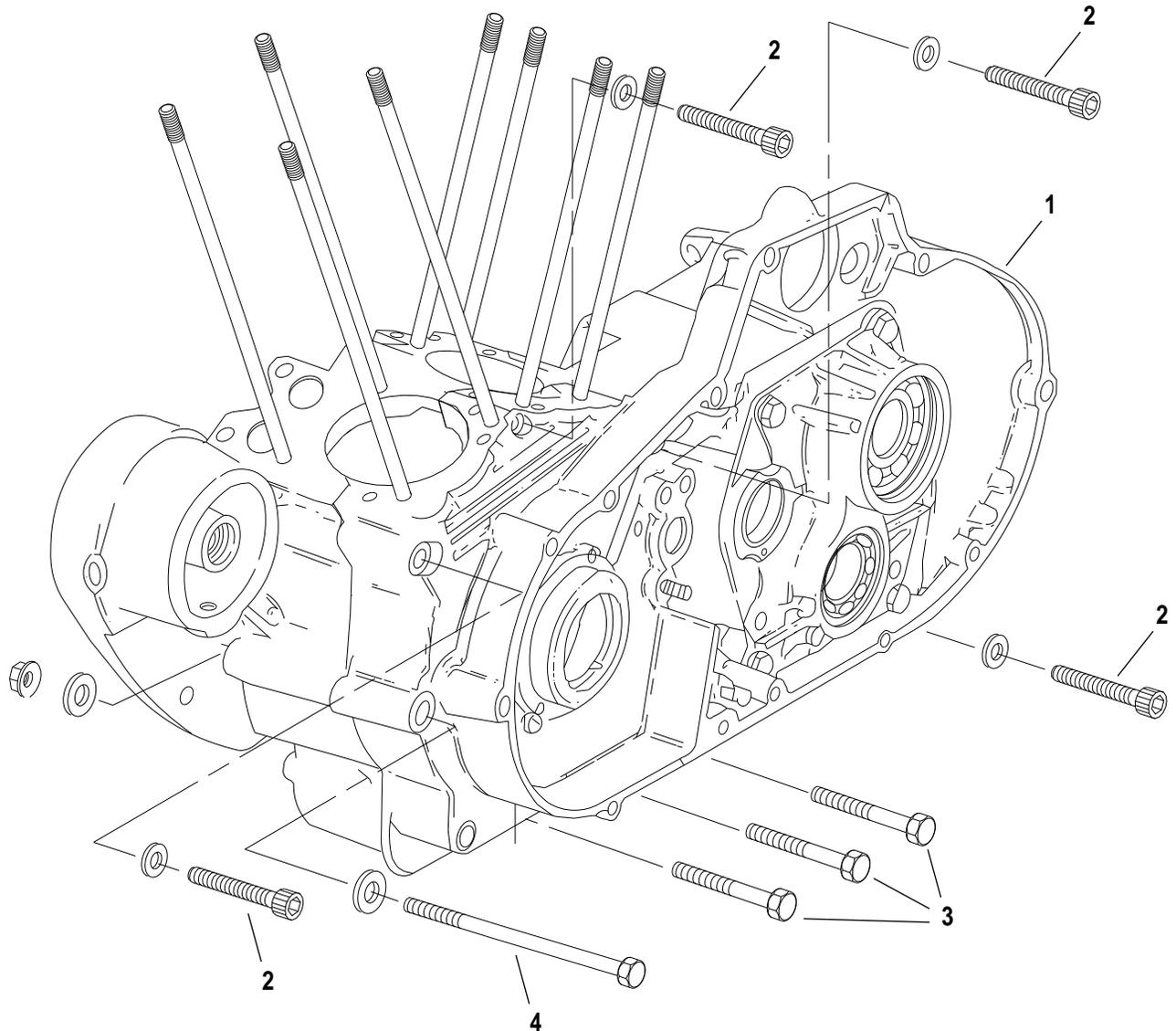
Crankcase Halves

1. Remove cylinder heads as described under [CYLINDER HEAD, REMOVAL](#) on page 3-11.

⚠ CAUTION

After removing cylinders, install plastic or rubber hose over cylinder studs. Lifting or moving crankcase by grasping studs will cause cylinder stud damage.

2. Remove cylinders and pistons. See [CYLINDER AND PISTON, REMOVAL/DISASSEMBLY](#) on page 3-22.
3. Remove oil pump as described under [OIL PUMP, REMOVAL/DISASSEMBLY](#) on page 3-35.
4. Remove gearcase components. See [GEARCASE COVER AND CAM GEARS, REMOVAL/DISASSEMBLY](#) on page 3-40.
5. Remove clutch and primary drive components. See [PRIMARY DRIVE/CLUTCH](#) in Section 6.



1. Crankcase
2. Upper case hex socket head screw – 5/16-18 X 2-1/2 in. long (4)
3. Bottom case hex head bolt – 1/4-20 X 3/4 in. long (3)
4. Muffer mount bolt – 3/8-16 X 5-1/2 in. long (2, with washers and locknuts)

Figure 3-65. Crankcase Hardware

6. Remove starter motor as described under [STARTER, REMOVAL](#) in Section 5.
7. Remove transmission. See [TRANSMISSION CASE](#) in Section 6.
8. See [Figure 3-65](#). Remove screws (2) and rear engine mount bolt securing crankcase halves together.
9. Position crankcase on work bench, gearcase side up. Tap crankcase with plastic mallet to loosen top half and separate the halves.

⚠WARNING

The following step requires using a press. Wear eye protection and make certain set-up is stable. The force involved could cause parts to “fly out” and cause personal injury.

10. See [Figure 3-66](#). Mount the left case half and flywheel assembly on a press table, supporting crankcase on parallel bars. Press on end of sprocket shaft with arbor press until flywheel assembly is free from case half. Do not drive flywheel assembly from case half as flywheels may be knocked out of alignment.

NOTE

See [Figure 3-68](#). If it is necessary to remove either the pinion shaft bearing (11) or sprocket shaft bearing (4 and 9), proceed as follows:

11. Pinion bearing (11) will remain on pinion shaft. Remove retaining ring (10), and bearing (11) may be slipped off pinion shaft.
12. See [Figure 3-69](#). Pull sprocket shaft bearing with [WEDGE ATTACHMENT FOR CLAW PULLER \(Part No. HD-95637-46A\)](#) and [ALL PURPOSE CLAW PULLER \(Part No. HD-95635-46\)](#) using bolts in place of jaws.
13. See [Figure 3-67](#). Use [CRANKSHAFT BEARING TOOL \(Part No. HD-94547-101\)](#) to remove sprocket shaft outer races.

NOTE

See [Figure 3-68](#). Do not remove retaining ring (7); the crankcase can easily be damaged during the removal process. Removal of the retaining ring is not necessary for the removal or installation of the outer bearing races.

Flywheels

1. See [Figure 3-70](#). Place flywheel assembly in holding fixture. Remove crank pin nut (1). Strike left flywheel with soft metal mallet at about 90° from crank pin hole on wheel periphery to loosen. Lift left flywheel (2) off crank pin.
2. Hold down crank pin bearing assembly (4) with a short length of pipe or tubing so connecting rods (3) may be slipped off bearings, then remove bearing assembly. Secure bearings (4) together in set until they are washed and refitted to crank pin.
3. Remove crank pin nut (9), then tap crank pin (6) out of flywheel and remove key (7).

CLEANING/INSPECTION

1. Wash all parts in solvent and blow dry with compressed air. Examine crank pin for wear, grooving and pitting. If the surface is at all worn, replace with **new** pin. Examine flywheel washers. If either washer is worn or grooved, it should be replaced. See [REPLACING FLYWHEEL WASHERS](#) on [page 3-51](#).
2. Examine connecting rod lower races. If they appear slightly grooved or shouldered where edge of bearing rollers ride, they may be lapped out, and an oversize crank pin and new bearing installed. If they appear badly worn, grooved or pitted, **new** rods should be installed, preferably as an assembly with **new** bearings and crank pin.
3. Inspect bearing for wear, pitting and heat discoloration. Replace as required.
4. Inspect crank pin, crank pin roller and connecting rods for correct freeplay.

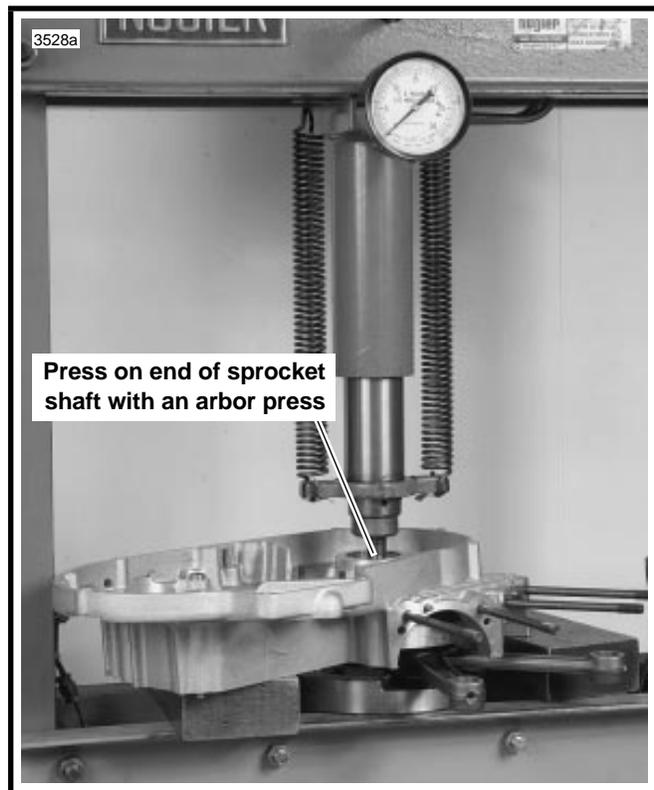
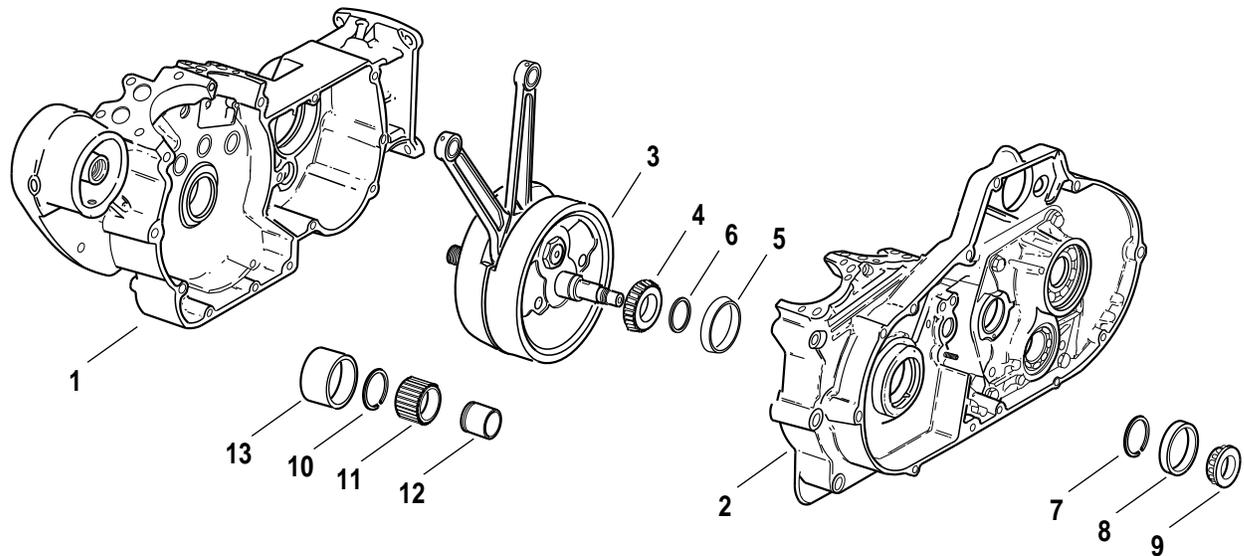


Figure 3-66. Pressing Flywheel from Crankcase



Figure 3-67. Sprocket Shaft Outer Race Removal



- | | |
|---|-------------------------------------|
| 1. Right crankcase half | 8. Sprocket left outer race |
| 2. Left crankcase half | 9. Sprocket left bearing |
| 3. Connecting rod and flywheel assembly | 10. Retaining ring |
| 4. Sprocket right bearing | 11. Pinion shaft bearing |
| 5. Sprocket right outer race | 12. Pinion shaft bearing inner race |
| 6. Spacer | 13. Pinion shaft bearing outer race |
| 7. Retaining ring | |

Figure 3-68. Crankcase and Flywheel Assembly

Replacing Flywheel Washers

Replace worn flywheel washers as follows:

- See [Figure 3-70](#). The washer (10) is a close fit in flywheel recess and is secured originally by punching flywheel metal tight against the washer at several points. It is usually necessary to drill a small hole (1/8 in. (3.2 mm) or smaller) at the outer edge of the washer to permit prying with a pointed tool.

NOTE

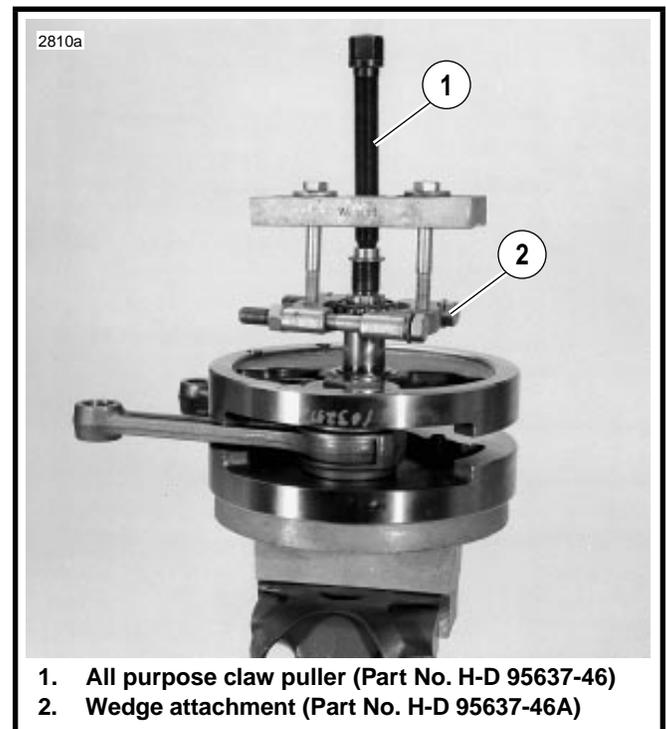
Drill hole only slightly deeper than thickness of washer. Avoid removing more material than necessary.

- Before installing a **new** washer, scrape outer edge of recess, where metal was punched against original washer, so **new** washer will seat fully against recess bottom. If washer does not seat fully, forked rod will not have necessary clearance (side play).

CAUTION

Be sure stepped thrust washers are installed with step facing crank pin bearing. Improper installation will damage washer and bearing set and cause accelerated wear and increased noise.

- Carefully tap **new** washers into place and using a punch, peen metal over edge to retain washer.



- All purpose claw puller (Part No. H-D 95637-46)
- Wedge attachment (Part No. H-D 95637-46A)

Figure 3-69. Removing Sprocket Shaft Roller Bearing

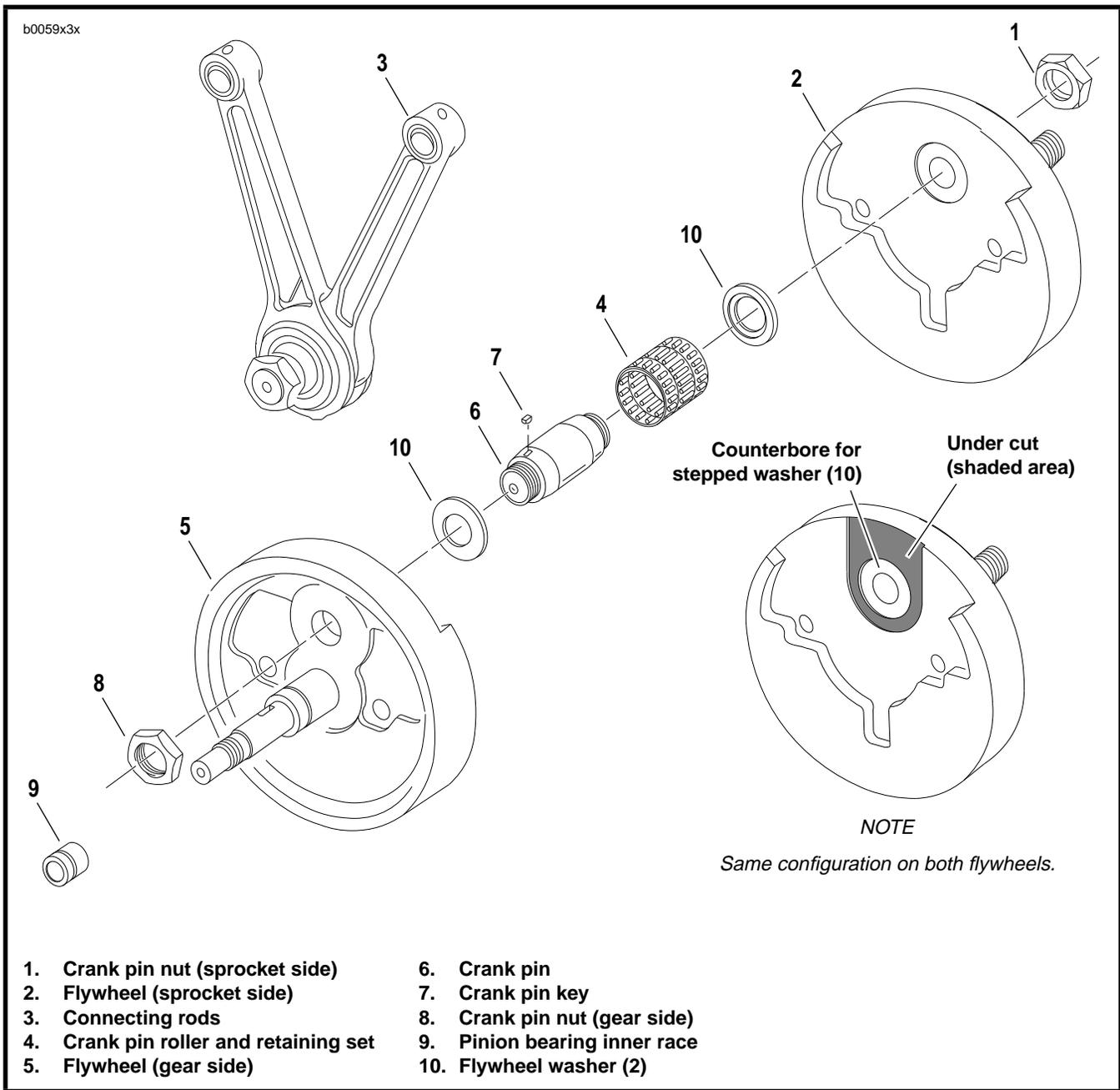


Figure 3-70. Flywheel and Connecting Rod Assembly

Lapping Connecting Rod Races

Connecting rod lower races that are likely to clean up within range of oversize bearing rollers and are otherwise in serviceable condition, should be trued and sized with [CONNECTING ROD LAPPING ARBOR \(Part No. HD-96740-36\)](#).

1. Clean lap before using.
2. See [Figure 3-71](#). Clamp lap into lathe chuck, carefully load lap with #220 grit grinding compound, mixed with oil. Adjust lathe to turn at approximately 150-200 RPM.
3. Carefully slide connecting rod over lap. Adjust lap to a dragging, but free, fit in rod race.

NOTE

A loose lap will BELL MOUTH bearing races, so lap must be kept adjusted at all times.

4. Start lathe and work rod back and forth, over full length of lap. Hold rod as near race end as possible.
5. Check rod frequently. When rod is lapped true and all traces of pit marks or grooves are cleaned up, wash and blow rod dry.
6. Repeat lapping procedure for other rod race.
7. Bearing races should have a soft velvety appearance and be free of shiny spots.

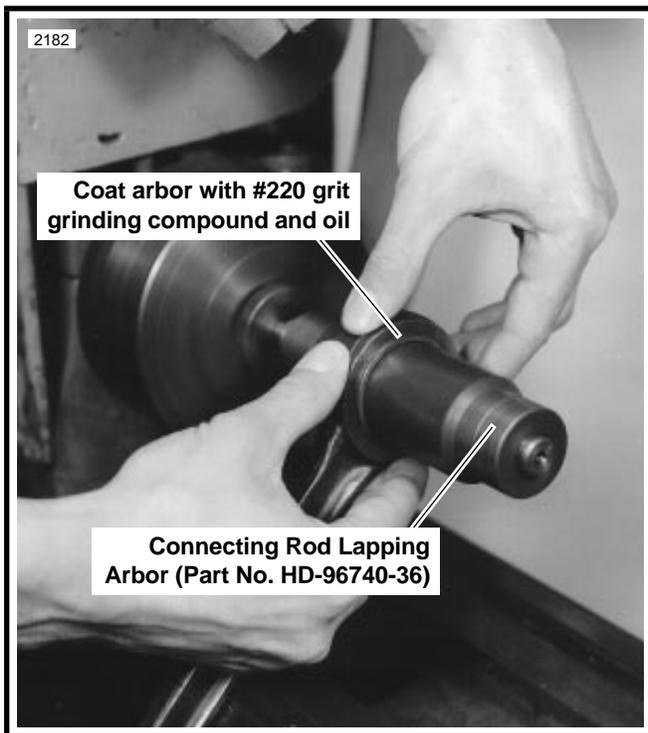


Figure 3-71. Lapping Connecting Rod Races

Fitting Rod Bearings

See [Figure 3-72](#). The new crank pin bearing set packages are color coded with either a red or blue identification. This color coding is used by the bearing manufacturer only. The color coding DOES NOT indicate size selection for crank pin bearing replacement.

CAUTION

Either a red or a blue coded bearing set may be used. DO NOT intermix bearings from a red and a blue bearing set because this may cause excessive loading on one bearing, resulting in premature bearing failure.

The bearings consist of rollers retained in steel cages. The wide bearing (male/front rod) retains rollers both internally and externally. The two narrow bearings (female/rear rod) only retain the rollers externally, so care must be taken to slide the bearing set directly from the inner sleeve onto the crank pin; this will prevent the rollers from dropping out of the cage.

Only one size replacement bearing set (standard, either red or blue coding) is sold. Oversize bearings are not available. Bearing clearance or fit is controlled by the connecting rod race inside diameters and the crank pin diameter. Two oversize crank pins are available.

1. See [Figure 3-73](#). Measure inside diameter (ID) of lapped connecting rod races with a dial bore gauge that has 0.0001 in. (0.0025 mm) graduations. Measure the ID at four places as shown. Record the four measurements. If any race ID exceeds Service Wear Limit of 1.6270 in. (41.326 mm), replace races or connecting rod set. If race ID measurements are less than 1.6270 in. (41.326 mm), continue procedure as follows:

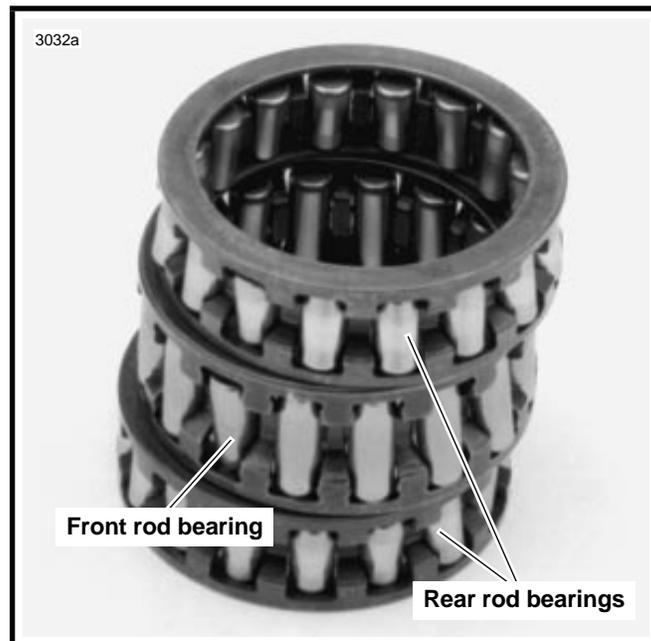


Figure 3-72. Crank Pin Bearing Set



Measure ID of each race at four locations

Figure 3-73. Measuring Connecting Rod Race Inside Diameter



- Compare the measurements recorded in Step 1 with the ranges given in [Table 3-12](#). If the four measurements taken in each race differ, use the smallest measurements.

NOTE

Front and rear rod race ID must be within the same tolerance range given in the above table. The following example will illustrate the procedure necessary if the lapped connecting rod races on both rods do not fall in the same range.

Table 3-12. Race Diameter and Crank Pin Size

CONNECTING ROD RACE ID REQUIRED	CRANK PIN REQUIRED
1.6245-1.6250 in. (41.262-41.275 mm)	Standard
1.6255-1.6260 in. (41.288-41.300 mm)	0.0010 in. oversize (0.025 mm)
1.6265-1.6270 in. (41.313-41.326 mm)	0.0020 in. oversize (0.051 mm)
Greater than 1.6270 in. (41.326 mm)	Service Wear Limit exceeded. Replace races or connecting rod set.

- As an example, assign the following values to the measurements taken in Step 1.

Front connecting rod race diameter: 1.6255 in.
(41.288 mm)

Rear connecting rod race diameter: 1.6250 in.
(41.275 mm)

See [Table 3-12](#). For the above example measurements, the front connecting rod would require a 0.0010 in. (0.025 mm) oversize crank pin, while the rear connecting rod could use the standard sized crank pin. The rear connecting rod races must be lapped so they have the same ID (within 0.0002 in. (0.005 mm)) as the front rod.

- See [Figure 3-74](#). Oversize (OS) crank pins are available in two oversizes: 0.0010 and 0.0020 in. (0.025 and 0.051 mm) OS crank pins will have a blue or red paint dot applied to the ends of the pins. A blue dot indicates 0.0010 in. (0.025 mm) OS, a red dot indicates 0.0020 in. (0.051 mm) OS. Standard size crank pins will not be marked.
- Before assembling the flywheel assembly, recheck connecting rods as follows:

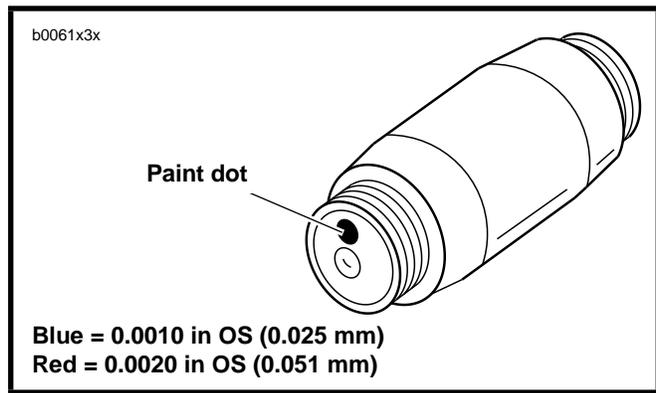


Figure 3-74. Oversize Crank Pin Identification

CAUTION

After the appropriate connecting rod race ID range specified in **RACE DIAMETER AND CRANK PIN SIZE** table has been achieved, verify that the following **CONNECTING ROD SPECIFICATIONS** are also met:

CONNECTING ROD SPECIFICATION

Rear Difference in ID of two races must not exceed 0.0001 in. (0.0025 mm).

Front and rear Difference in ID of races in front and rear connecting rods must not exceed 0.0002 in. (0.005 mm).

Front and rear Races must be round within 0.00025 in. (0.0064 mm). (Difference between largest and smallest ID measurement in any race must not exceed 0.00025 in. (0.0064 mm)).

NOTE

Always use **new** bearings and crank pin after resizing (lapping) connecting rods to insure proper running clearance.

CAUTION

Fitting components tighter than recommended may result in seizing and bearing damage when heat expands the parts. Such damage requires component replacement.

Fitting Sprocket Bearings

If flywheel end play is within tolerance, and if tapered roller bearings and races pass visual check and have no apparent wear, the same set may be reinstalled. Make certain all parts of bearing are installed in exactly the same order in which they were removed. If any part of bearing assembly is worn, entire assembly should be replaced.

Fitting Pinion Bearings

See [Figure 3-68](#). A pressed-in bushing in the right crankcase half is the outer race (13). The inner race (12) is pressed on the pinion shaft.

See [Figure 3-75](#). To remove pinion shaft inner race, use **TWO CLAW PULLER (Part No. HD-97292-61)**, **CENTER CAP (Part HD-95652-43A)**, and **BEARING SEPARATOR (SNAP-ON TOOLS Stock No. CJ950)**. Apply heat to race to aid removal. Four sizes of pinion bearings are available. Pinion bearing selection at the factory, during engine rebuild, or replacement of crankcase set or flywheel assembly is based on the largest measured outside diameter (OD) of the inner race and the smallest measured inside diameter (ID) of the outer race (crankcase bushing). A running clearance of 0.0002-0.0008 in. (0.005-0.020 mm) is established during crankcase set or flywheel assembly replacement and engine rebuild.

See [Figure 3-76](#). Installed inner races are identified at the factory as shown.

See [Figure 3-77](#). Outer races are identified at the factory as shown.

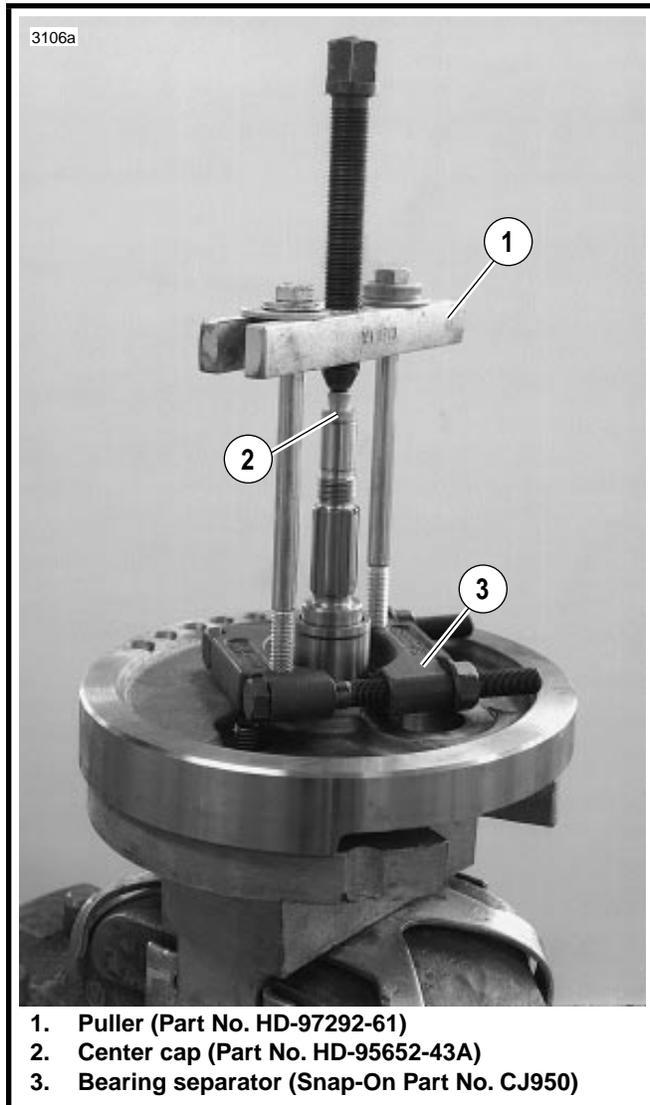


Figure 3-75. Pulling Pinion Shaft Inner Race

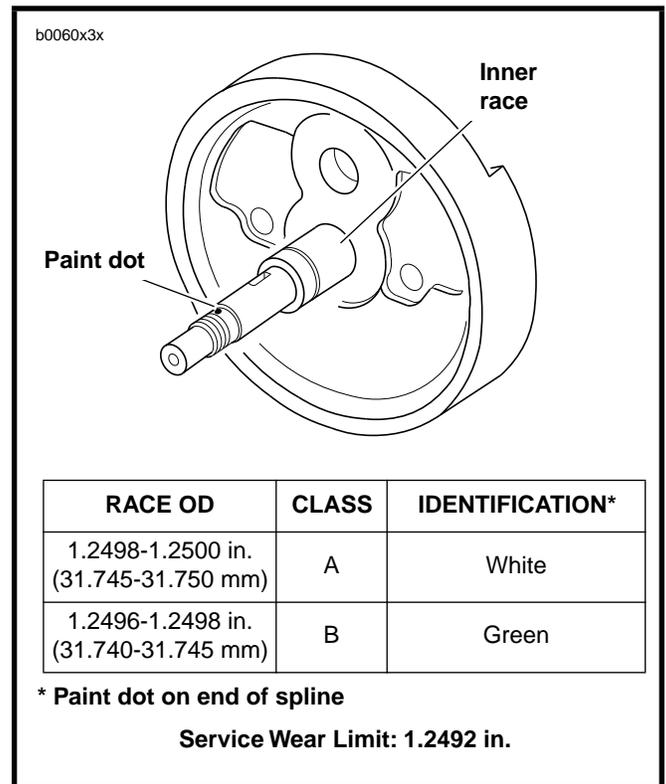


Figure 3-76. Factory Inner Race Sizes

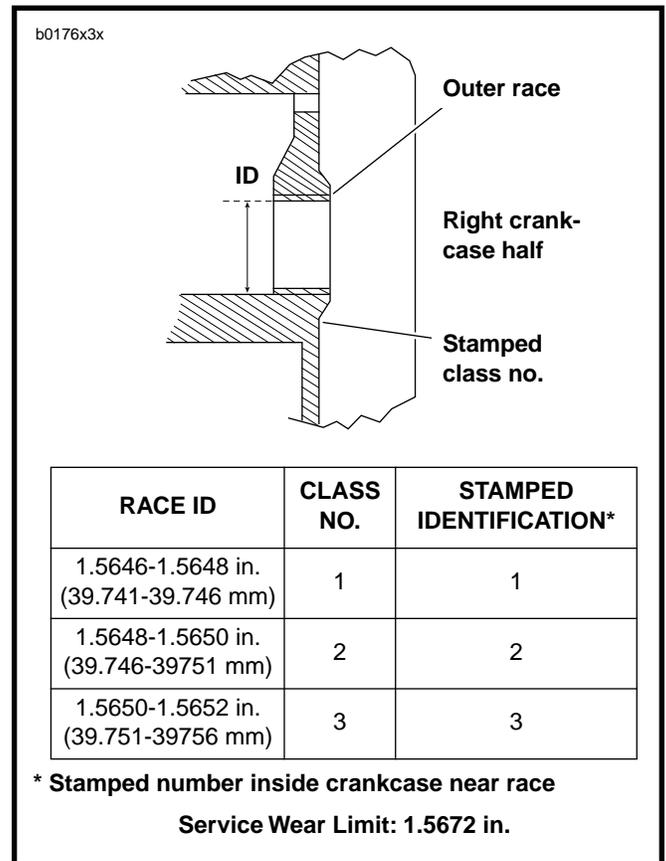


Figure 3-77. Factory Outer Race Sizes

NOTE

The different sizes of crankcase sets and flywheel assemblies will not have separate part numbers. That is, a replacement crankcase set may have a class 1, 2 or 3 pinion outer race. Replacement flywheel assemblies will have either a class A or B inner race.

See Figure 3-78. Pinion bearings are identified as shown.

BEARING SELECTION

Select bearings using the identification information given for inner and outer races and bearings. See Table 3-13.

NOTE

If either inner or outer race show wear, measure both races to confirm correct bearing fit.

1. Measure ID of outer race at four places with a dial bore gauge. Take measurement on ID where bearing rollers ride. Record the four measurements.
2. If the largest measurement is larger than 1.5672 in. (39.807 mm) or the required lapping to remove wear marks would enlarge bore beyond 1.5672 in., continue at Step 8.
3. If the largest measurement is 1.5672 in. (39.807 mm) or less, cover the cam bearings with masking tape to prevent debris from entering bearings. Assemble crankcase halves.

NOTE

The next step requires lapping the outer race. To keep sprocket shaft and pinion shaft bearings aligned the lap must be supported by an adaptor or pilot in the left crankcase half.

4. See [LAPPING ENGINE MAIN BEARING RACES](#) on page 3-58. Race must be lapped until all wear marks are removed.
5. Measure ID of race at four places and record the measurements.
6. Check measurements against these specifications:
Largest ID measured: 1.5672 in. (39.807 mm) or less
Roundness of ID: within 0.0002 in. (0.005 mm)
Taper: within 0.0002 in. (0.005)
7. If lapping increased bore ID to larger than 1.5672 in. (39.807 mm), go to Step 8. If roundness or taper do not meet specifications, continue lapping until specifications are met. If all specifications are met, continue at Step 10 to remove and size inner race.
8. Press the outer race from the right crankcase. Press **new** outer race into crankcase flush with inside edge of cast-in insert.

See Figure 3-80. Dimensions are shown for fabrication of tools used in pressing the outer race into or out of crankcase.

9. The **new** outer race must be lapped slightly to true and align with left case bearing and to meet the following specifications. See [LAPPING ENGINE MAIN BEARING RACES](#) on page 3-58.

ID: 1.5646 - 1.5652 in. (39.741 - 39.756 mm)
Roundness: within 0.0002 in. (0.005 mm)
Taper: within 0.0002 in. (0.005 mm)
Surface finish: 16 RMS

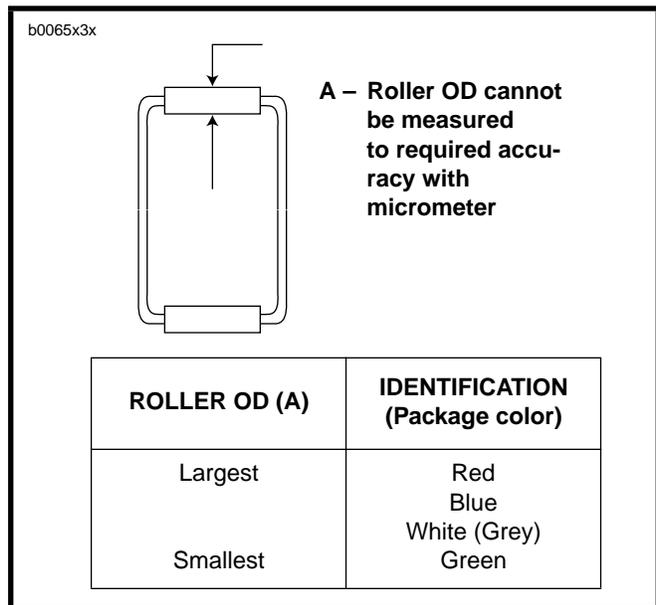


Figure 3-78. Bearing Identification

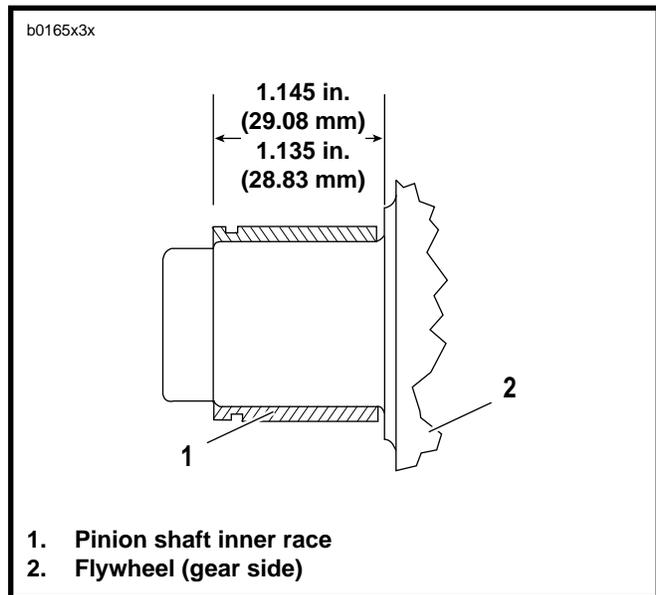


Figure 3-79. Inner Race Location

Table 3-13. Pinion Shaft Bearing Selection

FACTORY STAMPED NUMBER	OUTER RACE ID	BEARING SIZE AS IDENTIFIED BY COLOR CODING											
	over 1.5672 in. 39.807 mm	Service Wear Limit Exceeded – Replace Outer Race and Resize											
	1.5670-1.5672 in. 39.802-39.807 mm												Red
	1.5668-1.5670 in. 39.797-39.802 mm											Red	Blue
	1.5666-1.5668 in. 39.792-39.797 mm									Red	Blue	White-Gray	
	1.5664-1.5666 in. 39.787-39.792 mm								Red	Blue	White-Gray	Green	
	1.5662-1.5664 in. 39.781-39.787 mm							Red	Blue	White-Gray	Green		
	1.5660-1.5662 in. 39.776-39.781 mm						Red	Blue	White-Gray	Green			
	1.5658-1.5660 in. 39.771-39.776 mm					Red	Blue	White-Gray	Green				
	1.5656-1.5658 in. 39.766-39.771 mm				Red	Blue	White-Gray	Green					
	1.5654-1.5656 in. 39.761-39.766 mm			Red	Blue	White-Gray	Green						
	1.5652-1.5654 in. 39.756-39.761 mm		Red	Blue	White-Gray	Green							
3	1.5650-1.5652 in. 39.751-39.756 mm	Red	Blue	White-Gray	Green								
2	1.5648-1.5650 in. 39.746-39.751 mm	Blue	White-Gray	Green									
1	1.5646-1.5648 in. 39.741-39.746 mm	White-Gray	Green										
INNER RACE OD (In)		1.2496-1.2498 in.	1.2498-1.2500 in.	1.2500-1.2502 in.	1.2502-1.2504 in.	1.2504-1.2506 in.	1.2506-1.2508 in.	1.2508-1.2510 in.	1.2510-1.2512 in.	1.2512-1.2514 in.	1.2514-1.2516 in.	1.2516-1.2518 in.	
		31.740-31.745 mm	31.745-31.750 mm	31.750-31.755 mm	31.755-31.760 mm	31.760-31.765 mm	31.765-31.770 mm	31.770-31.775 mm	31.775-31.780 mm	31.780-31.786 mm	31.786-31.791 mm	3.791-31.796 mm	
FACTORY COLOR CODE		Green	White										

- See [Figure 3-75](#). Pull inner race from pinion shaft using [TWO CLAW PULLER \(Part No. HD-97292-61\)](#), [CENTER CAP \(Part No. HD-95652-43A\)](#), and [BEARING SEPARATOR \(SNAP-ON TOOLS Stock No. CJ950\)](#). Apply heat to race to aid removal.
- See [Figure 3-79](#). Press **new** inner race on pinion shaft as shown. The **new** inner race must be ground by a competent machinist to OD dimension range given in the [PINION SHAFT BEARING SELECTION TABLE](#), for the finished lapped ID of the outer race. The finished inner race must meet these specifications. For necessary dimensions for constructing a press-on tool see [Figure 3-80](#). When the tool bottoms against the flywheel, correct inner race location is automatically established.

Roundness: within 0.0002 in.
Taper: within 0.0002 in. (0.005 mm)
Surface finish: 16 RMS

- The following example illustrates how to determine the required inner race OD.

EXAMPLE:

- If smallest measured ID of outer race is 1.5651 in. (39.754 mm) Table 13 indicates an inner race OD range of 1.2496-1.2504 in. (31.740 - 31.760 mm) is required.

NOTE

Have machinist grind outer race to center or middle of required OD range. This will prevent grinding outer race undersize and gives a more easily achieved tolerance range.

- Grind inner race. Measure OD at four places and check that specifications in Step 11 are met.
- For example purposes, the largest measured OD of inner race after grinding is 1.2499 in. (31.747 mm) OD.
- See [Table 3-13](#). With a 1.5651 in. ID outer race and a 1.2499 in. (31.747 mm) OD inner race, a blue bearing is required.

NOTE

Always use the smallest outer race ID measurement and the largest OD inner race measurement when selecting bearings.

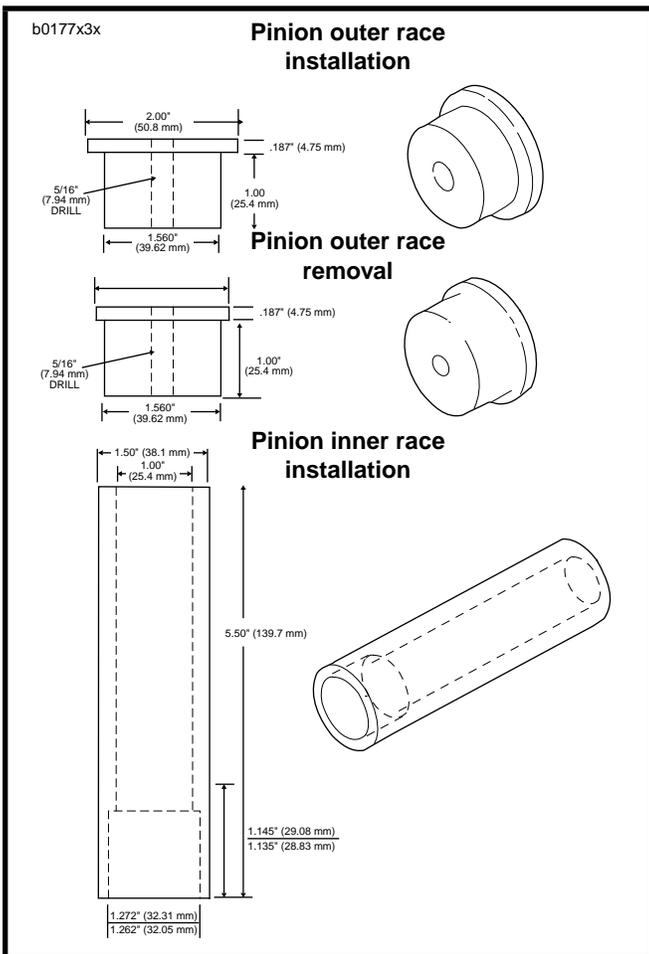


Figure 3-80. Pinion Shaft Bearing Tools

Lapping Engine Main Bearing Races

1. Secure right and left crankcase halves with three crankcase stud bolts (top center and bottom left and right). The sprocket shaft bearing outer races and large spacer must be installed in left crankcase.
2. See [Figure 3-81](#). Obtain **CRANKCASE MAIN BEARING LAPPING TOOL (Part No. HD-96710-40B)**. Assemble **CRANKCASE MAIN BEARING LAP (Part No. HD-96718-87)** to lapping handle. Assemble guide sleeve to sprocket shaft bearing bushing. Sleeves, for use with tapered bearing, are assembled to case with bearings and small spacer collar. Finger-tighten the sleeve parts.
3. Insert lap shaft with arbor assembled through pinion bearing bushing and into guide sleeve. Tighten arbor expansion collars using a length of 0.156 in. (3.96 mm) rod as spanner until arbor begins to drag. Do not adjust arbor snug in bushing or bushing will “bell,” a condition where hole is larger at ends than it is in the center.
4. Withdraw arbor far enough to coat lightly with 220 grit lapping compound. Do not apply a heavy coat. Reposition lap in bushing and turn handle at moderate hand speed. Work lap back and forth in bushing, as it is revolved, to avoid grooving and tapering.
5. At frequent intervals, remove lap from crankcase wash and inspect bushing. Lapping is completed when entire

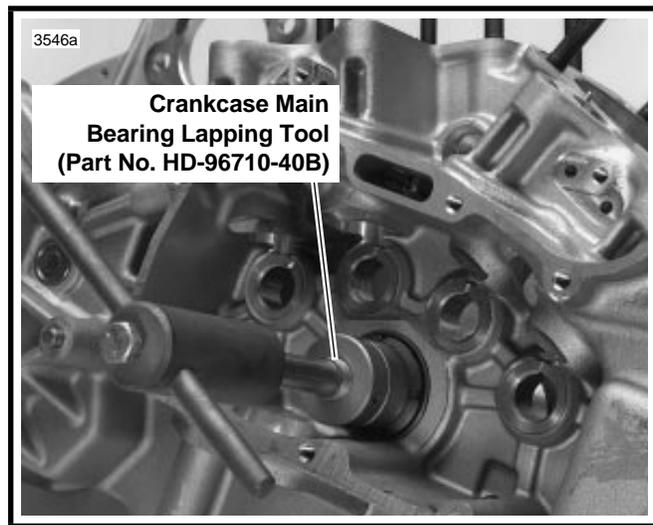


Figure 3-81. Lapping Pinion Shaft Main Bearing

bushing surface has a dull, satin finish rather than a glossy, smooth appearance. If necessary, flush off lap in cleaning solvent, air dry and apply fresh, light coat of fine lapping compound.

ASSEMBLY

Flywheels

After correct connecting rod bearing fit has been attained, clean and assemble parts as follows:

1. Carefully clean all flywheel components using a non-petroleum-based solvent, such as **LOCTITE CLEANING SOLVENT** or electrical contact cleaner. Thoroughly dry all components.
2. See [Figure 3-70](#). Apply two drops of **LOCTITE 620 RETAINING COMPOUND** to the crank pin threads, and apply no more than two drops to the nut bearing faces.

CAUTION

Do not apply any LOCTITE THREADLOCKER COMPOUND or RETAINING COMPOUND to shaft tapers. Any material on shaft tapers will cause component damage.

3. Assemble crank pin (6) to gear-side flywheel (5) making sure that key (7) is in proper position. Tighten crank pin nut. See [SPECIFICATIONS](#) for proper torque.
4. Position gear-side flywheel assembly in a flywheel fixture with crank pin pointing up. Wipe crank pin taper clean.
5. See [Figure 3-82](#). Slip bearings, and connecting rods over crank pin. Assemble angular boss of the female rod adjacent to large radius side of the male rod as shown. The side of the male rod with the larger radius is narrower in the area where it fits between the forks of the female rod.
6. Verify that oil passages through pinion shaft, gear-side flywheel and crank pin are clear by blowing compressed air into oil galley at end of pinion shaft.
7. Install sprocket-side flywheel. Lightly tighten nut.
8. See [Figure 3-83](#). Hold steel straightedge along outer face of wheel rims at 90° from crank pin as shown. Tap outer

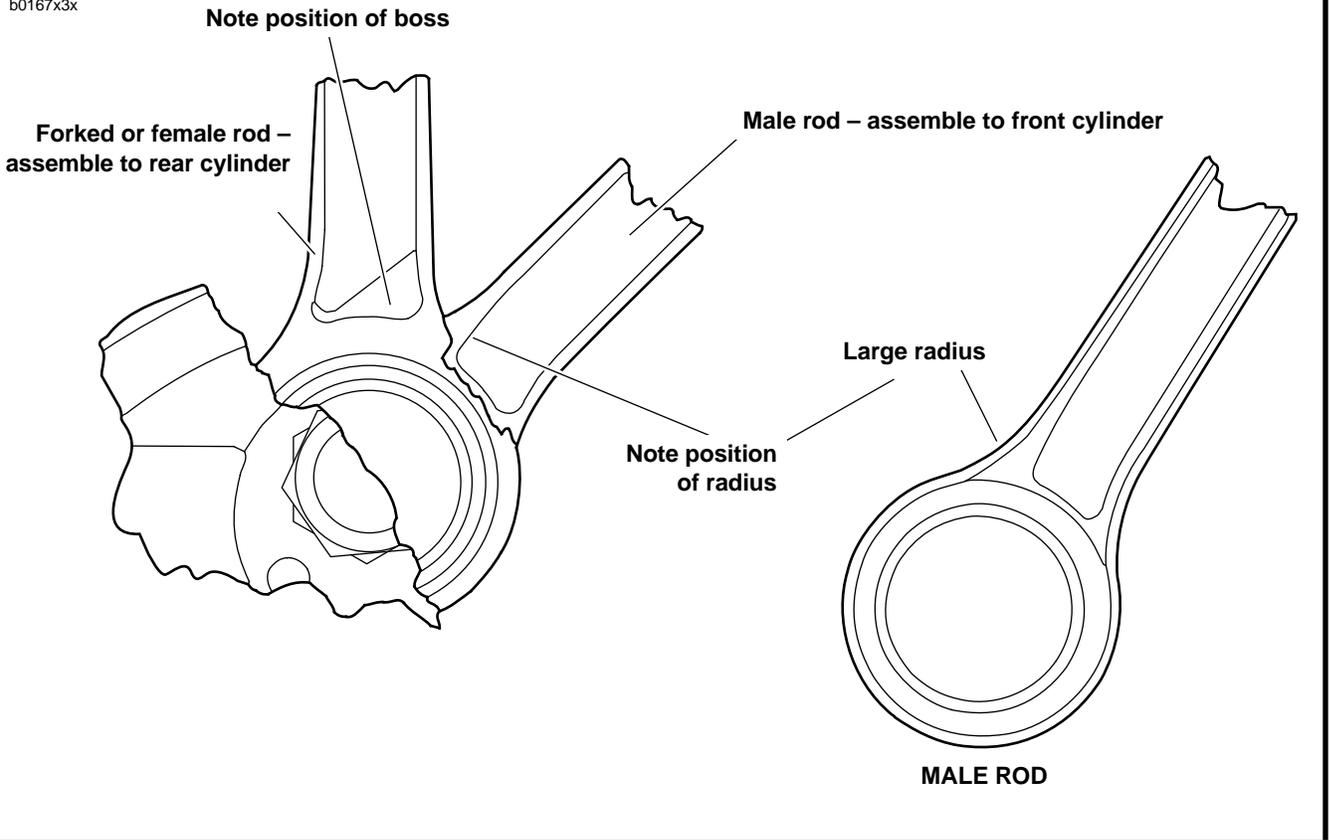


Figure 3-82. Installing Connecting Rods

rim of top wheel until wheels are concentric. Tighten nut, recheck with straightedge at frequent intervals.

NOTE

Use soft metal hammer to realign wheels.

9. Tighten crank pin nut to 150-185 ft-lbs (203-251 Nm). See [Figure 3-85](#). Install flywheel assembly in [FLYWHEEL TRUING STAND \(Part No. HD-96650-80\)](#) as shown. Adjust so centers are snug. Wheels must turn freely; however, shafts must not be loose in centers. If flywheel assembly is either loose or squeezed, indicators will not indicate accurately. Adjust indicators to take reading as near to flywheels as possible, so pointers read at about the middle of the scales.
10. Turn flywheels slowly and observe the movement of indicator pointers. Movement toward flywheels indicate high points of shafts. Find highest point of each shaft and chalk-mark flywheel rims at those points. Remove flywheel from stand and make corrections as follows:
 11. See [Figure 3-84](#). Flywheel may be out of true three ways, A, B and C or a combination of two of the three ways.
 12. When wheels are both out of true as indicated in A, tighten C-clamp on rims or wheels opposite crank pin and lightly tap the rim at the crank pin with lead or copper mallet.
 13. When wheels are both out of true as indicated in B, drive a hardwood wedge between the wheels opposite the crank pin and lightly tap the rims near the crank pin with a lead or copper mallet.
 14. When wheels are out of true as indicated in C, strike the rim of the wheel a firm blow at about 90° from crank pin on high side.

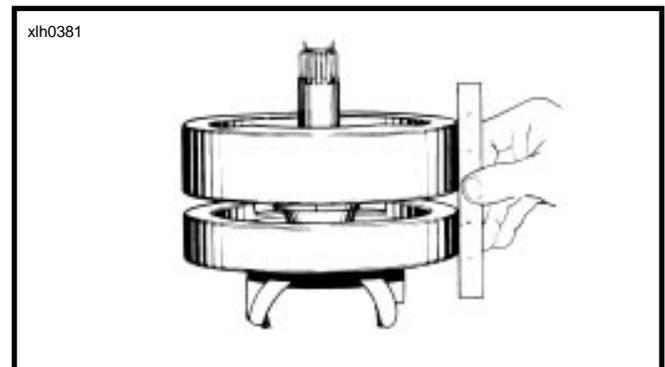


Figure 3-83. Squaring Flywheel Faces

15. When wheels are out of true in a combination of any of the conditions shown, correct C first, tapping rim of offending wheel only, and then correct condition A or B.

NOTE

The number of blows required and how hard they should be struck depends on how far shafts are out of true and how tight nuts are drawn. Always remove the flywheels from the stand, and strike the flywheel rim only at 90° to the crank pin. Use only a soft metal mallet. Never strike wheels a hard blow near crank pin. This could result in a broken crank pin.

16. See [Figure 3-85](#). Readjust centers, revolve wheels and take reading from indicator. Repeat truing operation until indicated shaft runout does not exceed 0.001 in. (0.025 mm) (each graduation on indicator is 0.002 in. (0.05 mm)).

17. If it is impossible to true wheels, check for a cracked flywheel, damaged or enlarged tapered hole or a sprocket or pinion shaft worn out-of-round at surface where indicator reading is being taken.
18. See [Figure 3-86](#). When wheels are true, check connecting rod side play with thickness gauge as shown. If it is greater than tolerance shown in [SPECIFICATIONS, CONNECTING ROD](#) draw up crank pin nuts until within tolerance. Insufficient play between rods and flywheel face is caused by one of the following conditions:
 - a. Flywheels and crank pin assembled with oil on tapers and nut over-tightened. Disassemble, clean and reassemble.
 - b. **New** flywheel washers installed and not fully seated. Disassemble, inspect, replace deepest seating flywheel or crank pin. As last resort, grind down width of forked rod.
 - c. Taper holes enlarged as a result of having been taken apart several times. Replace deepest seating wheel.
 - d. Cracked flywheel at tapered hole. Replace flywheel.

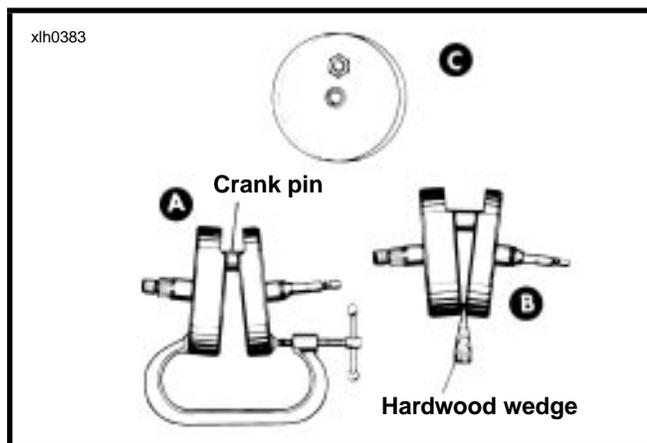


Figure 3-84. Correcting Flywheel Alignment

19. After rod side play is checked and adjusted, check that crank pin nut is tightened to specified torque, again check wheel trueness on truing device. Correct any runout as above.

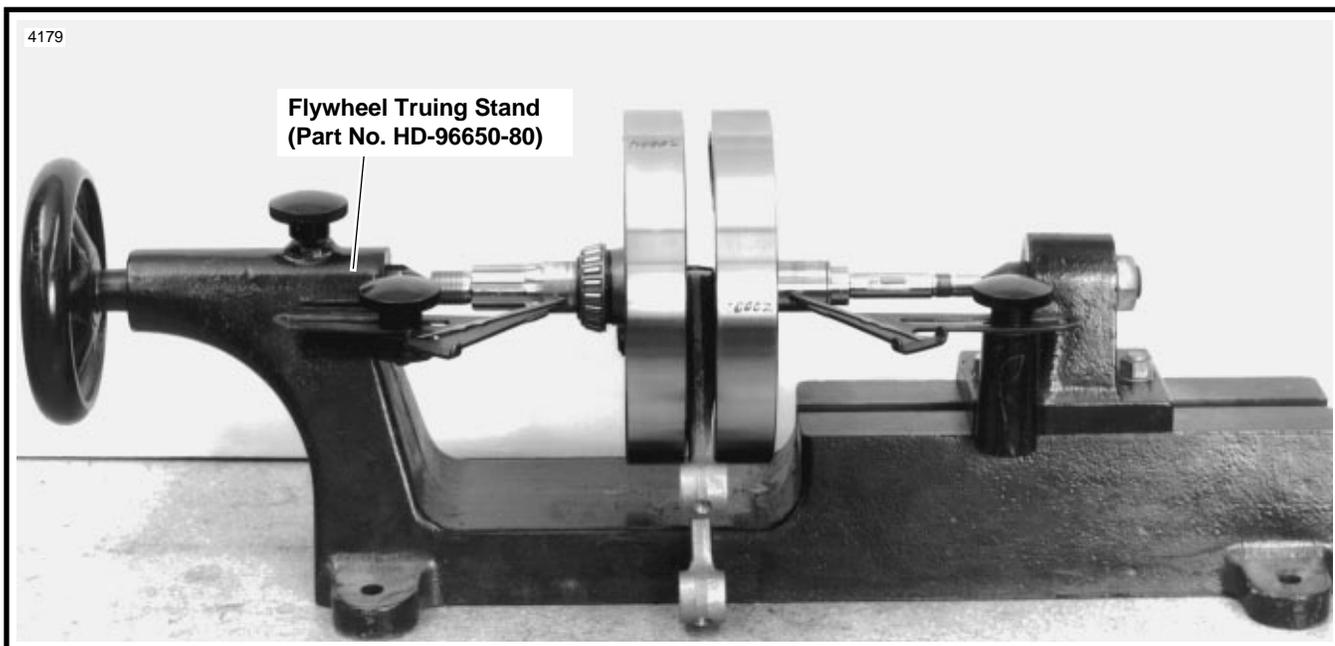


Figure 3-85. Truing Flywheel

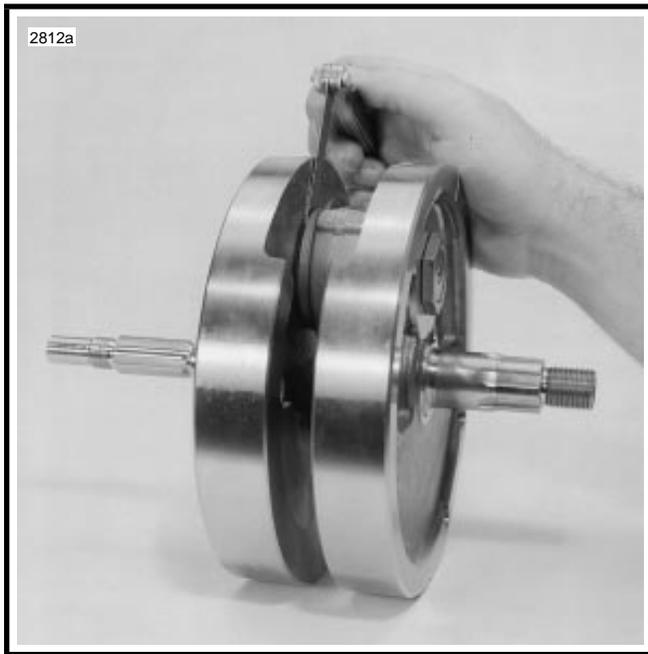


Figure 3-86. Checking Connecting Rod Sideplay

Crankcase Halves

Lubricate all parts with Harley-Davidson 20W50 engine oil, and proceed as follows:

1. See [Figure 3-87](#). The original retaining ring (3) is left in place to avoid damaging the bearing bore of the left crankcase half (6). Verify that gap in retaining ring is aligned with oil supply hole in bearing bore of left crankcase half.

NOTE

See [Figure 3-87](#). USE [SPROCKET SHAFT BEARING OUTER RACE INSTALLATION TOOL \(1-2 Part No. HD-39458\)](#) to install left and right outer races (4, 5) of sprocket shaft tapered roller bearings into left crankcase half (6). Always install left outer race (4) prior to installing right outer race (5); the installer base (1) is usable only when you follow this sequence of race installation.

2. Insert "SPORTSTER" end of installer base (1) into inboard side of left crankcase half (6) bearing bore until base contacts installed retaining ring (3).
3. Position left outer race (4) over bearing bore on outboard side of left crankcase half (6).
4. Insert shaft of installer plug (2) through left outer race (4) and into installer base (1). Press race into bore until firmly seated against retaining ring (3).
5. Insert "SPORTSTER" end of installer base (1) into outboard side of left crankcase half (6) bearing bore until base contacts outboard surface of installed left outer race (4).
6. Position right outer race (5) over bearing bore on inboard side of left crankcase half (6).
7. Insert shaft of installer plug (2) through right outer race (5) and into installer base (1). Press race into bore until firmly seated against retaining ring (3).

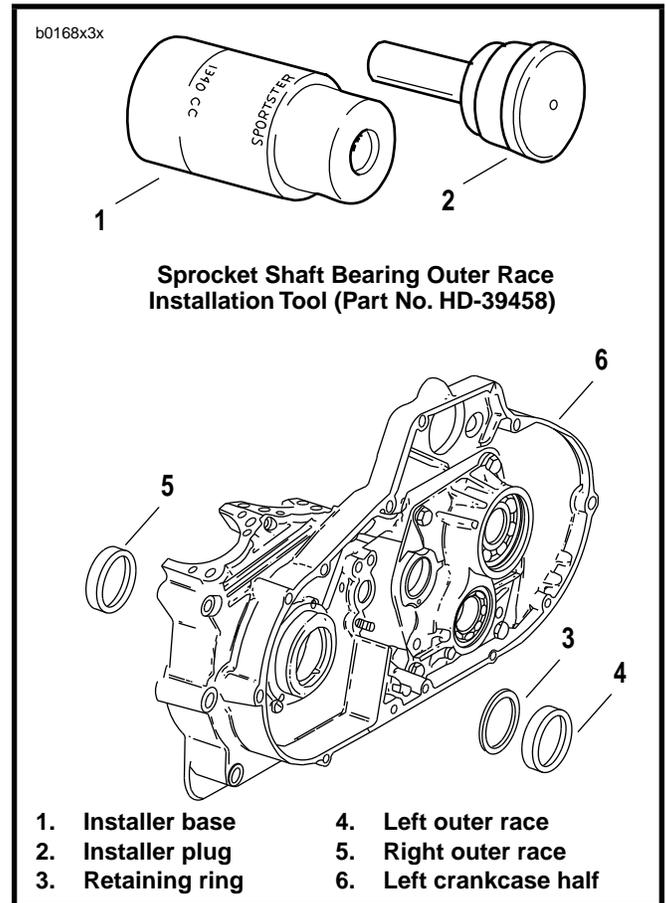
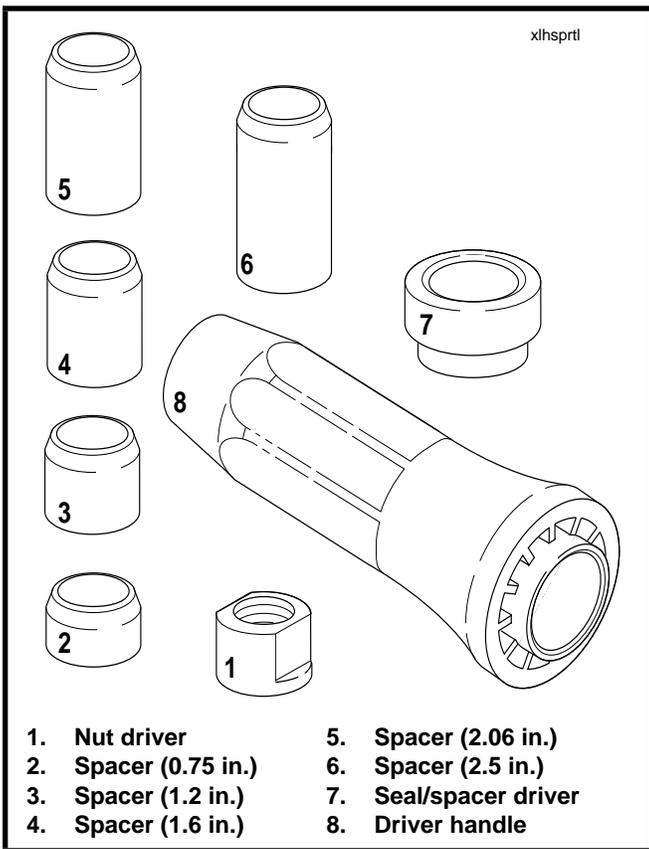


Figure 3-87. Installing Sprocket Shaft Bearing Outer Races

NOTE

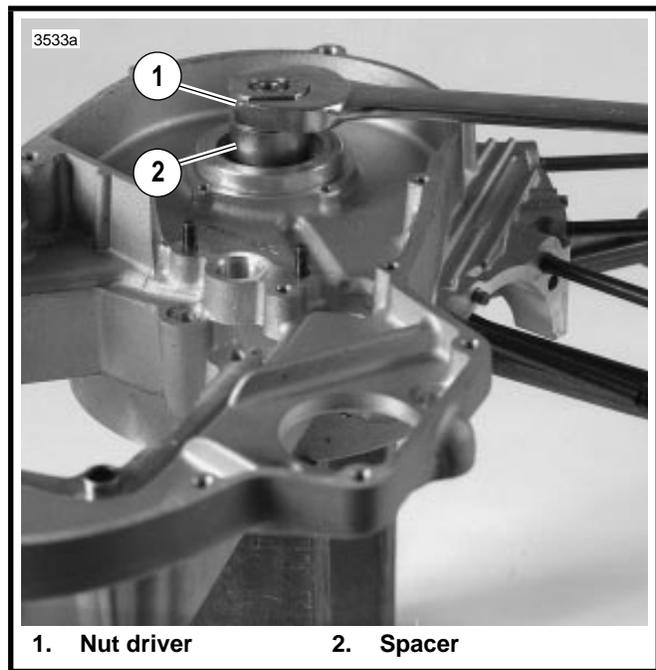
See [Figure 3-88](#). Use [SPROCKET SHAFT BEARING/SEAL INSTALLATION TOOL \(1 - 8, Part No. HD-37047A\)](#) to install sprocket shaft tapered roller bearings and seal.

8. See [Figure 3-89](#). Place bearing cone (3), small end upward, over end of sprocket shaft. Position spacer (2) over sprocket shaft with (radius) rounded end downward. Thread nut driver (1) on sprocket shaft. Turn nut driver onto shaft until nut bottoms at end of threads. Remove nut driver and spacer (2).
9. See [Figure 3-88](#). Repeat procedure using spacers (3, 4, 5 and 6) until bearing cone bottoms against the shaft shoulder.
10. See [Figure 3-90](#). Position left crankcase over sprocket shaft so that the shaft is through the bearing cups in the bearing bore. Place the spacer that determines end play (item 6 in [Figure 3-68](#)) over sprocket shaft. Position left bearing cone over end of shaft with small end downward. Place spacer (2) over sprocket shaft with flat end downward. Thread nut driver (1) on sprocket shaft. Turn nut driver onto shaft until threads bottom. Remove nut driver and spacer. See [Figure 3-88](#). Install spacers (3, 4 and 5) and nut driver (1) in same manner, and tighten until bearing cones and spacer are drawn together.
11. Remove nut driver and spacer.



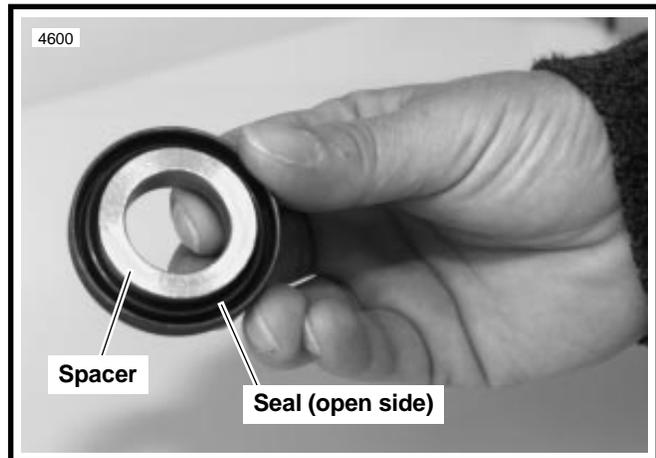
- | | |
|----------------------|-----------------------|
| 1. Nut driver | 5. Spacer (2.06 in.) |
| 2. Spacer (0.75 in.) | 6. Spacer (2.5 in.) |
| 3. Spacer (1.2 in.) | 7. Seal/spacer driver |
| 4. Spacer (1.6 in.) | 8. Driver handle |

Figure 3-88. Sprocket Shaft Bearing/Seal Installation Tool



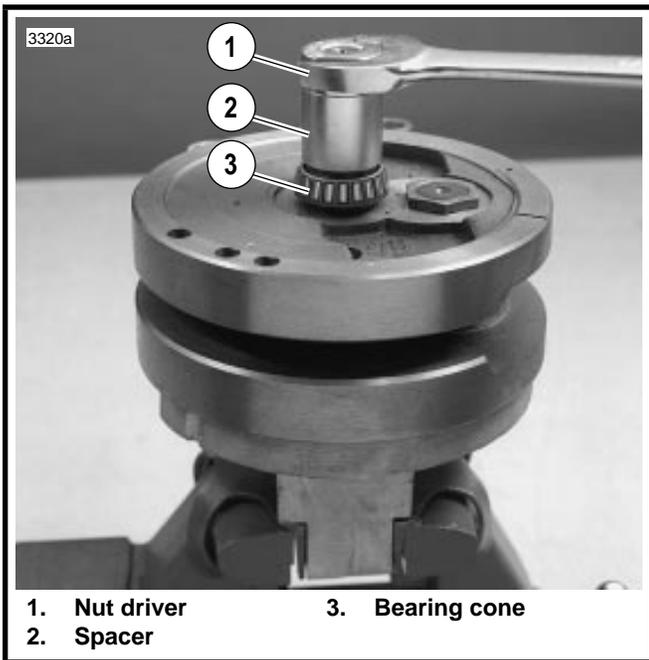
- | | |
|---------------|-----------|
| 1. Nut driver | 2. Spacer |
|---------------|-----------|

Figure 3-90. Installing Left Crankcase



- | | |
|--------|------------------|
| Spacer | Seal (open side) |
|--------|------------------|

Figure 3-91. Install Spacer in Seal



- | | |
|---------------|-----------------|
| 1. Nut driver | 3. Bearing cone |
| 2. Spacer | |

Figure 3-89. Installing Bearing Cone

12. See [Figure 3-91](#). Install spacer in seal ID. With the open (lipped) side facing outward, center seal/spacer assembly over bearing bore.

13. See [Figure 3-92](#). Center seal/spacer driver over seal, so that the sleeve (smaller OD) seats between seal wall and garter spring. Fit the sleeve of the driver handle into the recess at the top of the seal/spacer driver. Using a rubber or plastic mallet, drive the seal and spacer simultaneously into the bore until the spacer makes solid contact with the Timken bearing cage. Remove the driver handle and seal/spacer driver.

CAUTION

Do not remove the spacer after installation or the new seal will have to be discarded and the procedure repeated.

14. Apply a thin coat of DOW CORNING SILASTIC or 3-M 800 sealant to crankcase joint faces.

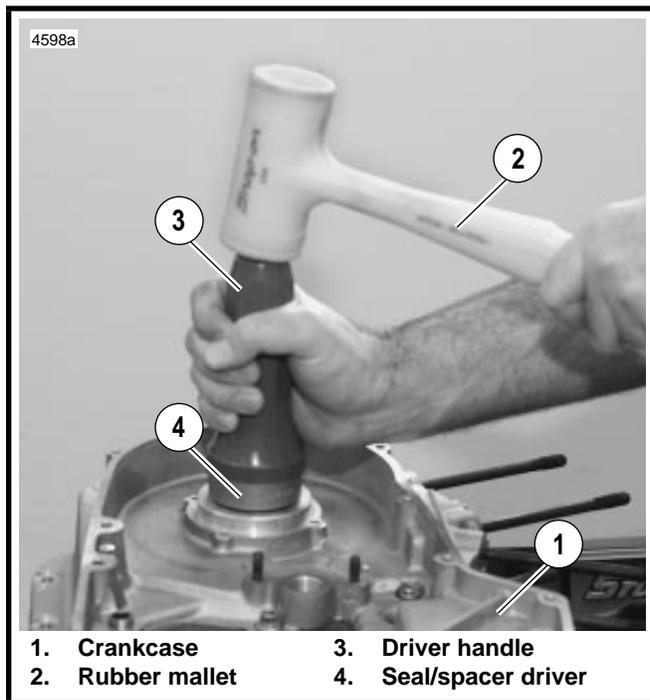


Figure 3-92. Install Bearing Seal/Spacer

15. Assemble crankcase halves together. See [Figure 3-65](#). Install hardware to secure crankcase halves. Tighten 1/4-in. fasteners to 70-110 **in-lbs** (7.9-12.4 Nm), and 5/16-in. fasteners to 15-18 ft-lbs (20-24 Nm).
16. See [Figure 3-68](#). Lubricate pinion shaft bearing (11) with engine oil. Slip bearing (11) on pinion shaft and into outer race in right crankcase. Install **new** retaining ring (10) in groove of pinion shaft bearing inner race (12).
17. See [Figure 3-93](#). The cylinder studs have a shoulder at the lower end.
18. Pack clean towels into crankcase opening.
19. Place a steel ball into a head bolt, then place the unpainted end of the stud into the head bolt.
20. See [Figure 3-94](#). Install the stud in the crankcase with the shoulder end down. Tighten to 10 ft-lbs (13.6 Nm).
21. See [Figure 3-65](#). Install crankcase in chassis using hardware shown.
22. Install transmission mainshaft sprocket. See [TRANSMISSION INSTALLATION AND SHIFTER PAWL ADJUSTMENT](#) in Section 6.
23. Install starter. See [STARTER, INSTALLATION](#) in Section 5.
24. Install primary drive components, clutch and clutch release mechanism. See [PRIMARY DRIVE/CLUTCH](#) in Section 6.
25. Apply two or three drops of LOCTITE THREADLOCKER 262 (red) on threads of sprocket shaft. Tighten front sprocket nut to 150-165 ft-lbs (203-224 Nm).

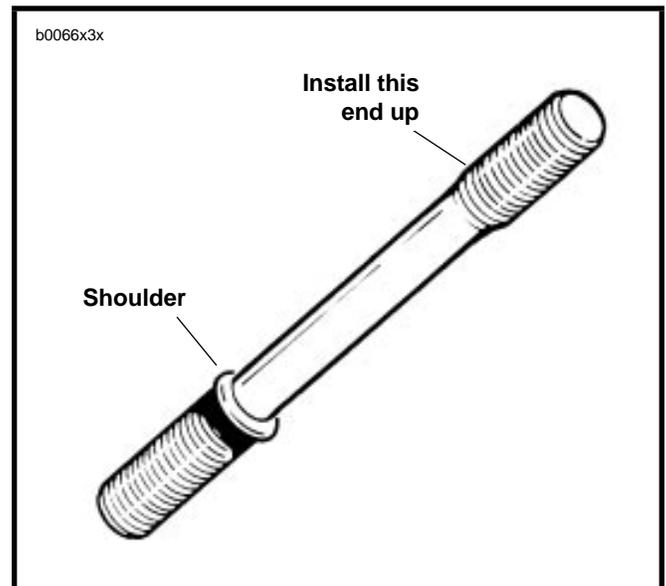


Figure 3-93. Cylinder Studs

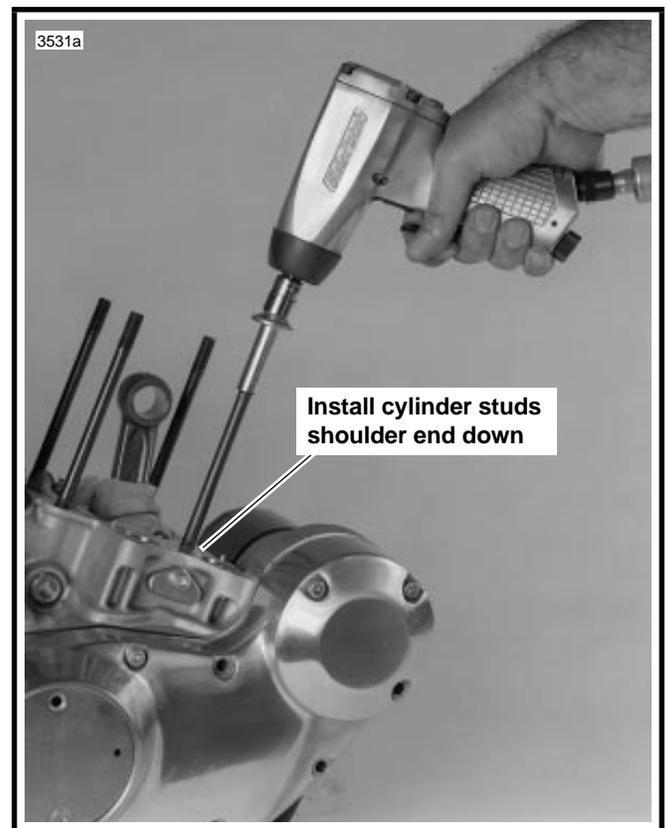


Figure 3-94. Install Cylinder Stud

NOTE

Be sure to refill transmission with lubricant. See [CLUTCH, TRANSMISSION FLUID](#) in Section 1.

26. Install transmission. See [TRANSMISSION INSTALLATION AND SHIFTER PAWL ADJUSTMENT](#) in Section 6.

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27. Install oil pump. See [OIL PUMP, ASSEMBLY/INSTALLATION](#) on [page 3-36](#).
 28. Install cylinders and pistons. See [CYLINDER AND PISTON, ASSEMBLY/INSTALLATION](#) on [page 3-27](#).
 29. Install cylinder heads. See [CYLINDER HEAD, INSTALLATION](#) on [page 3-20](#).

30. Install cam gears, gearcase cover, tappet guides and tappets. See [GEARCASE COVER AND CAM GEARS, ASSEMBLY/INSTALLATION](#) on [page 3-46](#).
31. Refer to [INSTALLING THE ENGINE](#) on [page 3-10](#) and perform the applicable steps.
32. Install ignition system and check/adjust engine ignition timing. See [IGNITION SYSTEM](#) in Section 7.