Club Car®

REPAIR AND REBUILD MANUAL

Engines and Drivetrain Components

Gasoline and Diesel Vehicles

Engine Models:
- **FE290**
- **FE350**
- **FE400**

Unitized Transaxle Models:
- **MC008C-ES00**
- **MC008C-FS00**
- **MC010C-BS00 (with Differential Lock)**
- **MC012C-AS00 (with Differential Lock)**
- **MC012C-BS00 (with Differential Lock)**

All-Wheel Drive:
- **Transmission**
- **Front Differential**
- **Rear Differential**

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FOREWORD

Club Car vehicles are designed and built to provide the ultimate in performance efficiency; however, proper maintenance and repair are essential for achieving maximum service life and continued safe and reliable operation.

This manual provides detailed information for the repair and rebuild of the following:

- FE290 Engine
- FE350 Engine
- FE400 Engine
- MC008C-ES00 and MC008C-FS00 Unitized Transaxle
- MC010C-BS00 Unitized Transaxle with Differential Lock
- MC012C-AS00 and MC012C-BS00 Unitized Transaxle with Differential Lock
- Transmission Models 420317 and 420682
- Front Differential Models 6203-01-139-S and 6203-01-189-S
- Rear Differential Models 420366 and 420851

This manual should be thoroughly reviewed prior to servicing. The procedures provided herein must be properly implemented, and the DANGER, WARNING, and CAUTION statements must be heeded.

This manual was written for the trained technician who already possesses knowledge and skills in electrical and mechanical repair. *If the technician does not have such knowledge and skills, attempted service or repairs to these components may render them unsafe.* For this reason, Club Car advises that all repairs and/or service be performed by an authorized Club Car distributor/dealer representative or by a Club Car factory-trained technician.

It is the policy of Club Car, Inc. to assist its distributors and dealers in continually updating their service knowledge and facilities so they can provide prompt and efficient service for vehicle owners. Regional technical representatives, vehicle service seminars, periodic service bulletins, maintenance and service manuals, and other service publications also represent Club Car's continuing commitment to customer support.

This manual covers all aspects of engine and drivetrain component repair and rebuild; unique situations, however, do sometimes occur when servicing. If it appears that a service question is not answered in this manual, you may write to us at: Club Car, Inc.; P.O. Box 204658; Augusta, Georgia 30917; Attention: Technical Services, or contact a Club Car Technical Service Representative at (706) 863-3000, ext. 3580.

This manual effective July 2004.

⚠ WARNING

- **Read General Warning, Section 1, Page 1-1 before attempting any service on the vehicle.**
- **Before servicing vehicle, read complete section(s) and any referenced information that may be relevant to the service or repair to be performed.**

NOTE: *This manual represents the most current information at the time of publication. Club Car, Inc. is continually working to further improve our other products. These improvements may affect servicing procedures. Any modification and/or significant change in specifications or procedures will be forwarded to all Club Car dealers and will, when applicable, appear in future editions of this manual.*

Club Car, Inc. reserves the right to change specifications and designs at any time without notice and without the obligation of making changes to units previously sold.

There are no warranties expressed or implied in this manual. See the limited warranty found in the vehicle owner's manual or write to Club Car, Inc., P.O. BOX 204658, Augusta, Georgia 30917-4658 USA, Attention: Warranty Department.

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SECTION 1 – SAFETY

To ensure the safety of those servicing Club Car vehicles, and to protect the vehicles from damage resulting from improper service or maintenance, the procedures in this manual must be followed. It is important to note that throughout this manual there are statements contained within boxes labeled DANGER, WARNING, or CAUTION. These special statements relate to specific safety issues, and must be read, understood, and heeded before proceeding.

⚠ DANGER

- **A DANGER indicates an immediate hazard that will result in severe personal injury or death.**

⚠ WARNING

- **A WARNING indicates an immediate hazard that could result in severe personal injury or death.**

⚠ CAUTION

- **A CAUTION with the safety alert symbol indicates a hazard or unsafe practice that could result in product or property damage or minor personal injury.**

CAUTION

- **A CAUTION without the safety alert symbol indicates a potentially hazardous situation that could result in property damage.**

GENERAL WARNING

The following safety statements must be heeded whenever the vehicle is being operated, repaired, or serviced. Service technicians should become familiar with these general safety statements, which can be found throughout this manual. Also, other specific safety statements appear throughout this manual and on the vehicle.

⚠ DANGER

- **Battery – Explosive gases! Do not smoke. Keep sparks and flames away from the vehicle and service area. Ventilate when charging or operating vehicle in an enclosed area. Wear a full face shield and rubber gloves when working on or near batteries.**
- **Battery – Poison! Contains acid! Causes severe burns. Avoid contact with skin, eyes, or clothing. Antidotes:**
  - **External: Flush with water. Call a physician immediately.**
  - **Internal: Drink large quantities of milk or water. Follow with milk of magnesia or vegetable oil. Call a physician immediately.**
  - **Eyes: Flush with water for 15 minutes. Call a physician immediately.**
- **Gasoline – Flammable! Explosive! Do not smoke. Keep sparks and flames away from the vehicle and service area. Service only in a well-ventilated area.**
- **Do not operate gasoline vehicle in an enclosed area without proper ventilation. The engine produces carbon monoxide, which is an odorless, deadly poison.**

⚠ WARNING

- **Follow the procedures exactly as stated in this manual, and heed all DANGER, WARNING, and CAUTION statements in this manual as well as those on the vehicle.**
- **Only trained technicians should service or repair the vehicle. Anyone doing even simple repairs or service should have knowledge and experience in electrical and mechanical repair. The appropriate instructions must be used when performing maintenance, service, or accessory installation.**
- **Prior to leaving the vehicle unattended or servicing the vehicle, set the park brake, place the Forward/Reverse handle in the NEUTRAL position, turn the key switch to the OFF position, and remove the key. Chock the wheels when servicing the vehicle.**
- **To avoid unintentionally starting the vehicle:**
  - **Disconnect battery cables, negative (–) cable first (Figure 1-1, Page 1-3).**
  - **Disconnect the spark plug wire from the spark plug.**
- **Frame ground – Do not allow tools or other metal objects to contact frame when disconnecting battery cables or other electrical wiring. Do not allow a positive wire to touch the vehicle frame, engine, or any other metal component.**
- **Wear safety glasses or approved eye protection when servicing the vehicle. Wear a full face shield and rubber gloves when working on or near batteries.**
- **Do not wear loose clothing or jewelry such as rings, watches, chains, etc., when servicing the vehicle.**
- **Moving parts! Do not attempt to service the vehicle while it is running.**
- **Hot! Do not attempt to service hot engine or exhaust system. Failure to heed this warning could result in severe burns.**
- **Use insulated tools when working near batteries or electrical connections. Use extreme caution to avoid shorting of components or wiring.**
- **Check the vehicle owner's manual for proper location of all vehicle safety and operation decals and make sure they are in place and are easy to read.**
- **Any modification or change to the vehicle that affects the stability or handling of the vehicle, or increases maximum vehicle speed beyond factory specifications, could result in severe personal injury or death.**
- **Lift only one end of the vehicle at a time. Use a suitable lifting device (chain hoist or hydraulic floor jack) with 1000 lb. (454 kg) minimum lifting capacity. Do not use lifting device to hold vehicle in raised position. Use approved jack stands of proper weight capacity to support the vehicle and chock the wheels that remain on the floor. When not performing a test or service procedure that requires movement of the wheels, lock the brakes.**
- **If wires are removed or replaced, make sure wiring and wire harness are properly routed and secured. Failure to properly route and secure wiring could result in vehicle malfunction, property damage, personal injury, or death.**
- **For vehicles with cargo beds, remove all cargo before raising the bed or servicing the vehicle. If the vehicle is equipped with a prop rod, ensure that it is securely engaged while bed is raised. Do not close bed until all persons are clear of cargo bed area. Keep hands clear of all crush areas. Do not drop cargo bed; lower gently and keep entire body clear. Failure to heed this warning could result in severe personal injury or death.**
- **Improper use of the vehicle or failure to properly maintain it could result in decreased vehicle performance, severe personal injury, or death.**
- **Do not leave children unattended on vehicle.**

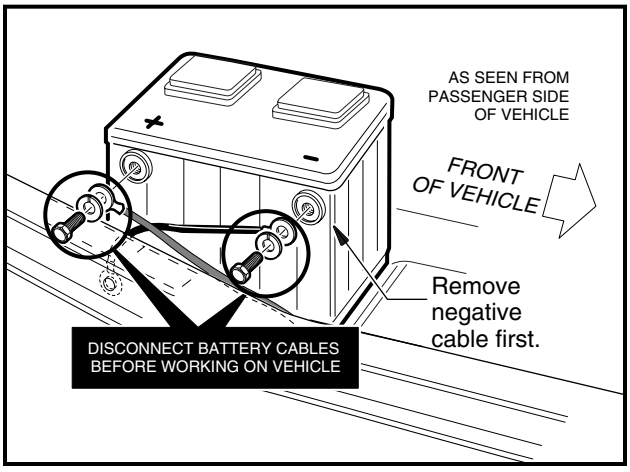


Figure 1-1 Gasoline Vehicle

SECTION 2 – FE290 ENGINE

⚠ DANGER

- **See General Warning on page 1-1.**

⚠ WARNING

- **See General Warning on page 1-1.**

GENERAL INFORMATION

See General Warning on page 1-1.

The FE290 gasoline engine is produced for pedal-start vehicles. This 4-cycle, single cylinder engine is designed for reliable heavy-duty service. It has two major component assemblies: the cylinder assembly and the crankcase assembly. The FE290 engine is provided with the MC008C-ES00 transaxle. **See Transaxle Models and Identification on page 5-1**.

SPECIAL ENGINE SERVICE TOOLS AVAILABLE FROM CLUB CAR

DESCRIPTION	CCI P/N
Bearing and seal remover assembly	1016417
Bearing driver set	1016416
Compression gauge and adapter	101641002
Flywheel puller kit	1016627
Gear yoke	1016418
Piston ring compressor kit	1016414
Piston ring pliers	1016415
Valve clearance adjuster screw holder	1016413
Valve guide reamer	101641201
Valve guide reamer arbor	101641202
Valve spring compressor	101641101
Valve seat cutter guide	1016552
Valve seat cutter t wrench	1016551
Valve seat cutter 30° and 45° x 35 mm diameter	1016554
Valve seat cutter 45° x 32 mm diameter (for FE290 engines only)	1016553

RECOMMENDED REPLACEMENT PARTS FOR ENGINE TEARDOWN

DESCRIPTION	CCI P/N
Air Filter	1015426
Carburetor insulator to throttle bracket gasket	1016439
Carburetor to intake manifold gasket	1016438
Drive belt	1016203
Exhaust gasket	1015330
Exhaust system (muffler)	101859301
FE290 gasket kit (for all internal gaskets)	102304701
Ignition coil (with internal igniter)	101909201
Insulator gasket	1016440
Muffler clamp	1017689
Oil filter	1016467
Oil level sensor	1016494
Oil seal	1016568
Starter/Generator belt	101916701
Spark plug	101881101
Throttle bracket to carburetor gasket	1016441

BEFORE SERVICING

To eliminate unnecessary work, carefully read the applicable information and instructions before beginning engine service. Diagrams, DANGER, WARNING, CAUTION and NOTE statements and detailed descriptions have been included wherever necessary. Nevertheless, even a detailed account has limitations. Therefore, anyone attempting engine service should have knowledge and experience in small engine service and repair.

NOTE: *Engine rotation is clockwise as viewed from the clutch side of the engine.*

MECHANICAL SYSTEMS

Adjustments

All adjustments shall be made in accordance with Adjustments and Settings on page 2-47.

Edges

⚠ WARNING

- **Watch for sharp edges, especially during major engine disassembly and assembly. Protect your hands with gloves or a piece of thick cloth when lifting the engine or turning it over.**

Force

Common sense should dictate how much force is necessary for assembly and disassembly. If a part seems especially difficult to remove or install, stop and determine what may be causing the problem. Whenever tapping is necessary, tap lightly using a wooden or plastic-faced mallet. Use an impact driver for the removal of screws (particularly those held by a locking agent) in order to avoid damaging the heads.

Dirt

Clean the engine thoroughly before servicing it. **See following CAUTION.**

CAUTION

- **Before removal and disassembly, clean the engine. Any dirt entering the engine, carburetor, or other parts will work as an abrasive and shorten the life of the engine. Before installing a new part, clean off any dust or metal filings.**

Tightening Sequence

Where there is a tightening sequence indicated, the bolts, nuts, or screws must be tightened in the order and by the method indicated. When installing a part that is secured with several bolts, nuts, or screws, hand tighten all, then tighten to specified torque in the proper sequence to avoid distortion of the part or leakage. Conversely, when loosening the bolts, nuts or screws, loosen all about a quarter of a turn first and then remove them.

Torque

The torque values given in this manual should always be adhered to. Applying too little or too much torque may lead to serious damage.

Lubricant

Some oils and greases should only be used in certain applications and may be harmful if used in an application for which they are not intended.

Lubrication

Engine wear is generally at its maximum while the engine is warming up and before all the rubbing surfaces have adequate lubrication. During assembly, oil or grease (whichever is more suitable) should be applied to any rubbing surface.

Press

A part installed using a press or driver, such as a seal, should first be coated with oil on its outer or inner circumference (contact surface) so that it will go into place smoothly.

Oil Seal, Grease Seal

During assembly use new oil or grease seals to replace any that were removed, as removal generally damages seals. To avoid damaging the seal lips, a seal guide is required for installation. Before a shaft passes through a seal, apply a small amount of lubricant (preferably high temperature grease) to the lip to reduce rubber-to-metal friction.

Gasket, O-Ring

When in doubt as to the condition of a gasket or O-ring, replace it with a new one. To avoid leaks, the mating surface around the gasket or O-rings should be free of foreign matter and perfectly smooth.

Ball Bearing Installation

When installing a ball bearing, the bearing race which has a press fit should be pushed by a suitable driver. This prevents severe stress on the balls and races, and prevents damage. Press on the inner race if the ball bearing is being pressed onto a shaft, or on the outer race if the ball bearing is being pressed into a housing. Press the ball bearing until it is seated against the housing or on the shaft.

Circlip, Retaining Ring

Replace circlips and retaining rings that were removed with new circlips and retaining rings. During installation, take care to compress or expand them only enough for installation.

High Flash-point Solvent

Use a high flash-point solvent when cleaning parts. Club Car recommends Stoddard solvent (generic name), a commercial solvent commonly available in North America. Always follow manufacturer and container directions regarding the use of any solvent.

Molybdenum Disulfide (MoS_2) Grease

NOTE: *This manual makes reference to molybdenum disulfide grease in the assembly of certain engine parts. Always refer to manufacturer's recommendations printed on the container before using such special lubricants.*

Engine Rotation

When turning the crankshaft by hand, always turn it clockwise as viewed from the clutch side of the engine. This will ensure proper adjustments.

CYLINDER COMPONENTS

CYLINDER HEAD

See General Warning on page 1-1.

GENERAL INFORMATION

Prior to attempting time-consuming repairs to the cylinder assembly, a cylinder compression test should be performed using a standard compression tester. Low compression would normally indicate a problem in the cylinder assembly such as defective rings, gaskets, etc. At a cranking speed of 550-600 rpm, the compression should be typically 156 psi. This value could vary slightly depending on wear of components affecting compression.

CYLINDER SHROUD REMOVAL

CAUTION

- **Before removal and disassembly, clean the engine.**

1. Remove governor guard (1) **(Figure 2-1, Page 2-5)**.
2. **Earlier Style Governor Cable End:**
   2.1. Remove cotter pin (3) and clevis pin (2) from throttle valve lever **(Figure 2-1, Page 2-5)**.
3. **Current Style Governor Cable End:**
   3.1. Remove the 'Z' shaped cable end from the throttle valve lever **(Figure 2-1, Page 2-5)**.

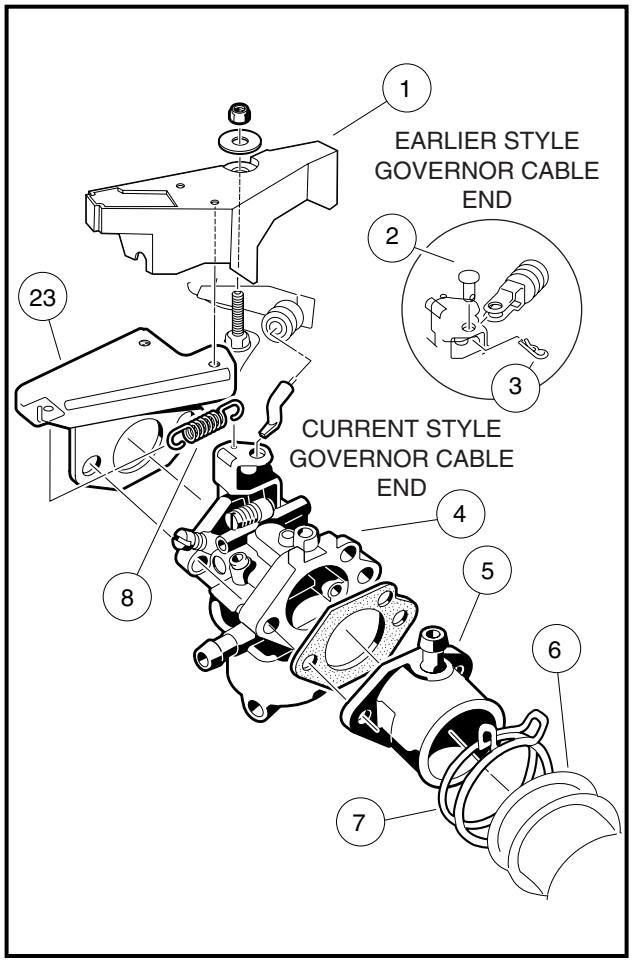


Figure 2-1 Carburetor Removal

4. Remove nuts at carburetor intake pipe (5) and remove intake pipe **(Figure 2-1, Page 2-5)**. **See following CAUTION**.

CAUTION

- **Disconnect the governor linkage from the carburetor before attempting to remove the carburetor. Failure to do so could damage the linkage.**

5. Remove carburetor (4) along with throttle spring (8) and throttle spring bracket (23) **(Figure 2-1, Page 2-5)**.

6. Remove muffler.

   6.1. Remove the muffler clamp (6) from the muffler (1) and clamp bracket (2) **(Figure 2-2, Page 2-6)**.

   6.2. Remove the hex-head cap screw (7), lock washer (8), and flat washer (9) from mounting bracket. Retain the governor cable bracket (13).

   6.3. Remove the hex nuts (10) and lock washers (11) from the manifold.

   6.4. Remove the muffler (1) from the vehicle.

Cylinder Shroud Removal, Continued:

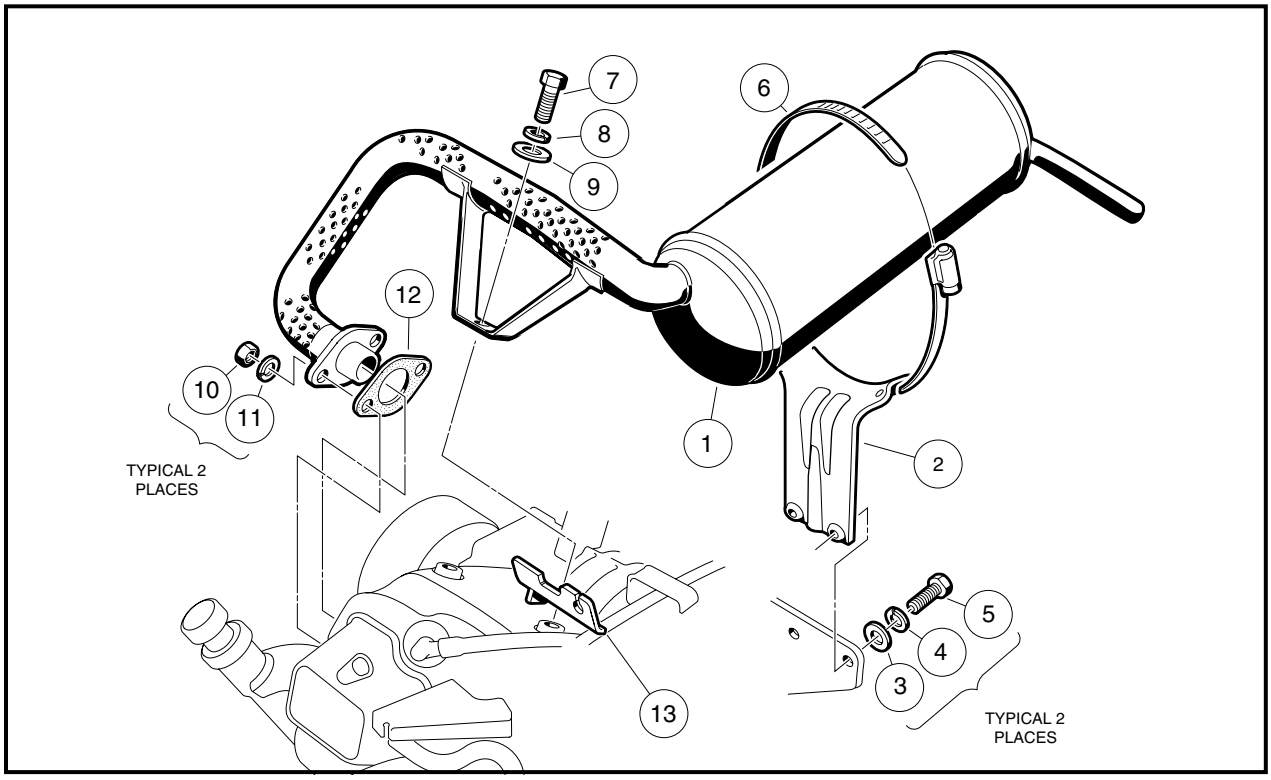


Figure 2-2 Exhaust System

7. Disconnect oil filler tube (20) from cylinder shroud by first removing the locknut (18), ground wire (17) and flange nut (10) **(Figure 2-3, Page 2-6)**. **See following NOTE.**

NOTE: *If the engine is to be totally disassembled, drain oil and remove the oil filter. If only the cylinder head is to be disassembled, proceed without draining the oil or removing the oil filter.*

Make sure vehicle is level before removing filler tube. This will prevent oil from spilling when filler tube is removed.

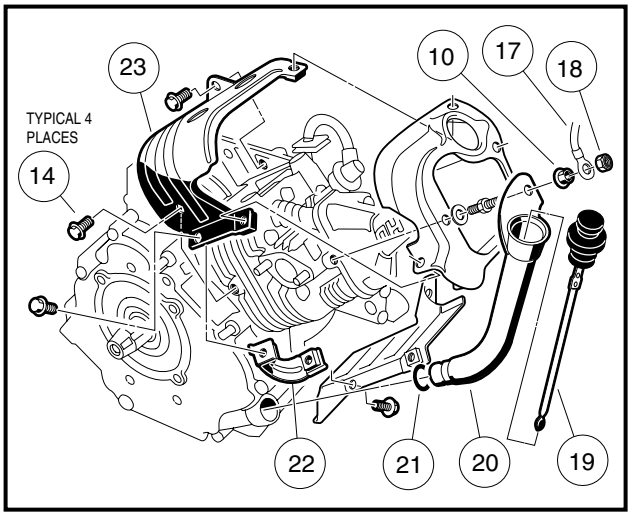


Figure 2-3 Upper Shroud and Oil Filter Removal

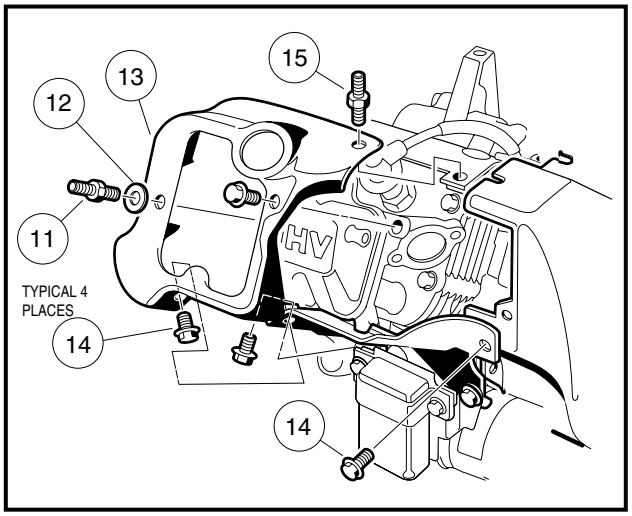


Figure 2-4 Head Shroud Removal

8. Remove the eight bolts (14) and the two-ended bolts (11 and 15) **(Figure 2-3, Page 2-6 and Figure 2-4, Page 2-6)**.
9. Take off the head shroud (13), the upper shroud (23) and the bracket (22) **(Figure 2-3, Page 2-6 and Figure 2-4, Page 2-6).**

ROCKER ARM AND PUSH ROD REMOVAL

1. Remove the two bolts (1) and remove the rocker cover (2) along with breather tube (3) **(Figure 2-5, Page 2-7). See following NOTE.**

NOTE: *Mark the rocker arms (6) and the push rods (8) so they can be put back in their original positions **(Figure 2-6, Page 2-7)**.*

2. Remove the E-ring (4) and pull the rocker shaft (5) out of the cylinder head **(Figure 2-6, Page 2-7)**.
3. Lift out the rocker arms (6), washer (7), and push rods (8).

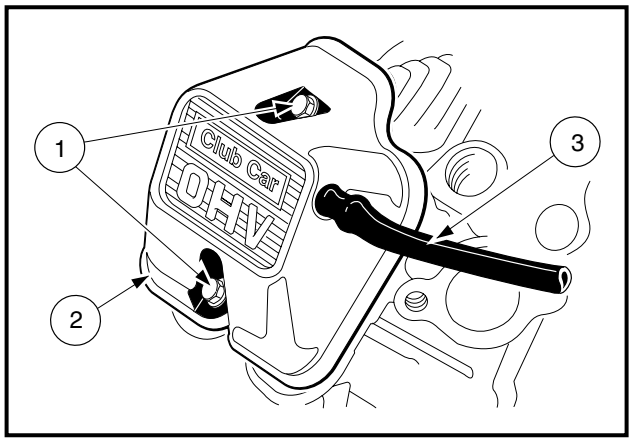


Figure 2-5 Rocker Cover Removal

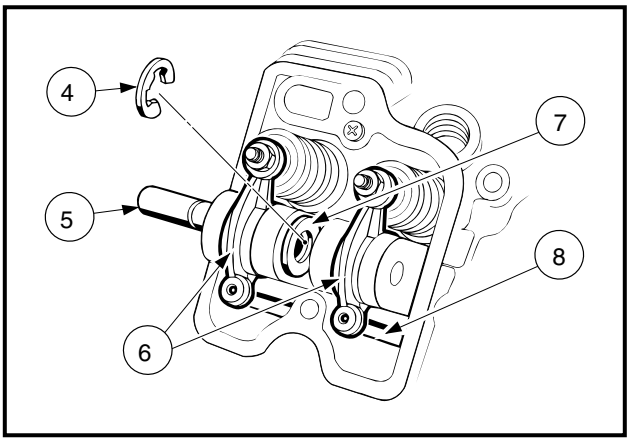


Figure 2-6 Rocker Shaft Removal

CYLINDER HEAD REMOVAL

1. Remove the six bolts (1) and remove the cylinder head assembly (2) **(Figure 2-7, Page 2-7)**.
2. Remove head gasket (3). Note the position of the two dowels (4) as shown **(Figure 2-8, Page 2-7)**.

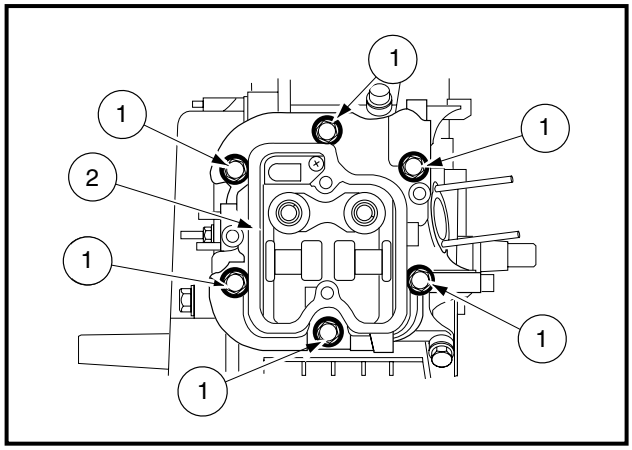


Figure 2-7 Cylinder Head

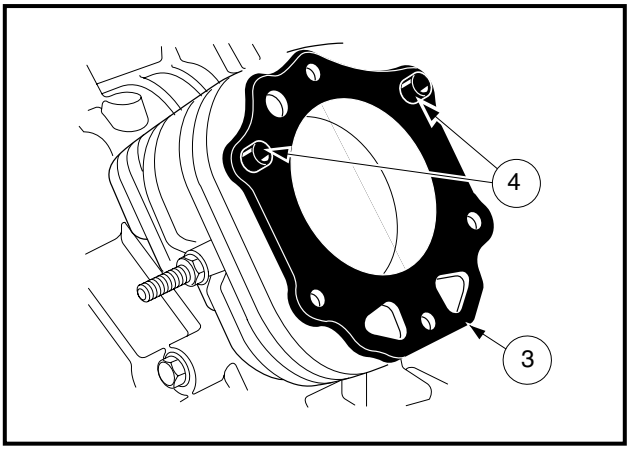


Figure 2-8 Head Gasket

VALVE REMOVAL

1. Compress the valve spring with the valve spring compressor (5) (CCI P/N 101641101) and remove the collet halves (6) **(Figure 2-9, Page 2-8)**.
2. Remove spring compressor and take out the upper retainer (7) and the spring (8).
3. Remove valve (10).
4. Remove valve stem seal (11) with a screwdriver **(Figure 2-10, Page 2-8)**. **See following CAUTION.**

CAUTION

- **To keep the screwdriver from damaging the cylinder head flange surface, place a piece of heavy cardboard or wood between them (Figure 2-10, Page 2-8).**
- **The valve stem seal cannot be reused. Replace valve stem seal with a new one.**

5. Remove spring seat (9) **(Figure 2-10, Page 2-8)**.

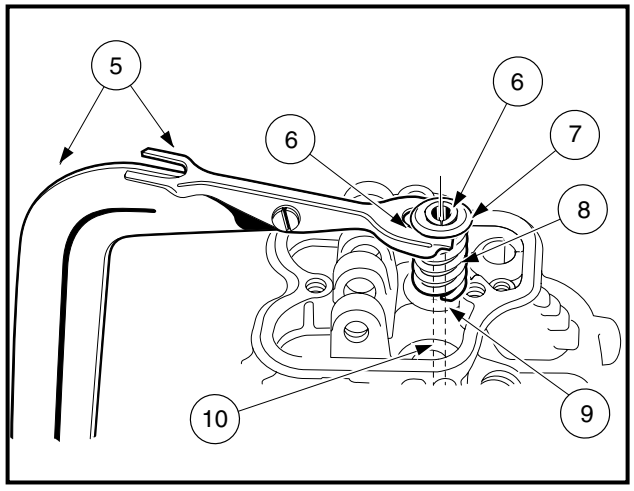


Figure 2-9 Valve Removal

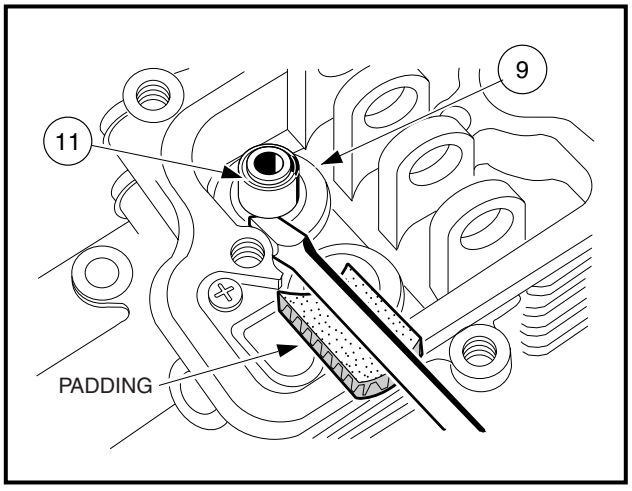


Figure 2-10 Spring Seat Removal

BREATHER VALVE (REED VALVE)

General Information

The function of the breather is to create a vacuum in the crankcase which prevents oil from being forced out of the engine through the piston rings, oil seals or gaskets.

The breather has a reed valve, which limits the direction of air flow caused by the piston moving up and down. Air can flow out of the crankcase, but the one-way reed valve blocks return flow. It thus maintains a vacuum in the crankcase.

Oil laden air in the crankcase passes through the reed valve and expands into the rocker chamber. In the rocker chamber most oil separates from the air and drains back to the crankcase. The air passes through a tube and vents to the intake manifold.

Breather Valve (Reed Valve) Removal

1. Unscrew the mounting screw (1) and remove the back plate (2) and reed valve (3) **(Figure 2-11, Page 2-9)**. For installation, **see Breather Valve Installation on page 2-19.**

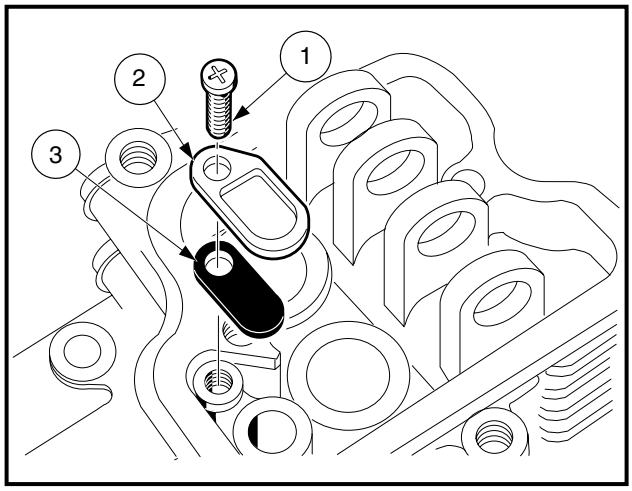


Figure 2-11 Reed Valve

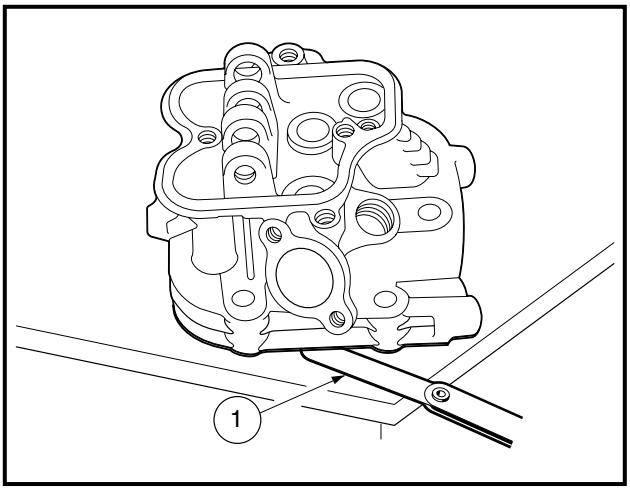


Figure 2-12 Check Flatness of Head Surface

CYLINDER HEAD CLEANING AND INSPECTION

1. Clean the head with a non-flammable solvent and dry thoroughly.
2. Bead blast or scrape carbon deposits from head. When scraping carbon deposits, be careful to avoid scratching or nicking the cylinder head.
3. Inspect the spark plug port threads for damage. If threads are damaged, replace the head.
4. Place the cylinder head on a surface plate **(Figure 2-12, Page 2-9).**
5. Measure the space between the surface plate and the head with a feeler gauge (1) to check the flatness of the head surface **(Figure 2-12, Page 2-9)**.
6. If the head is warped more than 0.002 inch (0.05 mm), replace the head. **See following CAUTION.**

CAUTION

- **Smooth out any damaged spots in the combustion chamber (1) using a small grinder. Sharp edges in the combustion chamber may cause pre-ignition. Do not remove any more material than is necessary or change the shape of the combustion chamber (Figure 2-13, Page 2-10).**
- **Do not grind the valve seats or the gasket surface.**

VALVE GUIDES

Valve Guide Inspection

1. Measure the inside diameter of each guide with a telescoping gauge **(Figure 2-14, Page 2-10)**.
2. If the inside diameter exceeds 0.2781 inch (7.065 mm), replace the guide.

Valve Guide Inspection, Continued:

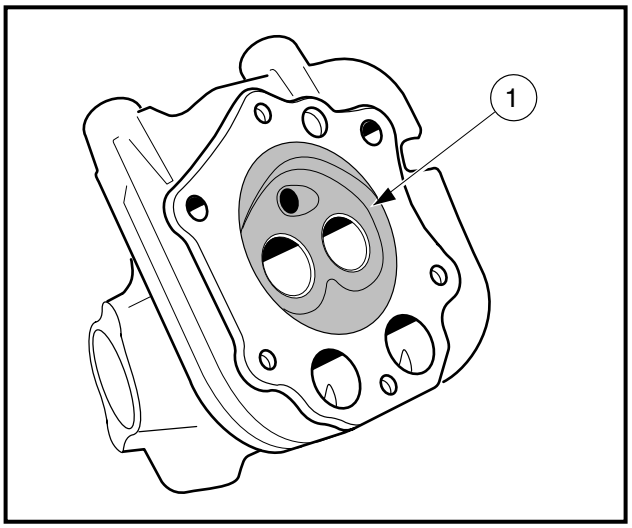


Figure 2-13 Combustion Chamber

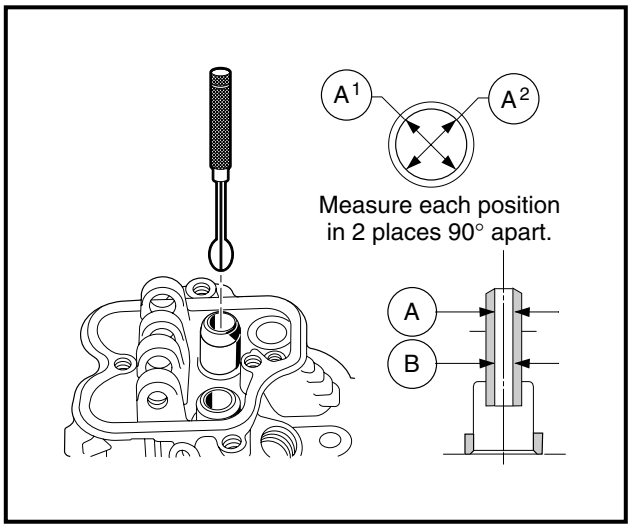


Figure 2-14 Measure I.D. of Valve Guides

Valve Guide Replacement

1. With the combustion chamber side of the head facing up, drive the guide out of the head with a valve guide arbor (1) (CCI P/N 101641202) **(Figure 2-15, Page 2-10)**.
2. Install the snap ring (2) on the new valve guide **(Figure 2-16, Page 2-10)**.
3. Coat the guide with a light film of clean engine oil.
4. With the rocker arm side of the head facing up, drive the new valve guide into the head with the valve guide arbor (3) until the snap ring (2) just seats on the head **(Figure 2-16, Page 2-10)**.
5. Ream the guide with a stanisol or kerosene lubricant and a valve guide reamer (CCI P/N 101641201). The valve guide inside diameter should be 0.2756 - 0.2762 inch (7.000 - 7.015 mm) **(Figure 2-17, Page 2-11)**.

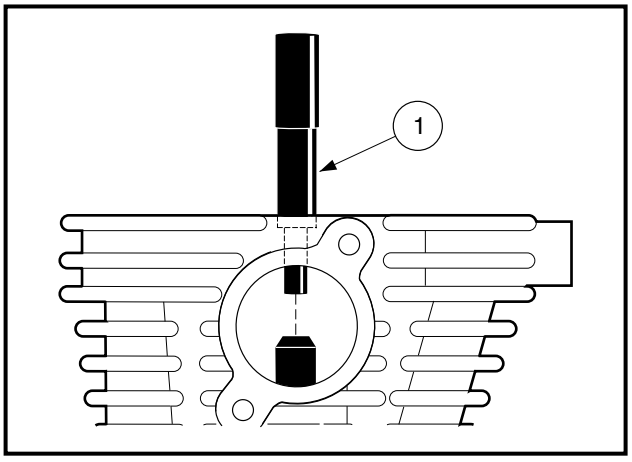


Figure 2-15 Valve Guide Removal

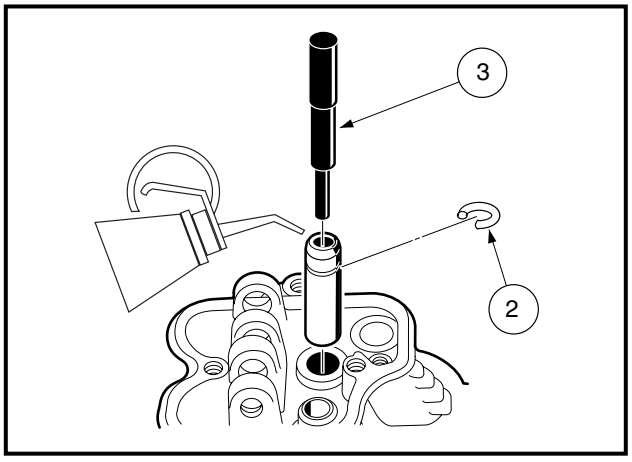


Figure 2-16 Valve Guide Installation

VALVE SEATS

See General Warning on page 1-1.

Valve Seat Inspection

1. Inspect the valve seats for damage. If the seats are warped or distorted beyond reconditioning, replace the cylinder head.
2. Use prussian blue metal die to coat the valve seat.
3. Push the valve into the guide.
4. Rotate the valve against the seat with a lapping tool (1) **(Figure 2-18, Page 2-11)**.

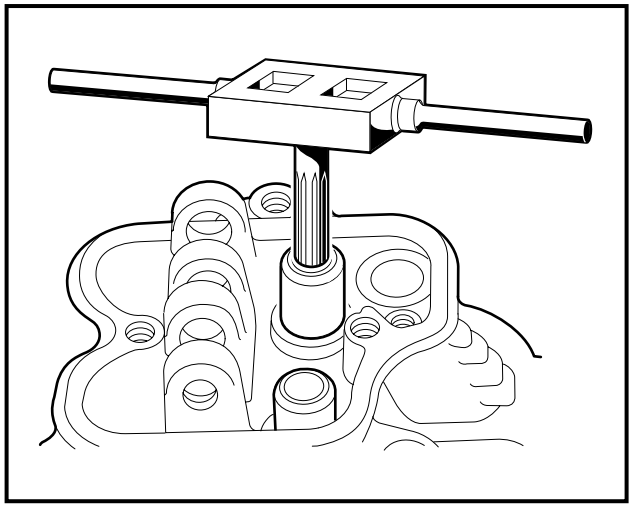


Figure 2-17 Ream Valve Guide

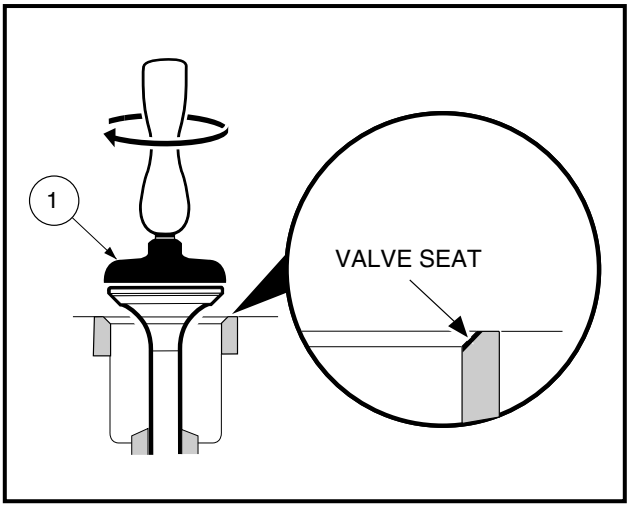


Figure 2-18 Rotate Valve against Valve Seat

5. Pull the valve out and check the mark on the valve head. It must be 0.0197 - 0.0433 inch (.50 - 1.10 mm) in width and even all the way around the seat and valve **(Figure 2-19, Page 2-11)**.

NOTE: *The valve stem and guide must be in good condition or step 5 will not be valid.*

6. If the valve seating surface is not correct or if it is , worn or pitted, the seat can be resurfaced. **See Valve Seat Repair on page 2-12.** Lap the valves to the seats after resurfacing.

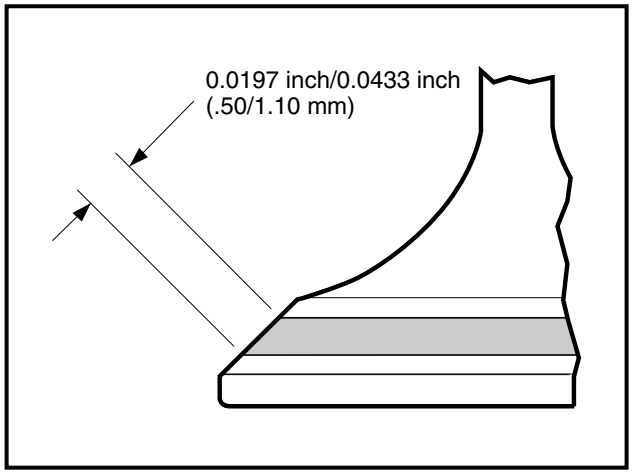


Figure 2-19 Check Mark on Valve Head

Valve Seat Repair

CAUTION

- **If you are unfamiliar with the following procedures, Club Car suggests that the cylinder head be taken to a professional engine machine shop for reconditioning.**

1. Clean the cylinder head thoroughly. **See Cylinder Head Cleaning and Inspection on page 2-9.**
2. Recondition the valve seats with a valve seat cutter (1) (45° x 32 mm exhaust seat CCI P/N 1016553, 45° x 35 mm intake seat CCI P/N 1016554) **(Figure 2-21, Page 2-13)**.
   2.1. Use prussian blue and check the seats for good contact all the way around. **See Valve Seats on page 2-11.**
   2.2. Measure the seat width of the 45° angle portion of the seat at several places around the seat **(Figure 2-20, Page 2-13)**.
   2.3. If the seat width is more than 0.079 inch (2.0 mm), the seating surface should be resurfaced.
   2.4. Resurface the valve seats with 45° cutter (1) (32 mm exhaust seat), and (35 mm intake seat) cutters, removing only enough material to produce a smooth and concentric seat **(Figure 2-21, Page 2-13)**. **See following CAUTION.**

CAUTION

- **Use care not to dull the cutter. Do not turn the cutter counterclockwise or allow it to hit a metal object.**

   2.5. Use a 30° x 35 mm seat cutter (1) (CCI P/N 1016554) to narrow the seat width to the standard width **(Figure 2-21, Page 2-13). See following CAUTION and NOTE.**
   2.6. Turn the seat cutter (1) clockwise one turn at a time while pressing down very lightly. Recheck the width after each cutter revolution. **See following CAUTION and NOTE.**

CAUTION

- **The 30° x 35 mm seat cutter removes material very quickly. Check the seat outside diameter frequently to prevent over-cutting.**

NOTE: *Keep the seat width as close as possible to 0.031 inch (0.8 mm).*

   2.7. Make a light pass with the 45° cutter (1) (32 mm exhaust valve seat cutter), and (35 mm intake valve seat cutter) to remove any possible burrs at the edge of the seat.

3. After applying a coat of prussian blue to the valve face, insert the valve, and snap it closed against the seat several times. The valve surface should show good contact all the way around. Be sure the valve seat is centered on the valve face. The position of the valve in the seat is evident after lapping the valve.
4. If the seat does not make proper contact, lap the valve into the seat with a vacuum cup tool.
   4.1. Coat the surface of the valve sparingly with a fine lapping compound.

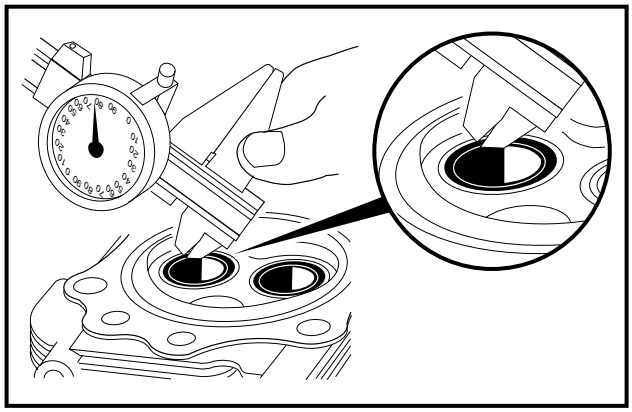


Figure 2-20 Measure Seat Width

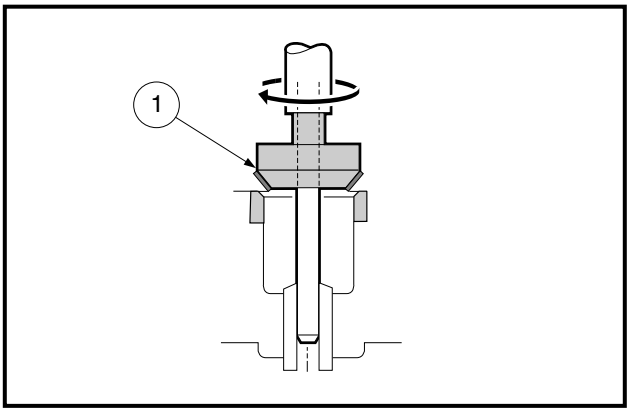


Figure 2-21 Resurface Valve Seat

4.2. Use the vacuum cup lapping tool (1) to grip the top of the valve. Rotate the valve in a circular motion to lap the valve to the seat **(Figure 2-22, Page 2-13)**.

4.3. Lift the valve slightly from the seat every 8 to 10 strokes, continuing the lapping operation until a uniform ring appears around the entire surface of the valve face.

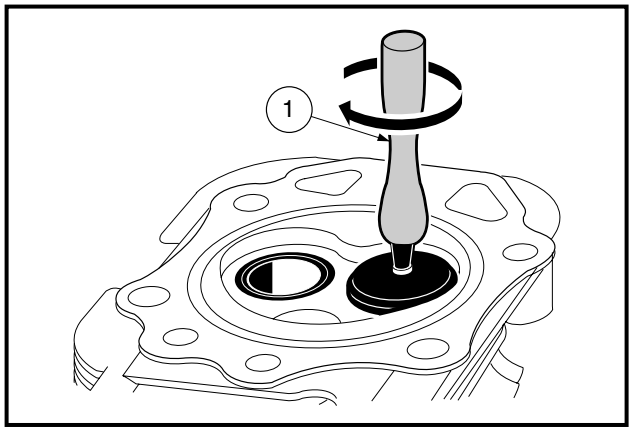


Figure 2-22 Lap Valve to Seat

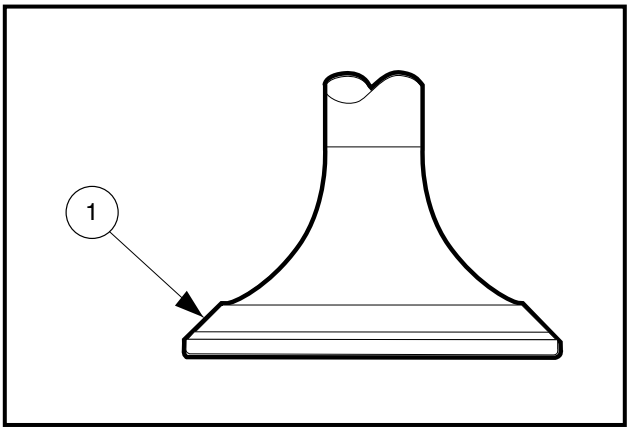


Figure 2-23 Valve Head Seating Area

5. When lapping is completed, wash all parts in solvent to remove lapping compound. Dry the parts thoroughly.
6. Note the position of the lapping mark on the valve face. The lapping mark should appear on or near the center of the face.
7. When the engine is assembled, be sure to adjust the valve clearance. **See Valve Clearance Check and Adjustment on page 2-18.**

VALVES

Visual Inspection

1. Inspect the valve head seating area (1) for erosion, nicks and warping, etc. **(Figure 2-23, Page 2-13)**.

NOTE: *The valve seating surface angle for the FE290 engine is 45°* ***(Figure 2-24, Page 2-14).***

2. If the valve head seating area is worn, replace the valve.
3. If the valve head seating area is eroded or nicked, it may be possible to repair the valve on a valve refacing machine. Follow the refacing machine manufacturer's instructions.

Visual Inspection, Continued:

4. Inspect the stem for obvious wear, discoloration, and stem end damage.
5. If the stem is obviously worn or discolored, replace the valve.

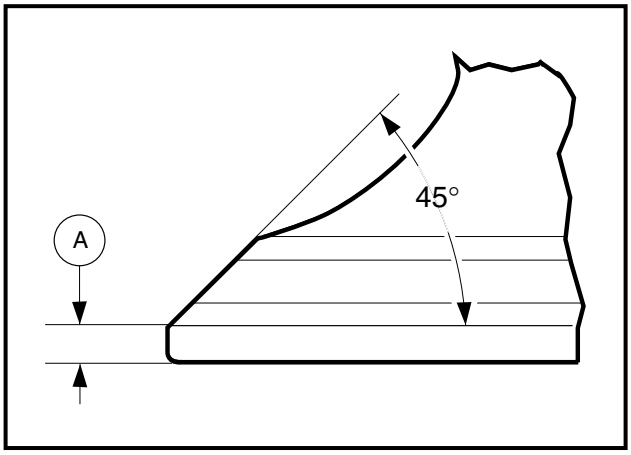


Figure 2-24 Valve Seating Surface Area

Valve Head Thickness

1. Measure the thickness of the valve head **(Figure 2-24, Page 2-14)**.
2. If the valve head thickness (A) is less than 0.024 inch (0.610 mm), replace the valve.

Valve Stem Bend

1. Support the valve in V-blocks at each end of the stem **(Figure 2-25, Page 2-14)**.
2. Position a dial gauge perpendicular to the stem.
3. Turn the valve and read the variation on the dial gauge.
4. If stem bend is greater than the service limit of 0.0012 inch (0.0305 mm), replace the valve.

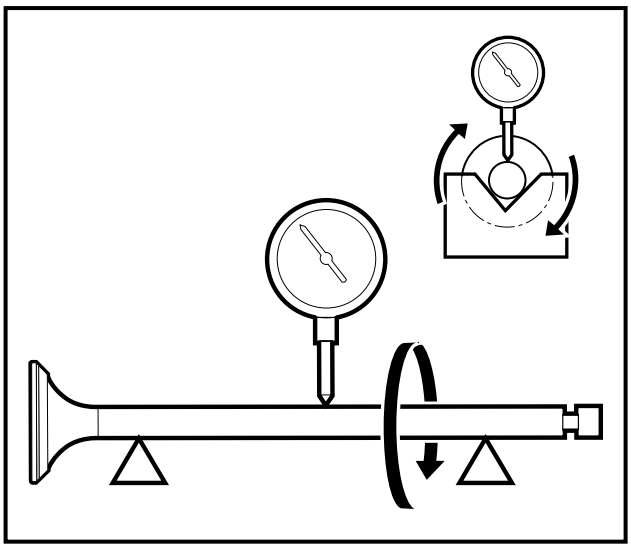


Figure 2-25 Measure Valve Stem Bend

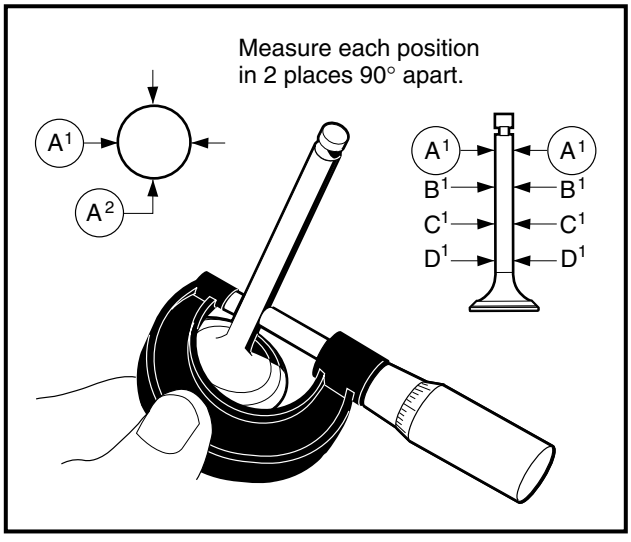


Figure 2-26 Measure Valve Stem Diameter

Valve Stem Diameter

1. Using a micrometer, measure the diameter of the stem at several points along its length **(Figure 2-26, Page 2-14)**.
2. If the outside diameter is less than the service limit of 0.2728 inch (6.930 mm) intake, 0.2722 inch (6.915 mm) exhaust, replace the valve.

Valve Spring Inspection

1. Inspect the valve springs (1) for pitting, cracks, corrosion, and burrs. Replace the springs if necessary **(Figure 2-27, Page 2-15)**.
2. Measure the free length of the spring. If the measurement is less than the service limit of 1.29 inch (32.77 mm), replace the spring.

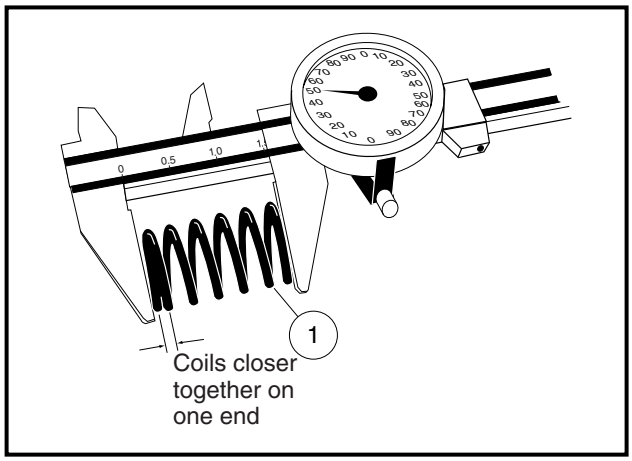


Figure 2-27 Measure Free Length of Spring

Valve Installation

1. Valve installation is the reverse of removal. **See Valve Removal on page 2-8. See following NOTE.**

NOTE: *Valve spring coils are closer together (have a narrower pitch) at one end of the spring than at the other. Install springs with the narrow pitch ends down on the spring seats* ***(Figure 2-27, Page 2-15)****.*

ROCKER ARM AND ROCKER SHAFT INSPECTION

1. Use a dial bore or telescoping gauge to measure the inside diameter of each rocker arm bearing at several points along its length **(Figure 2-28, Page 2-16)**.
2. If the inside diameter is more than the service limit of 0.4754 inch (12.075 mm), replace the rocker arm**.**
3. Use a micrometer to measure the outside diameter of the rocker shaft at several points along its length **(Figure 2-29, Page 2-16)**.
4. If the outside diameter is less than the service limit of 0.4704 inch (11.949 mm), replace the shaft.

Rocker Arm and Rocker Shaft Inspection, Continued:

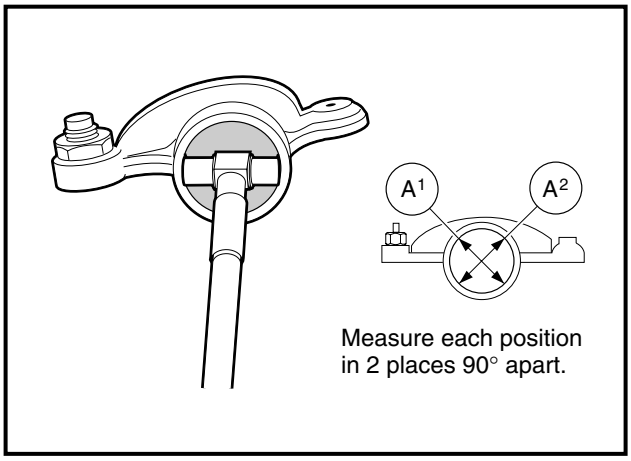


Figure 2-28 Measure I.D. of Rocker Arm Bearing

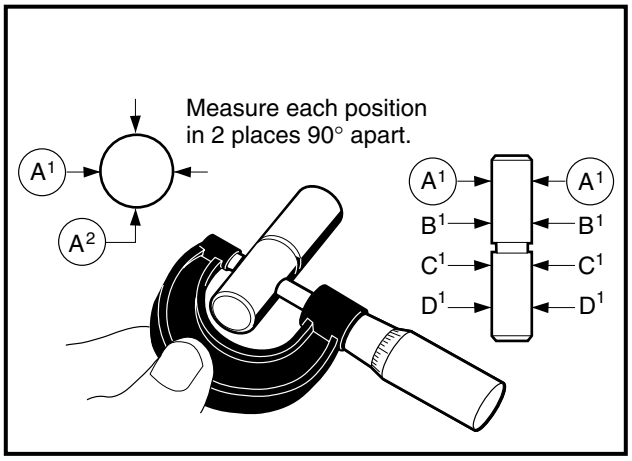


Figure 2-29 Measure O.D. of Rocker Shaft

PUSH ROD INSPECTION

1. Support the rod in V-blocks at each end of rod. Position a dial gauge perpendicular to the rod **(Figure 2-30, Page 2-16)**.
2. Turn the rod slowly and read the variation on the gauge.
3. If the push rod is bent more than 0.012 inch (0.3 mm), replace the push rod.

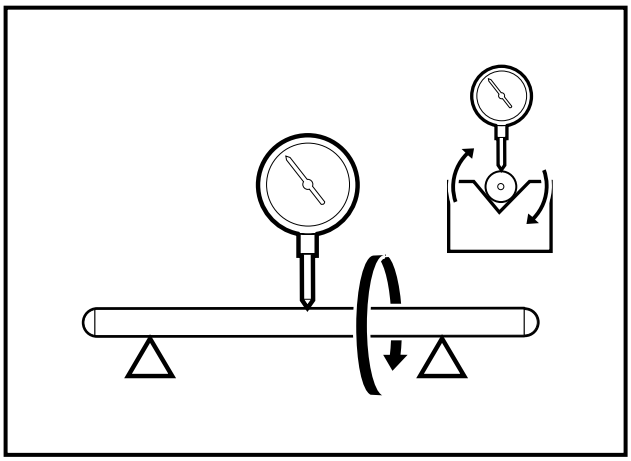


Figure 2-30 Measure Push Rod Bend

CYLINDER HEAD INSTALLATION

See General Warning on page 1-1.

1. Installation is the reverse of removal. **See Cylinder Head Removal on page 2-7.**
2. Position each push rod (5) between the rocker arm (3) and the tappet (6), then insert the rocker shaft (2) through the head posts and rocker arms (3) and washer (4) **(Figure 2-31, Page 2-17 and Figure 2-32, Page 2-17)**.

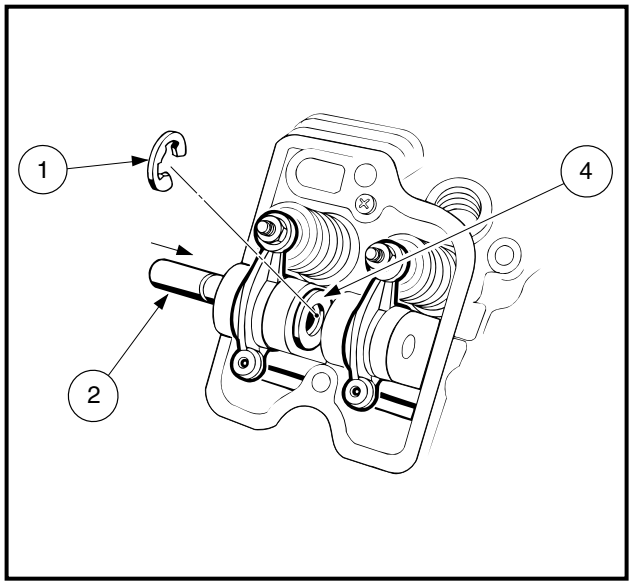


Figure 2-31 Rocker Arm Assembly

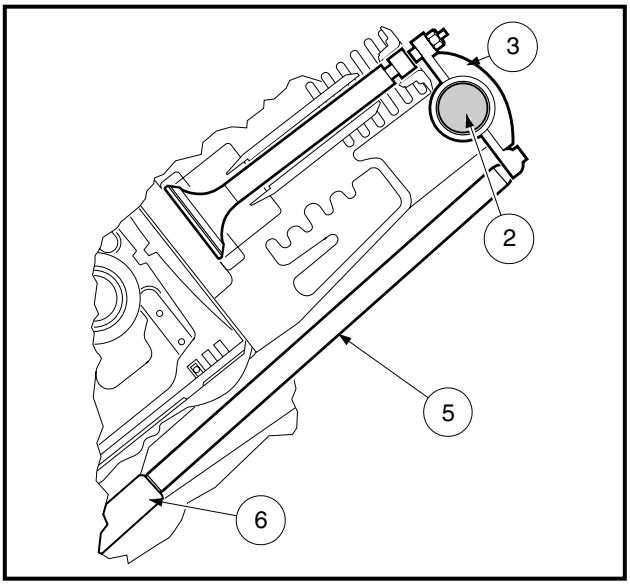


Figure 2-32 Cylinder Head Installation

3. Slide the washer (4) against the exhaust rocker and fit the E-ring (1) into the groove in the rocker shaft (2) **(Figure 2-31, Page 2-17)**.
4. Install cylinder head assembly to engine.
5. Tighten the bolts down evenly by hand.
6. Use a torque wrench to tighten the six bolts in the sequence shown **(Figure 2-33, Page 2-17)**.
7. Increase the torque in four increments of 50 in-lb (6 N·m) and then tighten to final torque of 220 in-lb (25 N·m). **See following CAUTION.**

CAUTION

- **Do not turn any one bolt down completely before tightening the others. Doing so may cause the cylinder head to warp.**

8. Adjust valve clearances.

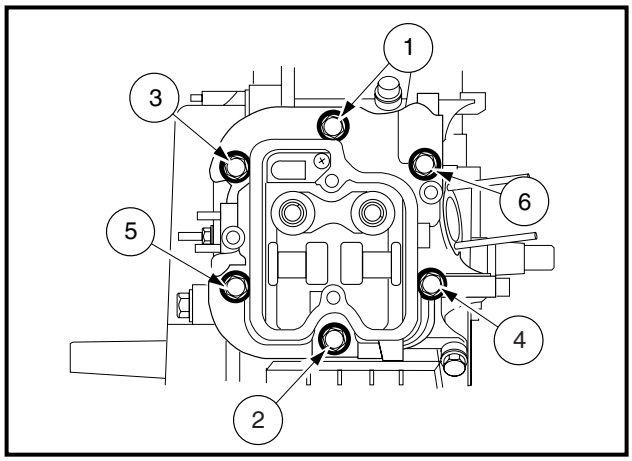


Figure 2-33 Bolt Torque Sequence

VALVE CLEARANCE CHECK AND ADJUSTMENT

NOTE: *Check and adjust clearance when the engine is cold.*

1. Turn the crankshaft until the piston is at the top of the compression stroke.
2. Use a feeler gauge (1) to measure the clearance (2) between the adjuster screw (3) and the top of the valve stem (4) **(Figure 2-34, Page 2-18 and Figure 2-35, Page 2-18)**.
3. If necessary, loosen the locknut (3) and turn the adjuster (6) up or down to adjust the clearance to 0.005 inch (0.127 mm) for both intake and exhaust **(Figure 2-34, Page 2-18)**.
4. Keep the adjuster from turning with the screw holder (5) (CCI P/N 1016413) and tighten the locknut (3) to 90 in-lb (10 N·m) **(Figure 2-34, Page 2-18)**.
5. Recheck the clearance on both valves.

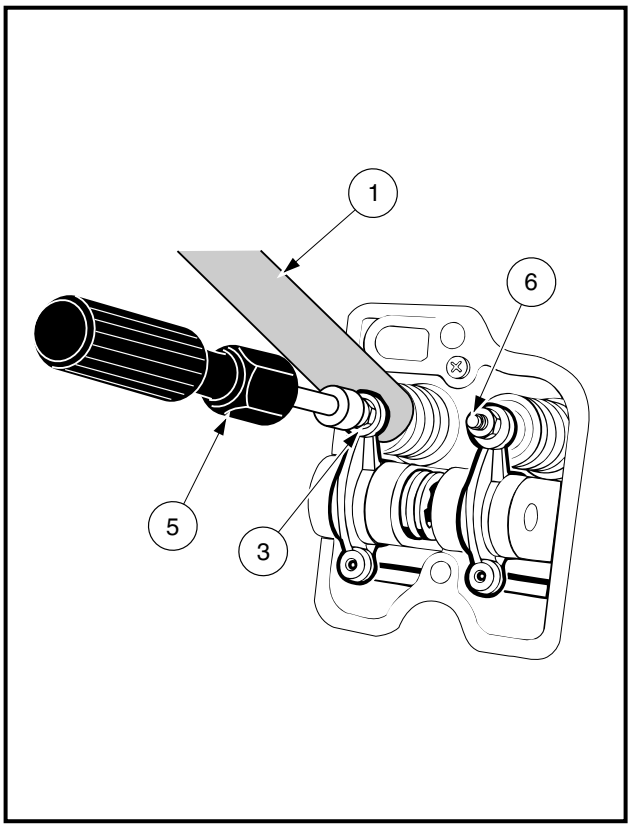


Figure 2-34 Valve Clearance

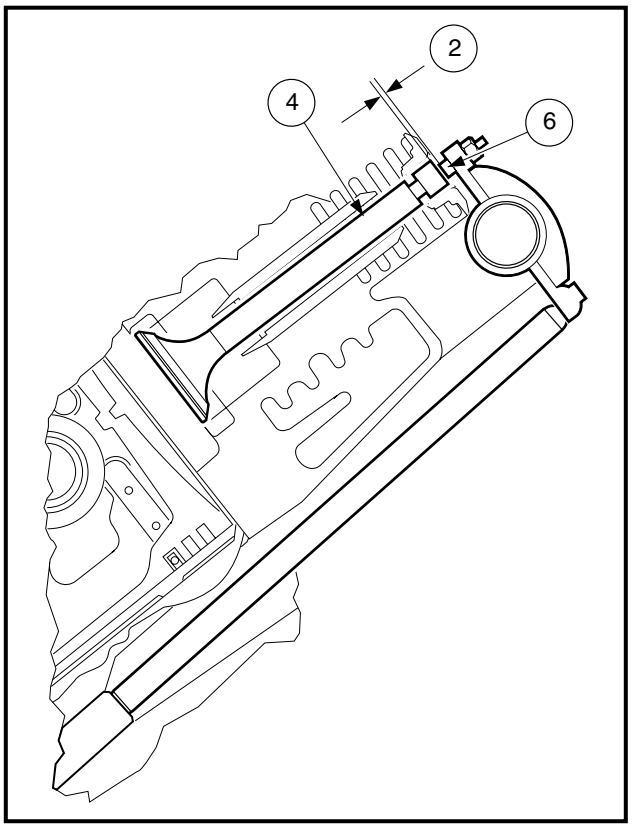


Figure 2-35 Cutaway View of Valve Clearance

BREATHER VALVE (REED VALVE)

General Information

Refer to Breather Valve (Reed Valve) on page 18 for general information.

Breather Valve Inspection

1. Inspect the reed valve (1) for sticking or binding. Replace if necessary **(Figure 2-36, Page 2-19)**.
2. Inspect the reed valve for hairline cracks, distortion or breakage. Replace if necessary.
3. Inspect the reed valve (1) seating surface. It must not have any nicks or burrs.

Breather Valve Installation

1. Installation is the reverse of removal. **See Breather Valve (Reed Valve) Removal on page 2-9.**

NOTE: *Place the reed valve on the seat so there is a slight gap (2) of 0.008 inch (0.203 mm) maximum between the valve and the seat* ***(Figure 2-36, Page 2-19)****.*

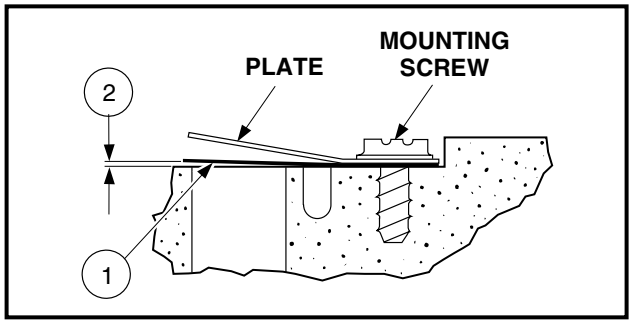


Figure 2-36 Reed Valve

INSTALLATION OF REMAINING ENGINE COMPONENTS

See General Warning on page 1-1.

1. Install rocker cover.
2. Install lower, upper, and head shrouds (1) along with two-ended bolt (2) **(Figure 2-37, Page 2-20)**.

NOTE: *The shorter threaded end of the two-ended bolt (2) goes through washer and upper shroud.*

To prevent leaks, apply a light coat of clean engine oil to the O-ring seal (7) before installation. Care should be taken during installation to avoid cutting or nicking the O-ring seal ***(Figure 2-37, Page 2-20)****.*

3. Install oil filler tube (6) and O-Ring (7) into the large hole in the crankcase cover. Install the upper end of the oil filler tube (6) onto the two-ended bolt (2). Install flange nut (8) and tighten to 50 in-lb (5.7 N·m).
4. Connect the ground wire (3) to the two-ended bolt and install and tighten the locknut (4) to 50 in-lb (5.7 N·m). Insert the dip stick (5) **(Figure 2-37, Page 2-20)**.
5. Install muffler **(Figure 2-2, Page 2-6)**.

NOTE: *Any time the muffler is removed from the vehicle, install a new muffler clamp (CCI P/N 1017689) and muffler gasket (CCI P/N 1015330).*

   5.1. Loosely attach muffler (1) to muffler mounting bracket (2) with clamp (6).
   5.2. Place a new gasket (12) on the exhaust manifold mounting flange.
   5.3. Attach muffler manifold with lock washers (11) and hex nuts (10) and tighten finger-tight.
   5.4. Loosely attach muffler bracket (1) and governor cable bracket (13) to engine block using hex-head cap screw (7), lock washer (8), and flat washer (9).
   5.5. Tighten manifold hex nuts (10) to 11 ft-lb (14.9 N·m).
   5.6. Tighten hex-head cap screw (7) to 14 ft-lb (18.9 N·m).
   5.7. Tighten muffler clamp (6) to 40 in-lb (4.5 N·m).

6. Install carburetor (11), throttle spring (12) and throttle spring bracket (13). Tighten to 50 in-lb (5.6 N·m) **(Figure 2-38, Page 2-20)**.
7. Install the spark plug and thread it in until finger tight, then tighten the plug to 20 ft-lb (27 N·m). **See following NOTE.**

Installation Of Remaining Engine Components, Continued:

NOTE: *Before installing the plug, check the condition of the threads in the cylinder head. Soften deposits in cylinder head threads with penetrating oil and clean the threads with a tap if necessary.*

8. **Earlier Style Governor Cable End:**
   8.1. Install governor cable clevis pin (9) through cable clevis and throttle valve lever and install a new cotter pin (10) **(Figure 2-38, Page 2-20)**.
9. **Current Style Governor Cable End:**
   9.1. Install 'Z' shaped cable end into carburetor throttle valve lever **(Figure 2-38, Page 2-20)**.
10. Install the governor guard (8), flat washer (15), and nylon locknut (14). Tighten to 30 in-lb (3.4 N·m) **(Figure 2-38, Page 2-20)**.
11. Apply a light film of clean engine oil onto the seal of the new oil filter and install the filter. Tighten the filter 2/3 turn after gasket contact. Fill crankcase with the correct level of oil.

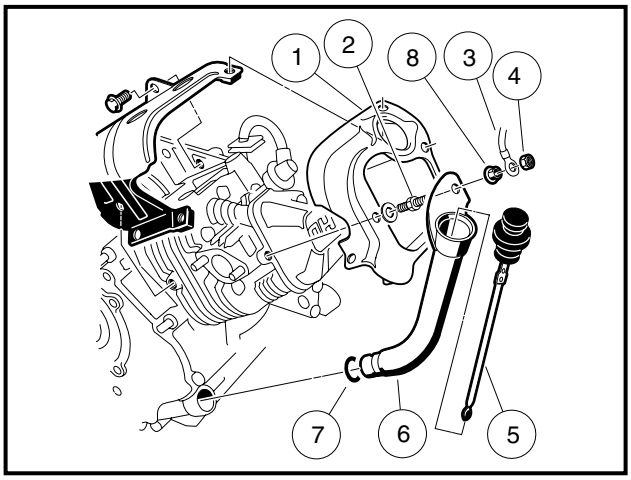


Figure 2-37 Oil Filler Tube and Ground Wire

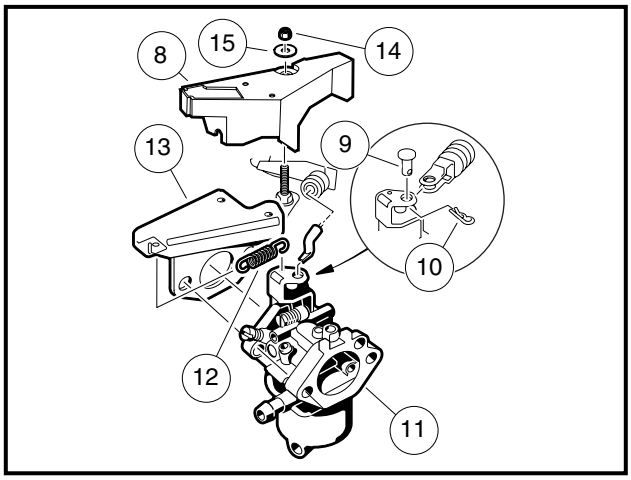


Figure 2-38 Governor Cable Connection

CRANKCASE COMPONENTS

See General Warning on page 1-1.

If the crankcase needs to be disassembled, the following procedures will apply.

1. Remove items associated with the cylinder assembly. **See Cylinder Shroud Removal on page 2-4.**
2. Remove crankcase oil drain plug and filler tube. Tip the engine slightly to allow all of the oil to drain from the crankcase. Dispose of engine oil properly.

CRANKCASE COVER REMOVAL

1. Remove yellow jumper wire (11) from cord connector (12) **(Figure 2-39, Page 2-21)**.
2. Remove nuts and clamps at two-ended bolts (1 and 2) **(Figure 2-40, Page 2-21)**.
3. Remove eight bolts (3) and remove the crankcase cover (4) **(Figure 2-40, Page 2-21)**. **See following NOTE**.

NOTE: *If the crankcase cover sticks, tap lightly with a plastic mallet on alternate sides near the dowel pins (5).*

4. Remove the crankcase cover gasket completely.

Oil Level Sensor Removal

1. Disconnect the oil level sensor wire (2) from the cord connector (1) **(Figure 2-41, Page 2-21)**.
2. Remove the screw (3) from the wire clamp (4).
3. Remove the two mounting screws (8) from the inside of the crankcase cover and remove the oil level sensor and bracket.
4. If necessary, remove the three screws (7) that hold the sensor to the bracket (5).

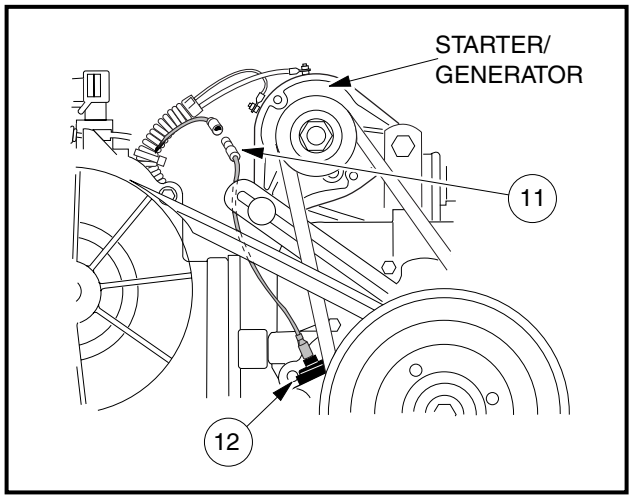


Figure 2-39 Oil Level Sensor Wire

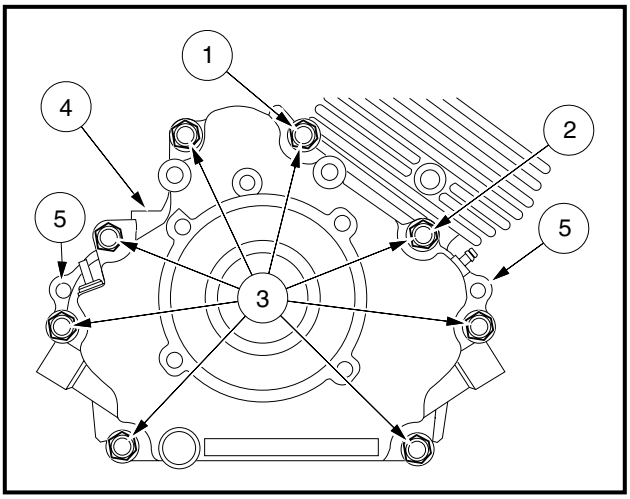


Figure 2-40 Crankcase Cover

Oil Level Sensor Installation

1. If the oil level sensor was removed from the bracket, install sensor (6) into bracket (5) and secure with three screws (7) **(Figure 2-41, Page 2-21)**. Tighten to 17 in-lb (1.9 N·m).
2. Position sending unit and bracket on inside of crankcase and install two mounting screws.
3. Connect sensor wire (2) to cord connector (1).
4. Install screw (3) through wire clamp and into crankcase cover. Tighten to 30 in-lb (3.4 N·m).

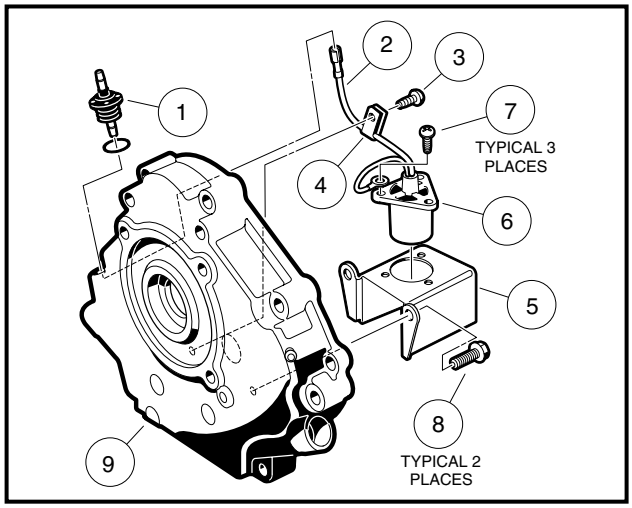


Figure 2-41 Oil Level Sensor

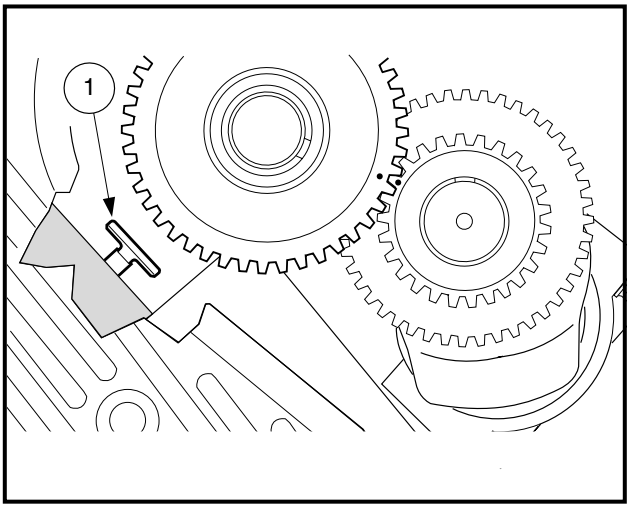


Figure 2-42 Timing Mark Alignment

CAMSHAFT AND TAPPETS

Camshaft Removal

1. Align timing marks before removing camshaft **(Figure 2-42, Page 2-21)**.
2. Turn the engine upside down to keep tappets (1) from catching the cam lobes **(Figure 2-42, Page 2-21)**.
3. Take the camshaft out of the engine block. Pull both tappets out.

NOTE: *Due to individualized wear patterns, each tappet should be reinstalled in the same position from which it was removed.*

Camshaft Inspection

1. Inspect the camshaft for wear or broken gear teeth.
2. Inspect the camshaft gear to ensure it is securely fastened to the shaft. If the cam gear is loose, replace the camshaft.
3. Measure camshaft journals and cam lobes with a micrometer at the points shown **(Figure 2-43, Page 2-22 and Figure 2-44, Page 2-22)**.

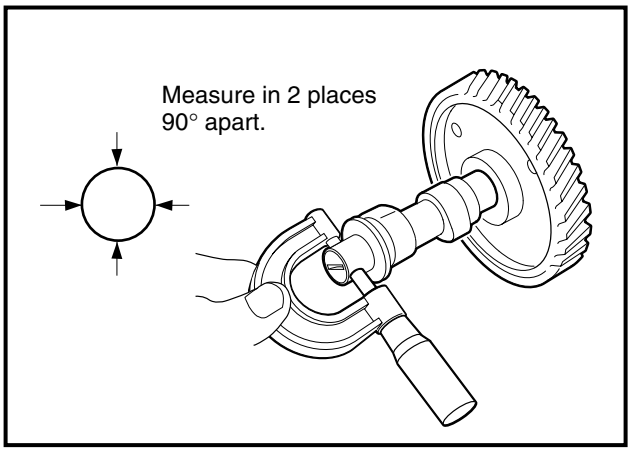


Figure 2-43 Measure O.D. of Camshaft Journals

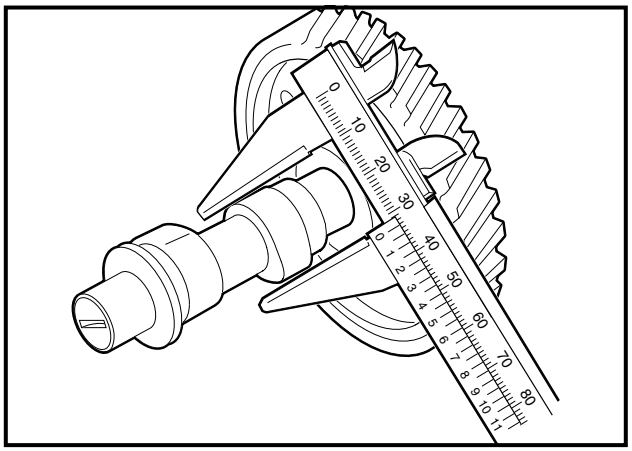


Figure 2-44 Measure O.D. of Cam Lobes

4. If camshaft journal diameter is less than 0.9026 inch (22.927 mm) at either end of the shaft, replace camshaft.
5. If the lobe height is less than 1.287 inches (32.690 mm) for either lobe, replace the camshaft. **See Camshaft Installation on page 2-42.**

PISTON AND CONNECTING ROD

See General Warning on page 1-1.

NOTE: *The connecting rod and cap must stay together as a set. Do not mix parts from any other engine.*

Piston and Connecting Rod Removal

1. Turn crankshaft to expose the two connecting rod cap bolts (1) **(Figure 2-45, Page 2-23)**.
2. Loosen the cap bolts and take them out together with the connecting rod cap (2).
3. Push the piston/connecting rod assembly out of the cylinder.

Piston and Connecting Rod Separation

1. Remove the two retaining rings holding the piston pin in place.
2. Remove the piston pin.

Piston Inspection and Repair

1. Remove all deposits from the piston.
2. Clean the carbon from the piston ring grooves. **See following CAUTION**.

CAUTION

- **Never clean the piston head with the engine assembled. Carbon particles will fall between the piston and cylinder wall and may cause severe cylinder wear.**

3. Be sure the oil return passages in the ring grooves are open.
4. Visually inspect the piston rings and ring grooves for uneven wear or damage. Replace the piston and/or piston rings if uneven wear or damage is present or if they exceed the wear limits.
5. Use a new piston ring and a feeler gauge and measure the clearance between the grooves and ring at several points around the grooves **(Figure 2-46, Page 2-23)**.
6. If the top groove has a clearance greater than 0.0063 inch (0.16 mm), replace the piston.
7. If the second groove has a clearance greater than 0.0055 inch (0.14 mm), replace the piston.
8. The oil ring is made of three pieces: upper and lower rails and expander. It is difficult to measure the ring groove clearance and thickness. Inspect visually for wear or damage.

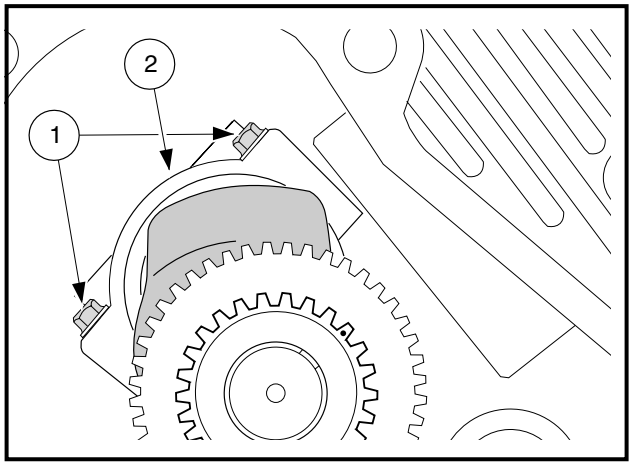


Figure 2-45 Connecting Rod Cap Bolts

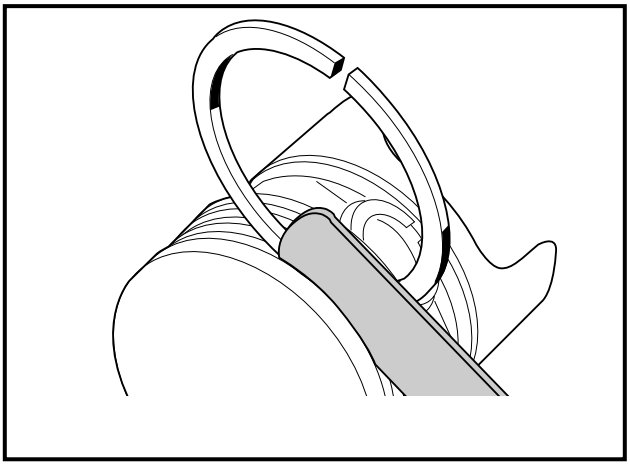


Figure 2-46 Measure Piston Ring and Groove Clearance

Piston Ring Inspection

1. Insert the ring squarely into the cylinder bore to a point approximately 1 inch (25 mm) down from the top the cylinder. **See following NOTE**.

NOTE: *Use the top of the piston to push the ring into the bore to be sure it is square.*

2. Use a feeler gauge to measure the ring end-gap **(Figure 2-47, Page 2-24)**.
3. If the end-gap of any ring is greater than 0.0472 inch (1.199 mm), replace the entire set of rings.

Piston Ring Inspection, Continued:

4. Use a micrometer to measure the thickness of both piston rings at several points around the rings **(Figure 2-48, Page 2-24)**.
5. If either ring thickness is less than 0.0566 inch (1.438 mm), replace the entire set of rings.

NOTE: *It is difficult to measure exactly the oil ring thickness. Replace the oil ring whenever the compression rings (top and second) are replaced.*

If a chrome ring is included as part of the ring set, always assemble it into the top piston groove.

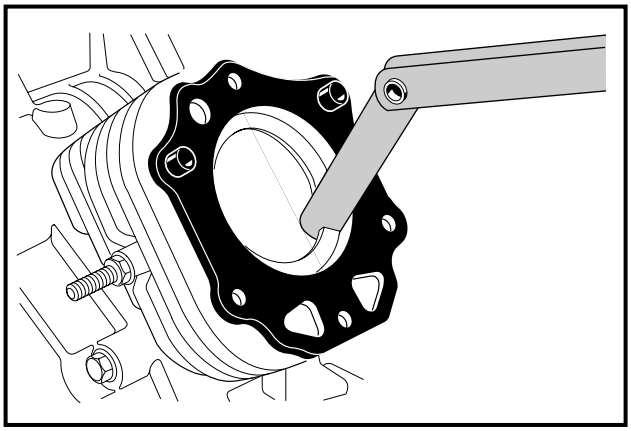


Figure 2-47 Measure Ring End-Gap

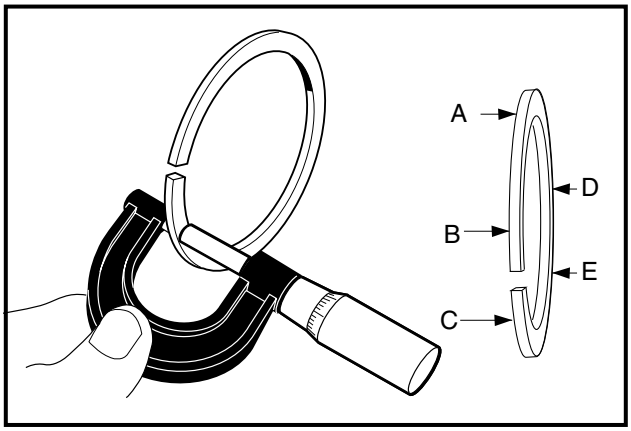


Figure 2-48 Measure Piston Ring Thickness

Piston Pin Inspection

1. Use a micrometer to measure the outside diameter of the piston pin at several points along its length **(Figure 2-49, Page 2-24)**.
2. If the pin diameter is smaller than 0.747 inch (18.974 mm), replace the piston pin.
3. Use an inside micrometer or telescoping gauge to measure the inside diameter of the piston pin hole in the piston at several points **(Figure 2-50, Page 2-24)**.
4. If the inside diameter exceeds 0.7439 inch (18.895 mm), replace the piston.

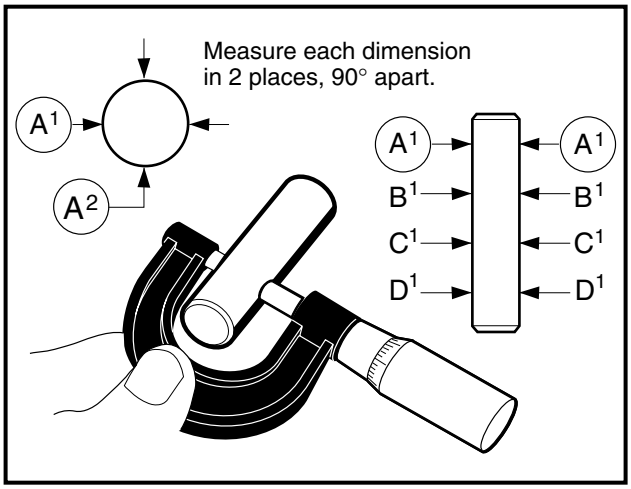


Figure 2-49 Measure O.D. of Piston Pin

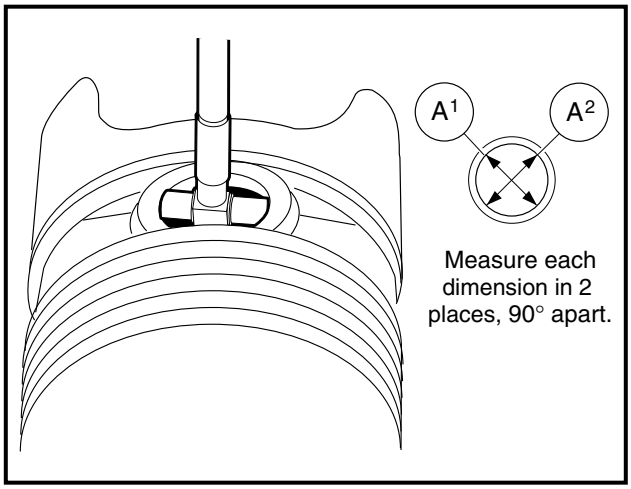


Figure 2-50 Measure I.D. of Piston Pin Hole

Connecting Rod Inspection

1. Clean and inspect the bearing surfaces of the connecting rod and cap. Replace parts if scored.
2. Use an inside micrometer or a telescoping gauge to measure the inside diameter of the connecting rod small bore at several points along its length **(Figure 2-51, Page 2-25)**.
3. If the inside diameter exceeds 0.7500 inch (19.050 mm), replace the connecting rod.
4. Remount the connecting rod cap to the connecting rod at the large bore end, aligning the pilot groove on the rod. Attach the connecting rod bolts and tighten them to 16.5 ft-lb (23 N·m).
5. Use a telescoping gauge or an inside micrometer to measure the inside diameter of the large bore at several points along its length **(Figure 2-52, Page 2-25)**.

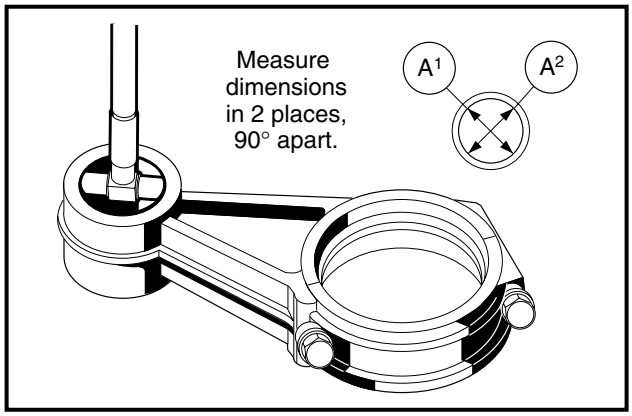


Figure 2-51 Measure I.D. of Small Bore

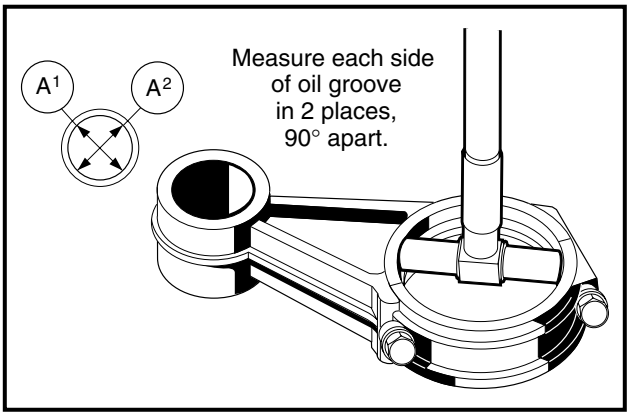


Figure 2-52 Measure I.D. of Large Bore

6. If the inside diameter exceeds 1.4003 inches (35.568 mm), replace the connecting rod. **See following NOTE.**

NOTE: *If the connecting rod is bent or twisted, it must be replaced.*

CAUTION

- **The connecting rod and cap must stay together as a set. Do not mix with parts from any other engine.**

Piston and Connnecting Rod Installation

See Piston and Connecting Rod Installation on page 2-39.

CYLINDER BLOCK

See General Warning on page 1-1.

When the engine is disassembled, inspect the cylinder block for cracks, stripped bolt holes, broken fins, or cylinder wall scoring. Repair or replace as necessary.

1. Use an inside micrometer or telescoping gauge, together with a micrometer, to measure the cylinder bore.
2. Make the first measurement parallel with the crankshaft and the second at right angles to the crankshaft at three different locations in the bore. The first measurement location is 0.4 inch (10 mm) from the top of the cylinder. The second location is in the center or 2.4 inches (60 mm) from the top, and the third location is 0.3 (8 mm) from the bottom of the cylinder or bottom of ring travel. **See locations 1, 2, and 3 (Figure 2-53, Page 2-26)**.

Cylinder Block, Continued:

- The standard bore diameter is 3.0700 - 3.0708 inches (77.980 - 78.000 mm).
- The maximum cylinder bore diameter wear limit is 3.0735 inches (78.067 mm).
- The maximum acceptable out of round cylinder bore is 0.0022 inch (0.056 mm).

3. If the cylinder bore is not within these measurements, the cylinder bore will need to be resized.

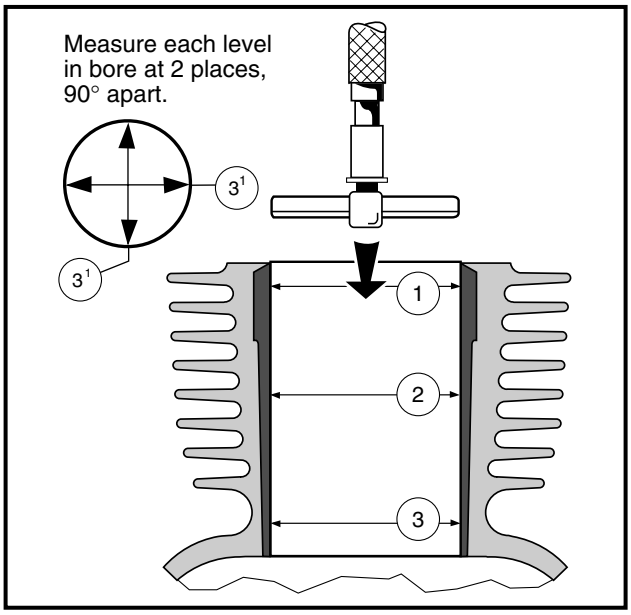


Figure 2-53 Measure Cylinder Bore

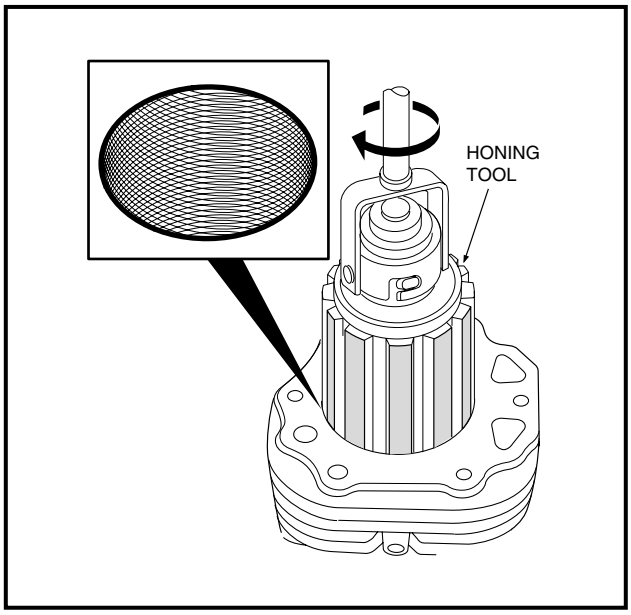


Figure 2-54 Hone Cylinder

To Resize Bore to Next Oversize

Always resize the bore to exactly 0.010 inch (0.25 mm) or to exactly 0.020 inch (0.50 mm) over standard size.

1. When the bore is resized to 0.010 inch over standard size, the new bore dimension is 3.0791 - 3.0799 inches (78.210 - 78.230 mm). When the bore is resized to 0.020 inch over standard size, the new bore dimension is 3.0890 - 3.0898 inches (78.460 - 78.480 mm). **See Specifications for Resizing Cylinder Bore on page 2-46.**

NOTE: *Allow for shrinkage (from the final size) of 0.0003 - 0.0004 inch (0.0076 - 0.0102 mm), which will occur when the cylinder cools down.*

2. Hone the cylinder that is to be 0.010 inch over standard size so that the final bore size diameter is 3.0799 - 3.0807 inches (78.230 - 78.250 mm). The final honed bore diameter for a 0.020 inch over standard size bore is 3.0898 - 3.0906 inches (78.480 - 78.500 mm). **See Specifications for Resizing Cylinder Bore on page 2-46. See following NOTE**.

NOTE: *It is important that the cylinder wall finish should have a 40° to 60° cross-hatch pattern* ***(Figure 2-54, Page 2-26).***

Do not use solvents or gasoline to clean cylinder after honing. Solvents and gasoline allow the grindings to remain in the honed surface and will not provide a surface suited for ring seating.

3. After honing, clean the cylinder wall thoroughly using soap, warm water and clean rags.
4. Dry the cylinder and coat with engine oil. **See following CAUTION.**

CAUTION

- **The cylinder must be thoroughly cleaned after honing to eliminate all grit.**

IGNITION COIL AND FLYWHEEL

See General Warning on page 1-1.

Ignition Coil and Flywheel Removal

1. Loosen three screws and remove the remaining four screws attaching the flywheel housing, then remove the housing **(Figure 2-55, Page 2-27).**
2. Disconnect the ignition coil (1) from its primary lead wire at the connector (2). Remove the two bolts (3) and remove the ignition coil **(Figure 2-56, Page 2-27)**.
3. Hold the flywheel (4), not the fan (7), with a strap wrench (5) and use a 22 mm socket to remove the flywheel nut (and flat washer) by turning it counterclockwise **(Figure 2-57, Page 2-28)**. **See following CAUTION.**

CAUTION

- **The flywheel nut has right-hand threads. Turn it clockwise to tighten, or counterclockwise to loosen.**
- **Do not damage the fan blades with the strap wrench. Do not place screwdriver or pry bar in the fan blades.**

4. Remove the flywheel with a puller (CCI P/N 1016627).
5. Remove the flywheel key from its groove.

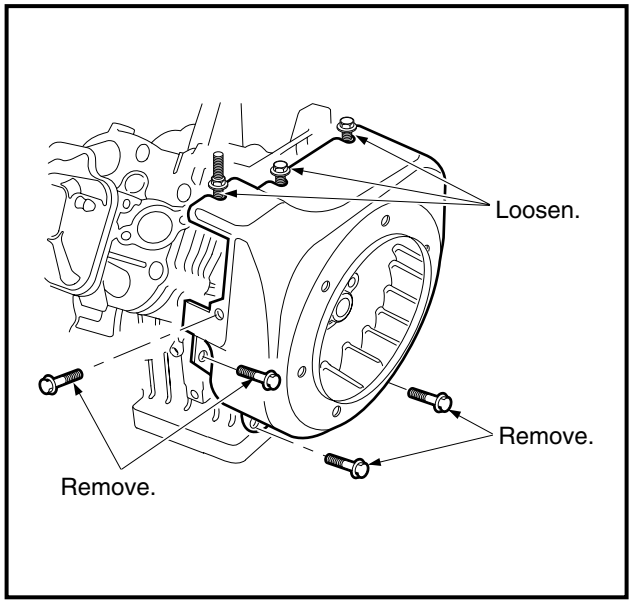


Figure 2-55 Flywheel Housing

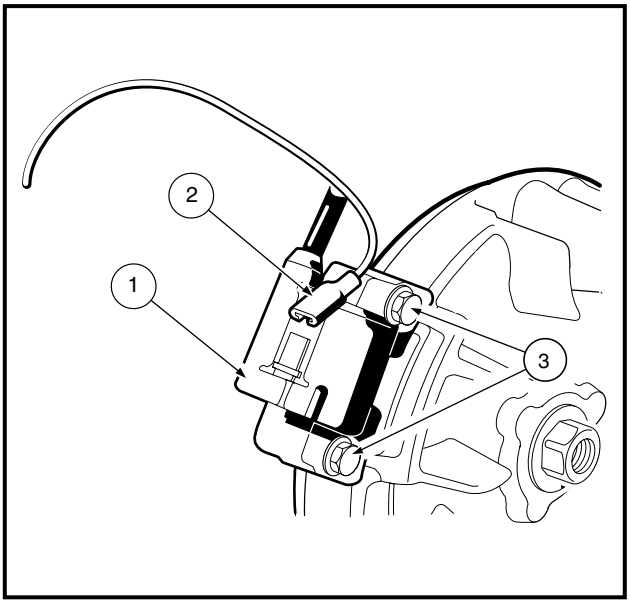


Figure 2-56 Ignition Coil

Flywheel Installation

See Engine Assembly on page 2-43.

Ignition Coil Installation

It is recommended that the ignition coil (CCI P/N 101909201) be replaced with engine teardown.

1. Installation is the reverse of removal.
2. Lightly tighten the two bolts (3), then use a bronze feeler gauge to adjust the ignition coil air gap to 0.012 inch (0.304 mm) **(Figure 2-58, Page 2-28)**.
3. Tighten the two ignition coil bolts to 30 in-lb (3.4 N·m).

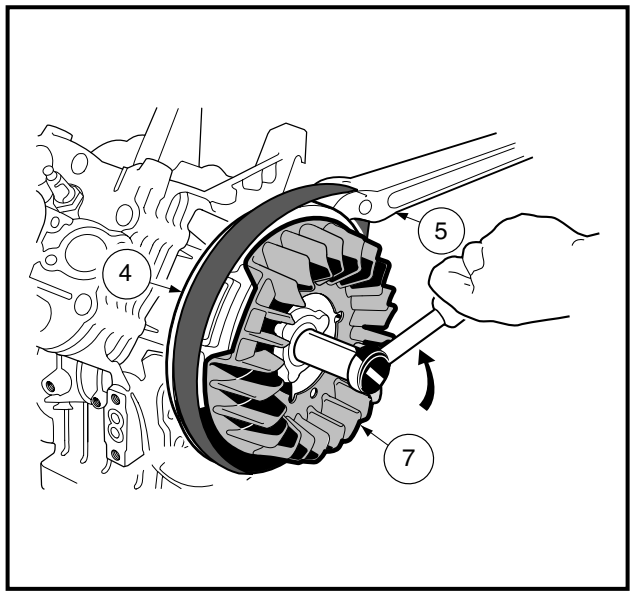


Figure 2-57 Flywheel Nut

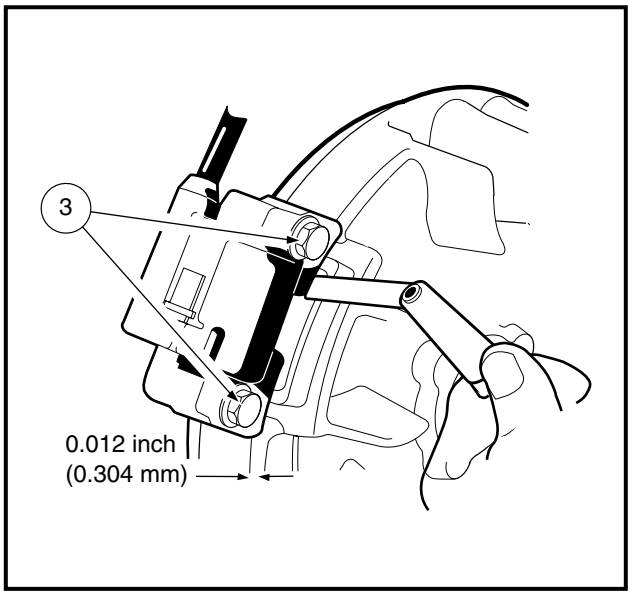


Figure 2-58 Adjust Ignition Coil Air Gap

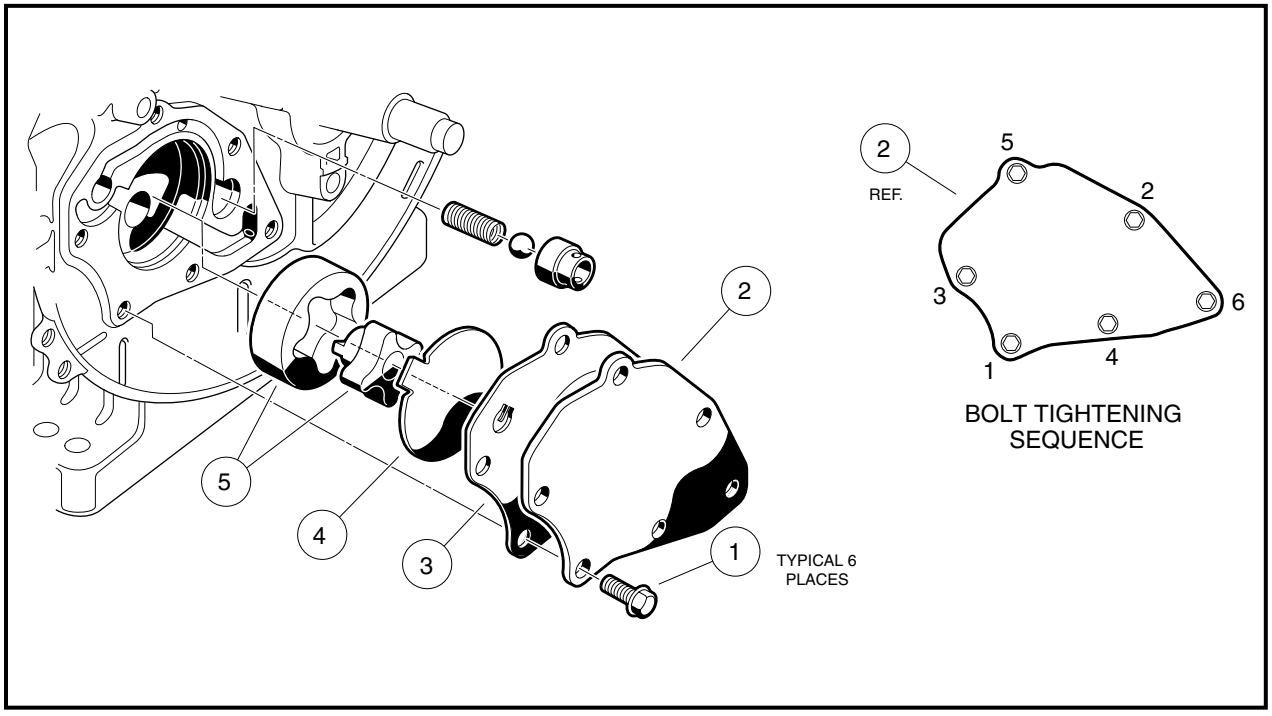


Figure 2-59 Oil Pump

OIL PUMP

See General Warning on page 1-1.

Oil Pump Cover Removal

1. Remove the six screws (1) and take off the oil pump cover (2) **(Figure 2-59, Page 2-28)**.
2. Peel off the oil pump cover gasket (3).
3. Remove the pump gear cover plate (4) **(Figure 2-59, Page 2-28)**.

Oil Pump Inspection

1. Check the clearance between the inner and outer rotors (5) with a feeler gauge (6). Measure the clearance between the high point of the inner rotor and the high point of the outer rotor **(Figure 2-60, Page 2-29)**.
2. Replace both rotors as a set if the measurement exceeds 0.012 inch (0.3 mm).
3. Remove inner and outer rotors (5).
4. Inspect the inner and outer oil pump rotors. If the rotors are worn or damaged, replace them.
   - 4.1. Measure the pump shaft bearing surface. Replace both rotors as a set if the measurement is less than 0.4971 inch (12.627 mm) **(Figure 2-61, Page 2-29)**.
   - 4.2. Use a micrometer to measure the diameter of the outer rotor at several points **(Figure 2-62, Page 2-29)**.
   - 4.3. If the rotor diameter is less than 1.5931 inches (40.467 mm), replace both rotors.
   - 4.4. Use a micrometer to measure the thickness of the outer rotor **(Figure 2-63, Page 2-29)**.
   - 4.5. If the rotor thickness is less than 0.3905 inch (9.920 mm), replace both rotors.

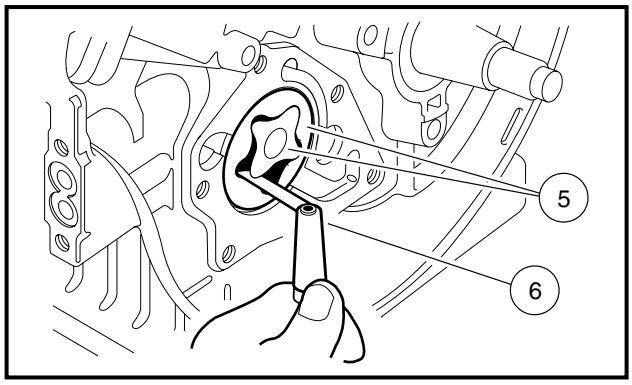


Figure 2-60 Check Clearance Between Rotors

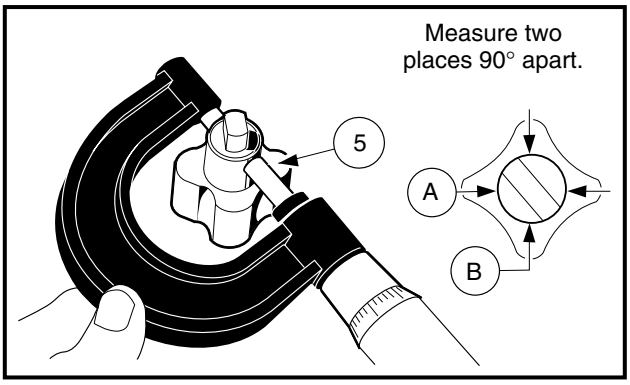


Figure 2-61 Measure Pump Shaft Bearing Surface

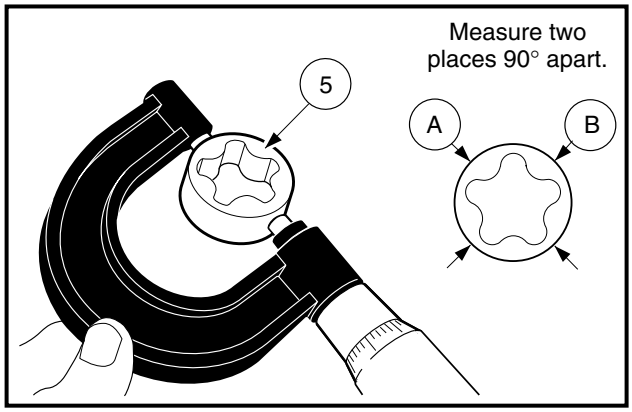


Figure 2-62 Measure O.D. of Outer Rotor

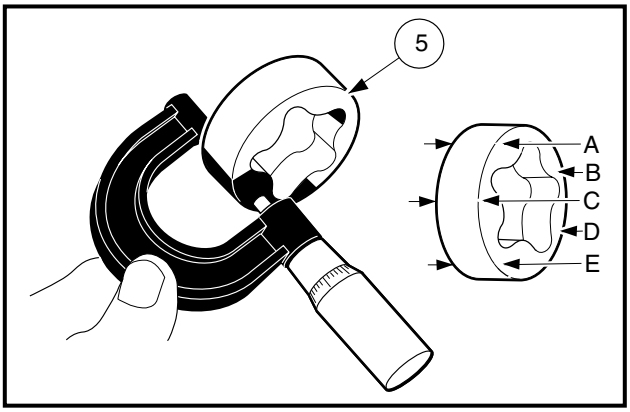


Figure 2-63 Measure Thickness of Outer Rotor

OIL PRESSURE RELIEF VALVE

Oil Pressure Relief Valve Removal

1. Remove the oil pump cover. **See Oil Pump Cover Removal on page 2-29.**
2. Remove the valve seat (1), ball (2) and spring (3) **(Figure 2-64, Page 2-30)**.

Oil Pressure Relief Valve Inspection

1. Note the condition of the ball (2) and the valve seat (1). They must not have any nicks or burrs **(Figure 2-64, Page 2-30)**.
2. Inspect the relief valve spring (3) for pitting, cracks, rusting and burrs. Replace it if necessary.
3. Measure free length of the spring (3) with a vernier caliper **(Figure 2-65, Page 2-30)**. If the free length of the relief valve spring is less than 0.748 inch (19.00 mm), replace the spring.

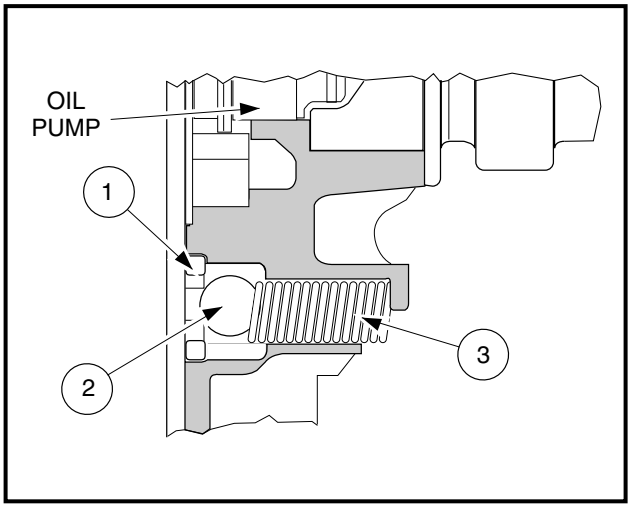


Figure 2-64 Oil Pressure Relief Valve

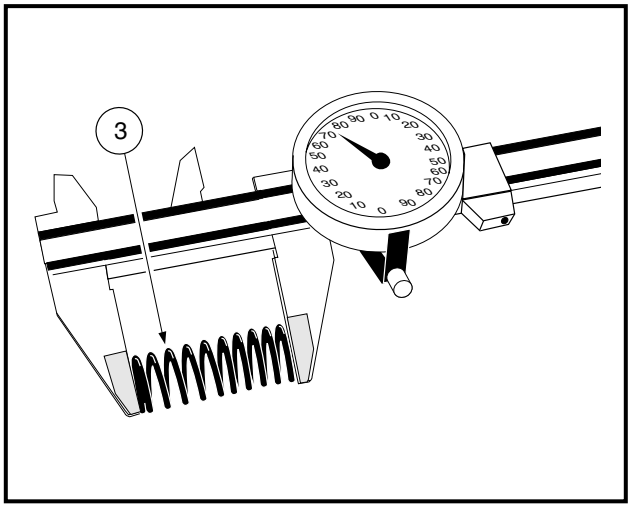


Figure 2-65 Measure Free Length of Spring

Oil Pressure Relief Valve Installation

1. Installation is the reverse of removal. If necessary, put the ball in position and lightly tap the ball with a plastic hammer to form a perfect seat.

Oil Pump Installation

CAUTION

- **Do not allow any dust or other foreign matter into the oil pump.**

1. Installation is the reverse of removal.
2. Install the inner rotor with its tang in the slot in the end of the camshaft **(Figure 2-66, Page 2-31)**.
3. Install six bolts (1) and finger tighten. Then tighten to 7 ft-lb (9.5 N·m) in the sequence shown **(Figure 2-59, Page 2-28)**. After tightening bolts, check torque of first bolt.

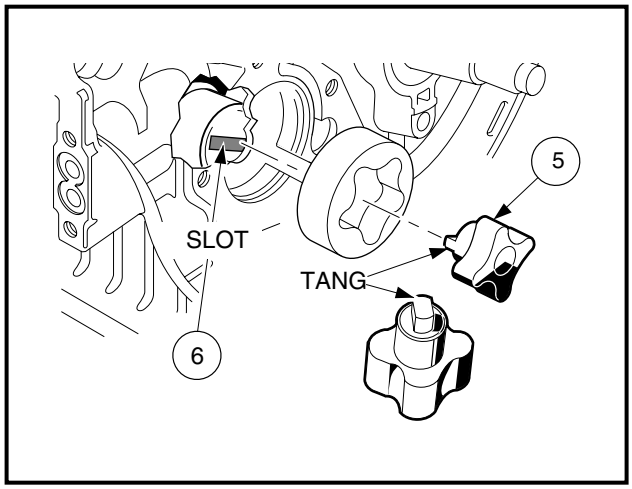


Figure 2-66 Install Inner Rotor

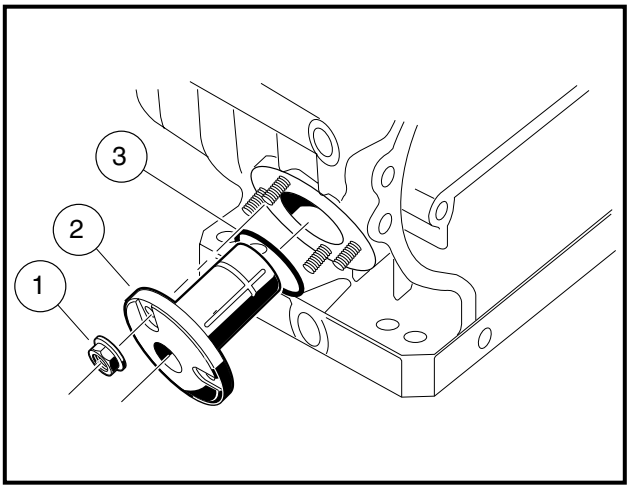


Figure 2-67 Counterbalance Guide Shaft and O-Ring

CRANKSHAFT AND COUNTERBALANCE

See General Warning on page 1-1.

Crankshaft and Counterbalance Removal

1. Remove the four nuts (1) and pull out the counterbalance guide shaft (2) and the O-Ring (3) **(Figure 2-67, Page 2-31)**.
2. Pull out the crankshaft and the counterbalance together as an assembly **(Figure 2-68, Page 2-32)**.

Crankshaft and Counterbalance Disassembly

1. Slide the spacer (2) and the link rod (3) off the flywheel end of the crankshaft. Remove the counterbalance from the remaining link rod **(Figure 2-68, Page 2-32)**. **See Link Rod Inspection on page 2-33.**
2. If the link rods need replacing, place the gear yoke (CCI P/N 1016418) under the spur gear with the small end of the connecting rod located opposite the crankpin **(Figure 2-70, Page 2-32)**.
3. Position the gear yoke with the side blocks positioned as close to the crankshaft as possible **(Figure 2-70, Page 2-32)**.
4. Use a press to push on the end of the crankshaft to remove the spur gear and the helical gear off the crankshaft **(Figure 2-71, Page 2-32)**. **See following WARNING and CAUTION**.

⚠ WARNING

- **Support the crankshaft while pressing. This will prevent the crankshaft from dropping to the floor after the gear has been removed.**

CAUTION

- **Use a press when removing the spur gear and helical gear from, or installing them on, the crankshaft.**

5. Remove the woodruff key.
6. Slide the remaining link rod off the crankshaft.

Crankshaft and Counterbalance Disassembly, Continued:

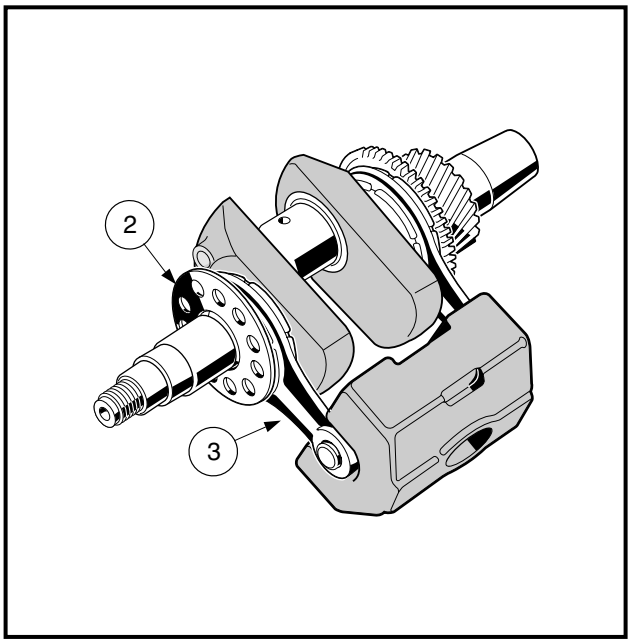


Figure 2-68 Crankshaft and Counterbalance

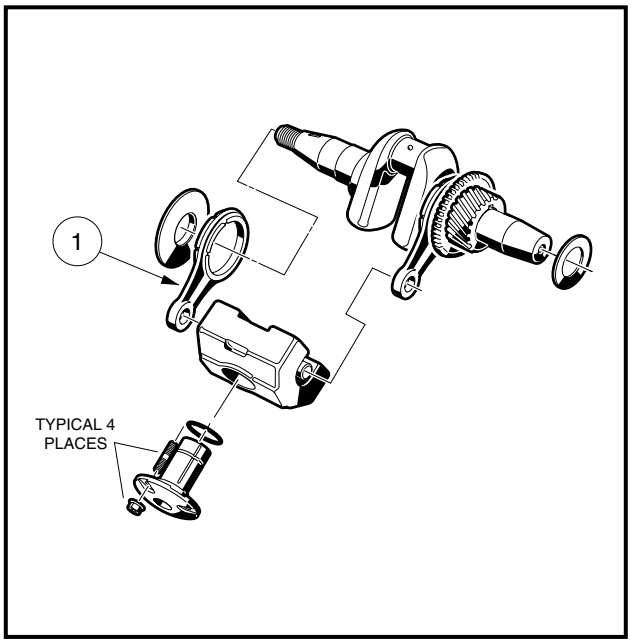


Figure 2-69 Inspect Link Rod

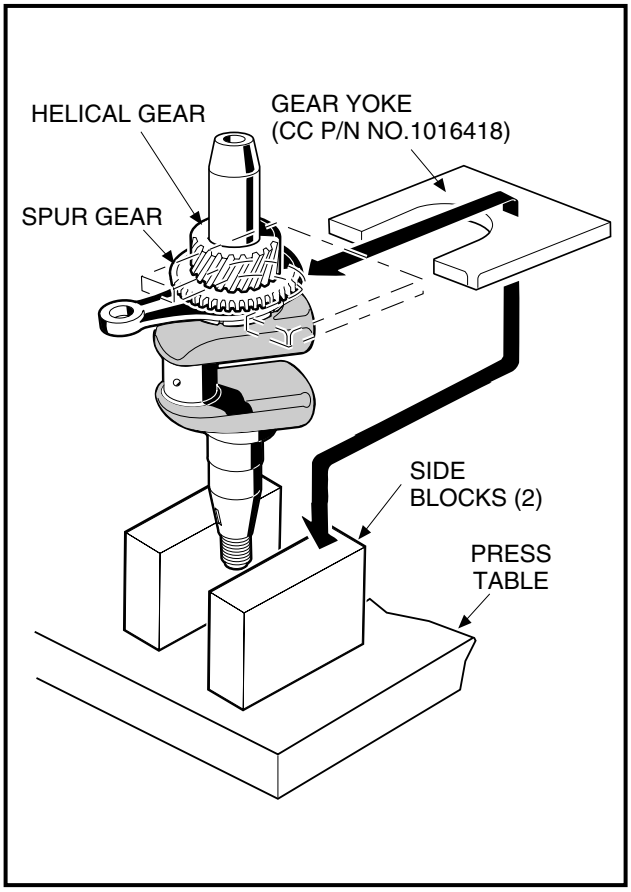


Figure 2-70 Place Assembly In Press

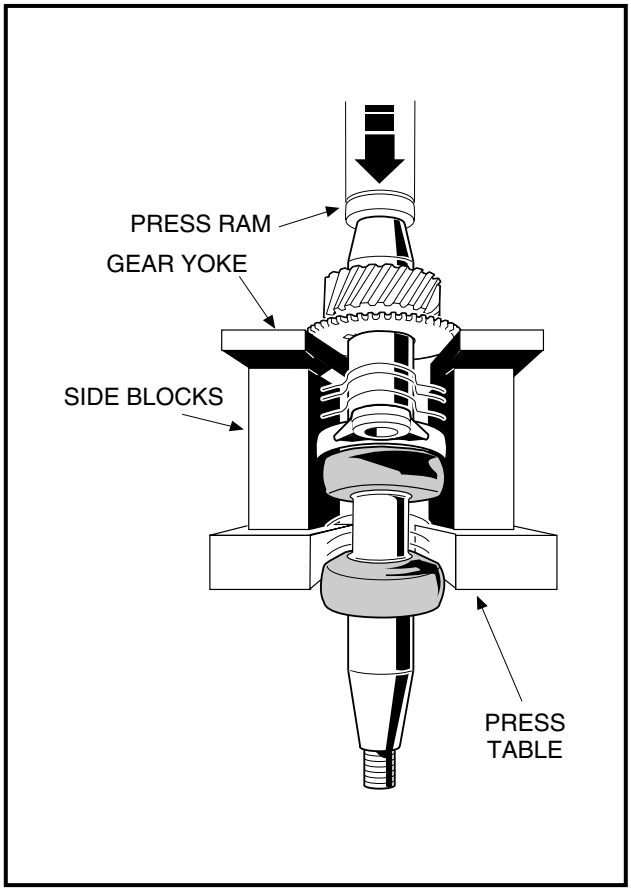


Figure 2-71 Remove Helical and Spur Gears

Link Rod Inspection

1. Clean and inspect the link rod (1) bearing surfaces. If the bearing surface of the small end is scored or damaged, replace the link rod. If the large end bearing is scored or damaged, the bearing must be replaced **(Figure 2-69, Page 2-32)**.

   1.1. Use a telescoping gauge and micrometer, measure both inside bearing surfaces at several points.

   1.2. If the inside diameter of the small end is greater than 0.4746 inch (12.057 mm), replace the link rod **(Figure 2-72, Page 2-33)**.

   1.3. If the inside diameter of the large end is greater than 1.8554 inches (47.127 mm), replace the bearing **(Figure 2-73, Page 2-33)**. **See following NOTE.**

NOTE: *Do not remove the link rod on the PTO (power take-off) side unless link rod on the opposite end needs replacement. The crank-gear is very tightly fitted to the crankshaft so that it can transfer engine torque to the camshaft (which also functions as a power take-off shaft)* ***(Figure 2-69, Page 2-32)****. Ignore crankshaft and counterbalance disassembly* ***(Steps 2 through 6, page 2-31****), if the link rod opposite of the PTO side passes inspection* ***(Figure 2-69, Page 2-32)****.*

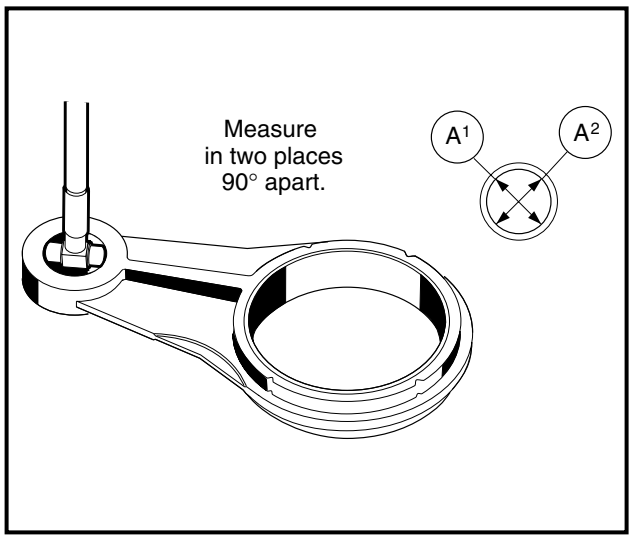


Figure 2-72 Measure I.D. of Small Bore

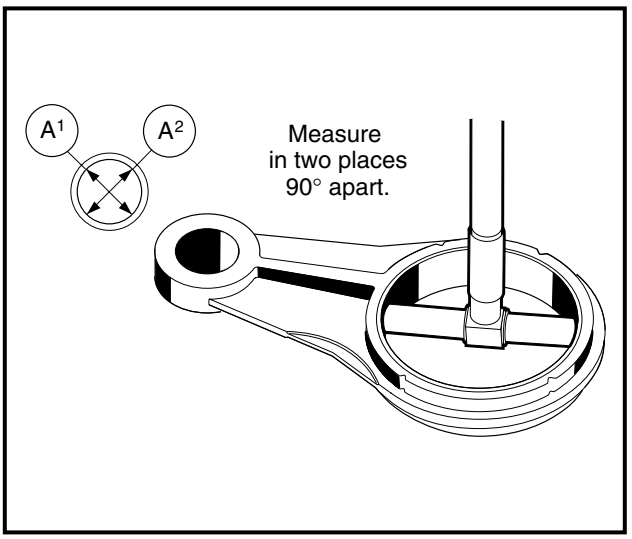


Figure 2-73 Measure I.D. of Large Bore

Link Rod Bushing Replacement

1. Support the link rod around the entire large end, and using a 1.97 inches (50 mm) bearing driver (1), drive the bearing (2) out of the rod (3) as shown **(Figure 2-74, Page 2-34)**.
2. Clean the parts thoroughly in a high flash-point solvent and dry them.
3. Coat the new bearing with new engine oil.
4. Use a 1.97 inches (50 mm) bearing driver to press the new bearing into the link rod with its seam (6) toward the side of the link rod with the hollow (5) and at right angles to the rod center, to a depth of 0.039 inch (0.991 mm) from the surface **(Figure 2-75, Page 2-34)**.

Link Rod Bushing Replacement, Continued:

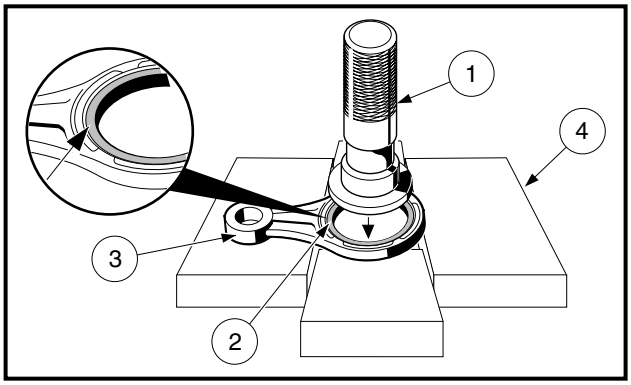


Figure 2-74 Remove Bearing From Link Rod

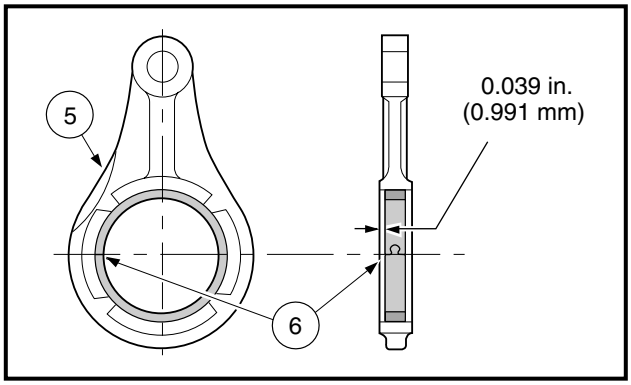


Figure 2-75 Install New Bearing Into Link Rod

COUNTERBALANCE WEIGHT

NOTE: *The wrist pins are tightly pressed into the weight and normally require no maintenance.*

Counterbalance Weight Inspection

1. Clean the inside of the bore surface and inspect it for wear or damage.
2. Use a telescoping gauge and micrometer to measure the inside diameter of the bearing bore **(Figure 2-76, Page 2-34)**.
3. If the inside diameter is greater than 1.0283 inches (26.119 mm), or the bore show signs of wear or damage, replace counterbalance weight.

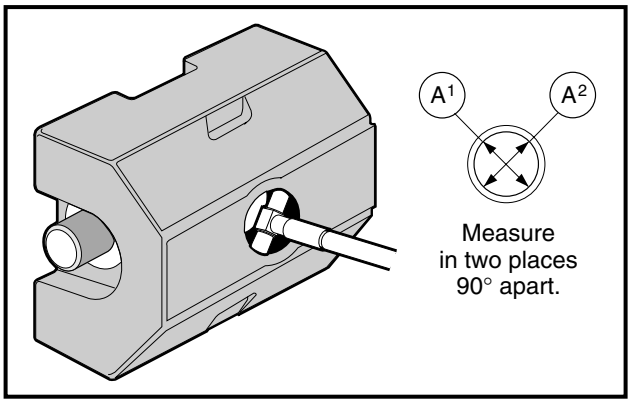


Figure 2-76 Measure I.D. of Counterbalance Weight Bore

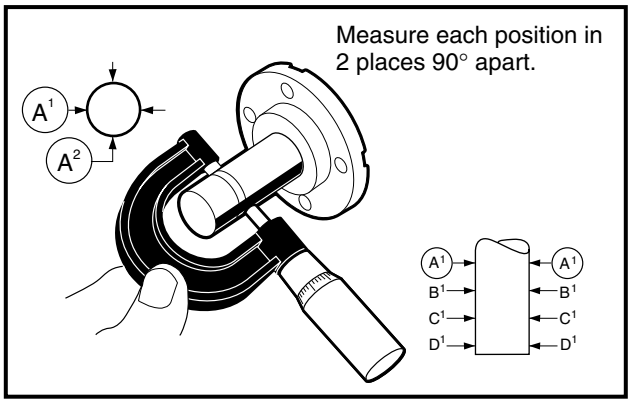


Figure 2-77 Measure O.D. of Counterbalance Guide Shaft

Counterbalance Guide Shaft Inspection

1. Clean the shaft surface and inspect it for wear or damage.
2. Use an outside micrometer to measure the outside diameter of the guide shaft surface **(Figure 2-77, Page 2-34)**.
3. If the outside diameter is smaller than 1.0199 inches (25.907 mm), or the shaft shows signs of wear or damage, replace the guide shaft.
4. Check the O-Ring seal to make sure the O-Ring is not damaged. Replace if necessary.

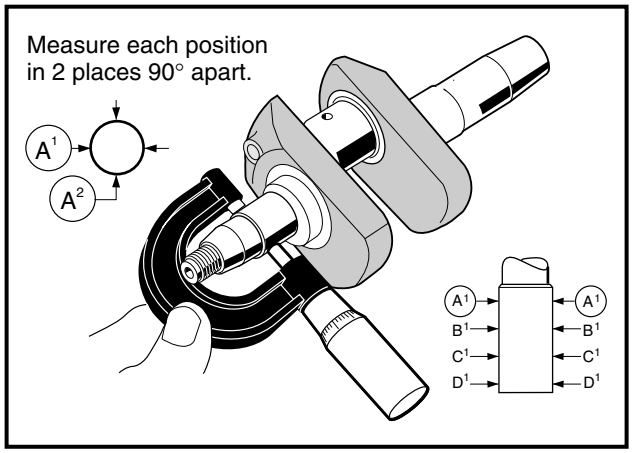


Figure 2-78 Measure Main Journals

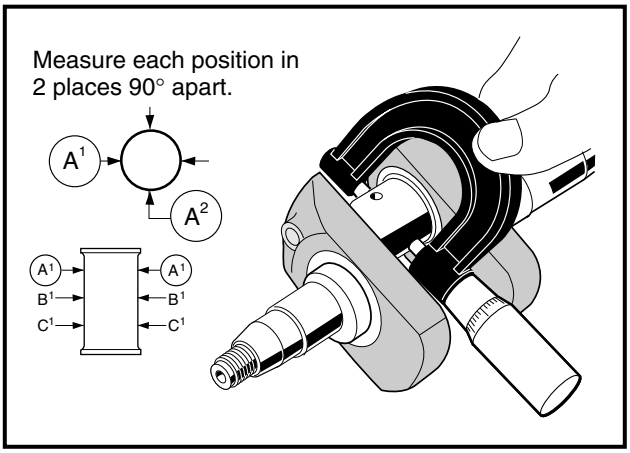


Figure 2-79 Measure Connecting Rod Journal

Crankshaft Inspection

1. Clean and inspect the journals for scoring. Inspect the crankshaft gear for cracks, scoring or broken teeth. Replace parts if necessary.
2. Use a micrometer to measure both main journals (PTO side and flywheel side) at several points along their lengths **(Figure 2-78, Page 2-35)**.
   2.1. If either journal diameter is less than 1.1783 inches (29.929 mm), replace the crankshaft.
3. Use a micrometer to measure connecting rod journal at several points along its length **(Figure 2-79, Page 2-35)**.
   3.1. If the journal diameter is less than 1.3954 inches (35.443 mm), replace the crankshaft.
4. Use a micrometer to measure the crankshaft link rod journals at several points **(Figure 2-80, Page 2-35)**.
   4.1. If the diameter of either journal is less than 1.8474 inches (46.924 mm), replace the crankshaft.
5. Check the crankshaft alignment.
   5.1. Place the crankshaft in an alignment jig.
   5.2. Turn the crankshaft (1) slowly and measure total indicated run-out at the location shown (2) **(Figure 2-81, Page 2-35)**.
   5.3. If total run-out exceeds 0.002 inch (0.051 mm), replace the crankshaft.

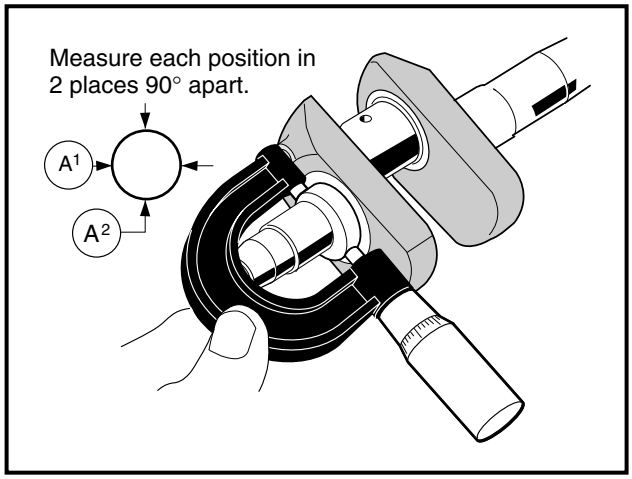


Figure 2-80 Measure Crankshaft Link Rod Journal

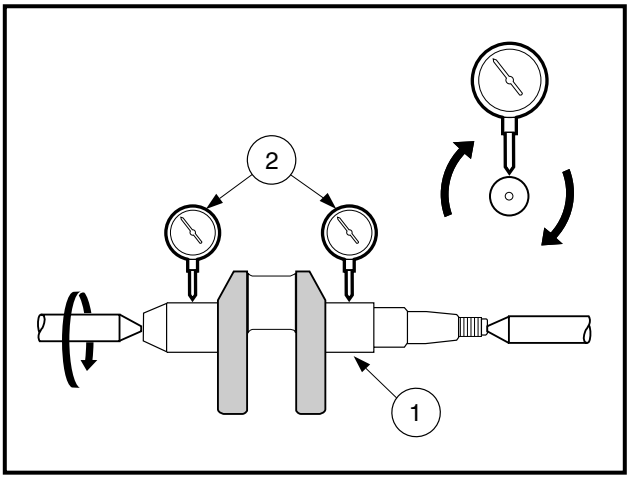


Figure 2-81 Measure Total Indicated Run-Out

Undersized Connecting Rod

The connecting rod journal can accept an undersized connecting rod with a 1.3779 inches (35.0 mm) inside diameter. Grinding the crankshaft is required before using the undersized connecting rod.

1. Have a reliable repair shop grind the crankshaft journal (A) **(Figure 2-82, Page 2-36)**.
2. The final finishing dimensions are as follows:

   (A) 1.3775 - 1.3779 inches (34.989 - 35.00 mm)

   (B) 0.110 - 0.126 inch (2.80 - 3.20 mm) radius two places

   (C) 1.12 inches maximum (28.4 mm)

   (D) 1.1811 - 1.1831 inches (30.0 - 30.05 mm)
3. The connecting rod journal (A) must be concentric and cylindrical within 0.0002 inch (0.005 mm) at full indicator reading **(Figure 2-82, Page 2-36)**.
4. Finish should be very smooth. Use a super fine finishing stone.

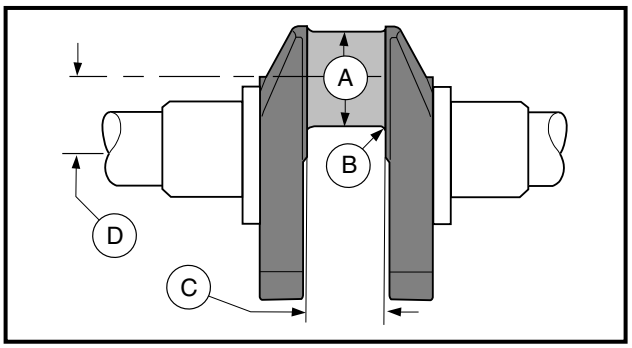


Figure 2-82 Crankshaft Finishing Dimensions

OIL SCREEN

Oil Screen Removal

1. Remove the two bolts (1) to take out the oil screen plate (2) and the oil screen (3) **(Figure 2-83, Page 2-36)**.
2. Clean the oil screen thoroughly with a high flash-point solvent and dry it.

Oil Screen Installation

1. To install the oil screen, reverse the removal procedure.
2. Tighten bolts to 30 in-lb (3.4 N·m).

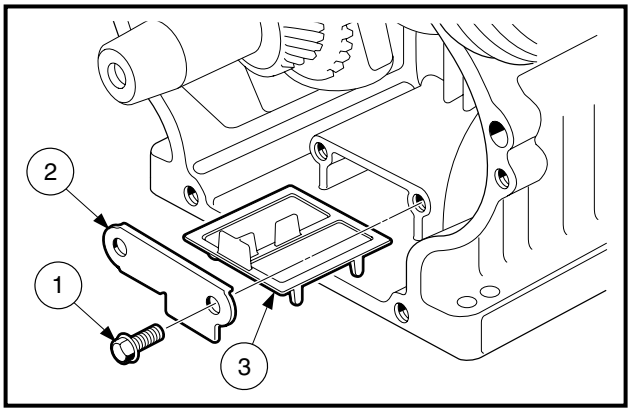


Figure 2-83 Oil Screen Removal

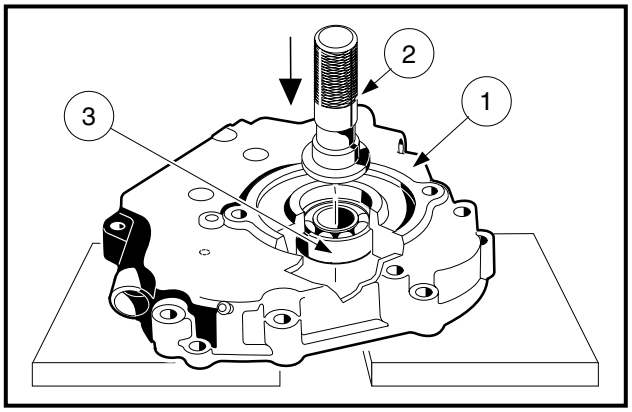


Figure 2-84 Ball Bearing Removal

BALL BEARING

Ball Bearing Removal

1. Remove the oil seal in the crankcase cover. **See following NOTE**.

NOTE: *Never reuse an oil seal. Replace the oil seal with a new one.*

2. Place the crankcase cover (1) on a bench with its outside up (gasket surface against bench) **(Figure 2-84, Page 2-36)**.
3. Use a bearing driver (2) (part of Bearing Driver Kit, CCI P/N 1016416) to drive out the ball bearing (3).

Ball Bearing Inspection

1. Clean the ball bearing thoroughly in high flash-point solvent and dry it.

NOTE: *Never use compressed air to dry bearing. Spinning the bearing at accelerated speeds without lubrication can damage both the bearings and bearing seat and result in premature bearing failure.*

2. Spin the ball bearing by hand and check for (A) axial play and (B) radial play. Replace the ball bearing if it is noisy, does not spin smoothly, or if it has any play **(Figure 2-85, Page 2-37)**.

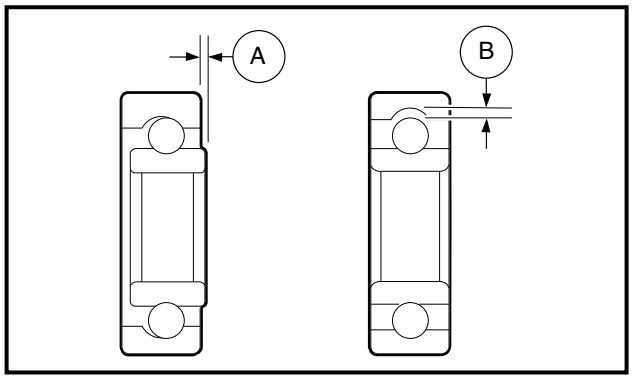


Figure 2-85 Check Ball Bearing

OIL SEALS

Oil seals are used on both ends of the crankshaft. Any time the crankshaft is removed from the seals, the seals must be replaced with new ones.

Oil Seal Removal

Use an oil seal remover to press or drive the seal out of the casing.

Oil Seal Installation

NOTE: *Never reuse an oil seal. Replace the oil seal with a new one.*

1. Put a light coating of clean engine oil on the outside edge and the inner lip of the oil seal to assist installation.
2. Install all oil seals with their lips facing the center of the engine.
3. Using the 1.37 inch (35 mm) seal driver, press the oil seal into the flywheel side of the crankcase until it is flush with the hole.
4. Using the 1.97 inch (50 mm) seal driver, press the oil seal into the crankcase cover until it is 0.157 inch (4 mm) below the outside surface.

Plain Bearing Surface Inspection

Plain bearing surfaces are used for both ends of the camshaft and the flywheel end of the crankshaft.

1. Inspect the camshaft surfaces, one in the crankcase (3) **(Figure 2-86, Page 2-38)** (and the other in the crankcase cover (1) **(Figure 2-87, Page 2-38)**. Use an inside micrometer or telescoping gauge to measure the inside diameter of each bearing surface. If the inside diameter is greater than 0.9080 inch (23.063 mm), replace the crankcase and/or the crankcase cover.
2. Inspect the crankshaft bearing surface (2) in the crankcase. Use an inside micrometer or telescoping gauge to measure the inside diameter of the bearing surface. If the inside diameter is greater than 1.1841 inches (30.075 mm), replace the crankcase **(Figure 2-86, Page 2-38)**.

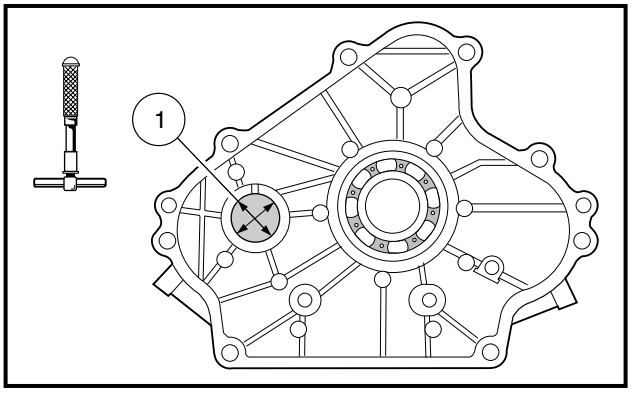


Figure 2-86 Inspect Bearing Surfaces in Crankcase

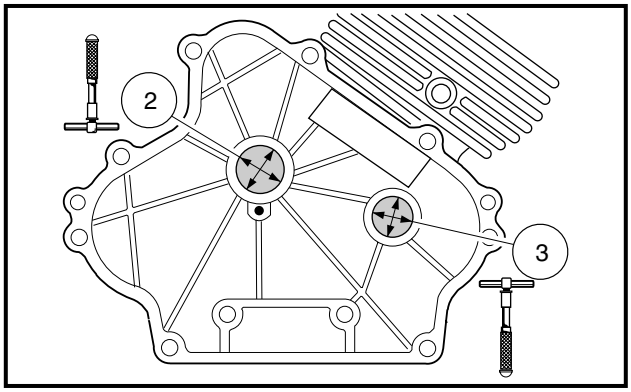


Figure 2-87 Inspect Camshaft Surface in Crankcase Cover

Crankshaft Installation

See General Warning on page 1-1.

CAUTION

- **Before assembly, make sure all parts are clean.**

NOTE: *When reassembling the crankshaft and the counterbalance weight, apply a light film of engine oil to the crankshaft journals and guide shaft* ***(Figure 2-88, Page 2-38)****.*

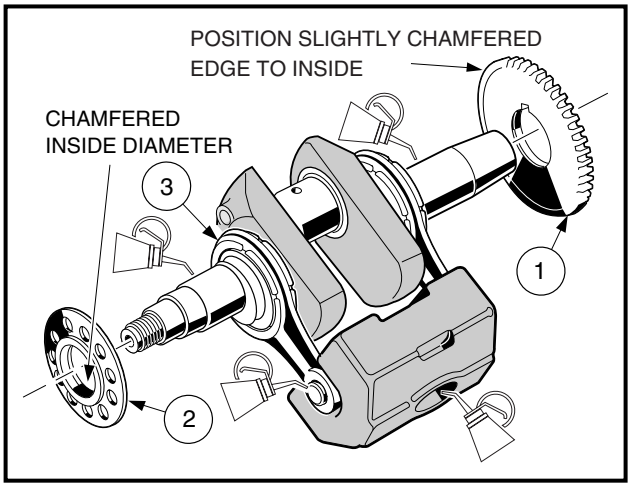


Figure 2-88 Crankshaft Assembly

1. Installation is the reverse of removal. **See Crankshaft and Counterbalance Removal on page 2-31.**
2. Tighten the four nuts (2) for counterbalance guide shaft to 50 in-lb (5.9 N·m) **(Figure 2-67, Page 2-31)**.
3. If the link rod was removed from the PTO side of the crankshaft, support the crankweb as shown, slide the link rod onto the crankshaft, and install the key. Press the spur gear and helical gear onto the crankshaft **(Figure 2-89, Page 2-39 and Figure 2-90, Page 2-39). See following CAUTION and NOTE.**

CAUTION

- **Always use a press when removing or installing the spur gear and helical gear on the crankshaft.**
- **If the spur gear was warped while being removed, install a new one.**

NOTE: *Make sure the chamfered inside diameters of the spur gear and helical gear are oriented downward on the crankshaft as shown **(Figure 2-89, Page 2-39)**.*

Make sure the link rods rotate smoothly after the gears are pressed on.

4. Slide the link rod, then the spacer, onto the flywheel end of the crankshaft.

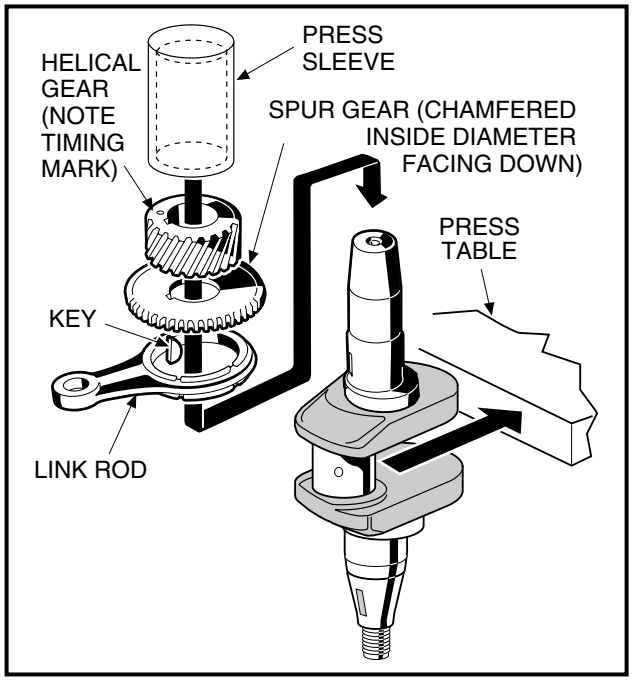


Figure 2-89 Crankshaft Installation

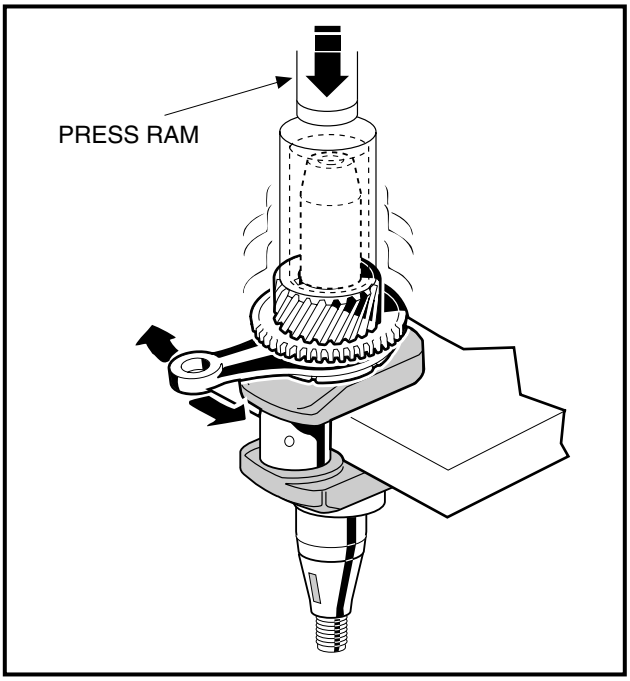


Figure 2-90 Press On Spur Gear and Helical Gear

PISTON AND CONNECTING ROD INSTALLATION

1. Reassemble the piston and the connecting rod into a unit, if disassembled.
   1.1. Align the arrow mark (1) on the piston head toward the words MADE IN JAPAN (2) on the connecting rod. Insert the piston pin through the piston holes and the connecting rod. Install the two retaining rings to hold the pin in place. The gap in the retaining rings should be facing towards the crankshaft. Make sure the retaining rings are seated in their grooves. Make sure the connecting rod moves freely **(Figure 2-91, Page 2-40)**.
2. Apply a light film of engine oil to the connecting rod bearing surfaces and the two connecting rod bolts.

Piston and Connecting Rod Installation, Continued:

3. Put the piston and connecting rod into the cylinder bore with the lettering MADE IN JAPAN on the connecting rod oriented toward the PTO side of the engine. Position piston ring gaps so that they are oriented toward the corresponding letters in:

   (A) Top Ring Gap

   (B) Second Ring Gap

   (C) Upper Side Rail Gap installed in the lowest ring groove

   (D) Lower Side Rail Gap installed in the lowest ring groove

4. Compress the rings on the piston and finish sliding piston into the cylinder **(Figure 2-92, Page 2-40)**.

NOTE: *The letter **R** marked on the top two piston rings should be facing up when the rings are installed. Install the chrome-edged ring into the top ring groove.*

5. Tighten the two connecting rod bolts to 16.5 ft-lb (23 N·m).

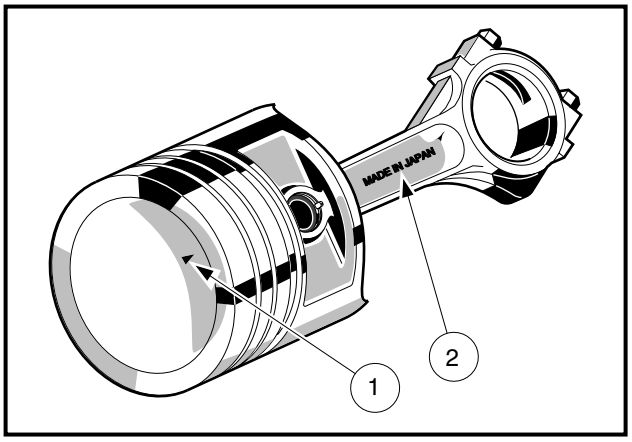


Figure 2-91 Piston/Connecting Rod

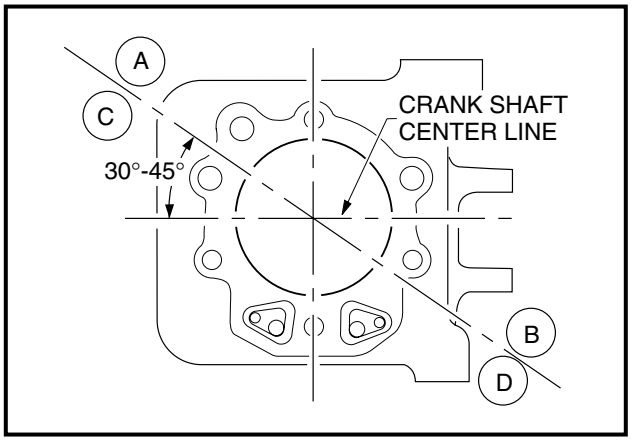


Figure 2-92 Position Piston Ring Gaps

CRANKSHAFT AXIAL PLAY ADJUSTMENT

See General Warning on page 1-1.

1. With the gasket installed on the crankcase, measure from the gasket surface (1) to the helical gear surface (2). Record measurement (A) **(Figure 2-93, Page 2-41)**.
2. Measure from the crankcase cover (3) mounting face to the crankshaft bearing inner end (4). Record measurement (B) **(Figure 2-93, Page 2-41)**.
3. Locate the measurements on the Crankshaft Shim Table. Follow lines to where the recorded measurements intersect **(Figure 2-95, Page 2-41)**.
4. Choose the next smaller shim from the table. Example: Measurement A is 15.87 mm and B is 17.66 mm. The correct crankshaft shim (5) is 1.53 mm.

NOTE: *Crankshaft shim sizes for FE290 engines range from 1.13 to 1.53mm.*

5. Install the shim (5) on the crankshaft (6) **(Figure 2-94, Page 2-41)**.

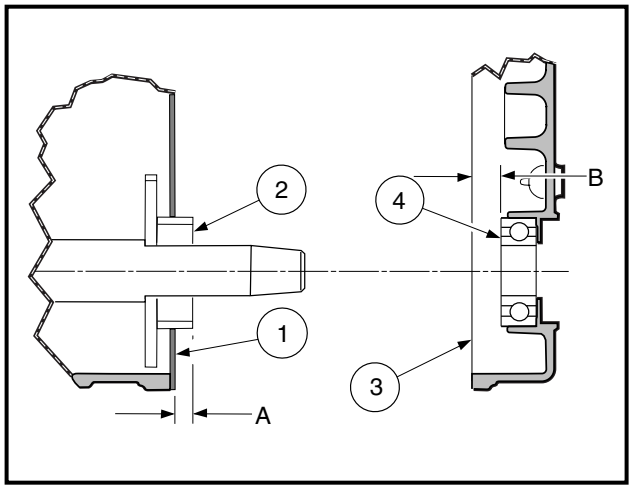


Figure 2-93 Determine Crankshaft Shim Size

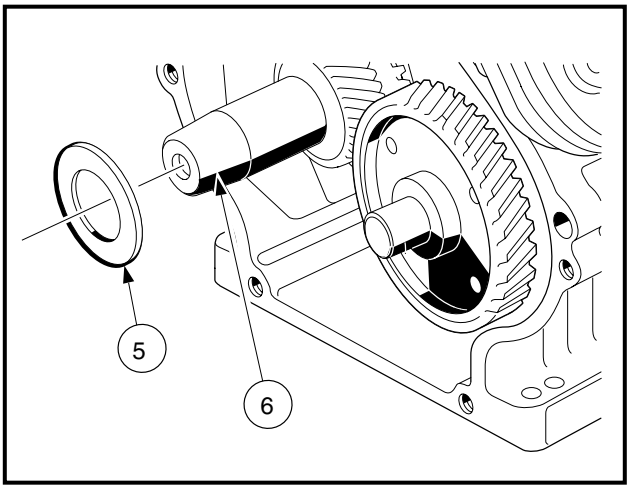


Figure 2-94 Install Shim on Crankshaft

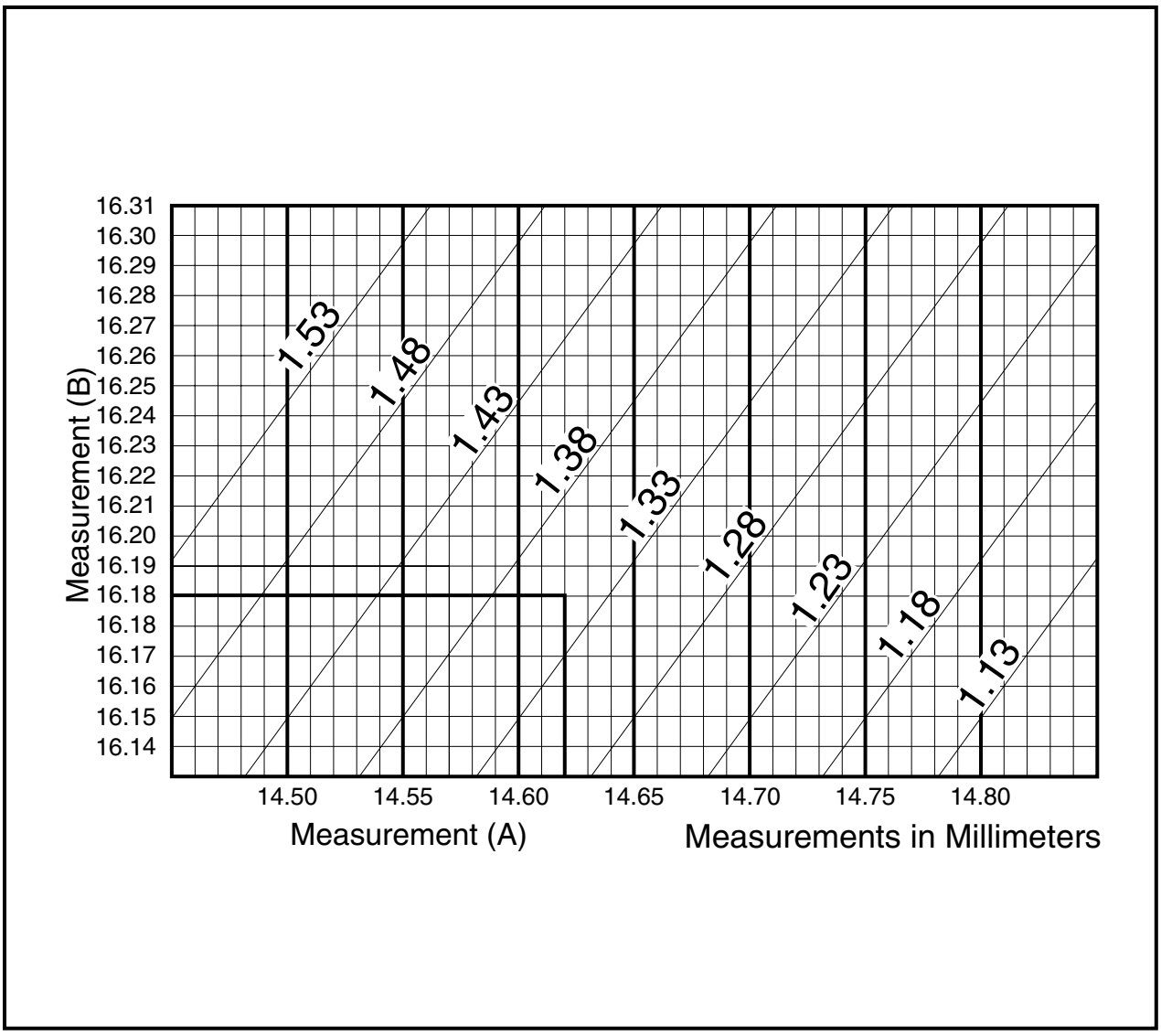


Figure 2-95 Crankshaft Shim Table

Camshaft Installation

CAUTION

- **When installing the camshaft, make sure that the tang (1) on the oil pump rotor seats in the slot (2) in end of the camshaft (Figure 2-96, Page 2-42). If the oil pump tang is not seated in the slot in the camshaft, serious engine damage will result.**

1. Installation is the reverse of removal. **See Camshaft Removal on page 2-22.**
2. Apply a light film of engine oil to the camshaft journals and cam lobes.
3. Align the timing marks (3) **(Figure 2-97, Page 2-42)**. **See following NOTE.**

NOTE: *If the outside edges of the camshaft and crankshaft gears are not flush, and the crankcase cover will not easily make full contact with the crankcase, make sure the tang on the oil pump rotor is seated in the camshaft slot.*

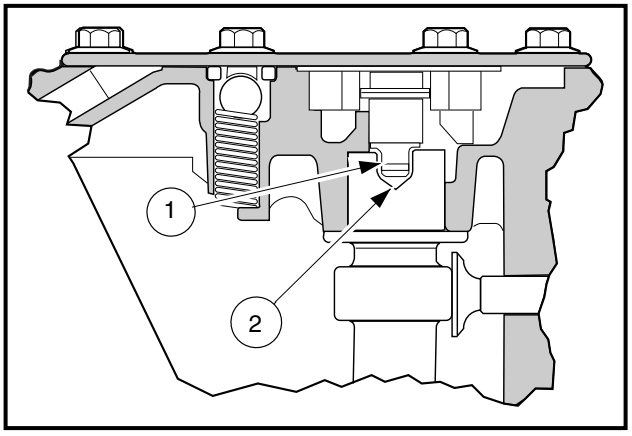


Figure 2-96 Proper Seating of Tang into Camshaft

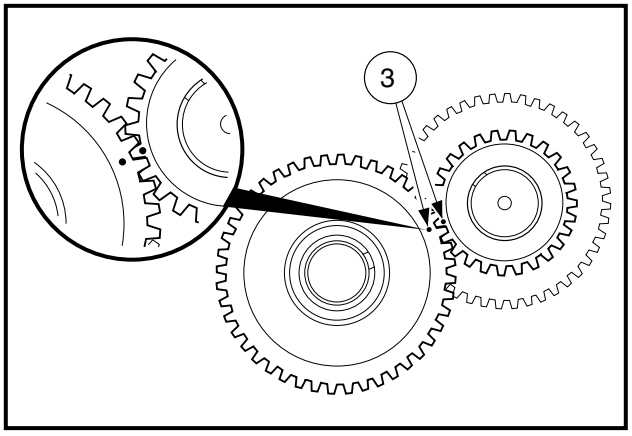


Figure 2-97 Align Timing Marks

CRANKCASE COVER INSTALLATION

CAUTION

- **Before assembly, make sure parts are clean.**
- **Do not reuse the gasket. Install a new one.**
- **Install and tighten crankcase cover bolts as instructed. Failure to do so could cause the cover to become warped.**

1. Clean the gasket surfaces on the crankcase cover to fit a new gasket during installation and inspect the oil seal for wear and damage.

Install crankcase cover. Using HANDS ONLY, seat cover completely against the crankcase. If the cover will not seat, the camshaft is not installed correctly.

2. Install and finger tighten evenly the eight cover mounting bolts **(Figure 2-98, Page 2-43)**.
3. Tighten the cover mounting bolts in two steps. First, in the sequence shown, tighten all eight bolts to approximately 130 in-lb (14 N·m). Then, repeating the sequence, tighten them to 250 in-lb (28.2 N·m) **(Figure 2-98, Page 2-43)**.

Crankcase Cover Installation, Continued:

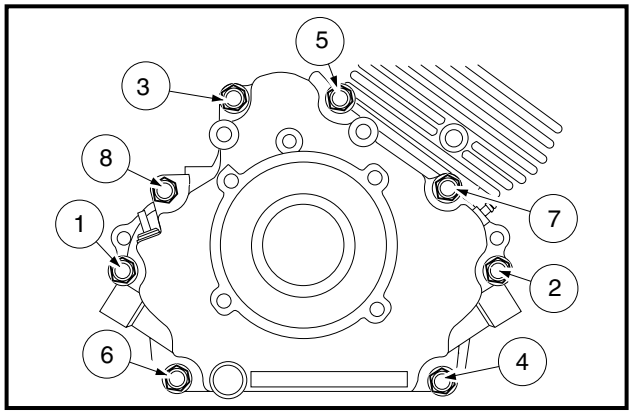


Figure 2-98 Crankcase Cover Installation

ENGINE ASSEMBLY

See General Warning on page 1-1.

CAUTION

- **Before assembly, make sure parts are clean.**

1. Install cylinder head. **See Cylinder Head Installation on page 2-16.**
2. Insert the flywheel key into the keyway in the crankshaft. Then align the keyway in the flywheel to the key and push the flywheel and fan assembly onto the crankshaft until it seats. Install flat washer and nut finger tight.
3. Use a strap wrench (3) to keep the flywheel and fan assembly (1) from turning while tightening the flywheel nut to 63 ft-lb (85.4 N·m) **(Figure 2-99, Page 2-43). See following CAUTION**.

CAUTION

- **The flywheel nut has right-hand threads. Turn it clockwise to tighten, or counterclockwise to loosen.**
- **Be careful not to damage the fan blades. Use a strap wrench to hold flywheel. Do not place screwdriver or pry bar between fan blades.**

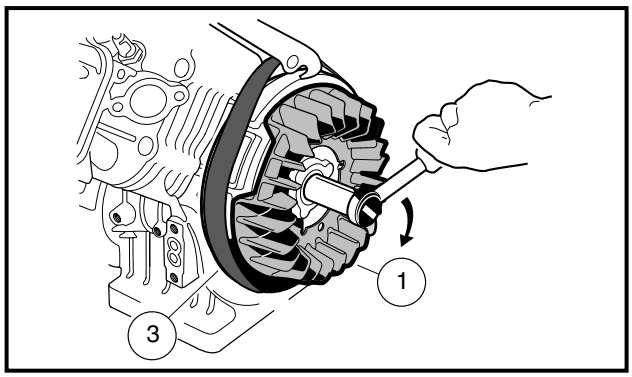


Figure 2-99 Fan and Flywheel Assembly

Engine Assembly, Continued:

4. Install ignition coil. **See Ignition Coil Installation on page 2-28.**
5. Install all remaining engine components. **See Installation Of Remaining Engine Components on page 2-19.**
6. Install a new spark plug, gap 0.027 to 0.031 inch (0.69 to 0.79 mm). Tighten to 20 ft-lb (27.1 N·m). **See following NOTE.**

NOTE: *Before installing the plug, check the condition of the threads in the cylinder head. Soften deposits in the cylinder head threads with penetrating oil and clean the threads with a tap if necessary.*

7. Connect the spark plug wire.

ENGINE INSTALLATION

See Engine Installation in the appropriate maintenance and service manual.

SERVICE SPECIFICATIONS

ITEM	SERVICE LIMIT
Breather reed valve (valve tip air gap)	0.008 in. (0.2 mm) max.
Camshaft axial play	0.0137 in. (0.35 mm)
Camshaft bearing	0.9080 in. (23.063 mm) inner diameter max.
Camshaft cam lobes (exhaust, intake)	1.287 in. (32.70 mm) outer diameter min.
Camshaft flywheel-side journal	0.9026 in. (22.927 mm) outer diameter min.
Camshaft PTO-side journal	0.9026 in. (22.927 mm) outer diameter min.
Connecting rod big-end bearing	1.4003 in. (35.567 mm) inner diameter max.
Connecting rod small-end bearing	0.7500 in. (19.051 mm) inner diameter max.
Counterbalancer rod big-end bearing	1.8554 in. (47.126 mm) inner diameter max.
Counterbalancer rod small-end bearing	0.4750 in. (12.064 mm) inner diameter max.
Counterbalancer weight bearing	1.0283 in. (26.118 mm) inner diameter max.
Crankshaft axial play	0.0137 in. (0.35 mm)
Crankcase cover camshaft bearing	0.9079 in. (23.063 mm) inner diameter max.
Crankshaft balancer – link-rod journals	1.8474 in. (46.924 mm) outer diameter min.
Crankshaft bearing	1.1841 in. (30.075 mm) inner diameter max.
Crankshaft crankpin journal	1.3954 in. (35.444 mm) outer diameter min.
Crankshaft flywheel-side journal	1.1783 in. (29.930 mm) outer diameter min.
Crankshaft PTO-side journal	1.1783 in. (29.930 mm) outer diameter min.
Cylinder bore	3.0700 to 3.0708 in. (77.980 to 78.000 mm) inner diameter standard
Cylinder bore	3.0735 in. (78.067 mm) inner diameter max.
Cylinder bore (out of round)	0.0022 in. (0.056 mm) max.
Exhaust valve stem	0.2722 in. (6.915 mm) outer diameter min.
Intake valve stem	0.2728 in. (6.930 mm) outer diameter min.
Oil pump housing	1.6050 in. (40.766 mm) inner diameter max.
Oil pump housing	0.4004 in. (10.170 mm) max.
Oil pump shaft bearing	0.5028 in. (12.770 mm) inner diameter max.
Oil pump shaft	0.4971 in. (12.627 mm) outer diameter min.
Outer rotor	1.5932 in. (40.467 mm) outer diameter min.
Outer rotor width	0.3905 in. (9.92 mm) min.
Piston oil-ring groove clearance and end gap	Visual inspection only
Piston pin	0.7470 in. (18.975 mm) outer diameter min.
Piston pin hole	0.7493 in. (19.033 mm) inner diameter max.
Piston second ring groove clearance (with new ring)	0.0055 in. (0.14 mm) max.
Piston top ring groove clearance (with new ring)	0.0063 in. (0.16 mm) max.
Push rod (rod bend)	0.012 in. (0.30 mm) max.
Relief valve spring (free length)	0.748 in. (19.0 mm) min.

ITEM	SERVICE LIMIT
Rocker arm bearing	0.4754 in. (12.074 mm) inner diameter max.
Rocker shaft	0.4704 in. (11.949 mm) outer diameter min.
Support shaft	1.0199 in. (25.907 mm) outer diameter min.
Valve clearance (exhaust, intake)	0.0047 in. (0.12 mm) standard
Valve face angle (exhaust, intake)	45° standard
Valve guide hole (intake)	0.2781 in. (7.065 mm) inner diameter max.
Valve guide hole (exhaust)	0.2781 in. (7.065 mm) inner diameter max.
Valve guide (exhaust, intake)	0.2756 to 0.2762 in. (7.00 to 7.015 mm) inner diameter standard
Valve margin (exhaust, intake)	0.024 in. (0.6 mm) max.
Valve seat angle (exhaust, intake)	45° standard
Valve seat width	0.0197 to 0.0433 in. (0.50 to 1.10 mm) standard
Valve seat width	0.075 in. (1.9 mm) max.
Valve spring (free length)	1.2894 in. (32.75 mm) min.
Valve stem (exhaust, intake) (stem bend)	0.0012 in. (0.03 mm) max.

SPECIFICATIONS FOR RESIZING CYLINDER BORE

ITEM	OVERSIZE	LIMITS
Final boring bore diameter	0.010 in. (0.25 mm) 0.020 in. (0.50 mm)	3.0791 to 3.0799 in. (78.210 to 78.230 mm) 3.0890 to 3.0898 in. (78.460 to 78.480 mm)
Final bore diameter	0.010 in. (0.25 mm) 0.020 in. (0.50 mm)	3.0799 to 3.0807 in. (78.230 to 78.250 mm) 30.0898 to 3.0906 in. (78.480 to 78.500 mm)

TORQUE SPECIFICATIONS

ITEM	SIZE	LIMITS
Cylinder head bolts	M8	220 in-lb (24 N·m)
Valve clearance adjustment nuts	M5	90 in-lb (10 N·m)
Connecting rod bolts (coat threads with engine oil)	M7	180 in-lb (20 N·m)
Flywheel retaining nut	M16	63 ft-lb (86 N·m)
Crankcase cover to block bolts	M8	250 in-lb (28.3 N·m)
Starter/Generator bracket to block bolts	M8	200 in-lb (23 N·m)
Oil drain plug	M14	20 ft-lb (27.1 N·m)
Fan housing screws	M6	90 in-lb (10 N·m)
Fan shroud screws	M6	25 in-lb (2.8 N·m)
Bolts marked with “4” (when used with nuts)	M8 M6 M5	130 in-lb (15 N·m) 50 in-lb (5.9 N·m) 30 in-lb (3.4 N·m)

ADJUSTMENTS AND SETTINGS

ITEM	LIMITS
Spark plug gap (standard)	0.027 to 0.031 in. (0.69 to 0.79 mm)
Ignition coil air gap (standard)	0.012 in. (0.304 mm)
Oil pressure (min.) at fast idle speed	45.5 psi (314 kPa)
Oil filter: bypass-valve opening pressure	11.4 to 17.0 psi (78 to 118 kPa)
Compression pressure (min.)	156 psi (1076 kPa)
Crankcase vacuum (min.) at governed speed	1.18 in. (30 mmHg)
Cylinder head-gasket surface flatness (max.)	0.002 in. (0.05 mm)
Valve clearance (exhaust, intake) when engine is cold	0.006 in. (0.15 mm)
Engine RPM	2700 (±30) RPM (DS Golf Car, Precedent, Villager 4) 2860 (±30) RPM (Turf 1, Carryall 1)

SECTION 3 – FE350 ENGINE

⚠ DANGER

- **See General Warning on page 1-1.**

⚠ WARNING

- **See General Warning on page 1-1.**

GENERAL INFORMATION

See General Warning on page 1-1.

The FE350 gasoline engine is produced for two different starting systems; pedal-start and key-start. These 4-cycle, single cylinder engines are designed for reliable heavy-duty service. These engines have two major component assemblies: The cylinder assembly and the crankcase assembly.

Servicing procedures for these two engines are identical. Except where noted, all maintenance and repair of component parts, both internal and external, are identical. When any specification or procedure differs from one engine model to another, those differences will be noted as pertaining to **pedal-start** or **key-start**. Tools used to service these engines are also identical. The FE350 engines may be provided with either the MC010C-BS00 or MC012C-AS00 transaxle. **See Transaxle Models And Identification on page 6-1.**

SPECIAL ENGINE SERVICE TOOLS AVAILABLE FROM CLUB CAR

DESCRIPTION	CCI P/N
Bearing and seal remover assembly	1016417
Bearing driver set	1016416
Compression gauge and adapter	101641002
Gear yoke	1016418
Piston ring compressor kit	1016414
Piston ring pliers	1016415
Valve clearance adjuster screw holder	1016413
Valve guide reamer	101641201
Valve guide reamer and arbor	101641202
Valve spring compressor	101641101
Valve seat cutter guide	1016552
Valve seat cutter t wrench	1016551
Valve seat cutter 30° and 45° x 35 mm diameter	1016554

RECOMMENDED REPLACEMENT PARTS FOR ENGINE TEARDOWN

DESCRIPTION	CCI P/N
Air filter	1015426
Carburetor insulator to throttle bracket gasket	101973401
Carburetor to intake manifold gasket	1016438
Drive belt	102267101
Exhaust gasket	102270101
Exhaust system (muffler)	101859401
FE350 Gasket kit (for all internal gaskets)	102304801
Ignition coil (with internal igniter)	101909201
Insulator gasket	1016440
Muffler clamp	1017689
Oil filter	1016467
Oil level sensor	1016494
Oil seal	1017503
Starter/Generator belt	101916701
Spark plug	101881101
Throttle bracket to carburetor gasket	1016441

BEFORE SERVICING

Carefully read the applicable information and instructions before beginning engine service. Diagrams, DANGER, WARNING, CAUTION and NOTE statements and detailed descriptions have been included wherever necessary. Anyone attempting engine service should have knowledge and experience in small engine service and repair.

NOTE: *Engine rotation on both engine models is clockwise as viewed from the clutch side of the engine.*

MECHANICAL SYSTEMS

Adjustments

All adjustments shall be made in accordance with Adjustment and Settings on page 3-49.

Edges

⚠ WARNING

- **Watch for sharp edges, especially during major engine disassembly and assembly. Protect your hands with gloves or a piece of thick cloth when lifting the engine or turning it over.**

Force

Common sense should dictate how much force is necessary for assembly and disassembly. If a part seems especially difficult to remove or install, stop and determine what may be causing the problem. Whenever tapping is necessary, tap lightly using a wooden or plastic-faced mallet. Use an impact driver for the removal of screws (particularly those held by a locking agent) in order to avoid damaging the heads.

Dirt

Clean the engine thoroughly before servicing it. **See following CAUTION.**

CAUTION

- **Before removal and disassembly, clean the engine. Any dirt entering the engine, carburetor, or other parts will work as an abrasive and shorten the life of the engine. Before installing a new part, clean off any dust or metal filings.**

Tightening Sequence

Where there is a tightening sequence indicated, the bolts, nuts or screws must be tightened in the order and by the method indicated. When installing a part that is secured with several bolts, nuts, or screws, hand tighten all, then tighten to specified torque in the proper sequence to avoid distortion of the part, or leakage. Conversely, when loosening the bolts, nuts or screws, loosen all about a quarter of a turn first and then remove them.

Torque

The torque values given in this manual should always be adhered to. Applying too little or too much torque may lead to serious damage.

Lubricant

Some oils and greases should only be used in certain applications and may be harmful if used in an application for which they are not intended.

Lubrication

Engine wear is generally at its maximum while the engine is warming up and before all the rubbing surfaces have adequate lubrication. During assembly, oil or grease (whichever is more suitable) should be applied to any rubbing surface.

Press

A part installed using a press or driver, such as a seal, should first be coated with oil on its outer or inner circumference (contact surface) so that it will go into place smoothly.

Oil Seal, Grease Seal

During assembly use new oil or grease seals to replace any that were removed, as removal generally damages seals. To avoid damaging the seal lips, a seal guide is required for installation. Before a shaft passes through a seal, apply a small amount of lubricant (preferably high temperature grease) to the lip to reduce rubber-to-metal friction.

Gasket, O-Ring

When in doubt as to the condition of a gasket or O-ring, replace it with a new one. To avoid leaks, the mating surface around the gasket or O-rings should be free of foreign matter and perfectly smooth.

Ball Bearing Installation

When installing a ball bearing, the bearing race, which has a press fit, should be pushed by a suitable driver. This prevents severe stress on the balls and races, and prevents damage. Press on the inner race if the ball bearing is being pressed onto a shaft, or on the outer race if the ball bearing is being pressed into a housing. Press the ball bearing until it is seated against the housing or on the shaft.

Circlip, Retaining Ring

Replace circlips and retaining rings that were removed with new circlips and retaining rings. During installation, take care to compress or expand them only enough for installation.

High Flash-point Solvent

Use a high flash-point solvent when cleaning parts. Club Car recommends Stoddard solvent (generic name), a commercial solvent commonly available in North America. Always follow manufacturer and container directions regarding the use of any solvent.

Molybdenum Disulfide (MoS_2) Grease

NOTE: *This manual makes reference to molybdenum disulfide grease in the assembly of certain engine parts. Always refer to manufacturer's recommendations printed on the container before using such special lubricants.*

Engine Rotation

When turning the crankshaft by hand, always turn it clockwise, as viewed from the clutch side of the engine. This will ensure proper adjustments.

CYLINDER COMPONENTS

CYLINDER HEAD

See General Warning on page 1-1.

GENERAL INFORMATION

Prior to attempting time-consuming repairs to the cylinder assembly, a cylinder compression test should be performed using a standard compression tester. Low compression would normally indicate a problem in the cylinder assembly such as defective rings, gaskets, etc.

- **Key-Start Engines:** These FE350 model engines are equipped with an automatic compression release valve (ACR). This valve releases compression pressure at normal cranking RPM, resulting in lower compression. At a normal cranking speed of 550 - 600 RPM, the compression should be typically 71 psi. This value could vary slightly depending on wear of components affecting compression. **See Automatic Compression Release Valve (ACR) Inspection on page 3-22.**
- **Pedal-Start Engines:** These FE350 model engines are not equipped with automatic compression release valves (ACR). At a normal cranking speed of 550 - 600 RPM, the compression should be typically 156 psi. This value could vary slightly depending on wear of components affecting compression.

CYLINDER SHROUD REMOVAL

CAUTION

- **Before removal and disassembly, clean the engine.**

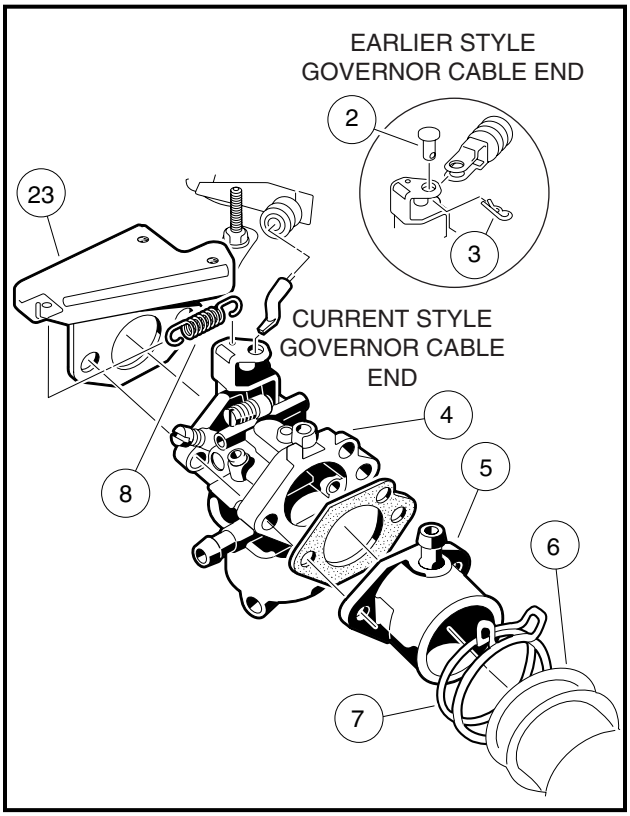


Figure 3-1 Carburetor Removal

1. **Earlier Style Governor Cable End:**

   1.1. Remove cotter pin (3) and clevis pin (2) from throttle valve lever **(Figure 3-1, Page 3-5)**.

2. **Current Style Governor Cable End:**

   2.1. Remove the 'Z' shaped cable end from the throttle valve lever **(Figure 3-1, Page 3-5)**.

3. Remove nuts at carburetor intake pipe (5) and remove intake pipe. **See following CAUTION.**

CAUTION

- **Disconnect the governor linkage from the carburetor before attempting to remove the carburetor. Failure to do so could damage the linkage.**

4. Remove carburetor (4) along with throttle spring (8) and throttle spring bracket (23) **(Figure 3-1, Page 3-5)**.

5. Remove muffler.

   5.1. Remove the muffler clamp (6) from the muffler (1) and clamp bracket (2) **(Figure 3-2, Page 3-6)**.

   5.2. Remove the hex-head cap screw (7), lock washer (8), and flat washer (9) from mounting bracket. Retain the governor cable bracket (13).

   5.3. Remove the hex nuts (10) and lock washers (11) from the manifold.

   5.4. Remove the muffler (1) from the vehicle.

Cylinder Shroud Removal, Continued:

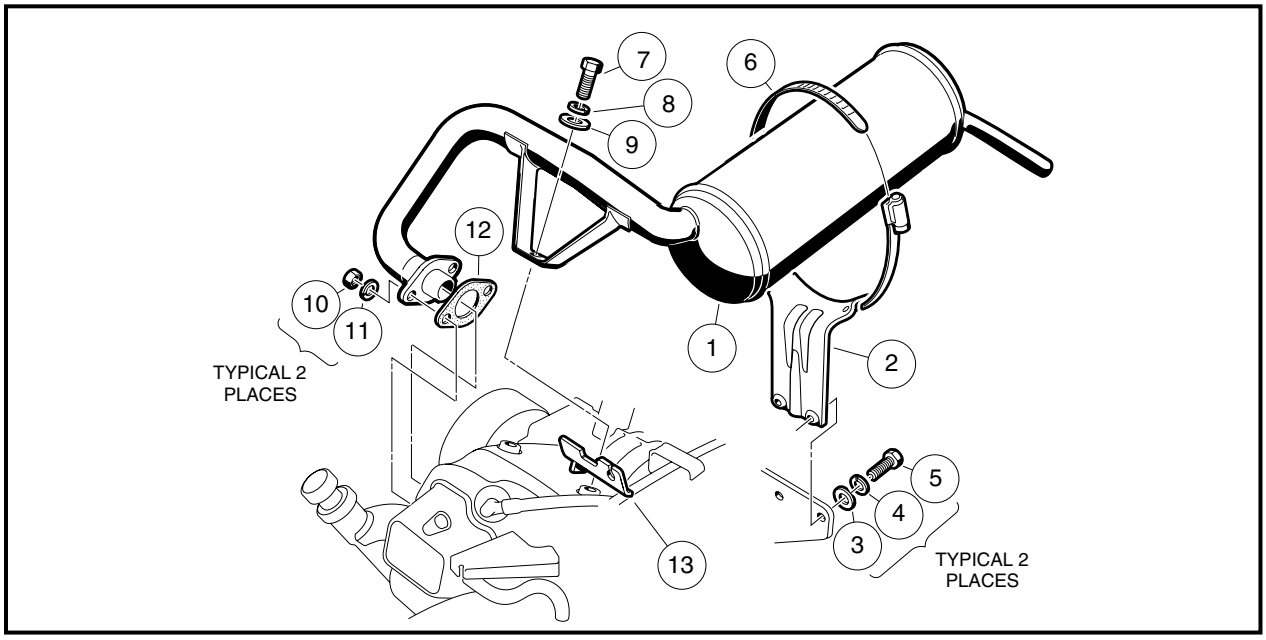


Figure 3-2 Muffler System - FE350 Engine

6. Disconnect oil filler tube (20) from cylinder shroud by first removing the locknut (18), ground wire (17) and flange nut (10) **(Figure 3-3, Page 3-6)**. **See following NOTE.**

NOTE: *If the engine is to be totally disassembled, drain oil and remove the oil filter. If only the cylinder head is to be disassembled, proceed without draining the oil or removing the oil filter.*

Make sure vehicle is level before removing filler tube. This will prevent oil from spilling when filler tube is removed.

7. Remove the nine bolts (14) and two-ended bolt (11) **(Figure 3-4, Page 3-6)**.
8. Take off the head shroud (13) **(Figure 3-4, Page 3-6)**, and the upper shroud (23) and the bracket (22) **(Figure 3-3, Page 3-6)**.

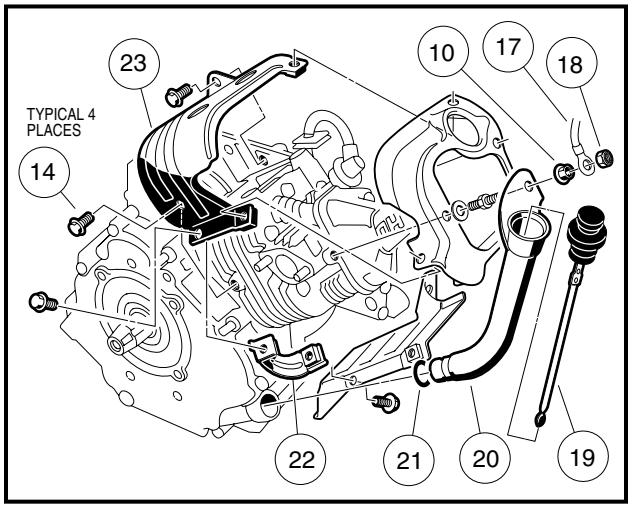


Figure 3-3 Upper Shroud & Oil Fill Tube Removal

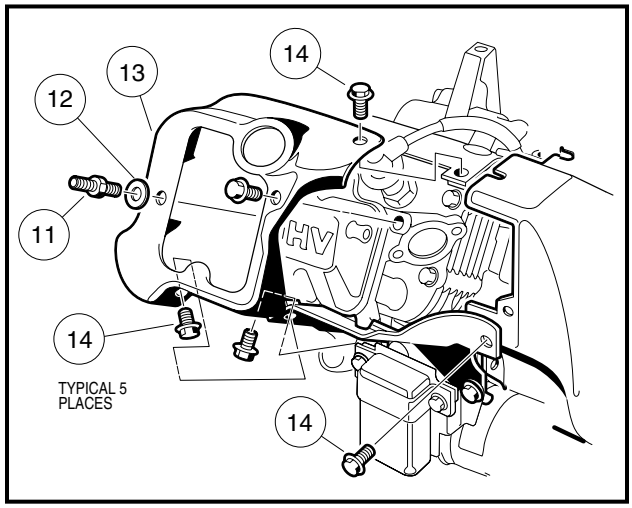


Figure 3-4 Head Shroud Removal

ROCKER ARM AND PUSH ROD REMOVAL

NOTE: *The FE350 engines are equipped with hydraulic lifters, which automatically eliminate all clearance in the valve train. Therefore, the rocker arms (3) and the push rods (5) do not need to be put back in their original positions* ***(Figure 3-6, Page 3-7)****.*

1. Remove the two bolts (1) and remove the rocker cover (2) along with the breather tube (3) **(Figure 3-5, Page 3-7)**.
2. Remove the E-ring (1) and pull the rocker shaft (2) out of the cylinder head **(Figure 3-6, Page 3-7)**.
3. Lift out the rocker arms (3), washer (4), and push rods (5).

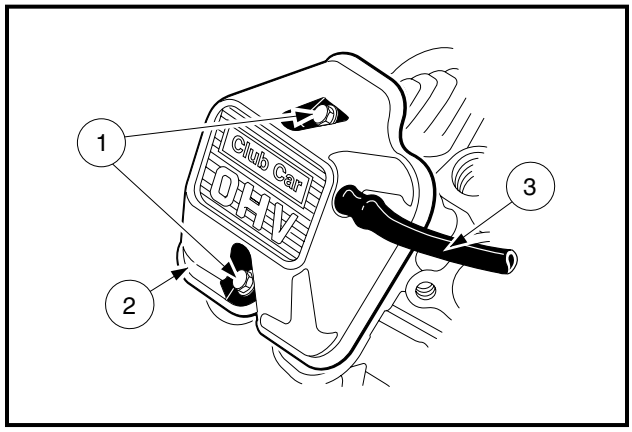


Figure 3-5 Remove Rocker Cover and Breather Tube

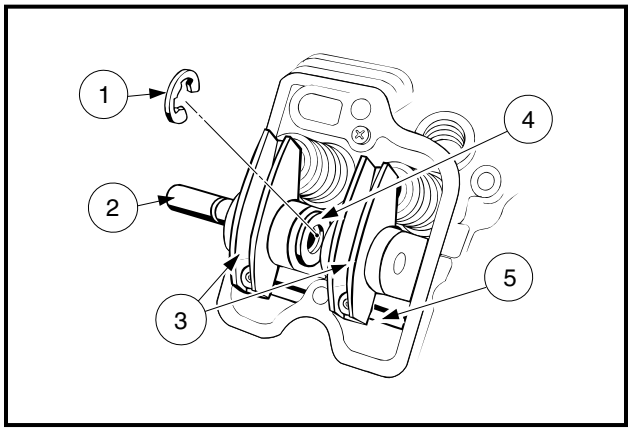


Figure 3-6 Remove Rocker Arms and Push Rods

CYLINDER HEAD REMOVAL

1. Remove the six bolts (1) and take off the cylinder head assembly (2) **(Figure 3-7, Page 3-7)**.
2. Remove head gasket (3). Note the position of the two dowels (4) as shown **(Figure 3-8, Page 3-7)**.

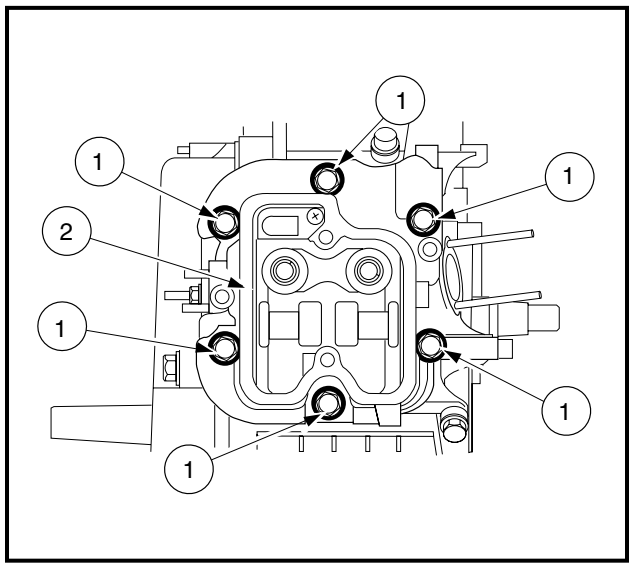


Figure 3-7 Remove Cylinder Head

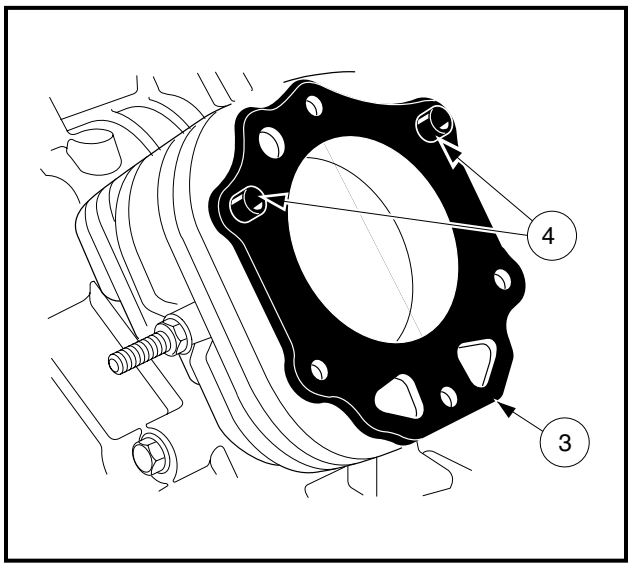


Figure 3-8 Remove Head Gasket

VALVE REMOVAL

1. Compress the valve spring using a valve spring compressor (5) (CCI P/N 101641101) and remove the collet halves (6) **(Figure 3-9, Page 3-8)**.
2. Remove spring compressor and take out the upper retainer (7) and the spring (8).
3. Remove valve (10).
4. Remove valve stem seal (11) with a screwdriver **(Figure 3-10, Page 3-8)**. **See following CAUTION.**

CAUTION

- **To keep the screwdriver from damaging the cylinder head flange surface, place a piece of heavy cardboard or wood between them (Figure 3-10, Page 3-8).**
- **The valve stem seal cannot be reused. Replace valve stem seal with a new one.**

5. Remove spring seat (9) **(Figure 3-10, Page 3-8)**.

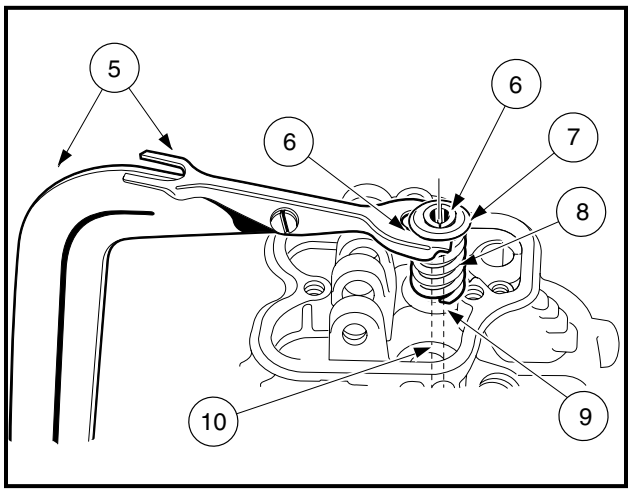


Figure 3-9 Valve Removal

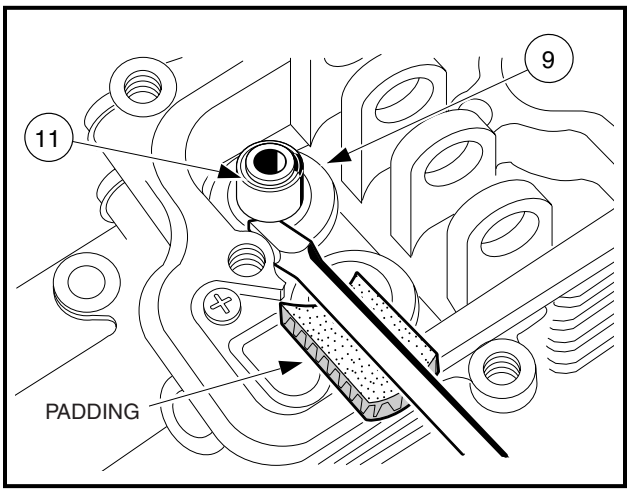


Figure 3-10 Spring Seat Removal

BREATHER VALVE (REED VALVE)

General Information

The function of the breather is to create a vacuum in the crankcase which prevents oil from being forced out of the engine through the piston rings, oil seals or gaskets.

The breather has a reed valve which limits the direction of air flow caused by the piston moving up and down. Air can flow out of the crankcase, but the one-way reed valve blocks return flow. It thus maintains a vacuum in the crankcase.

Oil laden air in the crankcase passes through the reed valve and expands into the rocker chamber. In the rocker chamber most oil separates from the air and drains back to the crankcase. The air passes through a tube and vents to the intake manifold.

Breather Valve (Reed Valve) Removal

1. Unscrew the mounting screw (1) and remove the back plate (2) and reed valve (3) **(Figure 3-11, Page 3-9)**. For installation, **see Breather Valve Installation on page 3-18**.

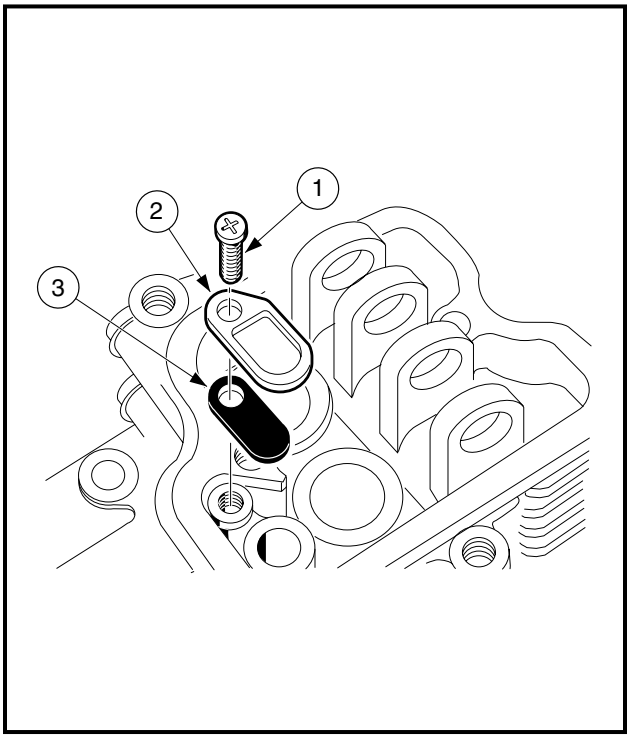


Figure 3-11 Reed Valve

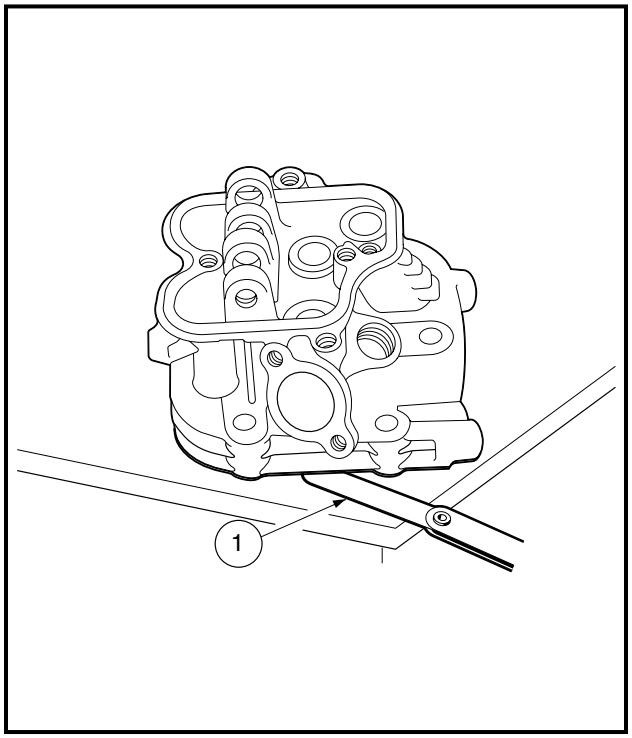


Figure 3-12 Check Flatness of Head Surface

CYLINDER HEAD CLEANING AND INSPECTION

1. Clean the head with a non-flammable solvent and dry thoroughly.
2. Bead blast or scrape carbon deposits from head. When scraping carbon deposits, be careful to avoid scratching or nicking the cylinder head.
3. Inspect the spark plug port threads for damage. If threads are damaged, replace the head.
4. Place the cylinder head on a surface plate **(Figure 3-12, Page 3-9).**
5. Measure the space between the surface plate and the head with a feeler gauge (1) to check the flatness of the head surface.
6. If the head is warped more than 0.002 inch (0.05 mm), replace the head. **See following CAUTION**.

CAUTION

- **Smooth out any damaged spots in the combustion chamber (1) using a small grinder. Sharp edges in the combustion chamber may cause pre-ignition. Do not remove any more material than is necessary or change the shape of the combustion chamber (Figure 3-13, Page 3-10).**
- **Do not grind the valve seats or the gasket surface.**

VALVE GUIDES

Valve Guide Inspection

1. Measure the inside diameter of each guide with a telescoping gauge **(Figure 3-14, Page 3-10)**.
2. If the inside diameter exceeds 0.2781 inch (7.065 mm), replace the guide.

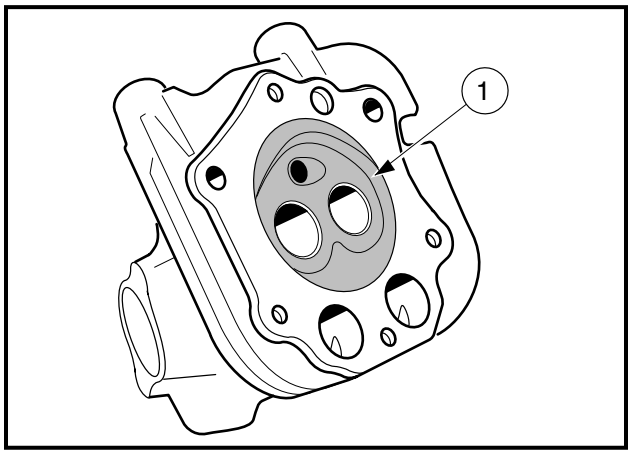


Figure 3-13 Combustion Chamber

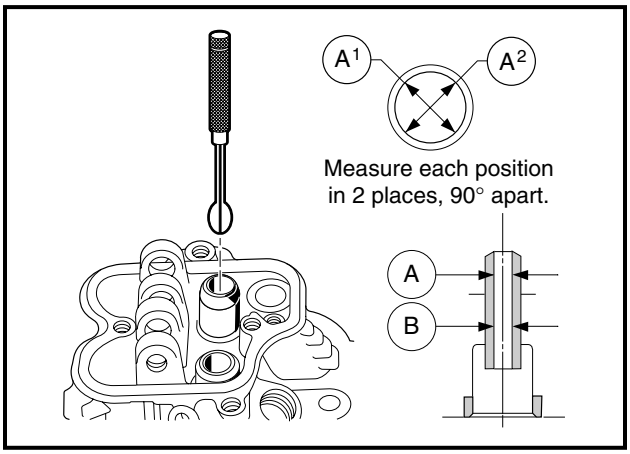


Figure 3-14 Measure I.D. of Valve Guides

Valve Guide Replacement

1. With the combustion chamber side of the head facing up, drive the guide out of the head with a valve guide arbor (1) (CCI P/N 101641202) **(Figure 3-15, Page 3-10)**.
2. Install the snap ring (2) on the new valve guide **(Figure 3-16, Page 3-10)**.
3. Coat the guide with a light film of clean engine oil.
4. With the rocker arm side of the head facing up, drive the new valve guide into the head with the valve guide arbor (3) until the snap ring (2) just seats on the head.
5. Ream the guide with a stanisol or kerosene lubricant and a valve guide reamer (CCI P/N 101641201). The valve guide inside diameter should be 0.2756 - 0.2762 inch (7.000 - 7.015 mm) **(Figure 3-17, Page 3-11)**.

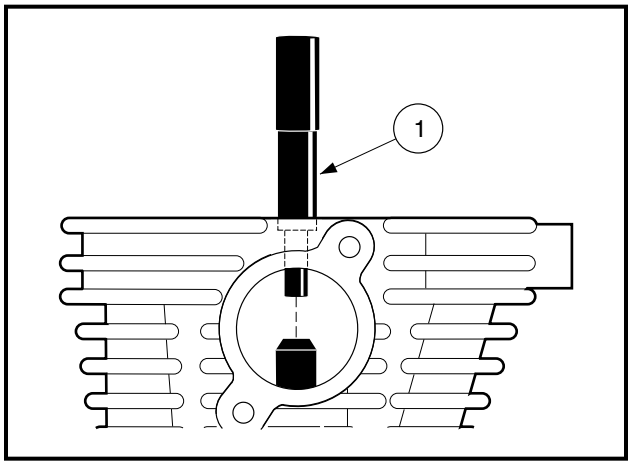


Figure 3-15 Valve Guide Removal

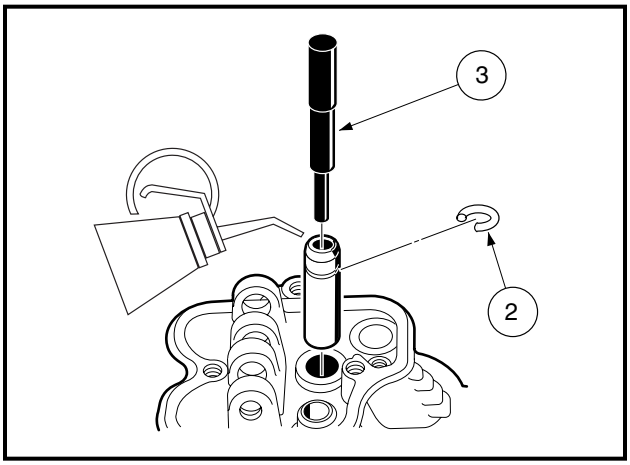


Figure 3-16 Valve Guide Installation

VALVE SEATS

Valve Seat Inspection

1. Inspect the valve seats for damage. If the seats are warped or distorted beyond reconditioning, replace the cylinder head.
2. Use prussian blue metal die to coat the valve seat.
3. Push the valve into the guide.
4. Rotate the valve against the seat with a lapping tool (1) **(Figure 3-18, Page 3-11)**.

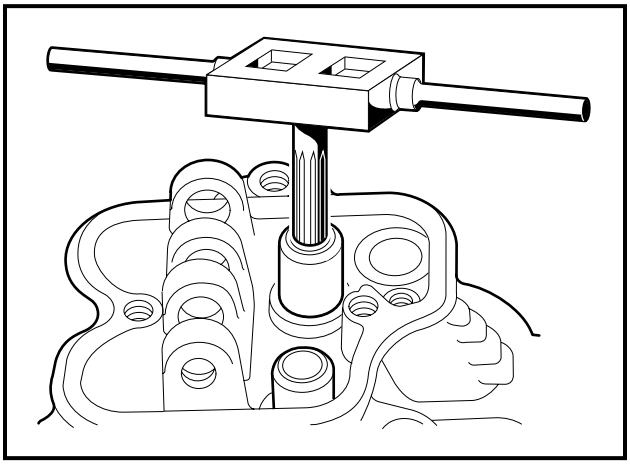


Figure 3-17 Ream Valve Guide

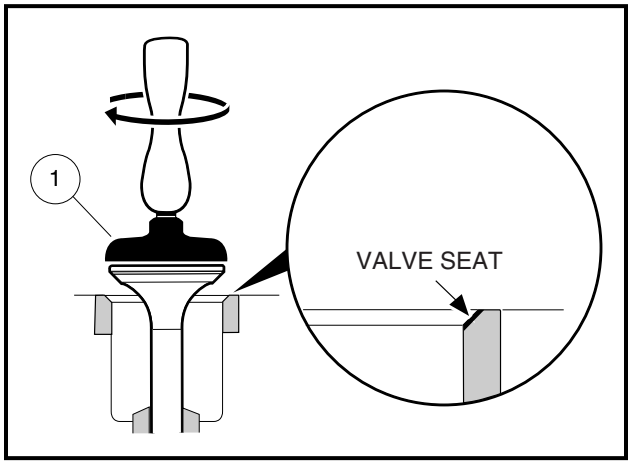


Figure 3-18 Rotate Valve Against Valve Seat

5. Pull the valve out and check the mark on the valve head. It must be 0.0197 - 0.0433 inch (0.50 - 1.10 mm) in width and even all the way around the seat and valve **(Figure 3-18, Page 3-11)**.

NOTE: *The valve stem and guide must be in good condition or step 5 will not be valid.*

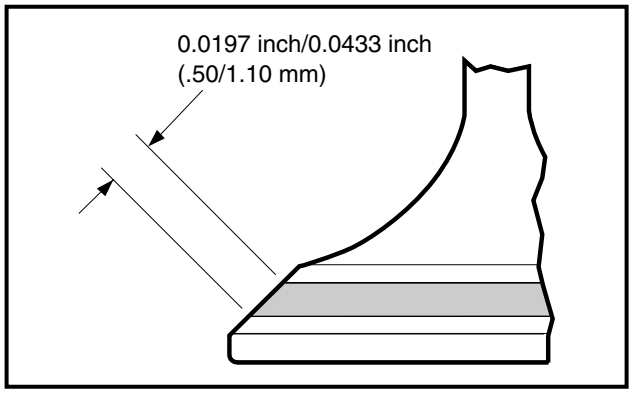


Figure 3-19 Check Mark on Valve Head

6. If the valve seating surface is not correct, repair the seat.
7. Pitted or worn valve seats can be resurfaced. Make sure to lap the valves to the seats after refacing. **See Valve Seat Repair on page 3-12.**

Valve Seat Repair

CAUTION

- **If you are unfamiliar with the following procedures, Club Car suggests that the cylinder head be taken to a professional engine machine shop for reconditioning.**

1. Clean the cylinder head thoroughly. **See Cylinder Head Cleaning and Inspection on page 3-9.**
2. Recondition the valve seats with a valve seat cutter (1) (45° x 35 mm exhaust seat, 30° x 35 mm intake seat CC P/N 1016554) and lap the valves **(Figure 3-21, Page 3-12)**.
   2.1. Use prussian blue metal die to check the seats for good contact all the way around. **See Valve Seat Inspection on page 3-11.**
   2.2. Measure the seat width of the 45° angle portion of the seat at several places around the seat **(Figure 3-20, Page 3-12)**.
   2.3. If the seat width is more than 0.079 inch (2.0 mm), the seating surface should be resurfaced.
   2.4. Resurface the valve seats with a 45° (exhaust seat) or a 30° (intake seat) cutter (1) removing only enough material to produce a smooth and concentric seat **(Figure 3-21, Page 3-12)**. **See following CAUTION.**

CAUTION

- **Use care not to dull the cutter. Do not turn the cutter counterclockwise or allow it to hit a metal object.**

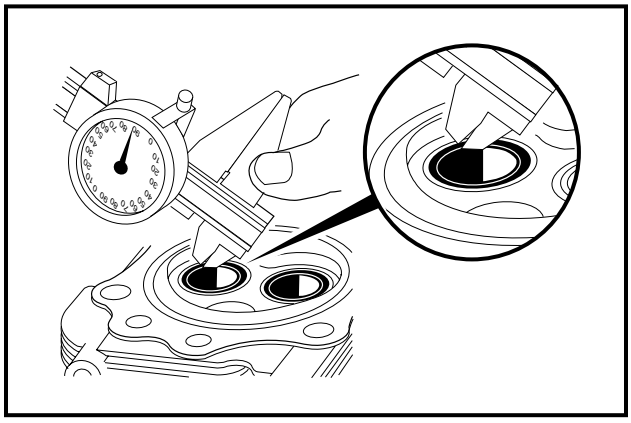


Figure 3-20 Measuring Valve Seats

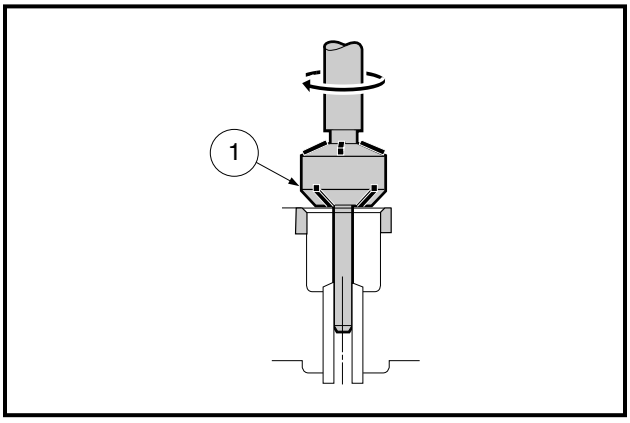


Figure 3-21 Resurfacing Valve Seat

   2.5. Use a 60° x 35 mm seat cutter (1) to narrow the seat to standard width **(Figure 3-21, Page 3-12)**. **See following CAUTION.**

CAUTION

- **The 60° seat cutter removes material very quickly. Check the seat outside diameter frequently to prevent over-cutting.**

   2.6. Turn the seat cutter (1) clockwise one turn at a time while pressing down very lightly. Check the width after each cutter revolution. **See following CAUTION and NOTE.**

NOTE: *Keep the seat width as close as possible to 0.031 inch (0.8 mm).*

   2.7. Make a light pass with the 45° cutter to remove any possible burrs at the edge of the seat.

3. Apply a coat of prussian blue metal die to the valve face, insert the valve, and snap it closed against the seat several times. The valve surface should show good contact all the way around. Be sure the valve seat is centered on the valve face. The position of the valve in the seat is evident after lapping the valve.
4. If the seat does not make proper contact, lap the valve into the seat with a vacuum cup tool.
   4.1. Coat the surface of the valve sparingly with a fine lapping compound.
   4.2. Use the vacuum cup lapping tool (1) to grip the top of the valve. Rotate the valve in a circular motion to lap the valve to the seat **(Figure 3-22, Page 3-13)**.
   4.3. Lift the valve slightly from the seat every 8 to 10 strokes, continuing the lapping operation until a uniform ring appears around the entire surface of the valve face.
5. When lapping is completed, wash all parts in solvent to remove lapping compound. Dry the parts thoroughly.
6. Note the position of the lapping mark on the valve face. The lapping mark should appear on or near the center of the face.

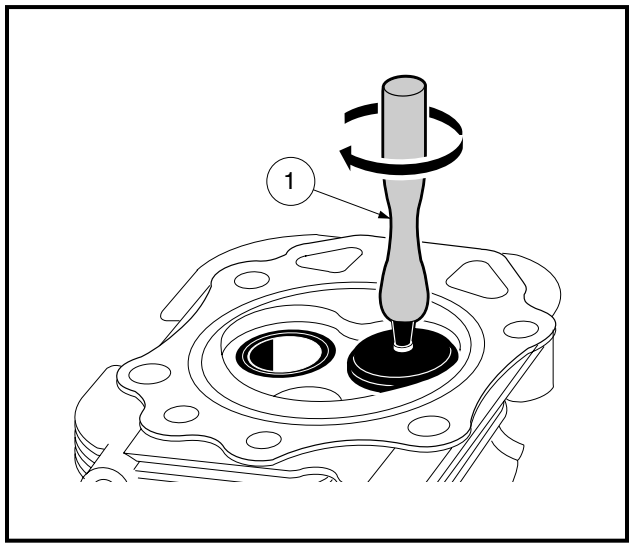


Figure 3-22 Lap Valve To Valve Seat

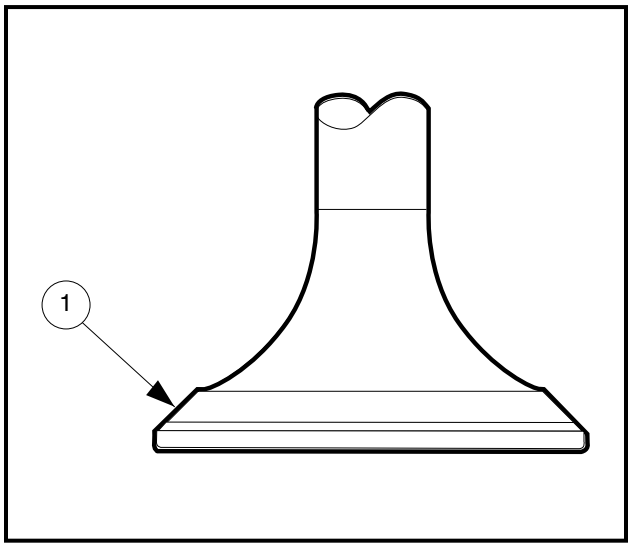


Figure 3-23 Valve Head Seating Area

VALVES

Visual Inspection

1. Inspect the valve head seating area (1) for erosion, nicks and warping, etc. **(Figure 3-23, Page 3-13)**. **See following NOTE.**

NOTE: *The valve seating surface angle is 30° (intake), 45° (exhaust)* ***(Figure 3-24, Page 3-14)****.*

2. If the valve head seating area is worn, replace the valve.
3. If the valve head seating area is eroded or nicked, it may be possible to repair the valve on a valve refacing machine. Follow the refacing machine manufacturer's instructions.
4. Inspect the stem for obvious wear, discoloration, and stem end damage.
5. If the stem is obviously worn or discolored, replace the valve.

Visual Inspection, Continued:

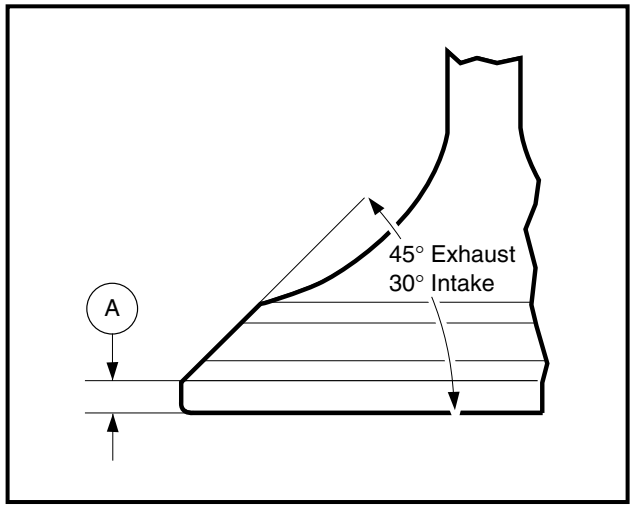


Figure 3-24 Valve Seating Surface Area

Valve Head Thickness

1. Measure the thickness of the valve head **(Figure 3-24, Page 3-14)**.
2. If the valve head thickness (A) is less than 0.024 inch (0.610 mm), replace the valve.

Valve Stem Bend

1. Support the valve in V-blocks at each end of the stem **(Figure 3-25, Page 3-14)**.
2. Position a dial gauge perpendicular to the stem.
3. Turn the valve and read the variation on the dial gauge.
4. If stem bend is greater than the service limit of 0.0012 inch (0.0305 mm), replace the valve.

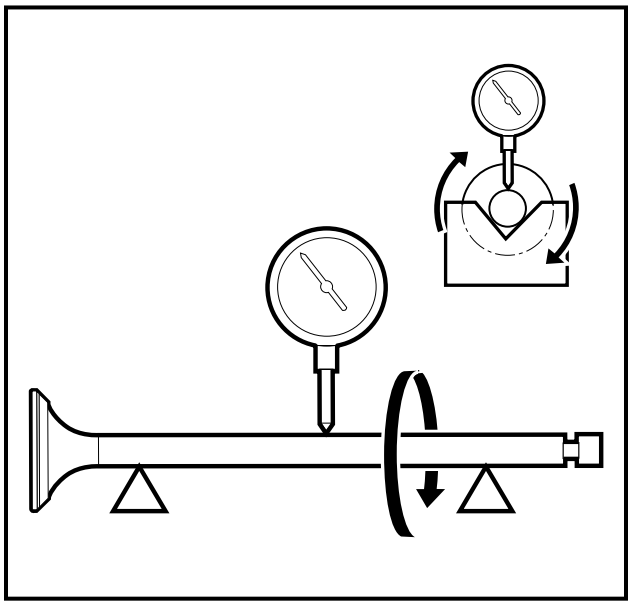


Figure 3-25 Measure Valve Stem Bend

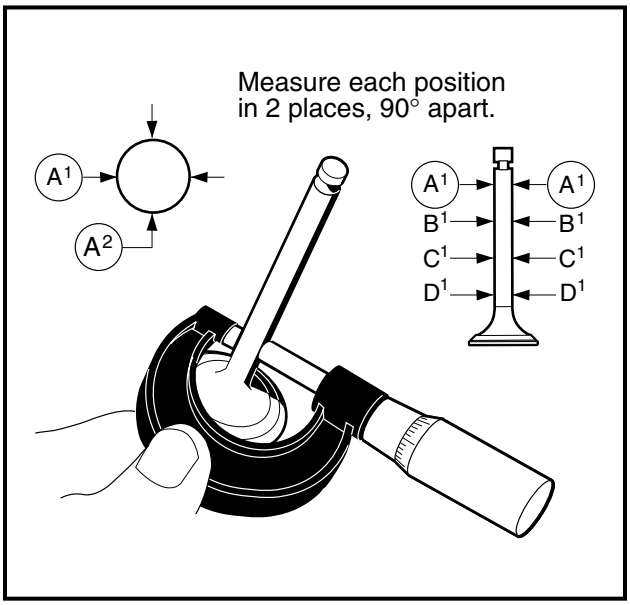


Figure 3-26 Measure Valve Stem Diameter

Valve Stem Diameter

1. Use a micrometer to measure the diameter of the stem at several points along its length **(Figure 3-26, Page 3-14)**.
2. If the outside diameter is less than the service limit of 0.2728 inch (6.930 mm) intake; 0.2722 inch (6.915 mm) exhaust, replace the valve.

Valve Spring Inspection

1. Inspect the valve springs for pitting, cracks, corrosion and burrs. Replace the springs if necessary **(Figure 3-27, Page 3-15)**.
2. Measure the free length of the spring. If the measurement is less than the service limit of 1.51 inch (38.50 mm), replace the spring.

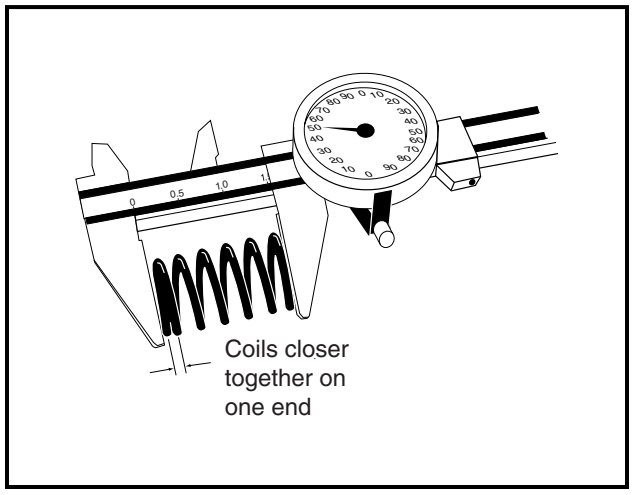


Figure 3-27 Measure Valve Spring Length

Valve Installation

1. Valve installation is the reverse of removal. **See Valve Removal on page 3-8. See following NOTE.**

NOTE: *Valve spring coils are closer together (have a narrower pitch) at one end of the spring than at the other. Install springs with the narrow pitch ends down on the spring seats* ***(Figure 3-27, Page 3-15)****.*

ROCKER ARM AND ROCKER SHAFT INSPECTION

1. Use a dial bore or telescoping gauge to measure the inside diameter of each rocker arm bearing at several points along its length **(Figure 3-28, Page 3-16)**.
2. If the inside diameter is more than the service limit of 0.4803 inch (12.20 mm), replace the rocker arm.
3. Use a micrometer to measure the outside diameter of the rocker shaft at several points along its length **(Figure 3-29, Page 3-16)**.
4. If the outside diameter is less than the service limit of 0.4704 inch (11.949 mm), replace the shaft.

Rocker Arm and Rocker Shaft inspection, Continued:

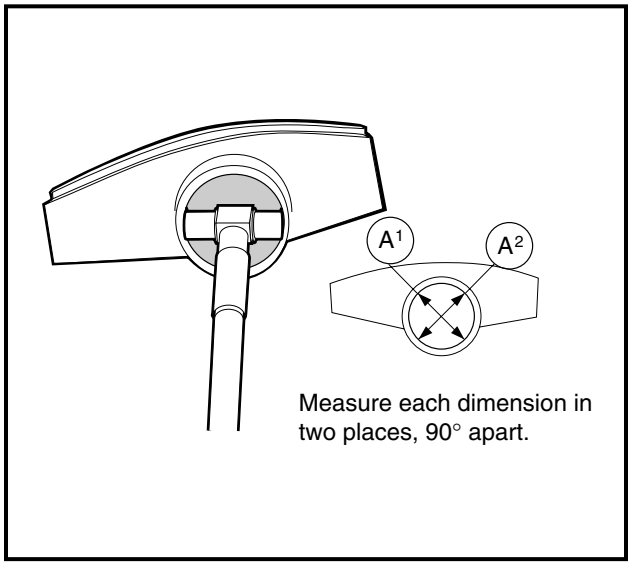


Figure 3-28 Measure I.D. of Rocker Arm Bearing

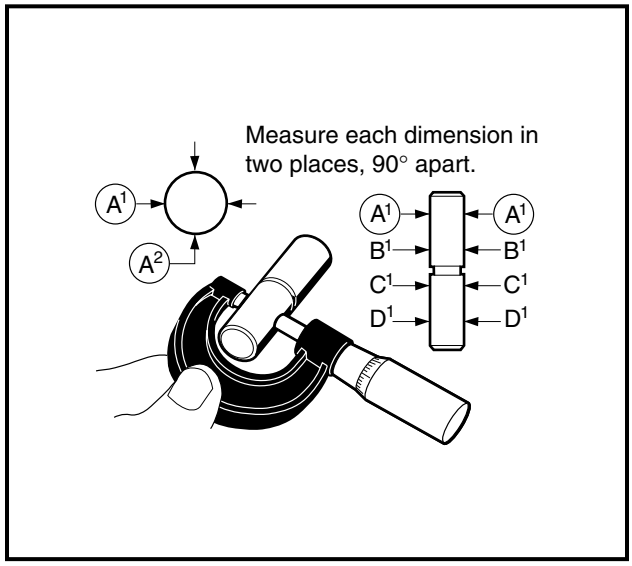


Figure 3-29 Measure O.D. of Rocker Shaft

PUSH ROD INSPECTION

1. Support the rod in V blocks at each end of the rod. Position a dial gauge perpendicular to the rod **(Figure 3-30, Page 3-16)**.
2. Turn the rod slowly and read the variation on the gauge.
3. If the push rod is bent more than 0.019 inch (0.5 mm), replace the push rod.

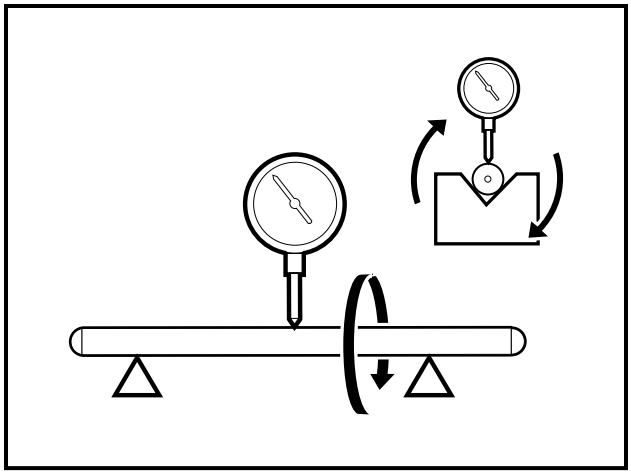


Figure 3-30 Measure Push Rod Bend

CYLINDER HEAD INSTALLATION

See General Warning on page 1-1.

1. Installation is the reverse of removal. **See Cylinder Shroud Removal on page 3-4.**
2. Insert the rocker shaft (2) through the head posts and rocker arm (3) and washer (4) **(Figure 3-31, Page 3-17)**.

3. Slide the washer (4) against the exhaust rocker and fit the E-ring (1) into the groove in the rocker shaft (2).
4. Install push rods into engine. Be sure they are properly seated in lifters.
5. Install cylinder head assembly to engine. Be sure push rods are properly seated in rockers.
6. Tighten the bolts down evenly by hand.
7. Use a torque wrench to tighten the six bolts in the sequence shown **(Figure 3-32, Page 3-17)**.
8. Increase the torque in four increments of 50 in-lb (6 N·m) and then tighten to final torque of 220 in-lb (25 N·m). **See following CAUTION**.

CAUTION

- **Do not turn any one bolt down completely before tightening the others. Doing so may cause the cylinder head to warp.**

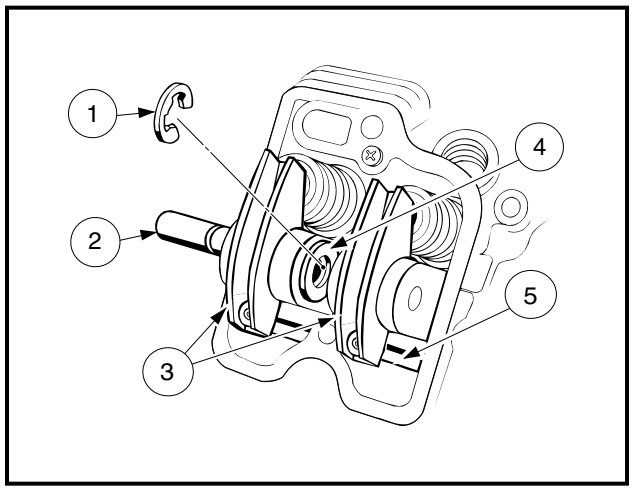


Figure 3-31 Rocker Arm Assembly

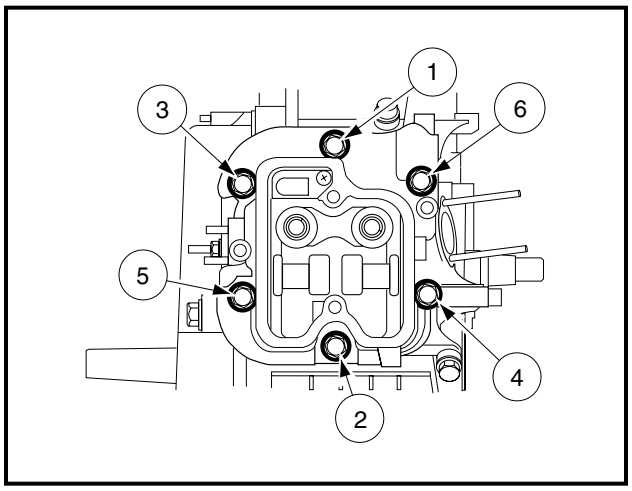


Figure 3-32 Bolt Torque Sequence

VALVE CLEARANCE CHECK AND ADJUSTMENT

No clearance check and no clearance adjustments are required. The FE350 engines are equipped with hydraulic lifters that automatically eliminate all clearance in the valve train components.

BREATHER VALVE (REED VALVE)

General Information

The function of the breather is to create a vacuum in the crankcase that prevents oil from being forced out of the engine through the piston rings, oil seals or gaskets.

The breather has a reed valve which limits the direction of air flow caused by the piston moving up and down. Air can flow out of the crankcase, but the one-way reed valve blocks return flow. It thus maintains a vacuum in the crankcase.

Oil laden air in the crankcase passes through the reed valve and expands into the rocker chamber. In the rocker chamber most oil separates from the air and drains back to the crankcase. The air passes through a tube and vents to the intake manifold.

Breather Valve Inspection

1. Inspect the reed valve (1) for sticking or binding. Replace if necessary **(Figure 3-33, Page 3-18)**.
2. Inspect the reed valve for hairline cracks, distortion or breakage. Replace if necessary.
3. Inspect the reed valve (1) seating surface. It must not have any nicks or burrs.

Breather Valve Installation

1. Installation is the reverse of removal. **See Breather Valve (Reed Valve) Removal on page 3-9.**

NOTE: *Place the reed valve on the seat so there is a slight gap of (2) 0.008 inch (0.203 mm) maximum between the valve and the seat* ***(Figure 3-33, Page 3-18)****.*

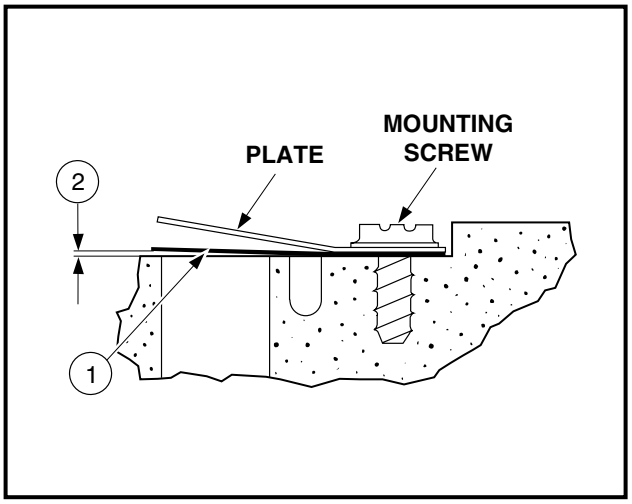


Figure 3-33 Reed Valve

INSTALLATION OF REMAINING ENGINE COMPONENTS

NOTE: *If the crankcase is to be disassembled, do not complete this procedure but go to* ***Crankcase Components on page 3-20*** *and follow all proceedures shown.*

1. Install rocker cover.
2. Install lower, upper, and head shrouds (1) along with two-ended bolt (2) **(Figure 3-34, Page 3-19)**.

NOTE: *The shorter end of the two-ended bolt (2) goes through washer and upper shroud.*

3. Install oil filler tube (6) and O-ring (7) into the large hole in the crankcase cover. Install the upper end of the oil filler tube (6) onto the two-ended bolt (2). Install flange nut (8) and tighten to 50 in-lb (5.7 N·m).

NOTE: *Check O-ring for damage and replace if necessary.*

To prevent leaks, apply a light coat of clean engine oil to the O-ring seal (7) before installation. Care should be taken during installation to avoid cutting or nicking the o-ring seal.

4. Connect the ground wire (3) to the two-ended bolt and install and tighten the nylon locknut (4) to 50 in-lb (5.6 N·m). Insert the dip stick (5) **(Figure 3-34, Page 3-19)**.

5. Install muffler **(Figure 3-2, Page 3-6)**.

NOTE: *Any time the muffler is removed from the vehicle, install a new muffler clamp (6) (CCI P/N 1017689) and muffler gasket (12).*

5.1. Loosely attach muffler (1) to muffler mounting bracket (2) with clamp (6).
5.2. Place a new gasket (12) on the exhaust manifold mounting flange.
5.3. Attach muffler manifold with lock washers (11) and hex nuts (10) and tighten finger-tight.
5.4. Loosely attach muffler bracket (1) and governor cable bracket (13) to engine block using hex-head cap screw (7), lock washer (8) and flat washer (9).
5.5. Tighten manifold hex nuts (10) to 11 ft-lb (14.9 N·m).
5.6. Tighten hex-head cap screw (7) to 14 ft-lb (18.9 N·m).
5.7. Tighten muffler clamp (6) to 40 in-lb (4.5 N·m).

6. Install carburetor (4), throttle spring (8) and the throttle spring bracket (23). Tighten to 50 in-lb (5.6 N·m) **(Figure 3-35, Page 3-19)**.
7. Install spark plug and thread it in until finger tight. Tighten the plug to 20 ft-lb (27 N·m). **See following NOTE.**

NOTE: *Before installing the plug, check the condition of the threads in the cylinder head. Soften deposits in cylinder head threads with penetrating oil and clean the threads with a tap if necessary.*

8. **Earlier Style Governor Cable End:**
   8.1. Install governor cable clevis pin (9) through cable clevis and throttle valve lever and install a new cotter pin (10) **(Figure 3-35, Page 3-19)**.
9. **Current Style Governor Cable End:**
   9.1. Install 'Z' shaped cable end into carburetor throttle valve lever **(Figure 3-35, Page 3-19)**.
10. Apply a light film of clean engine oil onto the seal of the new oil filter and install the filter. Tighten the filter 2/3 turn after gasket contact. Fill crankcase with the correct level of oil.

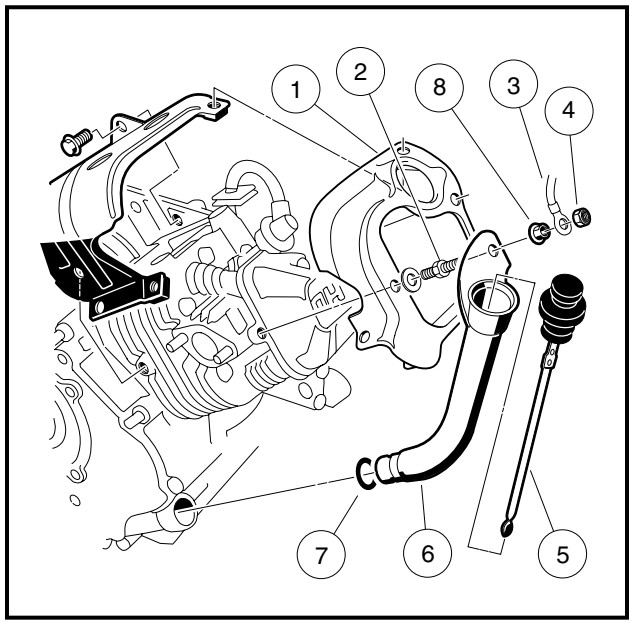


Figure 3-34 Oil Filler Tube and Ground Wire

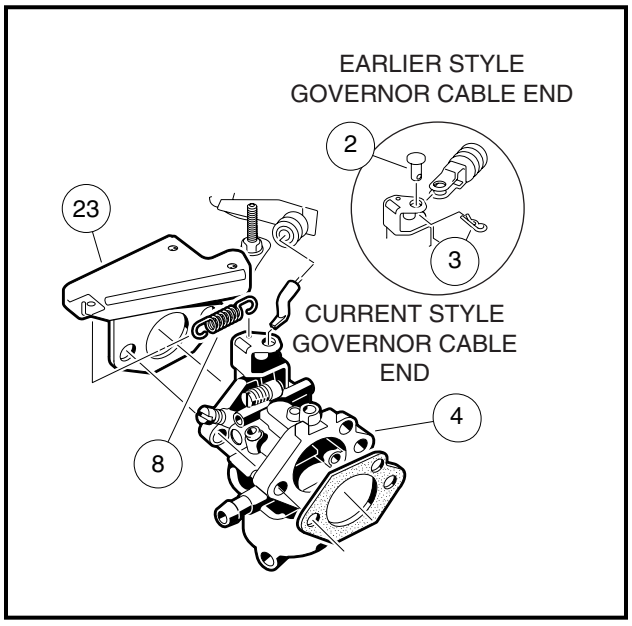


Figure 3-35 Governor Cable Connection

CRANKCASE COMPONENTS

See General Warning on page 1-1.

If the crankcase needs to be disassembled, the following procedures will apply.

1. Remove items associated with the cylinder assembly. **See Cylinder Shroud Removal on page 3-4.**
2. Remove crankcase oil drain plug. Tip the engine slightly to allow all of the oil to drain from the crankcase. Dispose of engine oil properly.

CRANKCASE COVER REMOVAL

1. Remove yellow jumper wire (11) from cord connector (12) **(Figure 3-36, Page 3-20)**.
2. Remove nuts and clamps at two-ended bolts (1 and 2) **(Figure 3-37, Page 3-20)**
3. Remove eight bolts (3) and remove the crankcase cover (4) **(Figure 3-37, Page 3-20)**. **See following NOTE.**

NOTE: *If the crankcase cover sticks, tap lightly with a plastic mallet on alternate sides near the dowel pins (5).*

4. Remove the crankcase cover gasket completely.

Oil Level Sensor Removal

NOTE: *It is recommended that the oil level sensor be replaced with a new one.*

1. Disconnect the oil level sensor wire (2) from the cord connector (1) **(Figure 3-38, Page 3-21)**.
2. Remove screw (3) from the wire clamp (4).
3. Remove the two mounting screws (8) from inside of the crankcase cover and remove the oil level sensor and bracket.
4. Remove the three screws (7) holding the sensor (6).

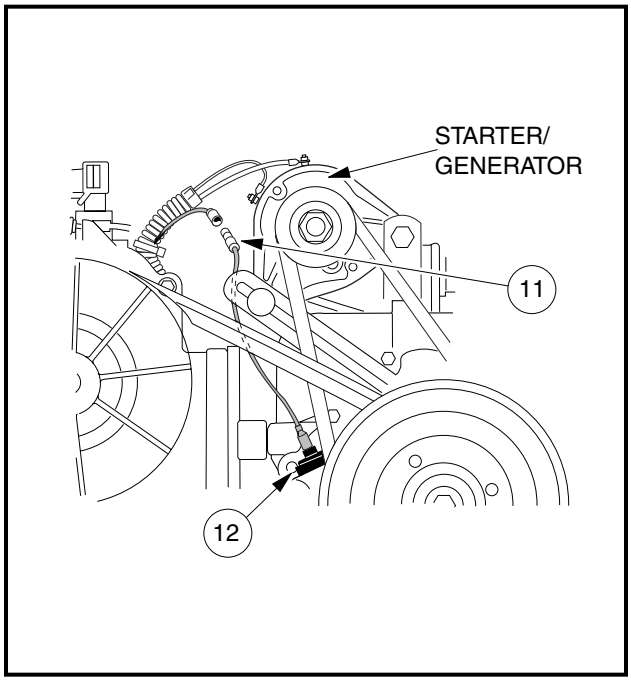


Figure 3-36 Oil Level Sensor Wire

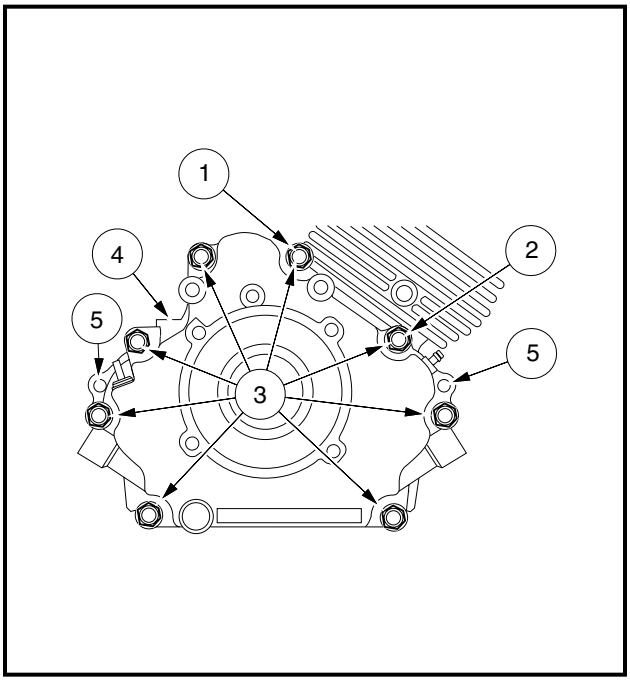


Figure 3-37 Crankcase Cover

Oil Level Sensor Installation

1. Install a new sensor (6) into bracket (5) and secure with three screws (7) and tighten to 17 in-lb (1.9 N·m) **(Figure 3-38, Page 3-21)**.
2. Position the sensor and bracket on inside of crankcase and install two mounting screws (8).
3. Connect sensor wire (2) to cord connector (1).
4. Install screw (3) through wire clamp and into crankcase cover. Tighten to 30 in-lb (3.4 N·m).

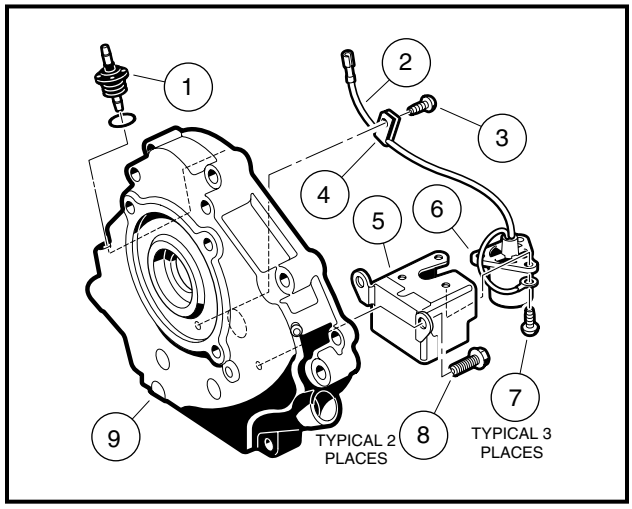


Figure 3-38 Oil Level Sensor

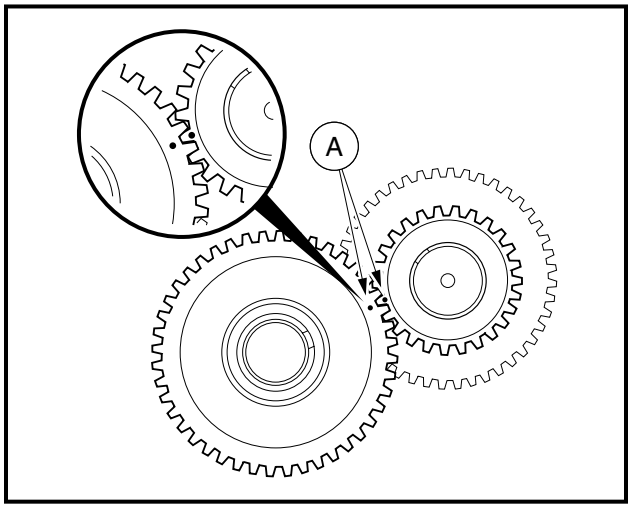


Figure 3-39 Timing Mark Alignment

CAMSHAFT AND HYDRAULIC LIFTERS

Camshaft and Hydraulic Lifter Inspection

If the engine typically has remained noisy for two minutes after starting, the hydraulic lifters might be worn between the plunger (2) and the body (3). Proceed with the following to check the hydraulic lifter for wear **(Figure 3-40, Page 3-21)**.

1. Put the hydraulic lifter vertically on a measuring stand to measure leak-down distance.
2. Push the socket (1) down and measure the distance that it sinks **(Figure 3-40, Page 3-21)**.
3. If the distance exceeds 0.0197 inch (0.5 mm), replace both hydraulic lifters as a set.

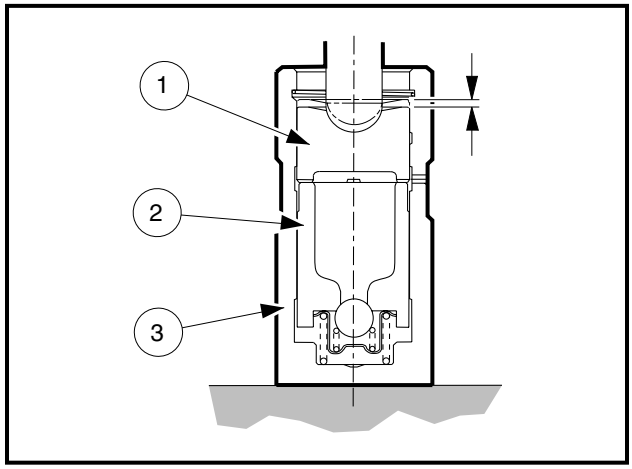


Figure 3-40 Inspect for Hydraulic Lifter Wear

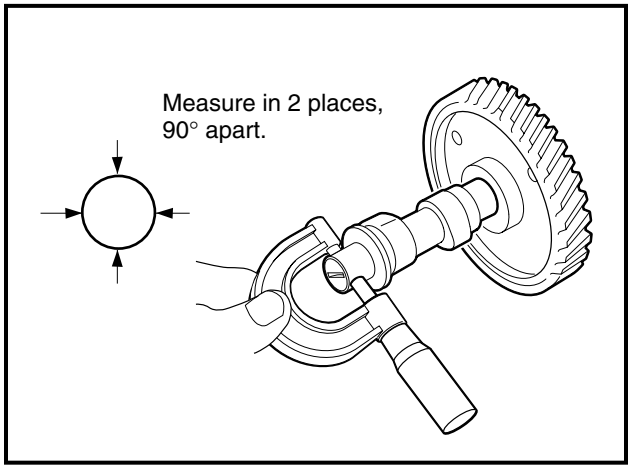


Figure 3-41 Measure O.D. of Camshaft Journals

Camshaft and Hydraulic Lifter Inspection, Continued:

4. Inspect the camshaft for wear or broken gear teeth.
5. Measure the camshaft journals and cam lobes with a micrometer at the points shown **(Figure 3-41, Page 3-21 and Figure 3-42, Page 3-23)**.
6. If the camshaft journal diameter is less than 0.9026 inch (22.927 mm) at either end of the shaft, replace the camshaft.
7. If the lobe height is less than 1.3086 inches (33.24 mm) for either lobe, replace the camshaft.
8. **Key-Start Engines:**

   8.1. Check the automatic compression release valve (ACR) arms to make sure they move freely and are not binding. Clean the arms if needed. Make sure the take-up spring is properly installed. Replace the spring if it is broken. If the arms are damaged, the camshaft assembly must be replaced.

Camshaft and Hydraulic Lifter Removal

1. Keep the timing marks (A) aligned during removal **(Figure 3-39, Page 3-21)**.
2. With cylinder head removed, pull the hydraulic lifters out of their bores to the top of the cylinder. **See Rocker Arm and Push Rod Removal on page 3-7. See following CAUTION.**

CAUTION

- **Do not press the socket (1) (Figure 3-40, Page 3-21). This will cause the engine oil to leak out of the high pressure chamber during storage. Keep the hydraulic lifters upright to prevent the engine oil from spilling out of the lifters during storage.**
- **Do not attempt to disassemble a hydraulic lifter because the engine oil will drain out of the high pressure chamber in the lifter.**

3. Take the camshaft out of the engine block.

Automatic Compression Release Valve (ACR) Inspection

Pedal-Start Engines: FE350 engines on pedal-start vehicles do not have automatic compression release valves (ACR).

Key-Start Engines: FE350 key-start engines have an automatic compression release valve (ACR) that is activated during the starting procedure **(Figure 3-43, Page 3-23)**. As the engine is cranked at a normal 550 to 600 RPM, the ACR opens and reduces compression in the cylinder, allowing the starter to turn the engine with a minimal amount of starter energy and helping to reduce starter/generator brush wear. A tapping noise will be heard while the ACR is in an open condition. It is normal for the ACR to click, or tap, during normal cranking RPM. When the engine starts and accelerates to 700 RPM, the ACR will close, the tapping noise will stop, and full compression will be reached. After the engine starts, it will idle at 1150 to 1200 RPM.

If the ACR fails to hold the valve open during the cranking function, the engine will have too much compression and may not turn over when the starter is activated. If, after the engine starts and reaches 700 RPM, the ACR fails to allow the exhaust valve to close, the engine will not reach required running compression and will not have complete acceleration power. The return spring on the ACR is the only serviceable part. The ACR is a component part of the camshaft assembly and if the ACR fails, the camshaft assembly must be replaced.

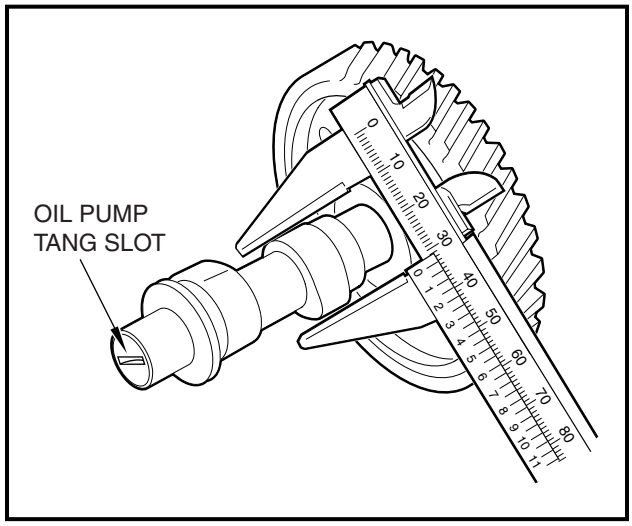


Figure 3-42 Measure O.D. of Camlobes

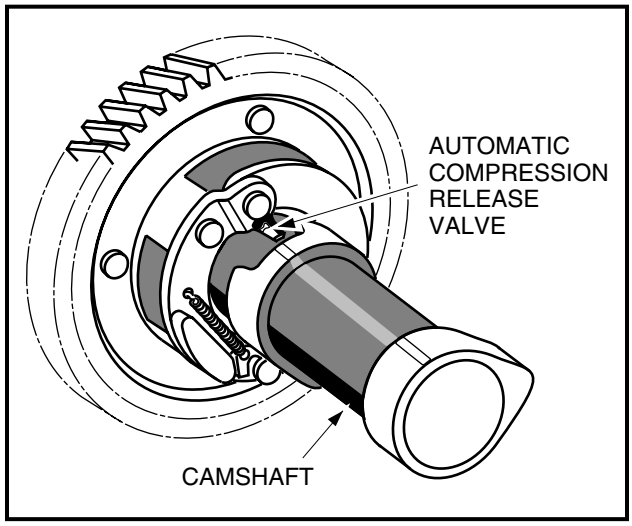


Figure 3-43 ACR Valve Inspection

Camshaft and Hydraulic Lifter Installation

CAUTION

- **When installing the camshaft, make sure that the tang (1) on the oil pump rotor seats in the slot (2) in end of the camshaft (Figure 3-42, Page 3-23 or Figure 3-94, Page 3-43). If the oil pump tang is not seated in the slot in the camshaft, serious engine damage will result.**

1. Installation is the reverse of removal. **See Camshaft and Hydraulic Lifter Removal on page 3-22.**
2. Apply a light film of engine oil to the camshaft journals and cam lobes.
3. Align the timing marks (3) **(Figure 3-39, Page 3-21)**. **See following NOTE.**

NOTE: *If the outside edges of the camshaft and crankshaft gears are not flush, and the crankcase cover will not easily make full contact with the crankcase, make sure the tang on the oil pump rotor is seated in the camshaft slot.*

PISTON AND CONNECTING ROD

See General Warning on page 1-1.

NOTE: *The connecting rod and cap must stay together as a set. Do not mix parts from any other engine.*

Piston and Connecting Rod Removal

1. Turn crankshaft to expose the two connecting rod cap bolts (1) **(Figure 3-44, Page 3-24)**.
2. Loosen the cap bolts and take them out together with the connecting rod cap (2).
3. Push the piston/connecting rod assembly out of the cylinder.

Piston and Connecting Rod Separation

1. Remove the two retaining rings holding the piston pin in place.
2. Remove the piston pin.

Piston Inspection and Repair

1. Remove all deposits from the piston.
2. Clean the carbon from the piston ring grooves. **See following CAUTION**.

CAUTION

- **Never clean the piston head with the engine assembled. Carbon particles will fall between the piston and cylinder wall and may cause severe cylinder wear.**

3. Be sure the oil return passages in the ring grooves are open.
4. Visually inspect the piston rings and ring grooves for uneven wear or damage. Replace the piston and/or piston rings if uneven wear or damage is present or if they exceed the wear limits.
5. Use a new piston ring and feeler gauge to measure the clearance between the grooves and ring at several points around the grooves **(Figure 3-45, Page 3-24)**.
6. If the top groove has a clearance greater than 0.0063 inch (0.16 mm), replace the piston.
7. If the second groove has a clearance greater than 0.0055 inch (0.14 mm), replace the piston.
8. The oil ring is made of three pieces: upper and lower rails and expander. It is difficult to measure the ring groove clearance and thickness. Inspect visually for wear or damage.

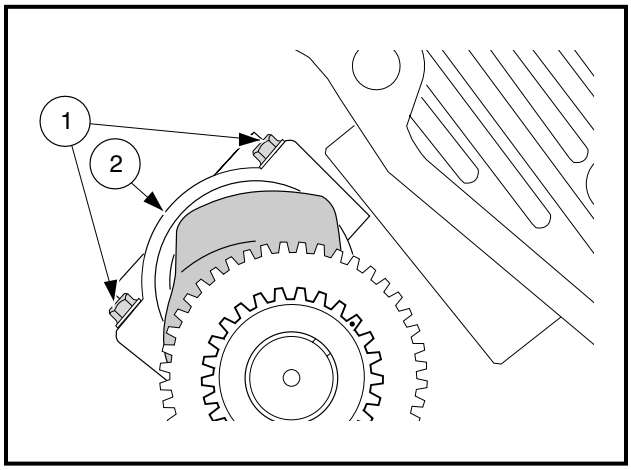


Figure 3-44 Connecting Rod Cap Bolts

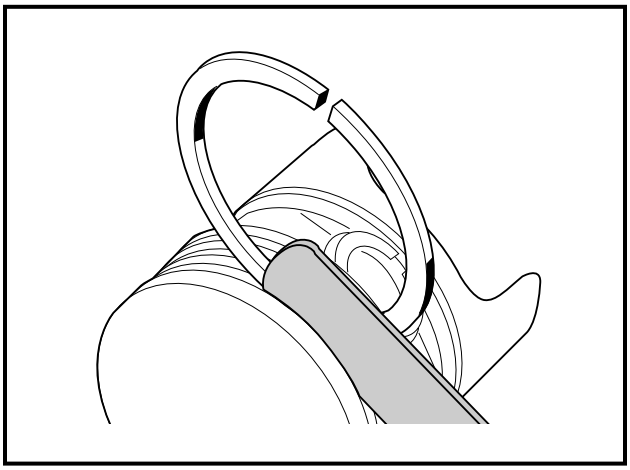


Figure 3-45 Measure Piston Ring Clearance

Piston Ring Inspection

1. Insert the ring squarely into the cylinder bore to a point approximately 1 inch (25 mm) down from the top the cylinder. **See following NOTE**.

NOTE: *Use the top of the piston to push the ring into the bore to be sure it is square.*

2. Use a feeler gauge to measure the ring end-gap **(Figure 3-46, Page 3-25)**.
3. If the end-gap of any ring is greater than 0.0472 inch (1.199 mm), replace the entire set of rings.
4. Use a micrometer to measure the thickness of both piston rings at several points around the rings **(Figure 3-47, Page 3-25)**.
5. If either ring thickness is less than 0.0566 inch (1.438 mm), replace the entire set of rings. **See following NOTE.**

NOTE: *It is difficult to measure the exact thickness of the the oil ring. Replace the oil ring whenever the compression rings (top and second) are replaced.*

If a chrome ring is included as part of the ring set, always assemble it into the top piston groove.

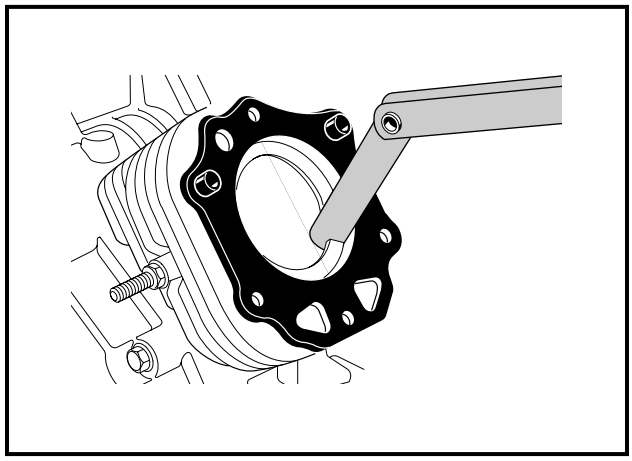


Figure 3-46 Measure Ring End-Gap

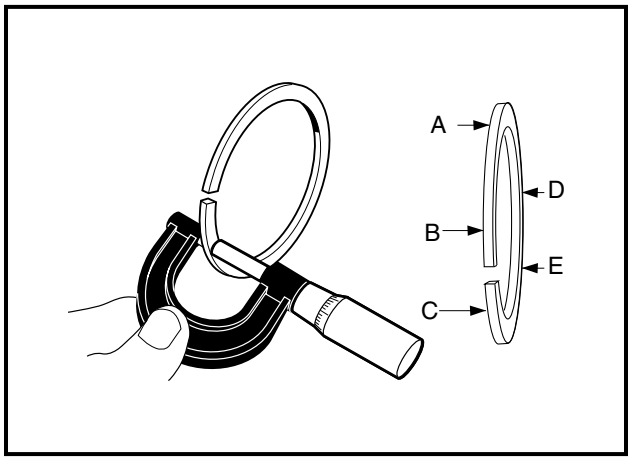


Figure 3-47 Measure Piston Ring Thickness

Piston Pin Inspection

1. Use a micrometer to measure the outside diameter of the piston pin at several points along its length **(Figure 3-48, Page 3-25)**.
2. If the pin diameter is smaller than 0.7864 inch (19.975 mm), replace the piston pin.
3. Use an inside micrometer or telescoping gauge to measure the inside diameter of the piston pin hole in the piston at several points **(Figure 3-49, Page 3-25)**.
4. If the inside diameter exceeds 0.7887 inch (20.033 mm), replace the piston.

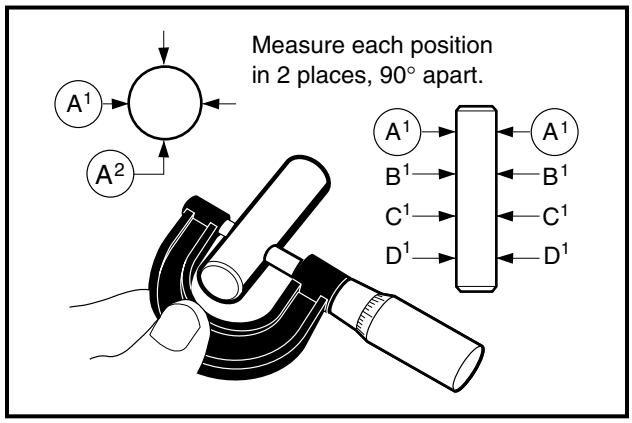


Figure 3-48 Measure O.D. of Piston Pin

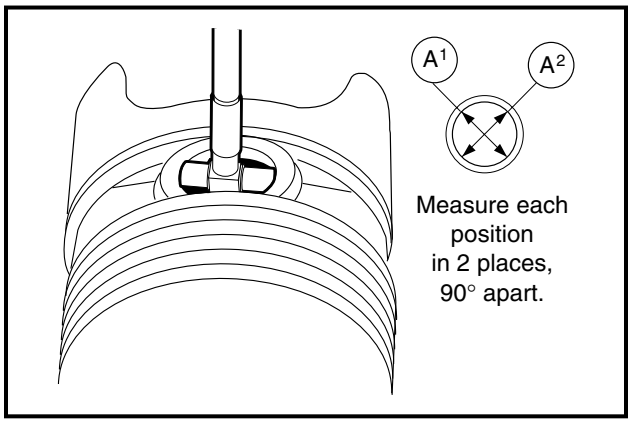


Figure 3-49 Measure I.D. of Piston Pin Hole

Connecting Rod Inspection

1. Clean and inspect the bearing surfaces of the connecting rod and cap. Replace parts if scored.
2. Use a telescoping gauge to measure the inside diameter of the connecting rod small bore at several points along its length **(Figure 3-50, Page 3-26)**.

Connecting Rod Inspection, Continued:

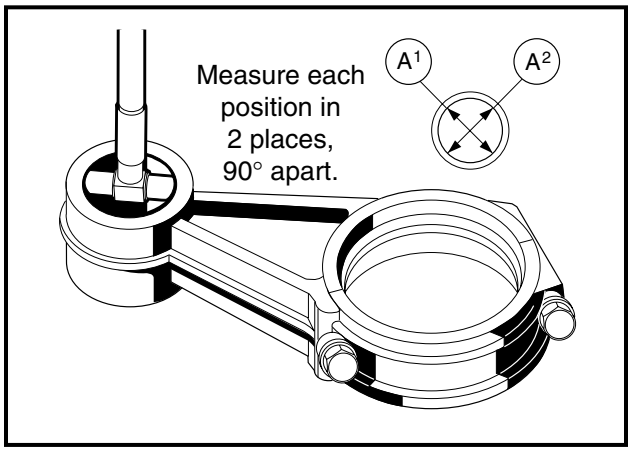


Figure 3-50 Measure I.D. of Connecting Rod Small Bore

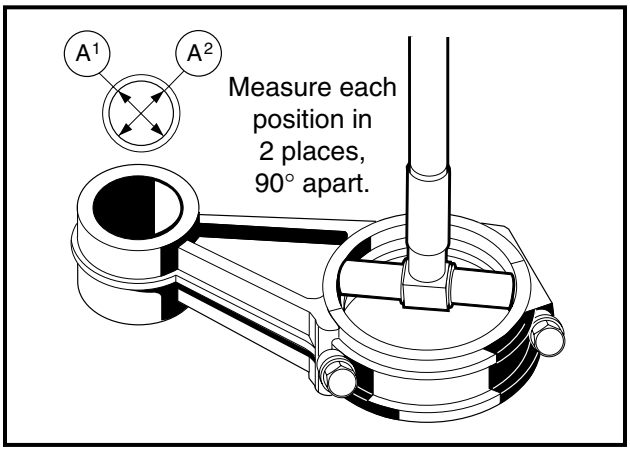


Figure 3-51 Measure I.D. of Connecting Rod Large Bore

3. If the inside diameter exceeds 0.7887 inch (20.033 mm), replace the connecting rod.
4. Remount the connecting rod cap to the connecting rod at the large bore end, aligning the pilot groove on the rod. Screw in the connecting rod bolts and tighten them to 16.5 ft-lb (23 N·m).
5. Use a telescoping gauge or an inside micrometer to measure the inside diameter of the large bore at several points along its length **(Figure 3-51, Page 3-26)**.
6. If the inside diameter exceeds 1.479 inches (37.567 mm), replace the connecting rod. **See following NOTE.**

NOTE: *If the connecting rod is bent or twisted, it must be replaced.*

CAUTION

- **The connecting rod and cap must stay together as a set. Do not mix parts from any other engine.**

Piston and Connecting Rod Installation

See Piston and Connecting Rod Installation on page 3-41.

CYLINDER BLOCK

See General Warning on page 1-1.

While the engine is disassembled, inspect the cylinder block for cracks, stripped bolt holes, broken fins, or cylinder wall scoring. Repair or replace as necessary.

1. Use an inside micrometer or telescoping gauge, together with a micrometer, to measure the cylinder bore.

2. Make the first measurement parallel with the crankshaft and the second at right angles to the crankshaft at three different locations in the bore. The first measurement location is 0.4 inch (10 mm) from the top of the cylinder. The second location is in the center or 2.4 inches (60 mm) from the top, and the third location is 0.3 inch (8 mm) from the bottom of the cylinder or bottom of ring travel. **(See locations 1, 2, and 3 in Figure 3-52, Page 3-27)**.
3. Engine Bore Dimensions: **FE350**
   3.1. The standard bore diameter is 3.2669 - 3.2677 inches (82.980 - 83.000 mm).
   3.2. The maximum cylinder bore diameter wear limit is 3.2703 inches (83.067 mm).
   3.3. The maximum acceptable out of round cylinder bore is 0.0022 inches (0.056 mm).
4. If the cylinder bore is not within these measurements, the cylinder bore will need to be resized where applicable.

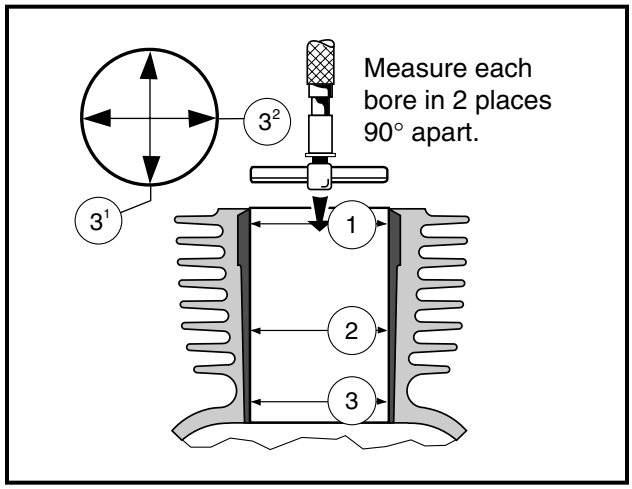


Figure 3-52 Measure Cylinder Bore

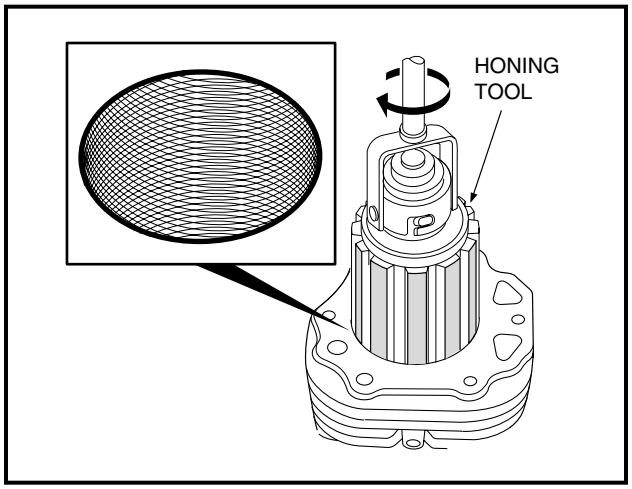


Figure 3-53 Hone Cylinder

To Resize Bore to Next Oversize

Always resize the bore to exactly 0.020 inches (0.50 mm) over standard size.

1. The bore size 0.020 inches over standard size is 3.2858 - 3.2866 inches (83.460 - 83.480 mm). **See Specifications for Resizing Cylinder Bore on page 3-48. See following NOTE.**

NOTE: *Allow for shrinkage (from the final size) of 0.0003 - 0.0004 inches (0.0007 - 0.0009 mm), which will occur when the cylinder cools down.*

2. Hone the cylinder to the final bore diameter of 3.2866 - 3.2874 inches (83.480 - 83.500 mm). **See Specifications for Resizing Cylinder Bore on page 3-48. See following NOTE**.

NOTE: *The cylinder wall finish should have a 40° to 60° cross-hatch pattern **(Figure 3-53, Page 3-27).***

Do not use solvents or gasoline to clean cylinder after honing. Solvents and gasoline allow the grindings to remain in the honed surface and will not provide a surface suited for ring seating.

3. After honing, clean the cylinder wall thoroughly using soap, warm water and clean rags. **See following CAUTION.**

CAUTION

- **The cylinder must be thoroughly cleaned after honing to eliminate all grit.**

4. Dry the cylinder and coat with engine oil.

IGNITION COIL AND FLYWHEEL

See General Warning on page 1-1.

Ignition Coil and Flywheel Removal

1. Loosen three screws and remove the remaining four screws attaching the flywheel housing, then remove the housing **(Figure 3-54, Page 3-28)**.
2. Disconnect the ignition coil (1) from its primary lead wire at the connector (2). Remove the two bolts (3) and remove the ignition coil **(Figure 3-55, Page 3-28)**.

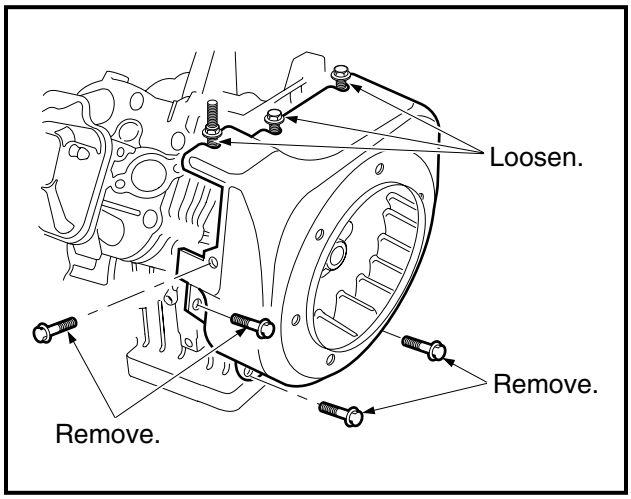


Figure 3-54 Flywheel Housing

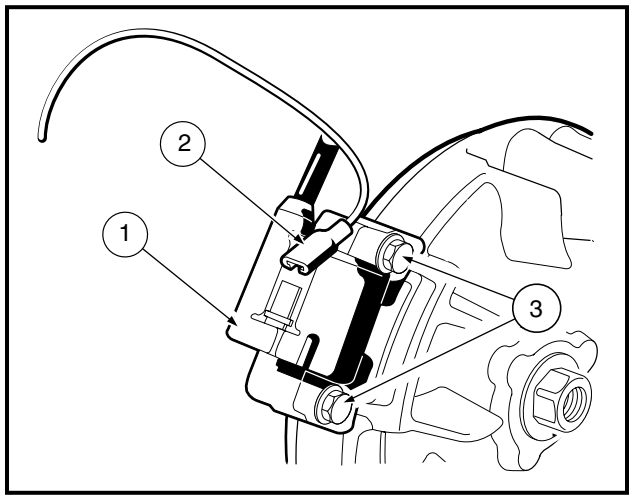


Figure 3-55 Ignition Coil

3. Hold the flywheel (4), not the fan (7), with a strap wrench (5) and use a 25 mm socket to remove the flywheel nut (and flat washer) by turning it counterclockwise **(Figure 3-56, Page 3-29)**. **See following CAUTION.**

CAUTION

- **The flywheel nut has right-hand threads. Turn it clockwise to tighten, or counterclockwise to loosen.**
- **Do not damage the fan blades with the strap wrench. Do not place screwdriver or pry bar in the fan blades.**

4. Remove the flywheel.
5. Remove the flywheel key from its groove.

Flywheel Installation

See Engine Assembly on page 3-45.

Ignition Coil Installation

It is recommended that the ignition coil (CCI P/N 101909201) be replaced with engine teardown.

1. Installation is the reverse of removal.
2. Lightly tighten the two bolts (3) while using a bronze feeler gauge to maintain the ignition coil air gap to 0.012 inch (0.304 mm) **(Figure 3-57, Page 3-29)**.
3. Tighten the two ignition coil bolts to 30 in-lb (3.4 N·m).

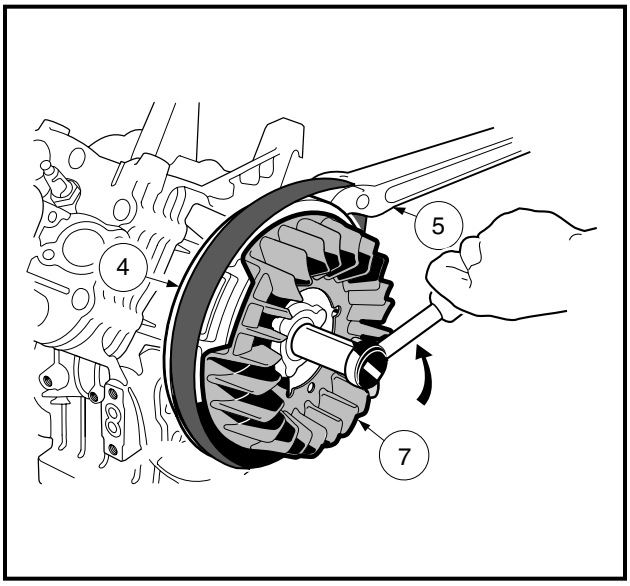


Figure 3-56 Flywheel Nut

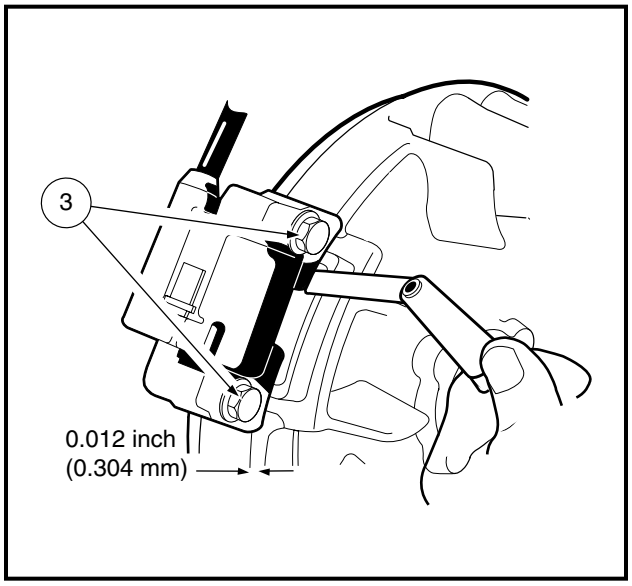


Figure 3-57 Adjust Ignition Coil Air Gap

OIL PUMP

See General Warning on page 1-1.

Oil Pump Cover Removal

1. Remove the six screws (1-6) and remove the oil pump cover (7) **(Figure 3-58, Page 3-29)**.
2. Peel off the oil pump cover gasket (8).
3. Remove the pump gear cover plate (9) and filter screen (10).

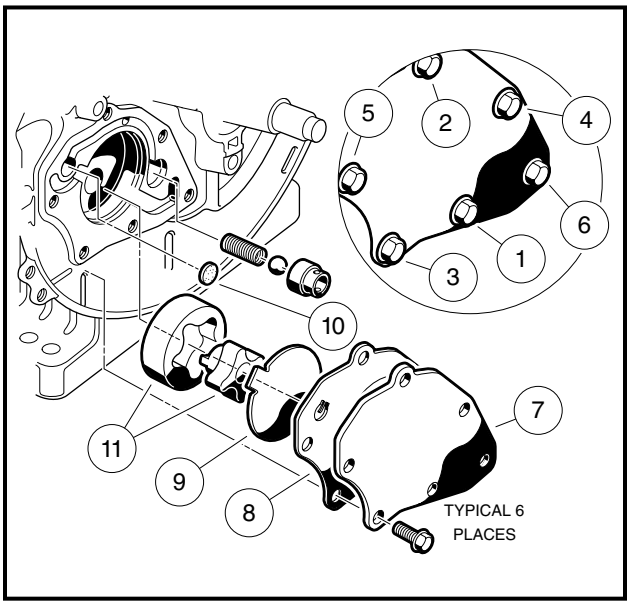


Figure 3-58 Oil Pump Removal

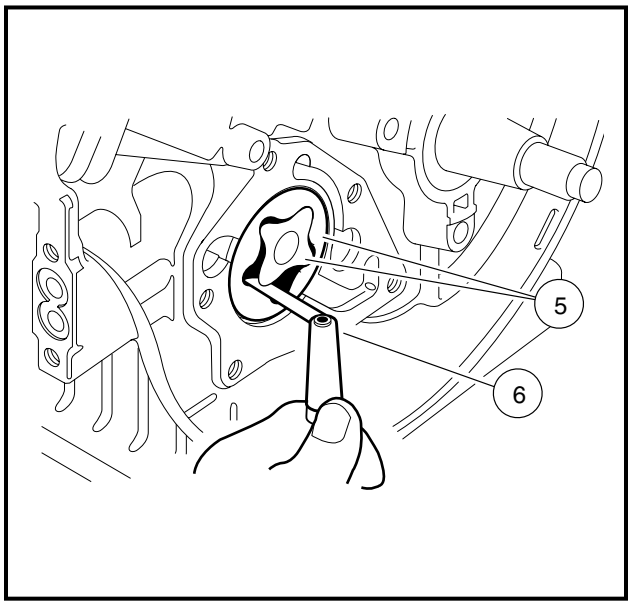


Figure 3-59 Check Clearance Between Rotors

Oil Pump Inspection

1. Check the clearance between the inner and outer rotors (5) with a feeler gauge (6). Measure the clearance between the high point of the inner rotor and the high point of the outer rotor **(Figure 3-59, Page 3-29)**.
2. Replace both rotors as a set if the measurement exceeds 0.012 inch (0.3 mm).
3. Remove inner and outer rotors (11) **(Figure 3-58, Page 3-29)**.
4. Inspect the inner and outer oil pump rotors. If the rotors are worn or damaged, replace them.
   4.1. Measure the pump shaft bearing surface. Replace both rotors as a set if the measurement is less than 0.4971 inch (12.627 mm) **(Figure 3-60, Page 3-30)**.
   4.2. Use a micrometer to measure the diameter of the outer rotor at several points **(Figure 3-61, Page 3-30)**.
   4.3. If the rotor diameter is less than 1.5923 inches (40.467 mm), replace both rotors.
   4.4. Use a micrometer to measure the thickness of the outer rotor at several points **(Figure 3-62, Page 3-30)**.
   4.5. If the rotor thickness is less than 0.3905 inch (9.920 mm), replace both rotors.

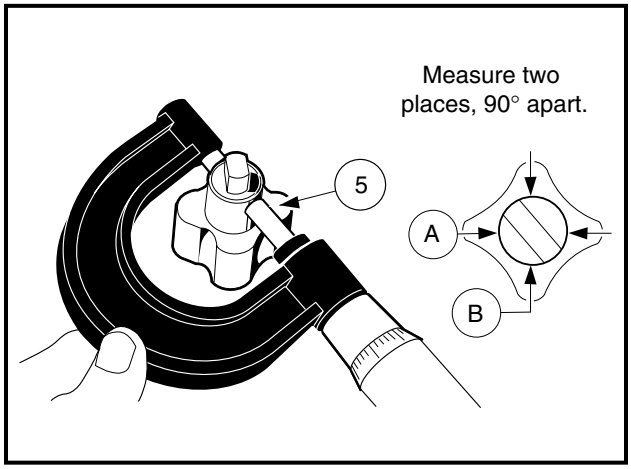


Figure 3-60 Measure Pump Shaft Bearing Surface

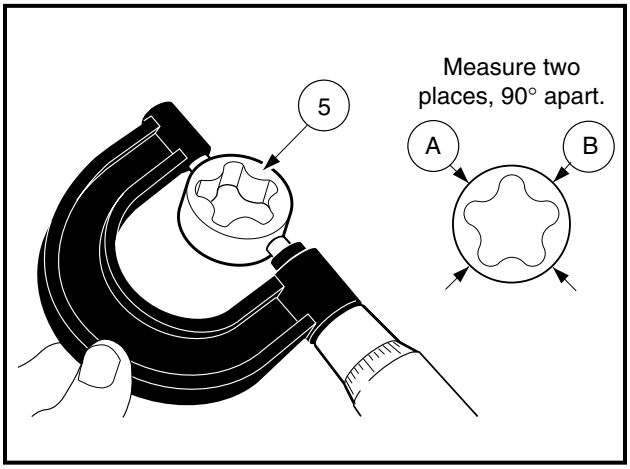


Figure 3-61 Measure O.D. of Outer Rotor

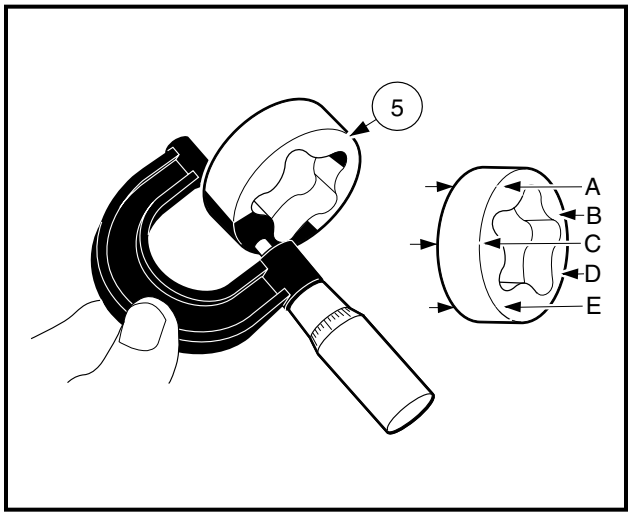


Figure 3-62 Measure Thickness of Outer Rotor

OIL PRESSURE RELIEF VALVE

Oil Pressure Relief Valve Removal

1. Remove the oil pump cover. **See Oil Pump Cover Removal on page 3-29.**
2. Remove the valve seat (1), ball (2) and spring (3) **(Figure 3-63, Page 3-31)**.

Oil Pressure Relief Valve Inspection

1. Note the condition of the ball (2) and the valve seat (1). They must not have any nicks or burrs. Replace if necessary **(Figure 3-63, Page 3-31)**.
2. Inspect the relief valve spring (3) for pitting, cracks, rusting and burrs. Replace if necessary.
3. Measure free length of the spring (3) with a vernier caliper **(Figure 3-64, Page 3-31)**. If the free length of the relief valve spring is less than 0.748 inches (19.00 mm), replace the spring.

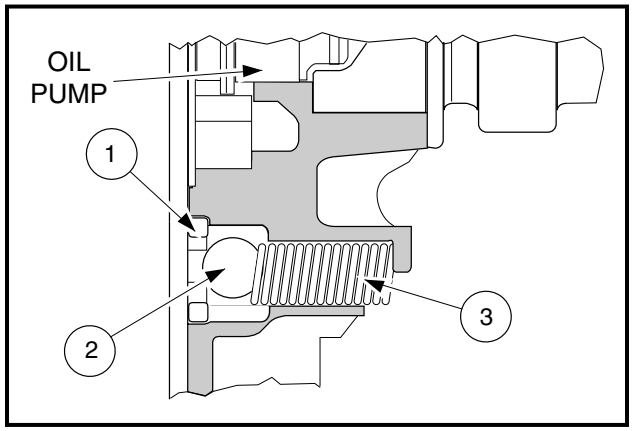


Figure 3-63 Oil Pressure Relief Valve

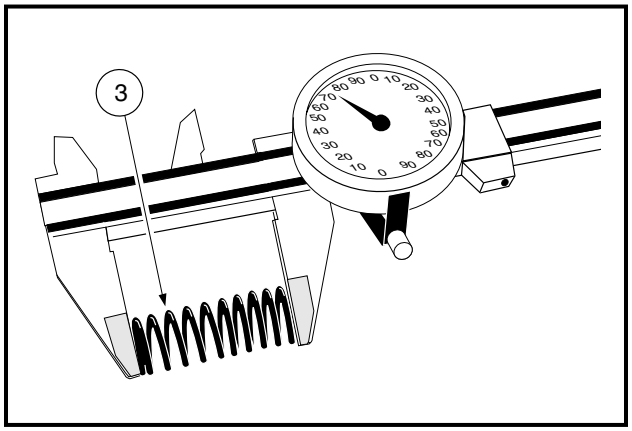


Figure 3-64 Measure Free Length of Spring

Oil Pressure Relief Valve Installation

1. Installation is the reverse of removal. If necessary, put the ball in position and lightly tap with a plastic hammer to form a perfect seat.

Oil Pump Installation

CAUTION

- **Do not allow any dust or other foreign matter into the oil pump.**

1. Installation is the reverse of removal.
2. Install the inner rotor with its tang in the slot in the end of the camshaft **(Figure 3-65, Page 3-32)**.
3. Install six bolts (1-6) and finger-tighten. Then tighten to 7 ft-lb (9.5 N·m) in the sequence shown **(Figure 3-58, Page 3-29)**. After tightening bolts, check the torque of the first bolt.

Oil Pump Installation, Continued:

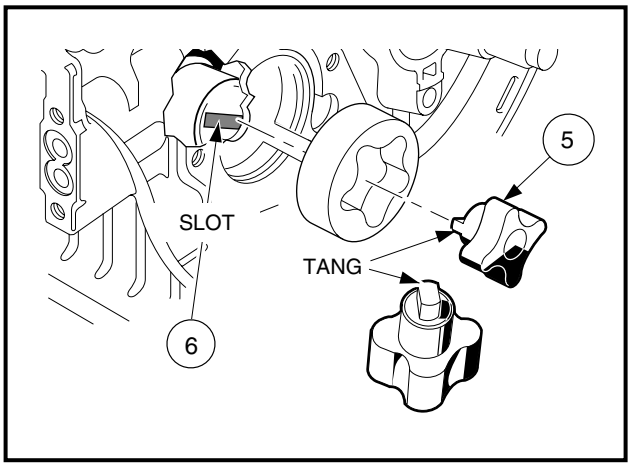


Figure 3-65 Install Inner Rotor

CRANKSHAFT AND COUNTERBALANCE

See General Warning on page 1-1.

Crankshaft and Counterbalance Removal

1. Remove the four nuts (1) and pull out the counterbalance guide shaft (2) and the O-ring (3) **(Figure 3-66, Page 3-32)**.
2. Pull out the crankshaft and the counterbalance together as an assembly **(Figure 3-67, Page 3-32)**.

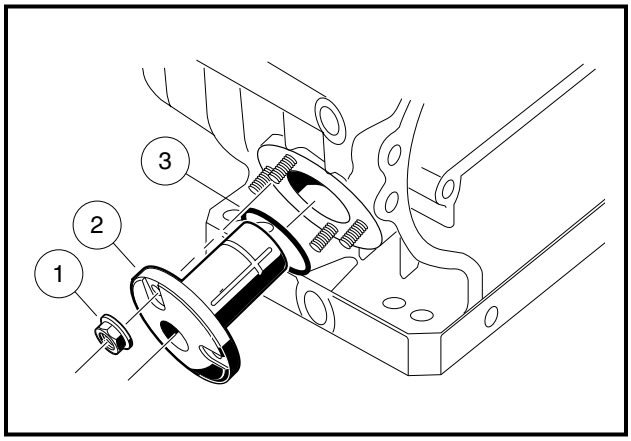


Figure 3-66 Counterbalance Guide Shaft and O-Ring

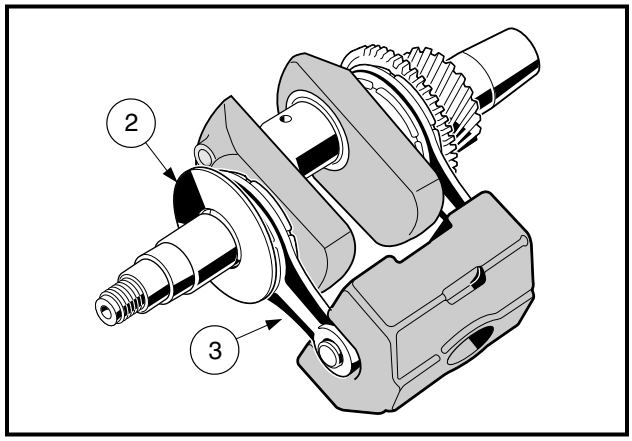


Figure 3-67 Crankshaft and Counterbalance

Crankshaft and Counterbalance Disassembly

1. Slide the spacer (2) and the link rod (3) off the flywheel end of the crankshaft. Remove the counterbalance from the remaining link rod **(Figure 3-67, Page 3-32)**. **Go to Link Rod Inspection on page 3-34.**
2. If the link rods need replacing, place the gear yoke (CCI P/N 1016418) under the spur gear with the small end of the connecting rod located opposite the crankpin **(Figure 3-68, Page 3-33)**.

3. Position the gear yoke with the side blocks positioned as close to the crankshaft as possible **(Figure 3-69, Page 3-33)**.

4. Use a press and push on the end of the crankshaft to pull the spur gear and the helical gear off the crankshaft. **See following WARNING and CAUTION.**

⚠ WARNING

- **Support the crankshaft while pressing. This will prevent the crankshaft from dropping to the floor after the gear has been removed.**

CAUTION

- **Always use a press when removing the spur gear and helical gear from, or installing them on, the crankshaft.**

5. Remove the woodruff key.

6. Slide the remaining link rod off the crankshaft.

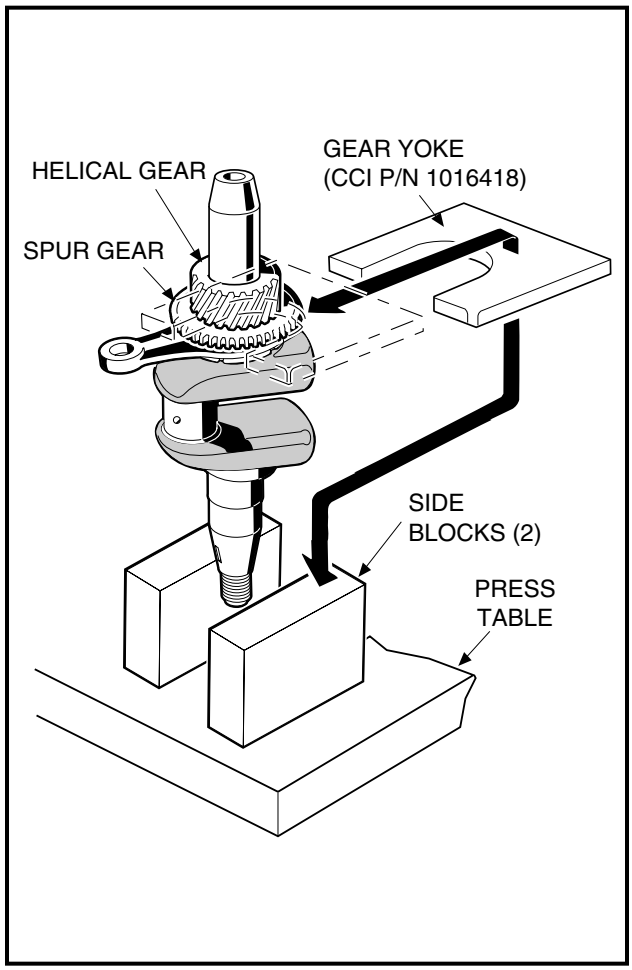


Figure 3-68 Place Assembly in Press

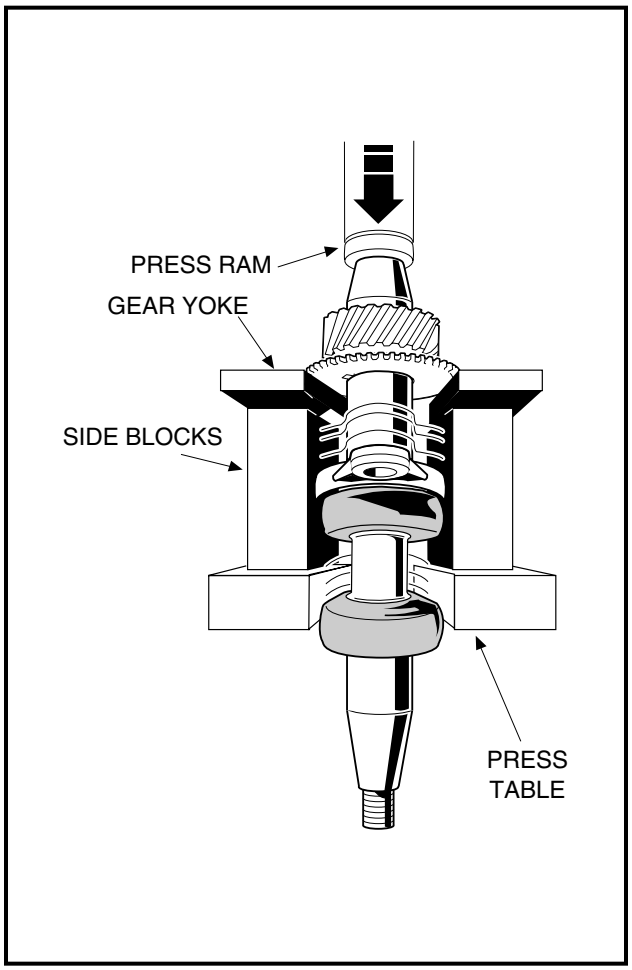


Figure 3-69 Remove Helical and Spur Gears

Link Rod Inspection

1. Clean and inspect the link rod (1) bearing surfaces. If the bearing surface of the small end is scored or damaged, replace the link rod. If the large end bearing is scored or damaged, the link rod must be replaced **(Figure 3-70, Page 3-34)**.

   1.1. Use a telescoping gauge and micrometer to measure both inside bearing surfaces at several points.

   1.2. If the inside diameter of the small end is greater than 0.4746 inch (12.057 mm), replace the link rod **(Figure 3-71, Page 3-34)**.

   1.3. If the inside diameter of the large end is greater than 1.9726 inches (50.106 mm), replace the link rod **(Figure 3-72, Page 3-34)**. **See following NOTE.**

NOTE: *Do not remove the link rod on the PTO (power take-off) side unless link rod on the opposite end needs replacement. The crank-gear is very tightly fitted to the crankshaft so that it can transfer engine torque to the camshaft. Ignore Crankshaft and Counterbalance Disassembly (steps 2 through 6, page 3-32), if the link rod opposite of the PTO side passes inspection* ***(Figure 3-70, Page 3-34)****.*

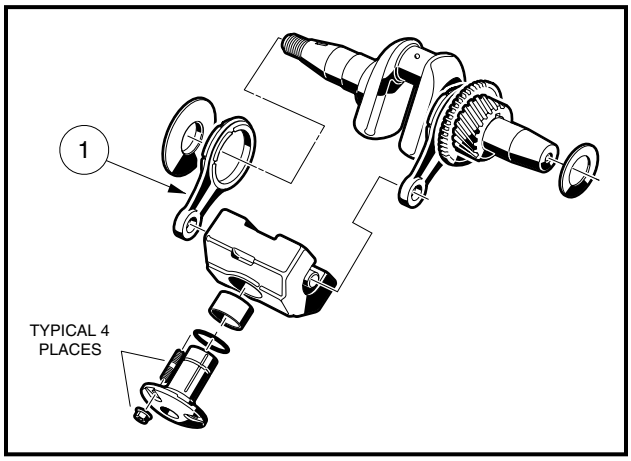


Figure 3-70 Inspect Link Rod

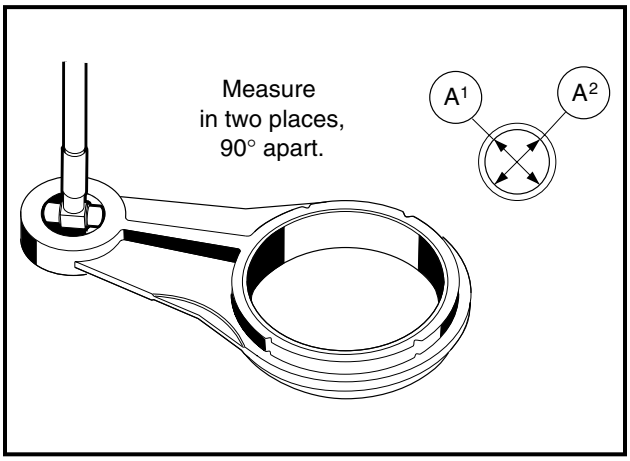


Figure 3-71 Measure Link Rod Small Bore I.D.

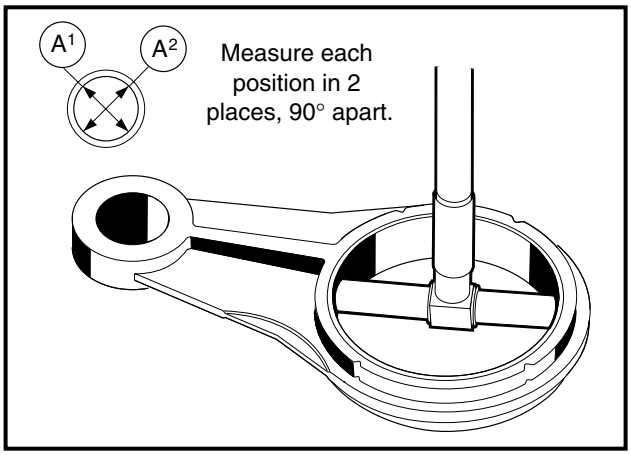


Figure 3-72 Measure Link Rod Large Bore I.D

COUNTERBALANCE WEIGHT

NOTE: *The wrist pins are tightly pressed into the weight and normally require no maintenance.*

Counterbalance Weight Inspection

1. Clean the inside bearing surface and inspect it for wear or damage.
2. Use a telescoping gauge and micrometer to measure the inside diameter of the bearing surface **(Figure 3-73, Page 3-35)**.
3. If the inside diameter is greater than 1.0274 inches (26.097 mm), or the bore shows signs of wear or damage, replace the counterbalance weight.

Counterbalance Weight Bearing Replacement

1. Support the weight around the bearing hole and drive the bearing out of the counterbalance weight with a bearing drive. **See following NOTE.**

NOTE: *Install the new bearing with its oil hole aligned with the oil passage in the counterbalance weight.*

2. Clean the parts thoroughly in a high flash-point solvent and wipe dry.
3. Coat new bearing with clean engine oil.
4. Press the new bearing into the counterbalance weight.

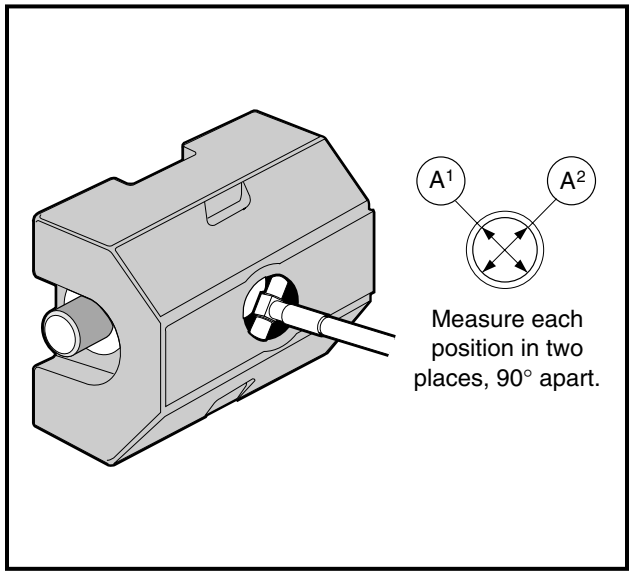


Figure 3-73 Measure I.D. of Courterbalance Weight Bore

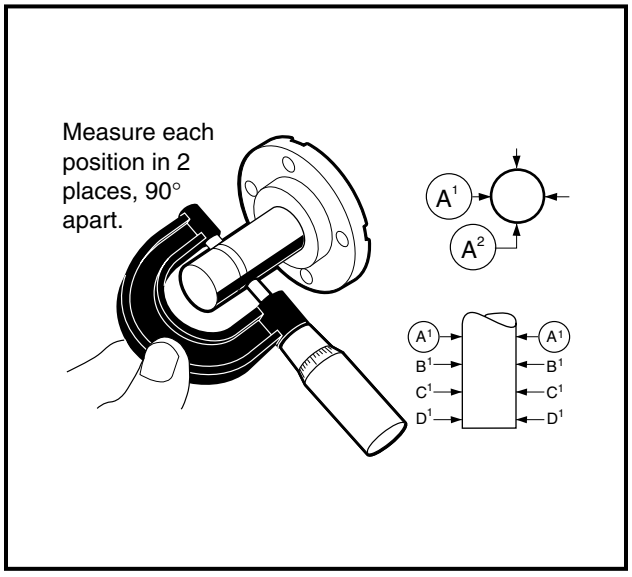


Figure 3-74 Measure O.D. of Counterbalance Guide Shaft

Counterbalance Guide Shaft Inspection

1. Clean the shaft surface and inspect it for wear or damage.
2. Use an outside micrometer to measure the outside diameter of the guide shaft surface **(Figure 3-74, Page 3-35)**.
3. If the outside diameter is smaller than 1.0593 inches (25.907 mm), or the shaft shows signs of wear or damage, replace the guide shaft.
4. Check the O-ring seal to make sure the O-ring is not damaged. Replace if necessary.

Crankshaft Inspection

NOTE: *The crankshaft for a unitized (clockwise) engine has left-hand threads at the clutch mounting hole, and there is a machined groove in the outside diameter of the counterweight as shown.* ***(Figure 3-75, Page 3-36)****.*

1. Clean and inspect the journals for scoring. Inspect the crankshaft gear for cracks, scoring or broken teeth. Replace parts if necessary.
2. Use a micrometer to measure both main journals at several points along their lengths **(Figure 3-76, Page 3-36)**.
3. If either journal diameter is less than 1.3752 inches (34.930 mm), replace the crankshaft.
4. Use a micrometer to measure the connecting rod journal at several points along its length **(Figure 3-77, Page 3-36)**.
5. If the journal diameter is less than 1.4742 inches (37.444 mm), replace the crankshaft.
6. Use a micrometer to measure crankshaft link rod journals at several points **(Figure 3-78, Page 3-36)**.

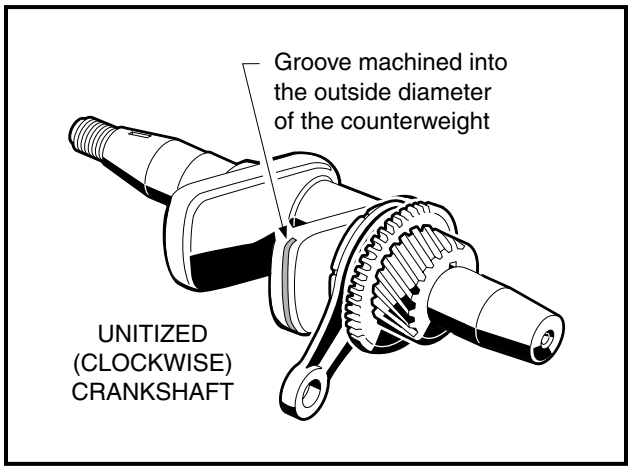


Figure 3-75 Crankshaft Inspection

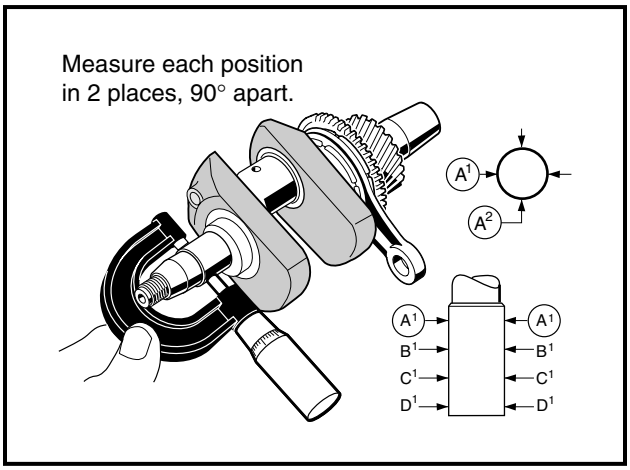


Figure 3-76 Measure Crankshaft Journals

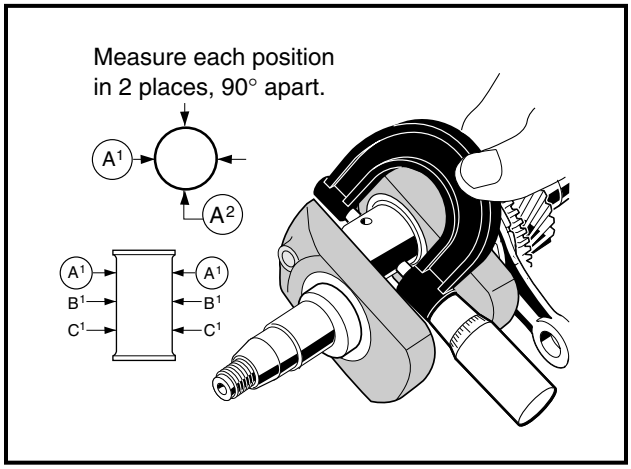


Figure 3-77 Measure Connecting Rod Journal

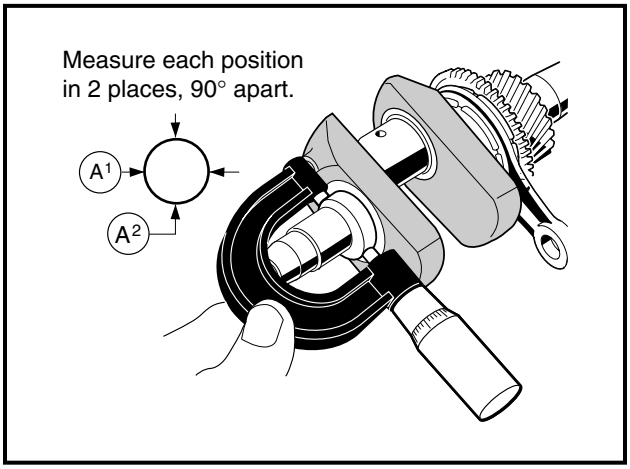


Figure 3-78 Measure Link Rod Journals

7. If the diameter of either journal is less than 1.9655 inches (49.924 mm), replace the crankshaft.
8. Check the crankshaft alignment.
   8.1. Place the crankshaft in an alignment jig.
   8.2. Turn crankshaft (1) slowly and measure total indicated run-out at the location shown **(Figure 3-79, Page 3-37)**.
   8.3. If total run-out exceeds 0.002 inch (0.05 mm), replace the crankshaft.

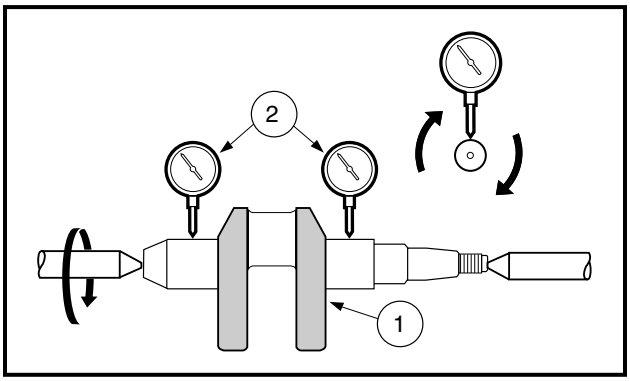


Figure 3-79 Check Crankshaft Alignment

Undersized Connecting Rod

The connecting rod journal can accept an undersized connecting rod with a 1.3779 inches (35.0 mm) inside diameter. Grinding the crankshaft is required before using the undersized connecting rod.

1. Have a reliable repair shop grind the crankshaft journal (A) **(Figure 3-80, Page 3-37)**.
2. The final finishing dimensions are as follows:

   (A) 1.4759 - 1.4763 inches (37.489 - 37.500 mm)

   (B) 0.110 - 0.126 inch (2.80 - 3.20 mm)

   (C) 1.1968 inches maximum (30.4 mm)

   (D) 1.2775 - 1.2814 inches (32.45 - 32.55 mm)
3. The connecting rod journal (A) must be concentric and cylindrical within 0.0002 inch (0.005 mm) at full indicator reading.
4. Finish should be very smooth. Use a super fine finishing stone.

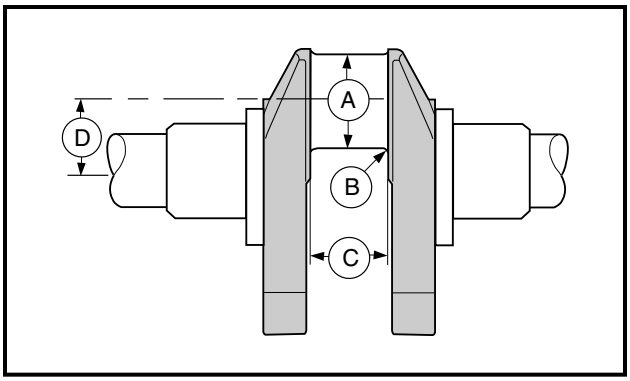


Figure 3-80 Crankshaft Finishing Dimensions

OIL SCREEN

Oil Screen Removal

1. Remove the two bolts (1) to take out the oil screen plate (2) and the oil screen (3) **(Figure 3-81, Page 3-38)**.
2. Clean the oil screen thoroughly with a high flash-point solvent and dry it.

Oil Screen Installation

1. Installation is the reverse of removal.
2. Tighten bolts (1) to 30 in-lb (3.4 N·m).

BALL BEARING

Ball Bearing Removal

1. Remove the oil seal in the crankcase cover. **See following NOTE.**

NOTE: *Never reuse an oil seal. Replace the oil seal with a new one.*

2. Place the crankcase cover (1) on a bench with its outside up (gasket surface against bench) **(Figure 3-82, Page 3-38)**.
3. Use a bearing driver (2) (part of Bearing Driver Kit, CCI P/N 1016416) to drive out the ball bearing (3).

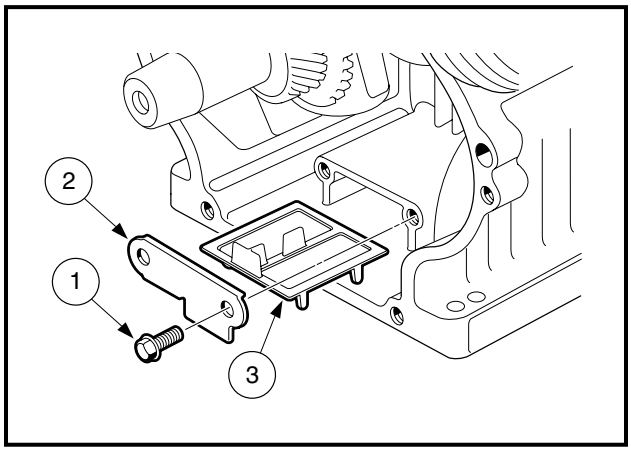


Figure 3-81 Oil Screen Removal

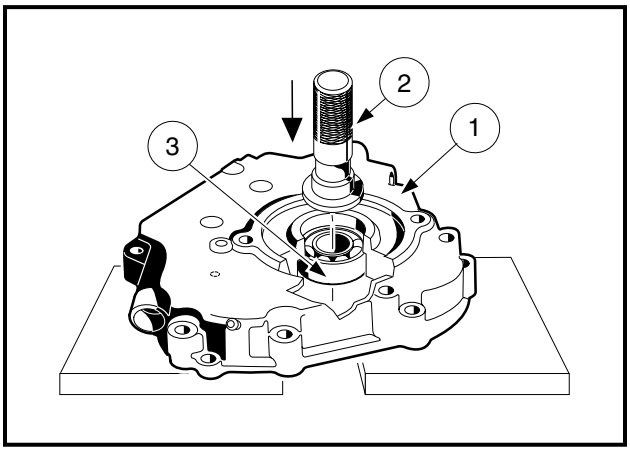


Figure 3-82 Ball Bearing Removal

Ball Bearing Inspection

1. Clean the ball bearing thoroughly in high flash-point solvent and dry it.

NOTE: *Never use compressed air to dry bearing. Spinning the bearing at accelerated speeds without lubrication can damage both the bearings and bearing seat and result in premature bearing failure.*

2. Spin the ball bearing by hand and check for (A) axial play and (B) radial play. Replace the ball bearing if it is noisy, does not spin smoothly, or if it has any play **(Figure 3-83, Page 3-39)**.

Ball Bearing Inspection, Continued:

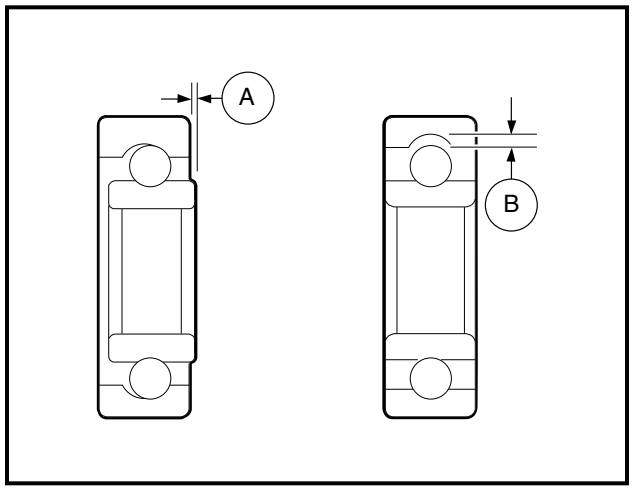


Figure 3-83 Check Ball Bearing

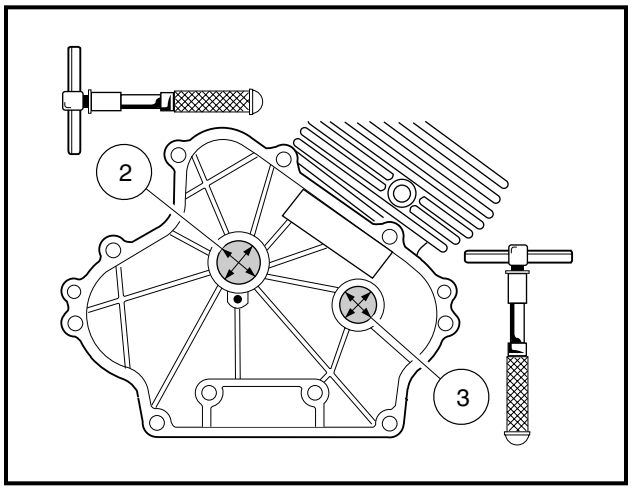


Figure 3-84 Inspect Bearing Surfaces in Crankcase

OIL SEALS

Oil seals are used on both ends of the crankshaft. Any time the crankshaft is removed from the seals, the seals must be replaced with new ones.

Oil Seal Removal

Use an oil seal remover to press or drive the seal out of the casing.

Oil Seal Installation

NOTE: *Never reuse an oil seal. Always replace the oil seal with a new one.*

1. Put a light coating of clean engine oil on the outside edge and the inner lip of the oil seal to assist installation.
2. Install all oil seals with their lips facing the center of the engine.
3. Use the 1.37 inch (35 mm) seal driver to press the oil seal into the flywheel side of the crankcase until it is flush with the hole.
4. Use the 1.97 inch (50 mm) seal driver to press the oil seal into the crankcase cover until it is 0.157 inch (4 mm) below the outside surface.

Plain Bearing Surface Inspection

Plain bearing surfaces are used for both ends of the camshaft and the flywheel end of the crankshaft.

1. Inspect the camshaft surfaces, one in the crankcase (3) **(Figure 3-87, Page 3-41)** and the other in the crankcase cover (1) **(Figure 3-88, Page 3-41)**. Use an inside micrometer or telescoping gauge to measure the inside diameter of each bearing surface. If the inside diameter is greater than 0.9080 inch (23.063 mm), replace the crankcase and/or the crankcase cover.
2. Inspect the crankshaft bearing surface (2) in the crankcase. Use an inside micrometer or telescoping gauge to measure the inside diameter of the bearing surface. If the inside diameter is greater than 1.1841 inch (30.075 mm), replace the crankcase **(Figure 3-87, Page 3-41)**.

Plain Bearing Surface Inspection, Continued:

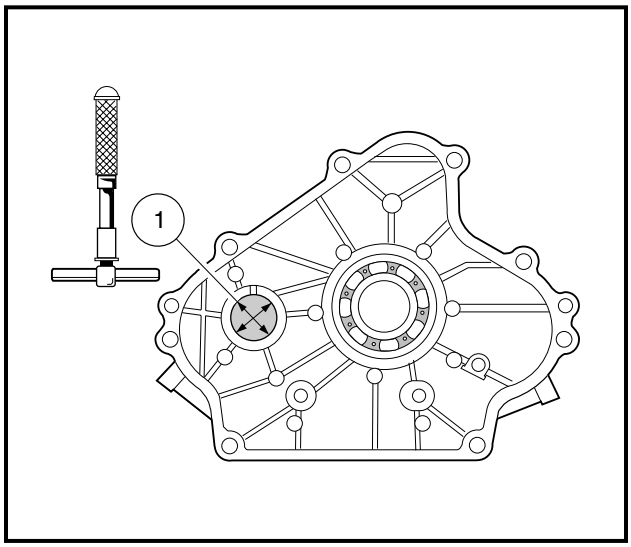


Figure 3-85 Inspect Camshaft Bearing Surface in Crankcase Cover

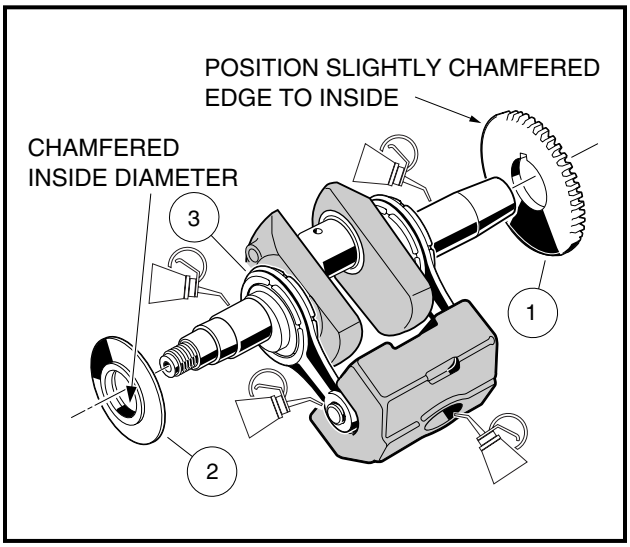


Figure 3-86 Crankshaft Assembly

Crankshaft Installation

CAUTION

- **Before assembly, make sure all parts are clean.**

NOTE: *When assembling the crankshaft and the counterbalance weight, apply a light film of engine oil to the crankshaft journals and guide shaft* ***(Figure 3-86, Page 3-40)****.*

1. Installation is the reverse of removal. **See Crankshaft and Counterbalance Removal on page 3-32.**
2. Tighten the four nuts (1) for counterbalance guide shaft to 50 in-lb (5.9 N·m) **(Figure 3-66, Page 3-32)**.
3. If the link rod was removed from the PTO side of the crankshaft, support the crankweb as shown, slide the link rod onto the crankshaft, and install the key. Press the spur gear and helical gear onto the crankshaft **(Figure 3-89, Page 3-41 and Figure 3-90, Page 3-41**). **See following CAUTION and NOTE.**

CAUTION

- **Always use a press when removing or installing the spur gear and helical gear on the crankshaft.**
- **If the spur gear was warped while being removed, install a new one.**

NOTE: *Make sure the chamfered inside diameters of the spur gear and helical gear are oriented downward on the crankshaft as shown* ***(Figure 3-89, Page 3-41)****.*

Make sure the link rods rotate smoothly after the gears are pressed on.

4. Slide the link rod, then the spacer, onto the flywheel end of the crankshaft.

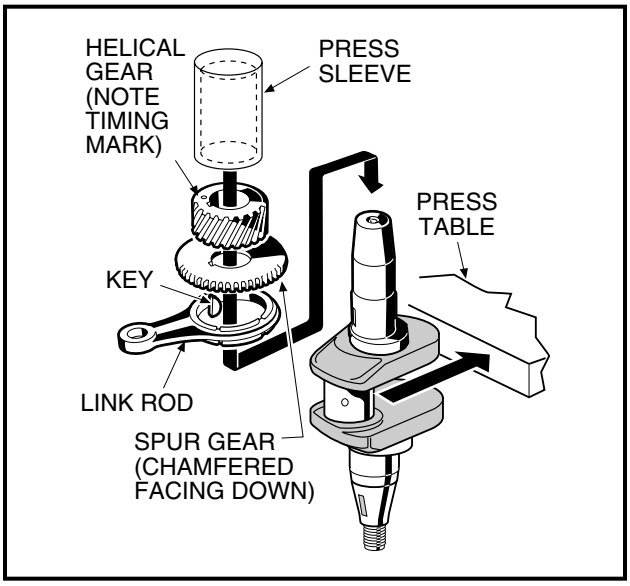


Figure 3-87 Crankshaft Installation

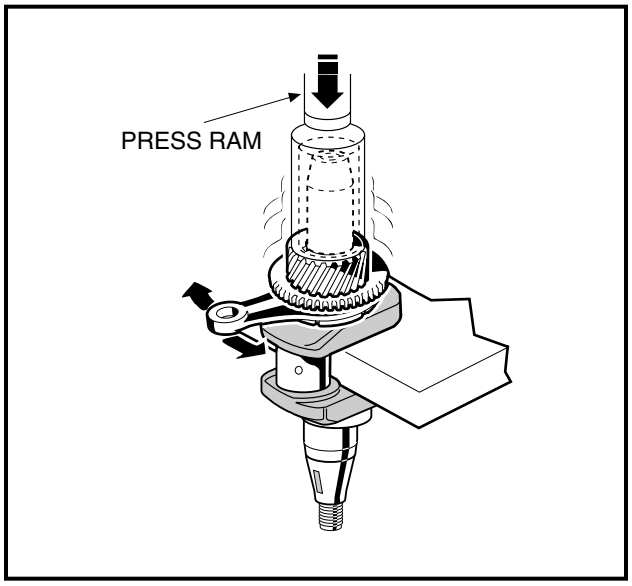


Figure 3-88 Press on Spur Gear and Helical Gear

PISTON AND CONNECTING ROD INSTALLATION

1. Installation is the reverse of removal.
2. Assemble the piston and the connecting rod into a unit, if disassembled. Align the L mark (1) on the piston head toward the lettering MADE IN JAPAN (2) on the connecting rod **(Figure 3-91, Page 3-42)**.
3. Apply a light film of engine oil to the connecting rod bearing surfaces and the two connecting rod bolts.
4. Place the piston/connecting rod into the cylinder bore with the lettering MADE IN JAPAN on the connecting rod oriented toward the flywheel side of the engine. Position piston ring gaps so that they are oriented toward the corresponding letters **(Figure 3-92, Page 3-42)**: (A) Top Ring Gap, (B) Second Ring Gap, (C) Upper Side Rail Gap, (D) Lower Side Rail Gap.

NOTE: *The letter **R** marked on the top two piston rings should be facing up when the rings are installed.*

Install the chrome-edged ring into the top ring groove.

5. Tighten the two connecting rod bolts to 16.5 ft-lb (23 N·m).

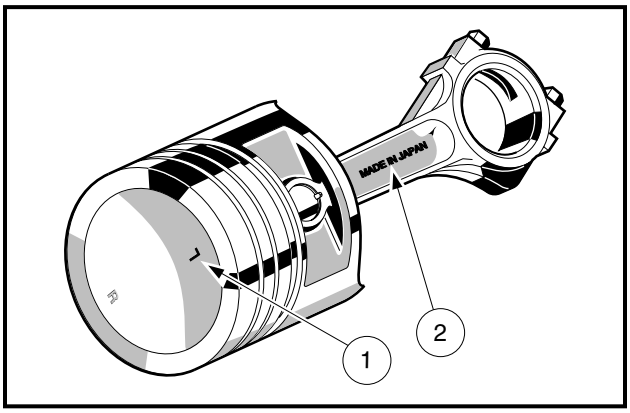


Figure 3-89 Piston Head and Connecting Rod Alignment

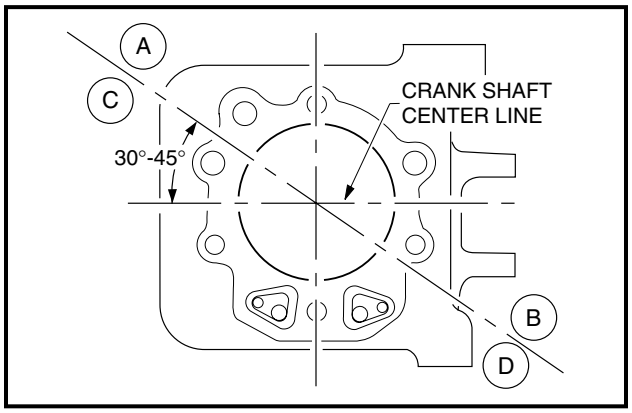


Figure 3-90 Piston Ring Gap Alignment

CRANKSHAFT AXIAL PLAY ADJUSTMENT

See General Warning on page 1-1.

1. With the gasket installed on the crankcase, measure from the gasket surface (1) to the helical gear surface (2). Record measurement (A) **(Figure 3-91, Page 3-42)**.

2. Measure from the crankcase cover (3) mounting face to the crankshaft bearing inner end (4). Record measurement (B).

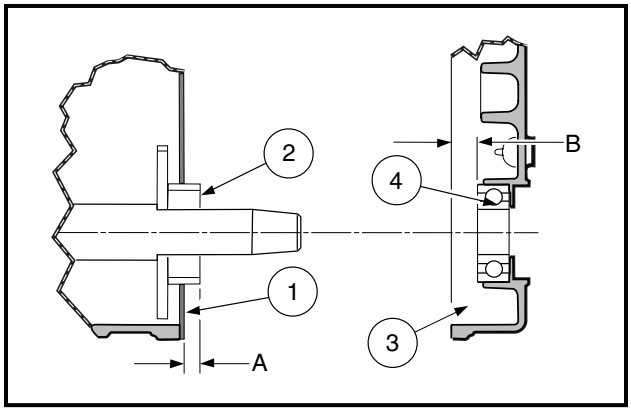


Figure 3-91 Determine Crankshaft Shim Size

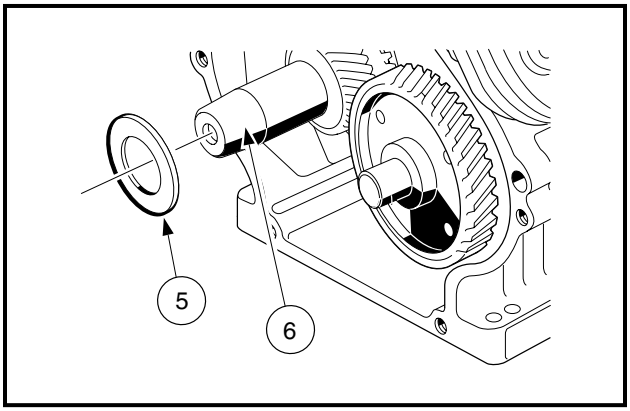


Figure 3-92 Install Shim On Crankshaft

3. Locate the measurements on the Crankshaft Shim Table. Follow lines to where the recorded measurements intersect **(Figure 3-93, Page 3-43)**.

4. Choose the next smaller shim from the table. Example: Measurement A is 15.87 mm and B is 17.66 mm. The correct crankshaft shim is 1.53 mm. **See following NOTE.**

NOTE: *Crankshaft shim sizes for FE350 engine range from 1.11 to 1.81 mm.*

5. Install the shim (5) on the crankshaft (6) **(Figure 3-92, Page 3-42)**.

Camshaft Installation

CAUTION

- **When installing the camshaft, make sure that the tang (1) on the oil pump rotor seats in the slot (2) in end of the camshaft (Figure 3-94, Page 3-43). If the oil pump tang is not seated in the slot in the camshaft, serious engine damage will result.**

1. Installation is the reverse of removal. **See Camshaft and Hydraulic Lifter Removal on page 3-22.**

2. Apply a light film of engine oil to the camshaft journals and cam lobes.

3. Align the timing marks (3) **(Figure 3-95, Page 3-43)**. **See following NOTE.**

NOTE: *If the outside edges of the camshaft and crankshaft gears are not flush, and the crankcase cover will not easily make full contact with the crankcase, make sure the tang on the oil pump rotor is seated in the camshaft slot.*

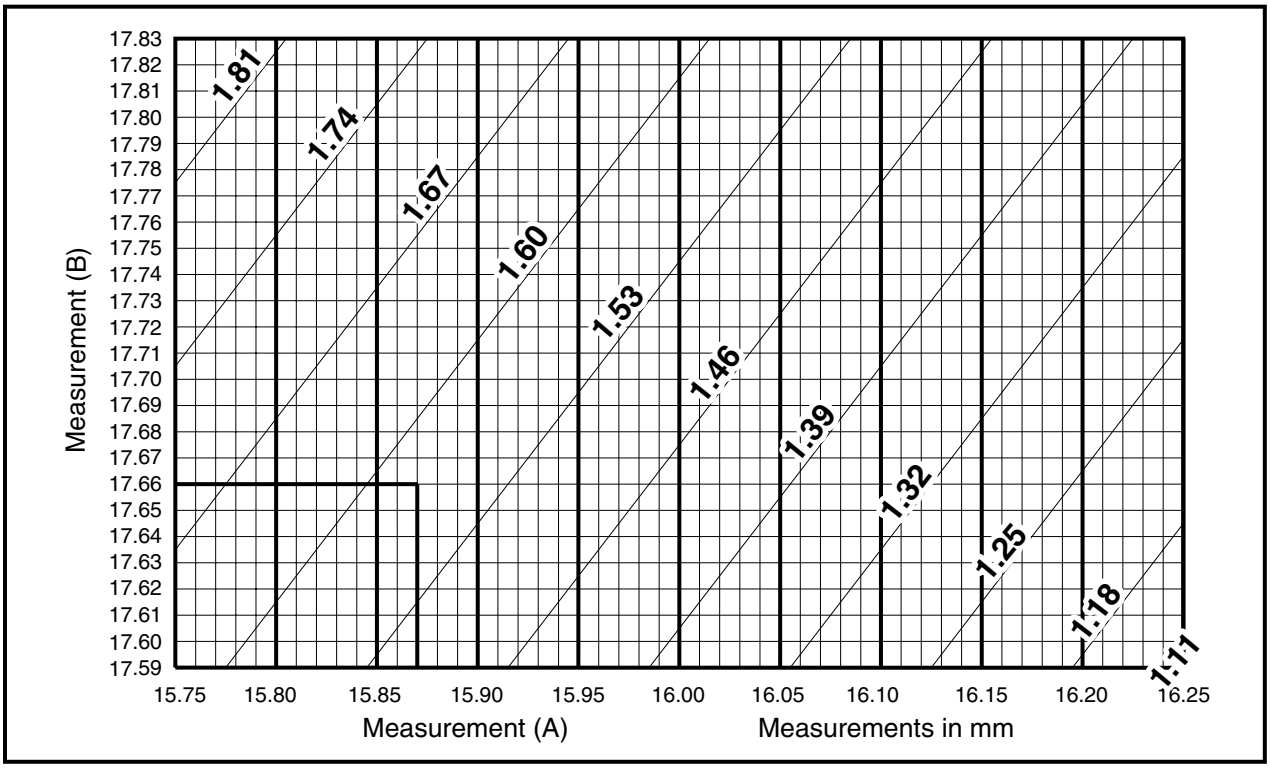


Figure 3-93 Crankshaft Shim Table

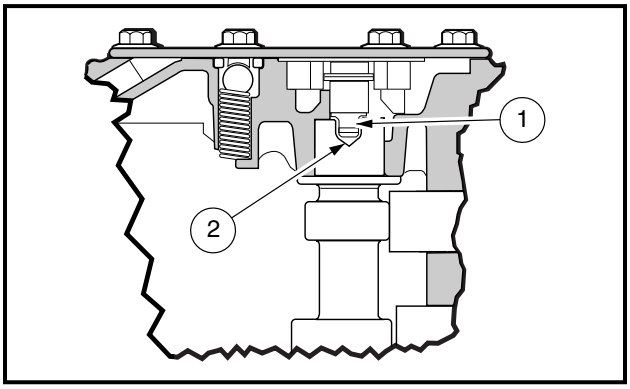


Figure 3-94 Proper Seating of Tang into Camshaft Slot

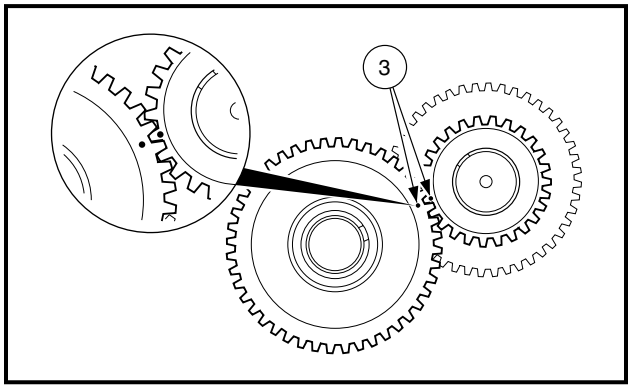


Figure 3-95 Align Timing Marks between Camshaft and Crankshaft

CAMSHAFT AXIAL PLAY ADJUSTMENT

1. With the gasket (1) installed on the crankcase, measure from the gasket surface to the camgear surface (2). Record this measurement (A) **(Figure 3-96, Page 3-44)**.
2. Measure from the crankcase cover (3) mounting face to the camshaft bearing inner end (4). Record this measurement (B).
3. Locate the measurements on the Camshaft Shim Table. Follow the lines to where the recorded measurements intersect **(Figure 3-98, Page 3-44)**.
4. Choose the next smaller shim from the table. Example: Measurement A is 13.41 mm and B is 14.09 mm. The correct camshaft shim is 0.4 mm.
5. Install the shim (1) on the camshaft (2) **(Figure 3-97, Page 3-44)**.

Camshaft Axial Play Adjustment, Continued:

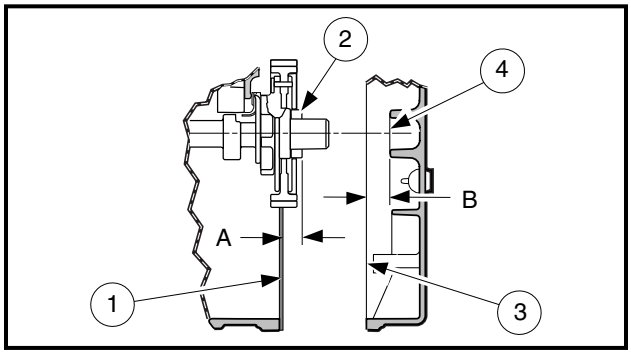


Figure 3-96 Record These Measurements

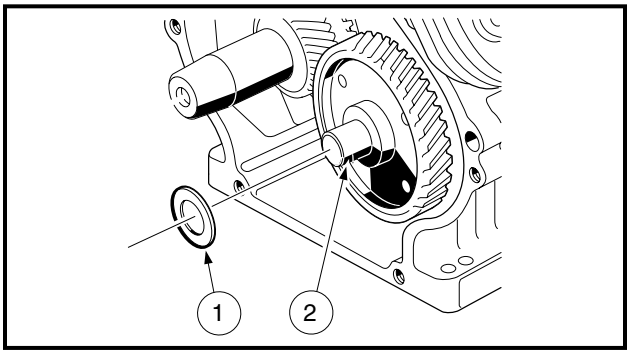


Figure 3-97 Shim Installation on Camshaft

CRANKCASE COVER INSTALLATION

CAUTION

- **Before assembly, make sure parts are clean.**
- **Do not reuse the gasket. Install a new one.**
- **Install and tighten crankcase cover bolts as instructed. Failure to do so could cause the cover to become warped.**

1. Clean the gasket surfaces on the crankcase cover to fit a new gasket during installation and inspect the oil seal for wear and damage.
2. Install crankcase cover. Using HANDS ONLY, seat cover completely against the crankcase. If the cover will not seat, the camshaft is not installed correctly.
3. Install and finger-tighten evenly the eight cover mounting bolts **(Figure 3-99, Page 3-45)**.
4. Tighten the cover mounting bolts in two steps. First, in the sequence shown, tighten all eight bolts to approximately 130 in-lb (14 N·m). Then, repeating the sequence, tighten them to 250 in-lb (28.2 N·m).
5. Connect the yellow jumper wire (11) to the cord connector (12) **(Figure 3-36, Page 3-20)**.

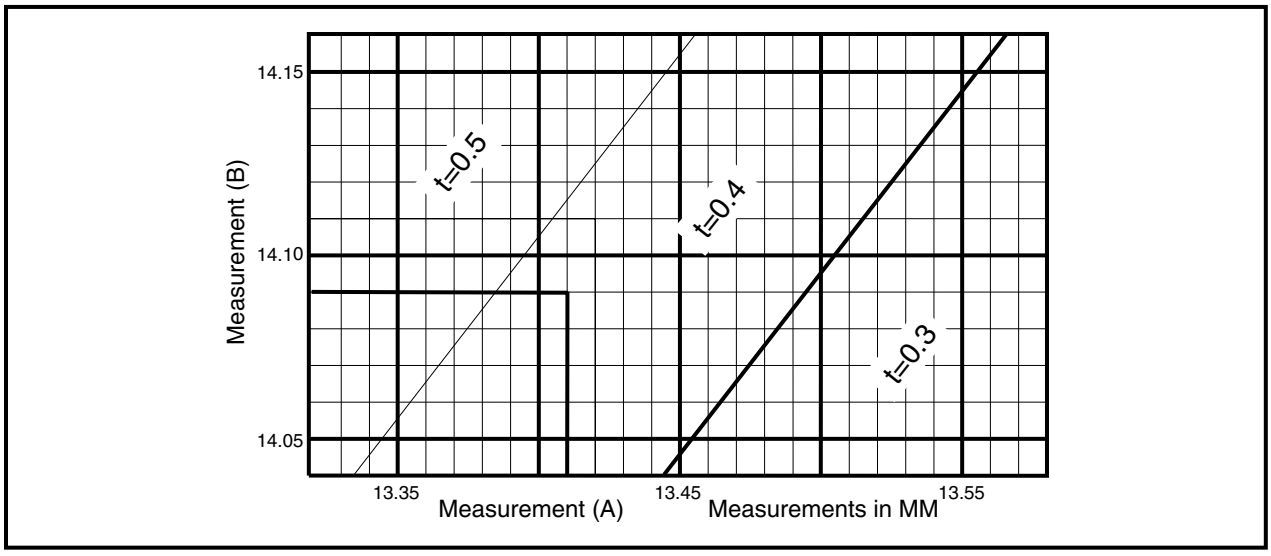


Figure 3-98 Camshaft Shim Table

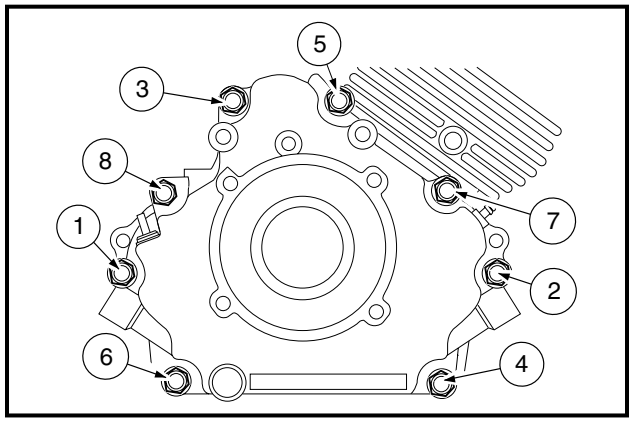


Figure 3-99 Crankcase Cover Installation

ENGINE ASSEMBLY

See General Warning on page 1-1.

CAUTION

- **Before assembly, make sure parts are clean.**

1. Install cylinder head. **See Cylinder Head Installation on page 3-16.**
2. Insert the flywheel key into the keyway in the crankshaft. Align the keyway in the flywheel to the key and push the flywheel and fan assembly onto the crankshaft until it seats. Install flat washer and nut finger-tight.
3. Use a strap wrench (3) to keep the flywheel and fan assembly (1) from turning and tighten the flywheel nut to 63 ft-lb (85.4 N·m) **(Figure 3-100, Page 3-45)**. **See following CAUTION.**

CAUTION

- **The flywheel nut has right-hand threads. Turn it clockwise to tighten, or counterclockwise to loosen.**
- **Be careful not to damage the fan blades. Use a strap wrench to hold flywheel. Do not place screwdriver or pry bar between fan blades.**

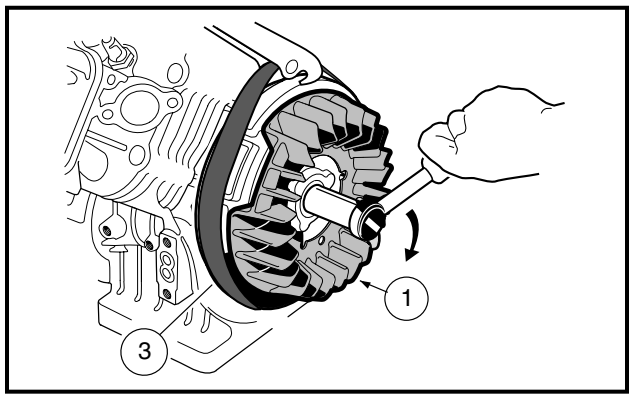


Figure 3-100 Fan and Flywheel Assembly

Engine Assembly, Continued:

4. Install ignition coil. **See Ignition Coil Installation on page 3-28.**
5. Install all remaining engine components. **See Installation of Remaining Engine Components on page 3-18.**
6. Install a new spark plug, gap 0.027 - 0.031 inch (0.69 - 0.79 mm). Tighten to 20 ft-lb (27.12 N·m). **See following NOTE.**

NOTE: *Before installing the plug, check the condition of the threads in the cylinder head. Soften deposits in the cylinder head threads with penetrating oil and clean the threads with a tap if necessary.*

7. Connect the spark plug wire.

ENGINE INSTALLATION

See Engine Installation in the appropriate maintenance and service manual.

SERVICE SPECIFICATIONS

ITEM	SERVICE LIMIT FE350 ENGINE
Breather reed valve (valve tip air gap)	0.008 in. (0.2 mm) max.
Camshaft axial play	0.0137 in. (0.35 mm)
Camshaft bearing	0.9080 in. (23.063 mm) inner diameter max.
Camshaft cam lobes (exhaust, intake)	1.3086 in. (33.24 mm) outer diameter min.
Camshaft flywheel-side journal	0.9026 in. (22.927 mm) outer diameter min.
Camshaft PTO-side journal	0.9026 in. (22.927 mm) outer diameter min.
Connecting rod big-end bearing	1.4790 in. (37.567 mm) inner diameter max.
Connecting rod small-end bearing	0.7894 in. (20.051 mm) inner diameter max.
Counterbalance guide shaft	1.0199 in. (25.907 mm) outer diameter min.
Counterbalance weight bearing	1.0274 in. (26.097 mm) inner diameter max.
Counterbalancer link rod big-end bearing	1.9726 in. (50.106 mm) inner diameter max.
Counterbalancer link rod small-end bearing	0.4746 in. (12.057 mm) inner diameter max.
Crankcase cover camshaft bearing	0.9079 in. (23.063 mm) inner diameter max.
Crankshaft axial play	0.0137 in. (0.35 mm)
Crankshaft balancer – link-rod journals	1.9655 in. (49.924 mm) outer diameter min.
Crankshaft bearing	1.3809 in. (35.075 mm) inner diameter max.
Crankshaft crankpin journal	1.4741 in. (37.444 mm) outer diameter min.
Crankshaft flywheel- side journal	1.3751 in. (34.930 mm) outer diameter min.
Crankshaft PTO-side journal	1.3751 in. (34.930 mm) outer diameter min.
Cylinder bore (standard)	3.2669 to 3.2677 in. (82.980 to 83.000 mm)
Cylinder bore (maximum)	3.2703 in. (83.067 mm)
Cylinder bore (out of round)	0.022 in. (0.056 mm) max.
Oil pump housing	1.6050 in. (40.766 mm) inner diameter max.
Oil pump housing	0.4004 in. (10.170 mm) max.
Oil pump shaft	0.4971 in. (12.627 mm) outer diameter min.
Oil pump shaft bearing	0.5028 in. (12.770 mm) inner diameter max.
Outer rotor	1.5932 in. (40.467 mm) outer diameter min.
Outer rotor width	0.3905 in. (9.92 mm) min.
Piston oil-ring groove clearance and end gap	Visual inspection only
Piston pin	0.7864 in. (19.975 mm) outer diameter min.
Piston pin hole	0.7887 in. (20.033 mm) inner diameter max.
Piston second ring groove clearance (with new ring)	0.0055 in. (0.14 mm) max.
Piston top ring groove clearance (with new ring)	0.0063 in. (0.16 mm) max.
Push rod (rod bend)	0.0196 in. (0.50mm) max.
Relief valve spring (free length)	0.748 in. (19.0 mm) min.
Rocker arm bearing	0.4754 in. (12.074 mm) inner diameter max.
Specifications continued on next page...	

ITEM	SERVICE LIMIT FE350 ENGINE
Rocker shaft	0.4704 in. (11.949 mm) outer diameter min.
Valve face angle (exhaust, intake)	45° (ex.), 30° (in.) standard
Valve guide (exhaust, intake)	0.2756 to 0.2762 in. (7.00 to 7.015 mm) inner diameter standard
Valve guide hole (exhaust)	0.2781 in. (7.065 mm) inner diameter max.
Valve guide hole (intake)	0.2781 in. (7.065 mm) inner diameter max.
Valve margin (exhaust, intake)	0.024 in. (0.6 mm) max.
Valve seat angle (exhaust, intake)	45° (Ex.), 30° (In.) standard
Valve seat width	0.0197 to 0.0433 in. (0.50 to 1.10mm) standard
Valve seat width	0.075 in. (1.9 mm) max.
Valve spring (free length)	1.5157 in. (38.50 mm) min.
Valve stem (exhaust)	0.2722 in. (6.915 mm) outer diameter min.
Valve stem (exhaust, intake) (stem bend)	0.0012 in. (0.03 mm) max.
Valve stem (intake)	0.2728 in. (6.930 mm) outer diameter min.

SPECIFICATIONS FOR RESIZING CYLINDER BORE

ITEM	OVERSIZE	FE350 LIMITS
Final boring bore diameter	0.020 in. (0.50 mm)	3.2877 in. (83.5075 mm)
Finished honed bore diameter	0.0034 in. (0.086 mm)	3.2903 in. (83.5736 mm)

TORQUE SPECIFICATIONS

ITEM	SIZE	FE350 LIMITS
Cylinder head bolts	M8	17.5 ft-lb (24 N·m)
Connecting rod bolts (coat threads with engine oil)	M7	16.5 ft-lb (23 N·m)
Flywheel retaining nut	M18	100 ft-lb (135 N·m)
Crankcase cover to block bolts	M8	22 ft-lb (31 N·m)
Starter/Generator bracket to block bolts	M8	16.5 ft-lb (23 N·m)
Oil drain plug	M14	16.5 ft-lb (23 N·m)
Fan housing screws	M6	90 in-lb (10 N·m)
Fan shroud screws	M6	25 in-lb (2.8 N·m)
Bolts marked with “4” (when used with nuts)	M8 M6 M5	130 in-lb (15 N·m) 50 in-lb (5.9 N·m) 30 in-lb (3.4 N·m)

ADJUSTMENT AND SETTINGS

ITEM	SERVICE LIMIT FE350 ENGINE
Spark plug gap (standard)	0.027 to 0.031 in. (0.69 to 0.79 mm)
Ignition coil air gap (standard)	0.012 in. (0.304 mm)
Oil pressure (min.) at fast idle speed	45.5 psi (3.14 Bars)
Oil filter: bypass-valve opening pressure	11.4 to 17.0 psi (.78 to 1.18 Bars)
Compression pressure (min.) (with automatic compression release)	71 psi (4.83 Bars)
Crankcase vacuum (min.) at fast idle speed	1.18 in. (30 mmHg)
Cylinder head-gasket surface flatness (max.)	0.002 in. (0.05 mm)
ACR lift (standard)	0.059 in. (1.5 mm)
ACR lift (min.)	0.0354 in. (0.9 mm)
Engine RPM	3800 (±30) RPM

SECTION 4 – FE400 ENGINE

⚠ DANGER

- **See General Warning on page 1-1.**

⚠ WARNING

- **See General Warning on page 1-1.**

GENERAL INFORMATION

See General Warning on page 1-1.

The FE400 gasoline engine is produced for one starting system: key-start. This 4-cycle, single cylinder engine is designed for reliable heavy-duty service. This engine has two major component assemblies: the cylinder assembly and the crankcase assembly.

Servicing and teardown procedures for the FE400 are identical to the FE350 engine with a few exceptions. All procedures shown here for the FE400 engine are the exceptions from the FE350 procedures. Review these procedures carefully and note where they differ from the FE350.

Tools used to service these engines are also identical to the tools used for the FE350, with one exception: the piston ring compressor sleeve; however, both the FE350 and FE400 piston ring compressor sleeves are provided in the piston ring compressor kit (CCI P/N 1016414).

The FE400 engine is only supplied with the MC012C-AS00 transaxle. **See Transaxle Models and Identification on page 7-1 or Transaxle Models And Identification on page 6-1.**

SPECIAL ENGINE SERVICE TOOLS AVAILABLE FROM CLUB CAR

DESCRIPTION	CCI P/N
Bearing and seal remover assembly	1016417
Bearing driver set	1016416
Compression gauge and adapter	1016414
Gear yoke	1016418
Piston ring compressor kit	1016414
Piston ring pliers	1016415
Valve clearance adjuster screw holder	1016413
Valve guide reamer	101641201
Valve guide reamer and arbor	101641202
Valve spring compressor	101641101
Valve seat cutter guide	1016552
Valve seat cutter t wrench	1016551
Valve seat cutter 30° and 45° x 35 mm diameter	1016554

RECOMMENDED REPLACEMENT PARTS FOR ENGINE TEARDOWN

DESCRIPTION	CCI P/N
Air filter	1015426
Carburetor insulator to throttle bracket gasket	101973401
Carburetor to intake manifold gasket	1016438
Drive belt	102267101
Exhaust gasket	102270101
Exhaust system (muffler)	102257201
FE350 Gasket kit (for all internal gaskets)	102304901
Ignition coil (with internal igniter)	101909201
Insulator gasket	1016440
Muffler clamp	1017689
Oil filter	1016467
Oil level sensor	1016494
Oil seal	1017503
Starter/Generator belt	101916701
Spark plug	101881101
Throttle bracket to carburetor gasket	1016441

BEFORE SERVICING

To eliminate unnecessary work, carefully read the applicable information and instructions before beginning engine service. Diagrams, DANGER, WARNING, CAUTION and NOTE statements and detailed descriptions have been included wherever necessary. Nevertheless, even a detailed account has limitations; therefore, anyone attempting engine service should have knowledge and experience in small engine service and repair.

CYLINDER HEAD

See General Warning on page 1-1.

GENERAL INFORMATION

NOTE: *Engine rotation is clockwise as viewed from the clutch side of the engine.*

Prior to attempting time-consuming repairs to the cylinder assembly, a cylinder compression test should be performed using a standard compression tester. Low compression would normally indicate a problem in the cylinder assembly such as defective rings, gaskets, etc.

- **Key-Start Engines:** FE400 model engines are equipped with an automatic compression release valve (ACR). This valve releases compression pressure at normal cranking RPM, resulting in lower compression during the starting cycle. **See Automatic Compression Release (ACR) Valve Inspection on page 4-3.**

Automatic Compression Release (ACR) Valve Inspection

As the engine is cranked at a normal 550 to 600 RPM, the ACR opens and reduces compression in the cylinder, allowing the starter to turn the engine with a minimal amount of starter energy, and helping to reduce starter/generator brush wear. A tapping noise will be heard while the ACR is in an open condition. It is normal for the ACR to click, or tap, during normal cranking RPM. When the engine starts and accelerates to 700 RPM, the ACR will close, the tapping noise will stop, and full compression will be reached. After the engine starts, it will idle at 1150 to 1200 RPM.

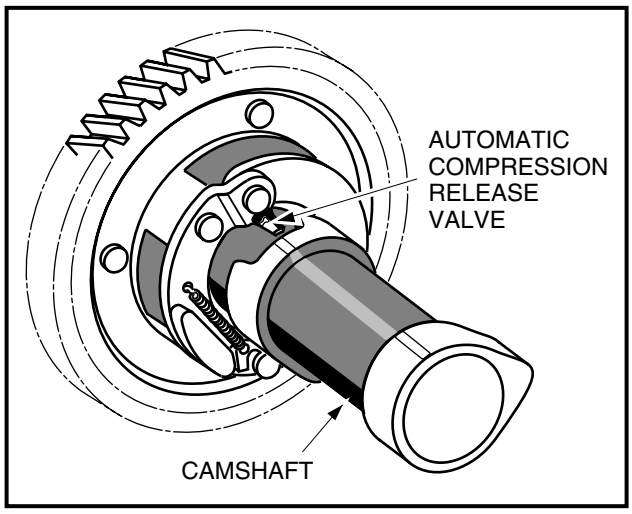


Figure 4-1 ACR Valve Inspection

If the ACR fails to hold the valve open during the cranking function, the engine will have too much compression and may not turn over when the starter is activated. If, after the engine starts and reaches 700 RPM, the ACR fails to allow the exhaust valve to close, the engine will not reach required running compression, and will not have complete acceleration power. The return spring on the ACR is the only serviceable part. The ACR is a component part of the camshaft assembly and if the ACR fails, the camshaft assembly must be replaced.

MUFFLER REMOVAL AND INSTALLATION

Removal and installation procedures for the muffler system are the same for the FE350 and FE400 engines, but the gasket (12) and shape of the muffler and pipe are different **(Figure 4-2, Page 4-4)**.

CYLINDER BLOCK

See on page 1-1.

While the engine is disassembled, inspect the cylinder block for cracks, stripped bolt holes, broken fins, or cylinder wall scoring. Repair or replace as necessary.

1. Use an inside micrometer or telescoping gauge, together with a micrometer, to measure the cylinder bore.

Cylinder Block, Continued:

2. Make the first measurement parallel with the crankshaft and the second at right angles to the crankshaft at three different locations in the bore. The first measurement location is 0.4 inch (10 mm) from the top of the cylinder. The second location is in the center or 2.4 inches (60 mm) from the top, and the third location is 0.3 inch (8 mm) from the bottom of the cylinder or bottom of ring travel. **See locations 1, 2, and 3 (Figure 4-3, Page 4-4)**.

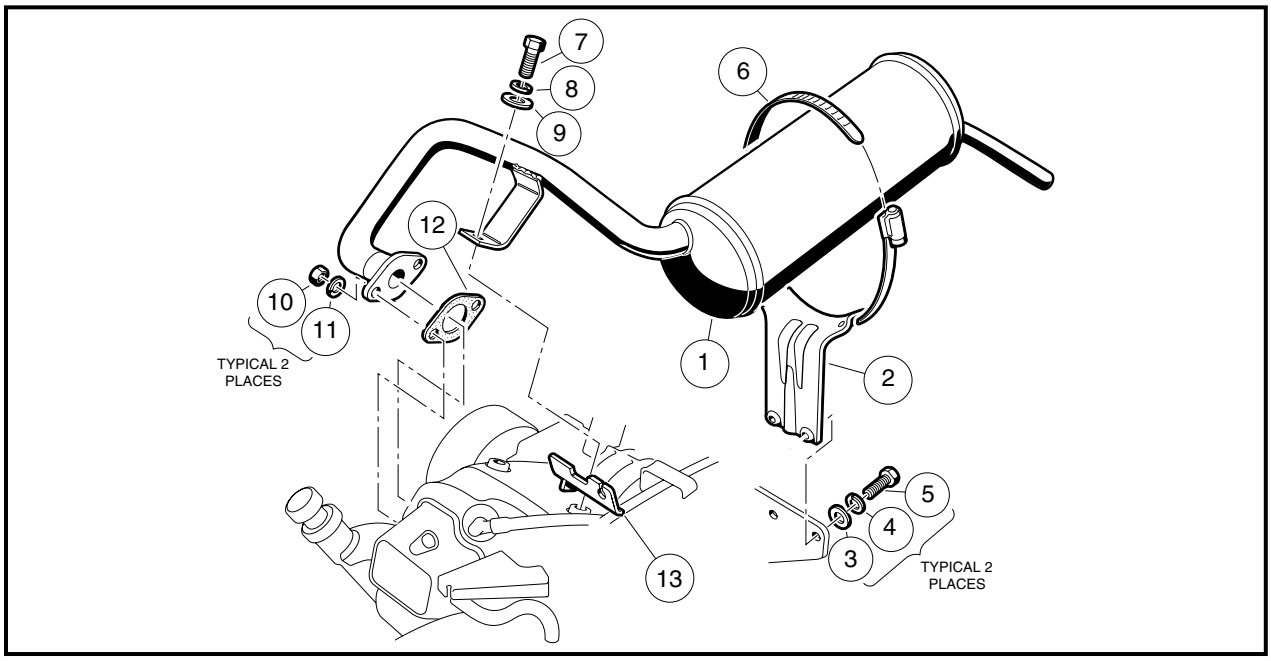


Figure 4-2 Muffler System – FE400 Engine

3. Engine Bore Dimensions: **FE400**
   3.1. The standard bore diameter is 3.4278 inches (87.067 mm).
   3.2. The maximum cylinder bore diameter wear limit is 3.4278 inches (87.067 mm).
   3.3. The maximum acceptable out of round cylinder bore is 0.022 inches (0.56 mm).
4. If the cylinder bore is not within these measurements, the cylinder bore will need to be resized where applicable.

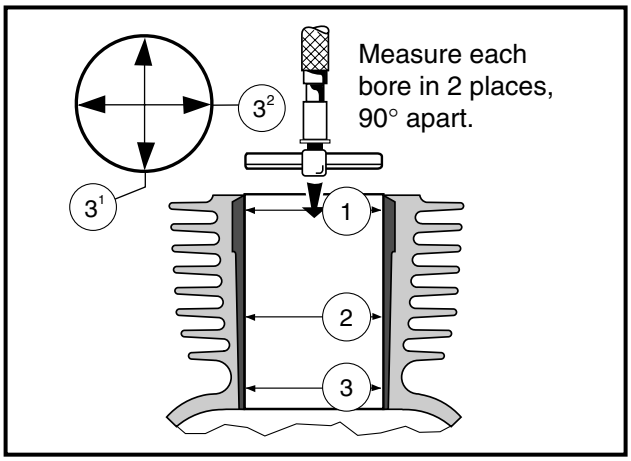


Figure 4-3 Measure Cylinder Bore

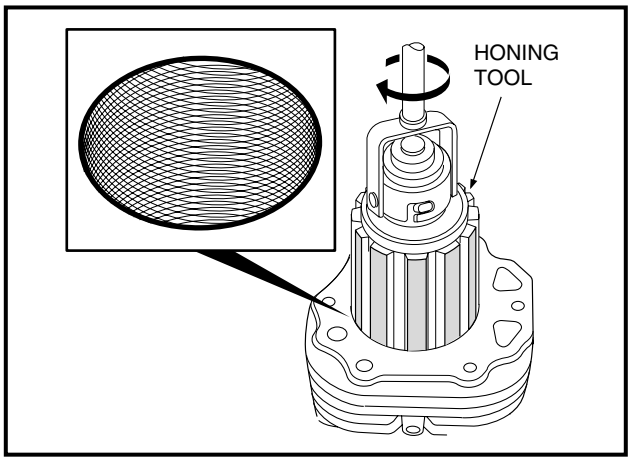


Figure 4-4 Hone Cylinder

To Resize Bore to Next Oversize

CAUTION

- **It is not recommended that the bore size of the FE400 be made larger than standard bore size.**

1. The standard bore size is 3.4478 inches (87.574 mm). **See Specifications for Resizing Cylinder Bore on page 4-6.**

NOTE: *The bore diameter can be increased by honing to correct an out of round condition to a total of .022 inches (0.56 mm) maximum diameter.*

2. Hone the cylinder to the final bore diameter of 3.4698 inches (88.133 mm). **See Specifications for Resizing Cylinder Bore on page 4-6. See following CAUTION and NOTE**.

NOTE: *The cylinder wall finish should have a 40° to 60° cross-hatch pattern **(Figure 4-4, Page 4-4).***

Do not use solvents or gasoline to clean cylinder after honing. Solvents and gasoline allow the grindings to remain in the honed surface and will not provide a surface suited for ring seating.

3. After honing, clean the cylinder wall thoroughly using soap, warm water and clean rags.
4. Dry the cylinder and coat with engine oil. **See following CAUTION.**

CAUTION

- **The cylinder must be thoroughly cleaned after honing to eliminate all grit.**

Crankshaft and Counterbalance Weight

⚠ WARNING

- **Before assembly, make sure all parts are clean.**

CAUTION

- **The crankshaft and counterbalance weight look the same on the FE350 and FE400 engines, but they are not. Do not mix. The crankshaft and counterbalance weight for each engine are designed to be fitted as a set.**

NOTE: *The crankshaft for the FE400 engine has a different center line dimension from the main journal to the rod journal than the FE350. They are not interchangable.*

The counterbalance weight has different dimensions for the FE400 engine than the FE350. They are not interchangable.

When reassembling the crankshaft and the counterbalance weight, apply a light film of engine oil to the crankshaft journals and guide shaft.

Piston and Connecting Rod

NOTE: *The piston connecting rod for the FE350 and FE400 engines are the same. But, it's not recommended to mix a rod from one engine with a rod from another engine after either has been used.*

The pistons for the FE350 and FE400 are different. The piston for the FE400 is larger in diameter and the rod pin is on a different center line from the top of the piston surface.

ENGINE INSTALLATION

⚠ CAUTION

- **The FE400 engine is designed to be used on the MC012C-AS00 transaxle. Do not use it on any other transaxle assembly.**

See Engine Installation in the appropriate maintenance and service manual.

SERVICE SPECIFICATIONS

ITEM	SERVICE LIMIT FE400 ENGINE
Camshaft axial play	0.024 in. (0.06 mm)
Cylinder bore (standard)	3.4278 in. (87.067 mm) inner diameter standard
Cylinder bore (maximum)	3.4278 in. (87.067 mm) inner diameter maximum

SPECIFICATIONS FOR RESIZING CYLINDER BORE

ITEM	HONING OVERSIZE	FE400 LIMITS
Finished honed bore diameter	Not applicable	3.4278 in. (87.067 mm))

TORQUE SPECIFICATIONS

ITEM	SIZE	FE350 AND FE400 LIMITS
Cylinder head bolts	M8	17.5 ft-lb (24 N·m)
Connecting rod bolts (coat threads with engine oil)	M7	16.5 ft-lb (23 N·m)
Flywheel retaining nut	M18	100 ft-lb (135 N·m)
Crankcase cover to block bolts	M8	22 ft-lb (31 N·m)
Starter/Generator bracket to block bolts	M8	16.5 ft-lb (23 N·m)
Oil drain plug	M14	16.5 ft-lb (23 N·m)
Fan housing screws	M6	90 in-lb (10 N·m)
Fan shroud screws	M6	25 in-lb (2.8 N·m)
Bolts marked with “4” (when used with nuts)	M8 M6 M5	130 in-lb (15 N·m) 50 in-lb (5.9 N·m) 30 in-lb (3.4 N·m)

ADJUSTMENT AND SETTINGS

ITEM	SERVICE LIMIT FE400 ENGINE
Engine RPM	3850 (±30) RPM

SECTION 5 – MC008C-ES00 AND MC008C-FS00 UNITIZED TRANSAXLES

⚠ DANGER

- **See General Warning on page 1-1.**

⚠ WARNING

- **See General Warning on page 1-1.**

GENERAL INFORMATION

The MC008C-ES00 and MC008C-FS00 are heavy-duty, fully-synchronized unitized transaxles. With fully-synchronized internal gearing to change vehicle direction, wear and maintenance requirements on the engine, drive clutch, belt, and driven clutch are greatly reduced. All components rotate in the same direction; therefore, the engine and clutches are not subjected to reversing loads. Power is transferred from the engine through the drive clutch, the drive belt, the driven clutch, then through the unitized transaxle to the wheels.

TRANSAXLE MODELS AND IDENTIFICATION

The MC008C-ES00 transaxle has been supplied on all FE290 gasoline engine powered Club Car vehicles since the beginning of the 1997 model year **(Figure 5-1, Page 5-1)**. The MC008C-FS00 replaced the ES00 model in October, 2003. Both operate the same. Most parts and housing are the same. The input shaft and associated bearings are different between the two models. All parts are identified in their respective illustrated parts list (IPL) manuals. Both models are illustrated here for purposes of service procedures. All illustrated references will be shown for the MC008C-ES00 except where components are specific to the MC008C-FS00.

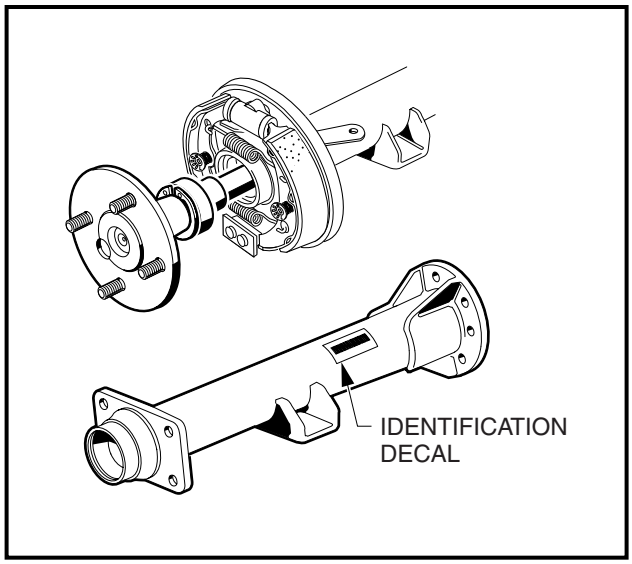


Figure 5-1 MC008C-ES00

Tools Required For This Section

Hydraulic floor jack (or chain hoist)	12 to 18 in. straight edge	17 mm socket, 3/8 in. drive
Jack stands (2) (one ton capacity)	Small ball peen hammer (10 oz.)	7/16 in. combination wrench
Hydraulic press	Plastic or rubber mallet	1/2 in. combination wrench
Bench vise	Ratchet wrench, 3/8 in. drive	9/16 in. combination wrench
Standard slip joint pliers	Torque wrench, 3/8 in. drive	11/16 in. combination wrench (2)
External snap ring pliers (.070 in. tip)	3/8 in. Socket, 3/8 in. drive	17 mm combination wrench
External snap ring pliers (.047 in. tip)	7/16 in. Socket, 3/8 in. drive	Small flat blade screwdriver
90° Internal snap ring pliers (.090 in. tip)	10 mm Combination wrench	Medium flat blade screwdrivers (2)
Feeler gauge	1/2 in. Socket, 3/8 in. drive	No. 2 phillips head screwdriver
16 in. rolling head prybar	9/16 in. Socket, 3/8 in. drive	1/4 in. nut driver
Small punch or scratch awl	5/8 in. Socket, 3/8 in. drive	5/16 in. nut driver
1/4 in. diameter drift or metal rod	12 mm Socket, 3/8 in. drive	Small knife or wire snippers
Bearing puller wedge attachment (CCI P/N 1012812)	Axle seal tool (CCI P/N 1014162)	Governor gear shaft installation tool (CCI P/N 101933101)

AXLE SHAFT

See Axle Shaft and Oil Seal Removal, Section 16, in the appropriate maintenance and service manual.

UNITIZED TRANSAXLE REMOVAL

See Unitized Transaxle Removal, Section 16, in the appropriate maintenance and service manual.

UNITIZED TRANSAXLE DISASSEMBLY

See General Warning on page 1-1.

NOTE: *The following information provides instructions for disassembling the unitized transaxle and internal gears.*

1. Position the unitized transaxle case on a clean bench surface with the bottom lubrication plug over a pan suitable for draining lubrication oil.
2. Remove both the top and bottom lubrication port plugs and gaskets. Drain and dispose of the oil properly **(Figure 5-2, Page 5-3)**. **See following NOTE.**

NOTE: *The lower plug is used for draining lubricant. When draining lubricant, remove both plugs to allow the lubricant to drain faster.*

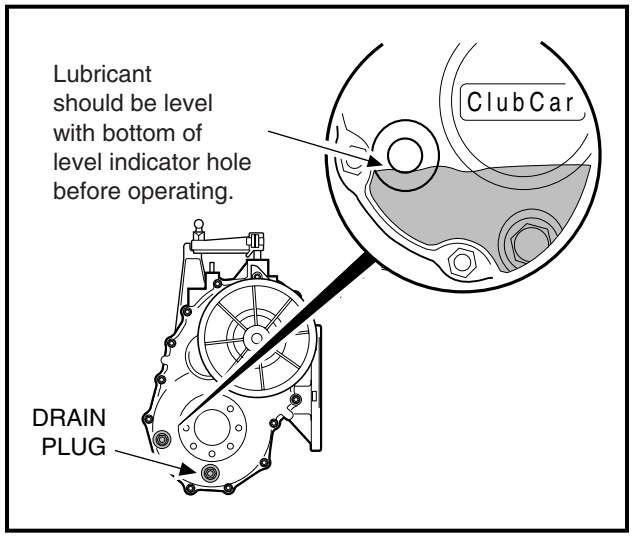


Figure 5-2 Lubricant Fill and Drain Plugs

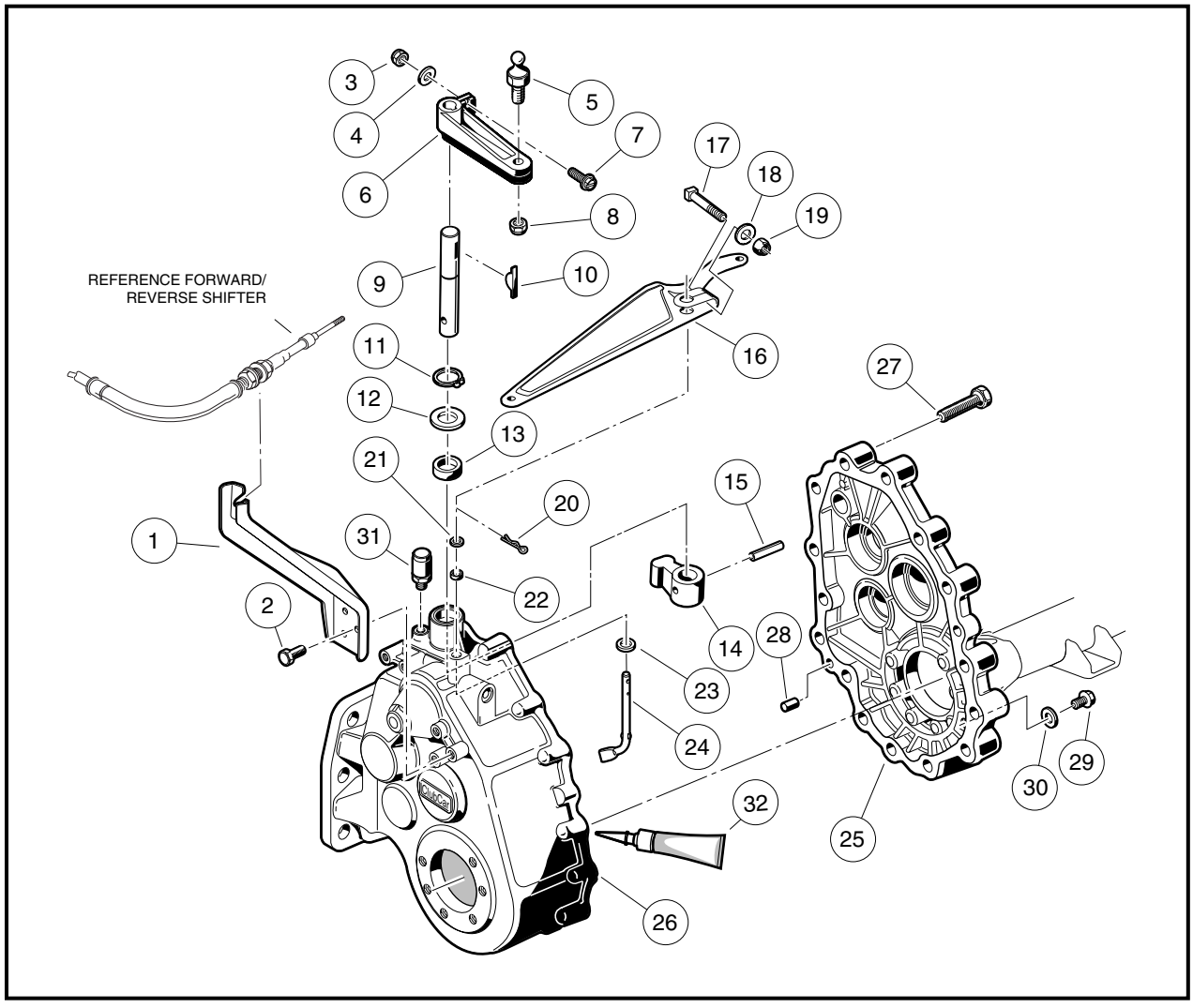


Figure 5-3 Transaxle Gear Casing and Brackets

Unitized Transaxle Disassembly, Continued:

3. Remove the fifteen bolts (27) that hold the transaxle housing together **(Figure 5-3, Page 5-3)**.
4. The transaxle is equipped with a slot for prying the housing apart. Use the slot to open the case. Make sure all gear assemblies inside the transaxle stay together in one (either) side of the case. **See following CAUTION.**

CAUTION

- **To prevent damage to the mating seal surfaces of the case, use care when separating the halves.**

5. Turn the case section containing the gearing on edge **(Figure 5-4, Page 5-4)**. Hold it in this position and gently rock all the gear assemblies to slightly loosen them in their seating. **See following CAUTION.**

CAUTION

- **To prevent damage to the gears, use extreme care when handling them.**

6. Remove the differential gear case assembly by gently rocking it while pulling it from the case **(Figure 5-5, Page 5-4)**.
7. Continue to rock and loosen the remaining gear assemblies until the intermediate gear assembly can be removed. Remove the idler shaft assembly **(Figure 5-6, Page 5-5)**.

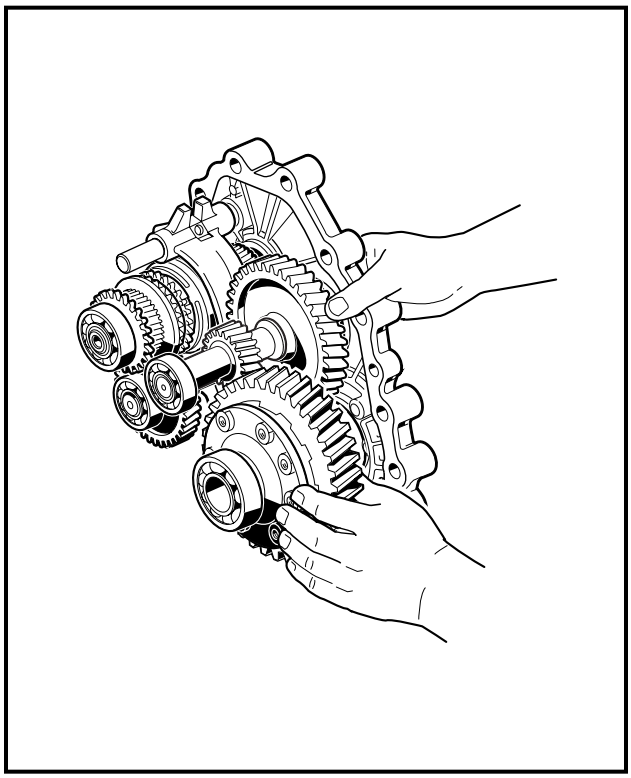


Figure 5-4 Loosen Gears

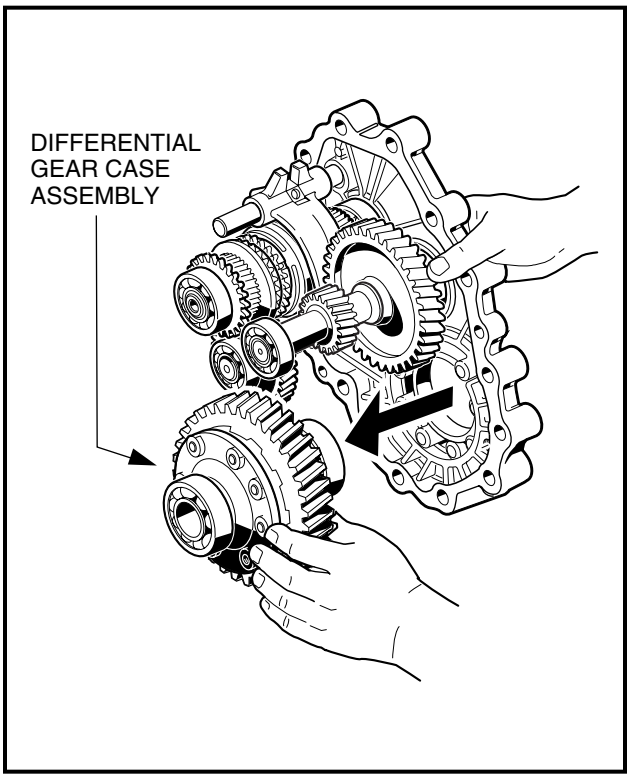


Figure 5-5 Remove Differential Gear Case

8. Remove the synchronizer gear assembly and shifter fork assembly as a unit **(Figure 5-6, Page 5-5)**.
9. Use a seal puller (CCI P/N 1012809) or rolling head prybar to remove the input shaft oil seal **(Figure 5-7, Page 5-5)**.

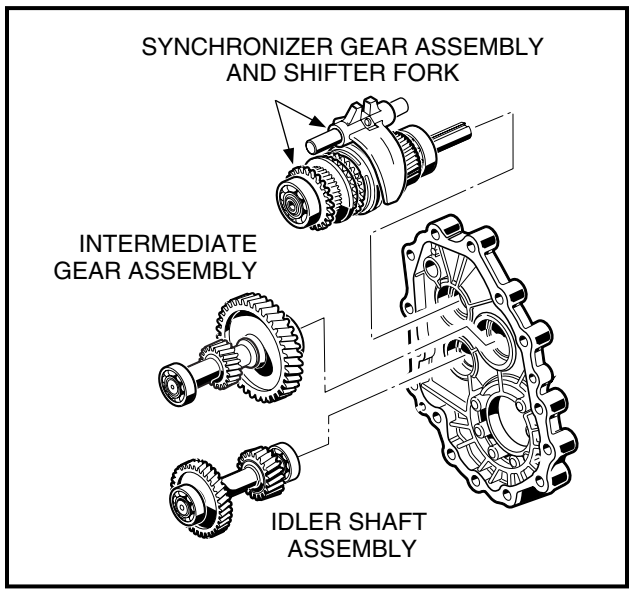


Figure 5-6 Remove Intermediate Gear

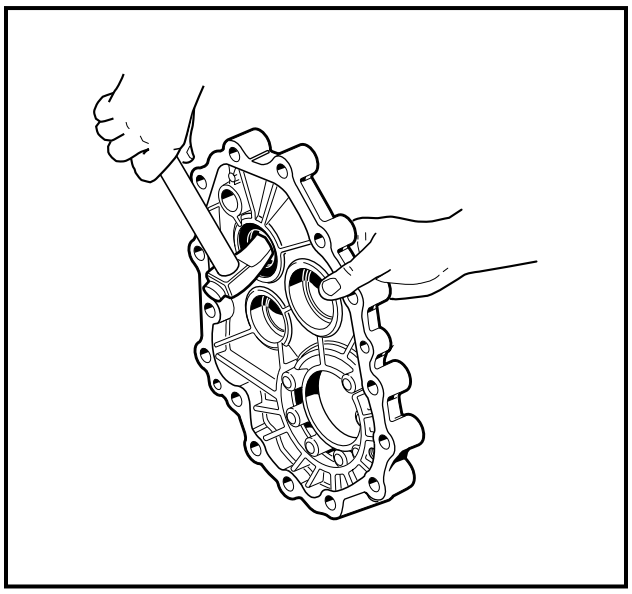


Figure 5-7 Input Shaft Oil Seal

10. Remove the oil flow guide **(Figure 5-8, Page 5-6)**.
11. Remove the shifter shaft and oil seal **(Figure 5-8, Page 5-6)**.
    - 11.1. Loosen nut (3), washer (4) and bolt (7) on transaxle shifter lever and remove lever from shaft **(Figure 5-3, Page 5-3)**.
    - 11.2. Remove woodruff key (10) from shaft.
    - 11.3. Use snap ring pliers (0.047 tip) to remove the retaining ring (11) on the shifter shaft.
    - 11.4. Remove flat washer (12) from the shifter shaft on the outside of the case, then remove the shifter shaft by pushing it through the case toward the interior of transaxle.
    - 11.5. Use a seal puller to remove the shifter shaft oil seal (13).
12. Remove the breather (31) **(Figure 5-3, Page 5-3)**.
13. Remove the governor assembly.
    - 13.1. Remove the cotter pin (20) and flat washer (21) from the pivot arm (24).
    - 13.2. Remove the pivot arm (24) by pulling it through the wall to the interior of the case.
    - 13.3. Use a small chisel or similar pointed instrument to pry the pivot arm oil seal (22) out of the case **(Figure 5-3, Page 5-3)**. **See also Figure 5-9, Page 5-6**.
    - 13.4. Remove the governor gear assembly (63 and 64) and flat washer (62) **(Figure 5-11, Page 5-7)** by lightly tapping the gear shaft through the case wall, from the outside, with a hammer and drift . **See also Figure 5-10, Page 5-6.**

Unitized Transaxle Disassembly, Continued:

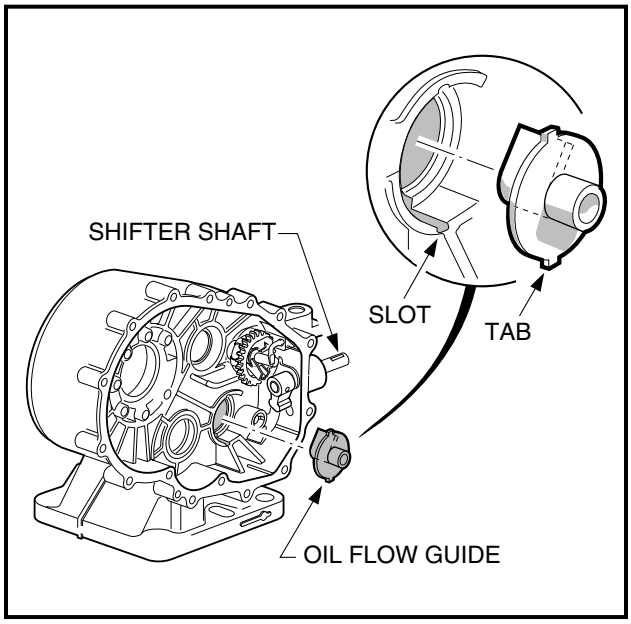


Figure 5-8 Oil Flow Guide

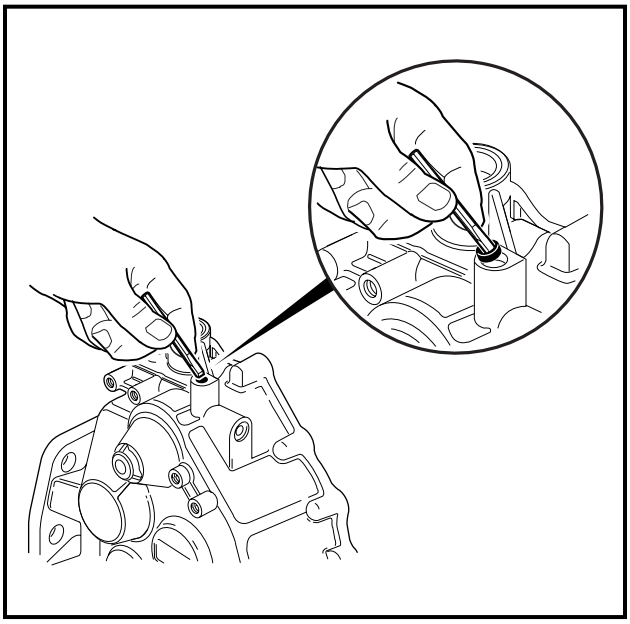


Figure 5-9 Pivot Arm Oil Seal

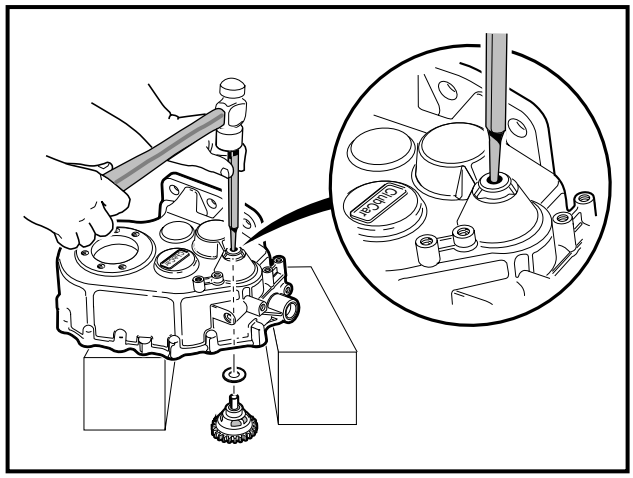


Figure 5-10 Remove Governor Gear

COMPONENT DISASSEMBLY

See General Warning on page 1-1.

GOVERNOR GEAR DISASSEMBLY

NOTE: *It will be necessary to disassemble the governor gear assembly in order to install it into the transaxle case.*

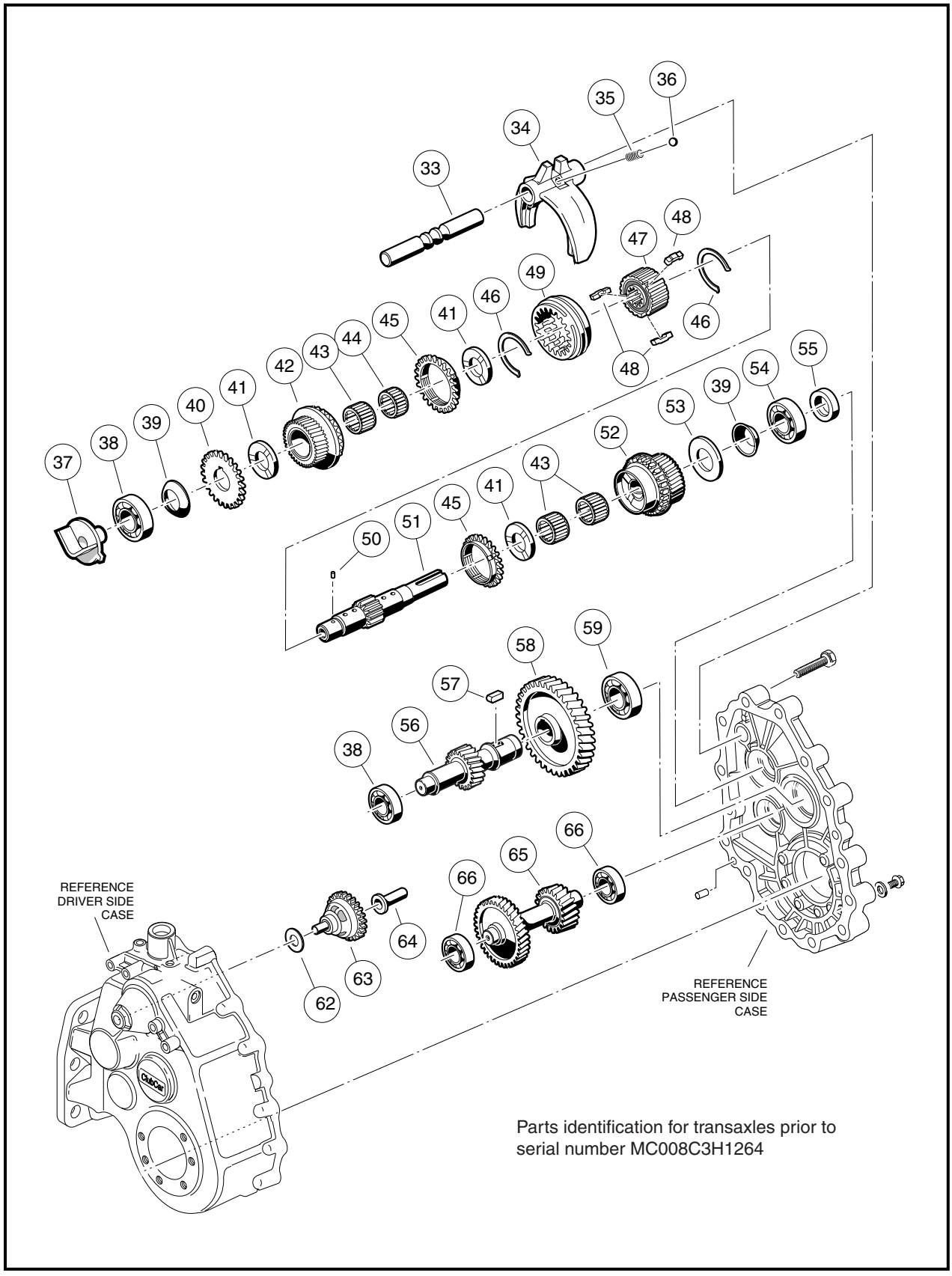


Figure 5-11 MC008C-ES00 Unitized Transaxle

Governor Gear Disassembly, Continued:

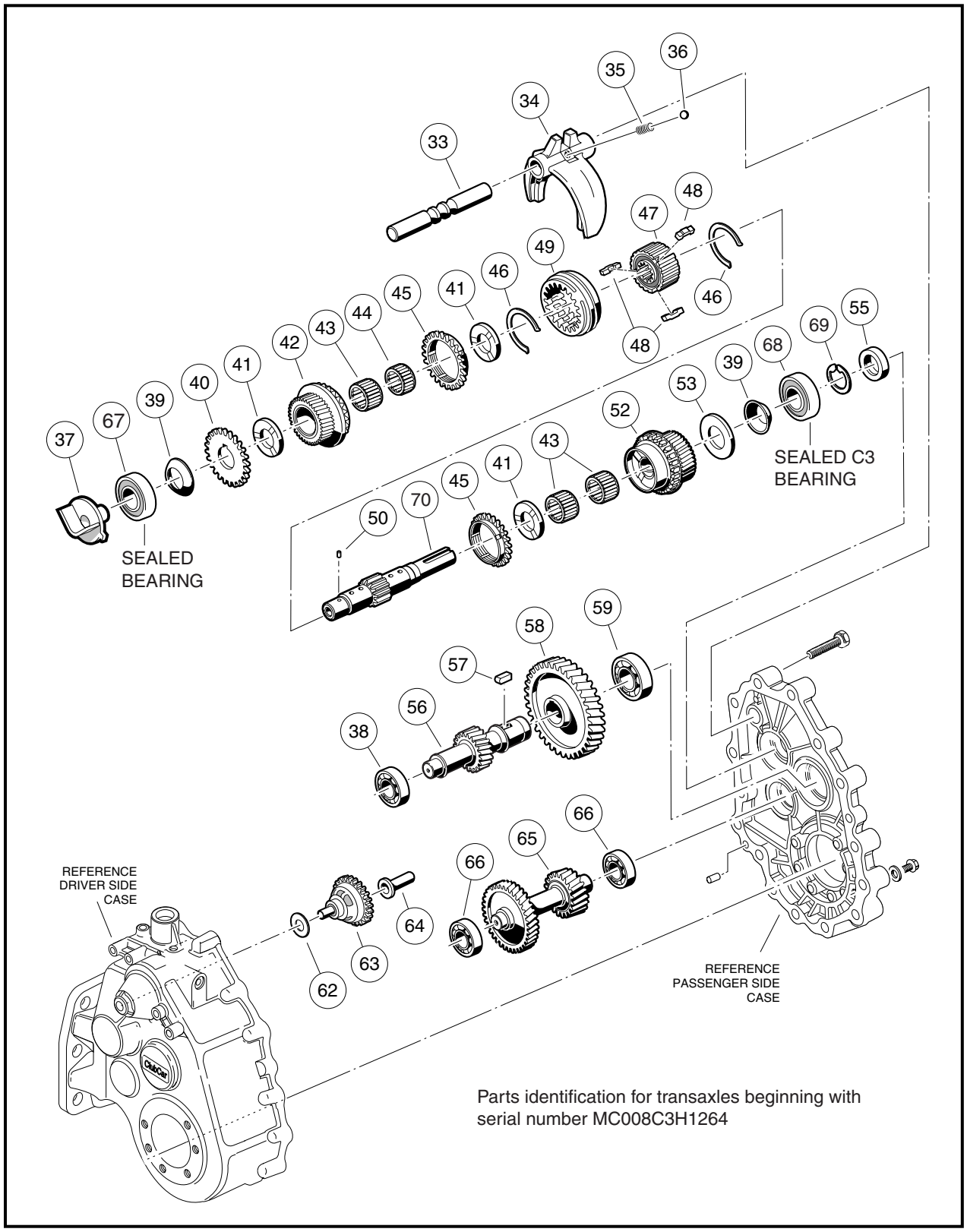


Figure 5-12 MC008C-FS00 Unitized Transaxle

1. Secure the governor gear assembly in a vise. Wrap shaft in a cloth to prevent damage **(Figure 5-13, Page 5-9)**.

2. Use two small screwdrivers to pry the gear and flyweight off the shaft.

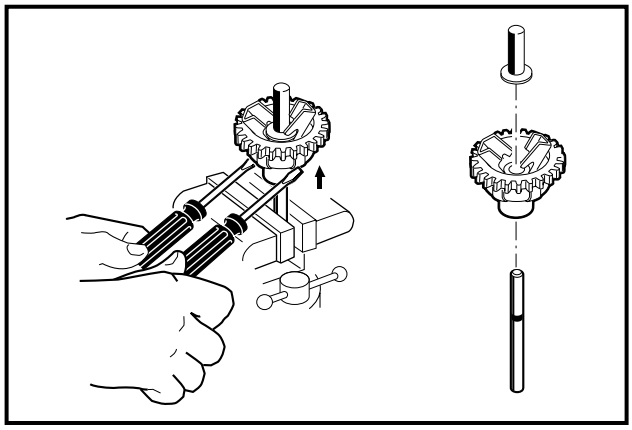


Figure 5-13 Pry Gear from Shaft

DIFFERENTIAL GEAR CASE DISASSEMBLY

CAUTION

- **Mark parts for identification as they are disassembled. Parts must be assembled in their original locations and orientations.**

1. Remove eight ring gear retaining bolts (80) and remove the ring gear from the assembly **(Figure 5-14, Page 5-9)**.

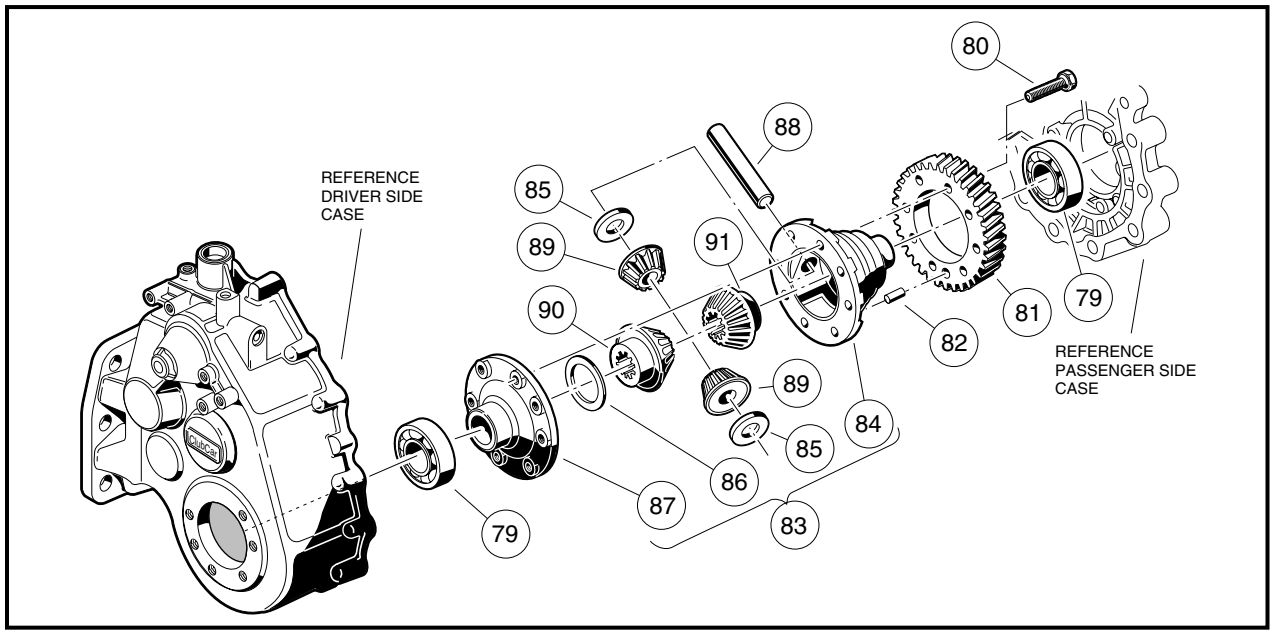


Figure 5-14 Differential Gear Case

Differential Gear Case Disassembly, Continued:

2. It may be necessary to tap the ring gear off with a plastic or rubber mallet **(Figure 5-15, Page 5-10)**. **See following NOTE.**

NOTE: *Loctite® was applied to the bolts during assembly. It may be necessary to place the differential gear case in a vise to remove the bolts.*

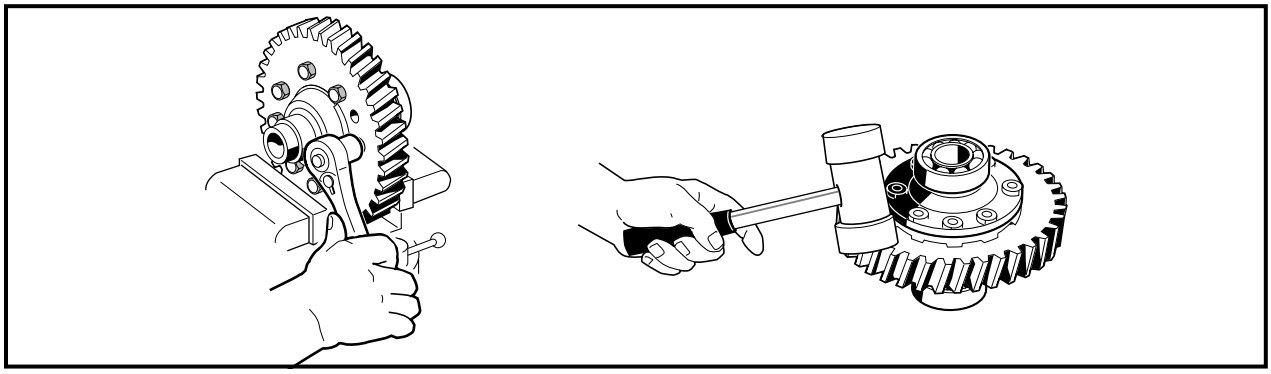


Figure 5-15 Remove Ring Gear

3. Pull the cover (87) and thrust plate (86) from the differential gear carrier case **(Figure 5-14, Page 5-9)**.
4. Remove the differential gear (90) from the differential gear carrier case.
5. Remove the differential pin (88) by pushing it through from one side **(Figure 5-14, Page 5-9)**. Remove the two differential idler gears (89) and two idler gear thrust plates (85) as the pin is driven through **(Figure 5-16, Page 5-10)**.

NOTE: *It may be necessary to drive the differential pin out with hammer and punch.*

6. Remove the differential gear (91) from the carrier case **(Figure 5-14, Page 5-9)**.
7. If the bearings (79) are to be removed, place a bearing puller wedge attachment (CCI P/N 1012812) between the bearing and gear case (84) and press the bearing off **(Figure 5-14, Page 5-9 and Figure 5-17, Page 5-10)**. Repeat the process for the bearing on the carrier cover (87)**. See following CAUTION.**

CAUTION

- **Do not tighten the bearing puller wedge attachment against the shaft.**

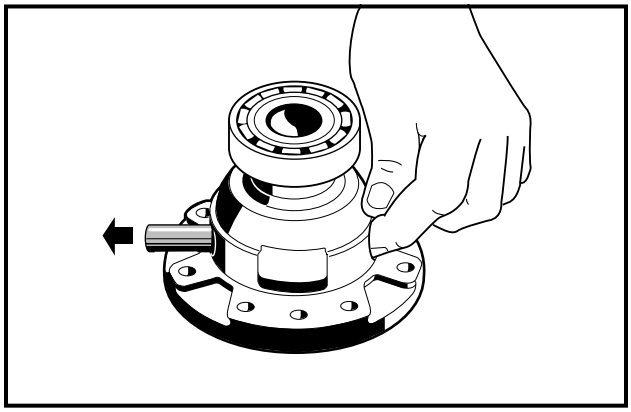


Figure 5-16 Differential Pin

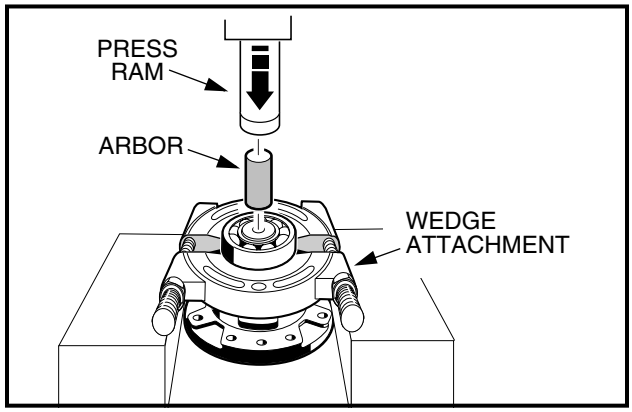


Figure 5-17 Remove Bearing

SHIFTER FORK DISASSEMBLY

1. Push the shift rod (33) out of the shifter fork (34) **(Figure 5-11, Page 5-7)**.
2. Shake the shifter fork to remove the spring (35) and ball (36).

SYNCHRONIZER GEAR DISASSEMBLY

CAUTION

- **Mark parts for identification as they are disassembled. Parts must be assembled in their original locations and orientations.**
- **Do not tighten the bearing puller wedge attachment against the shaft. This could damage the shaft.**

1. **MC008C-ES00:**
   1.1. Place a bearing puller wedge attachment (CCI P/N 1012812) between the bearing (38) and spur (governor drive) gear (40) **(Figure 5-11, Page 5-7)**, then press the bearing off the input shaft (51) **(Figure 5-18, Page 5-12)**. **See preceding CAUTION.**
2. **MC008C-FS00:**
   2.1. Place a bearing puller wedge attachment (CCI P/N 1012812) between the sealed bearing (67) and spur (governor drive) gear (40) **(Figure 5-12, Page 5-8)**, then press the bearing off the input shaft (70) **(Figure 5-18, Page 5-12)**. **See preceding CAUTION.**
3. Pull the spring washer (39), spur gear (40), dowel pin (50), thrust plate (41), input gear assembly (42), large needle bearing (43), small needle bearing (44), synchronizer ring (45), and thrust plate (41) from the input shaft **(Figure 5-11, Page 5-7)**.
4. **MC008C-ES00:**
   4.1. Place a bearing puller wedge attachment (CCI P/N 1012812) between the bearing (54) and input gear assembly (52) **(Figure 5-11, Page 5-7)**, then press the bearing off the input shaft (51) **(Figure 5-19, Page 5-12)**. **See following CAUTION.**
5. **MC008C-FS00:**
   5.1. Remove the external snap ring (69) from the input shaft (70) **(Figure 5-12, Page 5-8)**.
   5.2. Place a bearing puller wedge attachment (CCI P/N 1012812) between the sealed C3 bearing (68) and input gear assembly (52) **(Figure 5-12, Page 5-8)**, then press the bearing off the input shaft (70) **(Figure 5-19, Page 5-12)**. **See following CAUTION.**

CAUTION

- **Do not tighten the bearing puller wedge attachment against the shaft.**

6. Pull the spring washer (39), thrust washer (53), input gear assembly (52), two needle bearings (43), thrust plate (41), and synchronizer ring (45) from the input shaft **(Figure 5-11, Page 5-7)**.

Synchronizer Gear Disassembly, Continued:

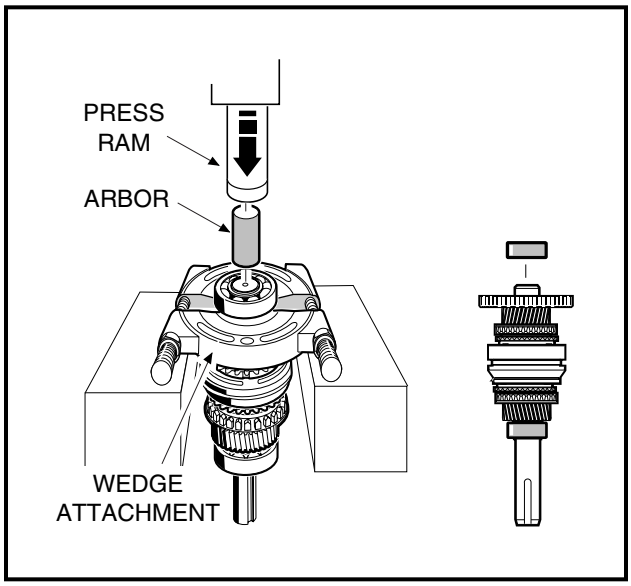


Figure 5-18 Remove Bearing

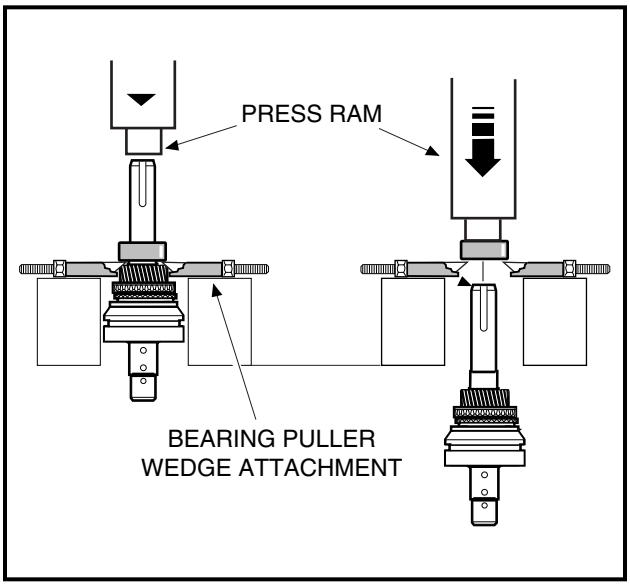


Figure 5-19 Remove Bearing

7. Use a small flat-blade screwdriver to remove two synchronizer springs (snap rings) (46), then slide the synchronizer clutch hub (49) from the input shaft (51). **See following NOTE.**

NOTE: *There are three synchronizer inserts (48) set into slots in the synchronizer sleeve (47)* ***(Figure 5-11, Page 5-7).*** *These may fall free when the synchronizer clutch hub (49) is removed. Do not lose these inserts.*

8. Remove the three synchronizer inserts (48) from the synchronizer sleeve **(Figure 5-11, Page 5-7)**.
9. Press the synchronizer sleeve (47) from the input shaft.

INTERMEDIATE GEAR DISASSEMBLY

1. Place bearing puller wedge attachment (CCI P/N 1012812) between bearing (38) and shaft/gear (56) **(Figure 5-11, Page 5-7)**, then press bearing off shaft **(Figure 5-20, Page 5-13). See following CAUTION.**

CAUTION

- **Do not tighten the bearing puller wedge attachment against the shaft. This could damage the shaft.**

2. Place the bearing puller wedge attachment under the bearing (59) and press the bearing from the shaft **(Figure 5-11, Page 5-7)**. **See following CAUTION.**
3. Press the gear (58) from the shaft (56), then remove the key (57) **.**

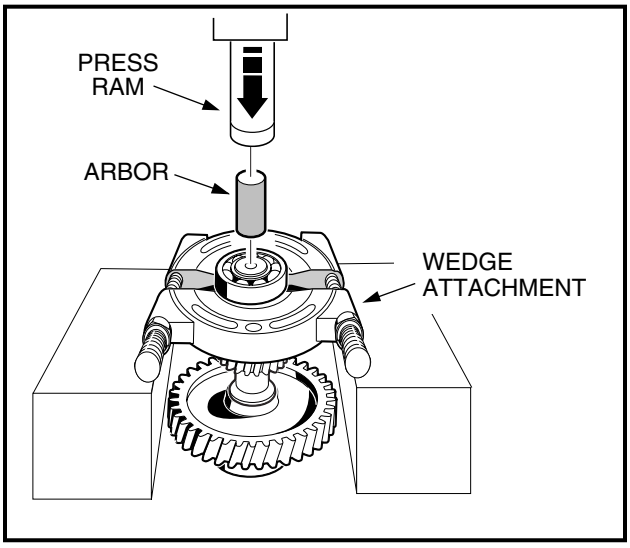


Figure 5-20 Remove Bearing

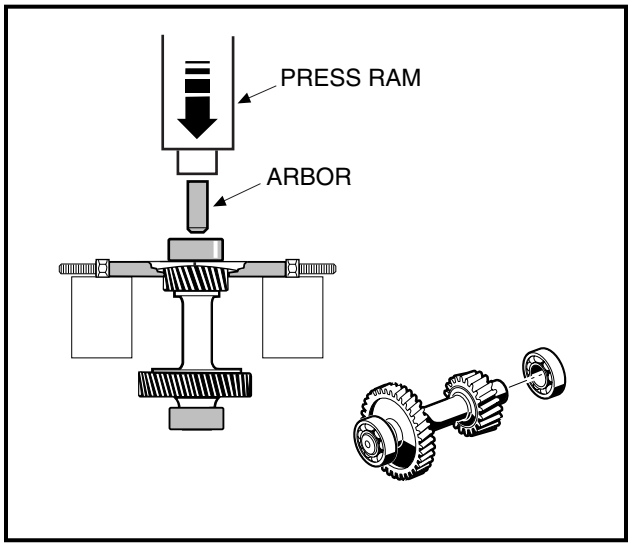


Figure 5-21 Remove Bearing

IDLER SHAFT DISASSEMBLY

1. Place a bearing puller wedge attachment (CCI P/N 1012812) between the bearing (66) and the small gear on the idler shaft (65) **(Figure 5-11, Page 5-7)**, then press the bearing off the shaft as shown **(Figure 5-21, Page 5-13). See following CAUTION.**

CAUTION

- **Do not tighten the bearing puller wedge attachment against the shaft. The shaft could be damaged when pressing the bearing off.**

2. Place a bearing puller wedge attachment (CCI P/N 1012812) between the bearing and the larger gear on the idler shaft (65) **(Figure 5-11, Page 5-7)**, then press the bearing off the shaft as shown **(Figure 5-22, Page 5-13)**.

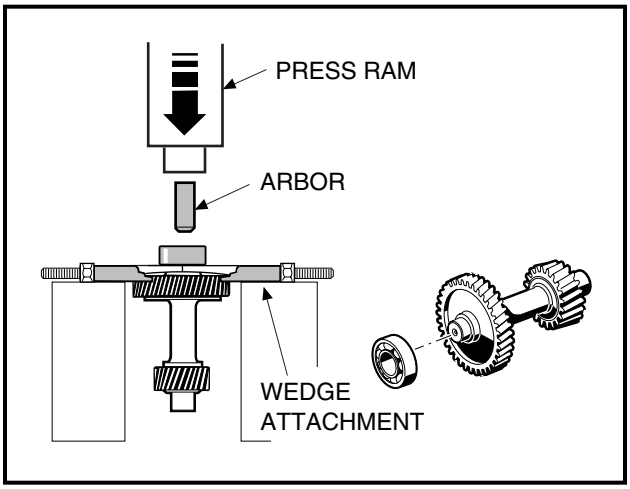


Figure 5-22 Remove Idler Shaft

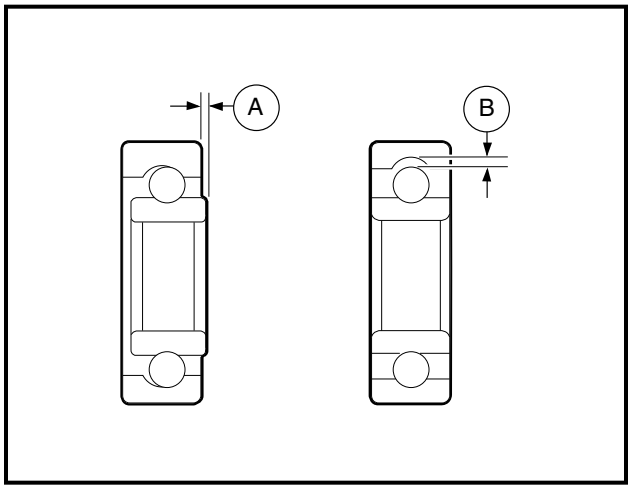


Figure 5-23 Inspect Bearings

UNITIZED TRANSAXLE COMPONENT INSPECTION

See General Warning on page 1-1.

1. Clean all of the component parts of the transaxle in a high flash-point solvent and dry them. Inspect all components for excessive wear or damage.
2. Inspect all bearings by spinning them by hand. Check the bearings for excessive axial (A) and radial (B) play **(Figure 5-23, Page 5-13)**. Replace bearings if they do not spin smoothly, if they are noisy, or if they have excessive play. Replace bearings if they are rusted, worn, cracked, pitted, or discolored.
3. Gears should be inspected for tooth surface damage or fractures.
4. Synchronizer ring teeth should be inspected for severe wear, fractures, or other damage.
5. Using a feeler gauge, measure the distance X at several points around the assembly. The synchro ring should be replaced when X is 0.02 inch (0.5 mm) or less **(Figure 5-24, Page 5-14).**

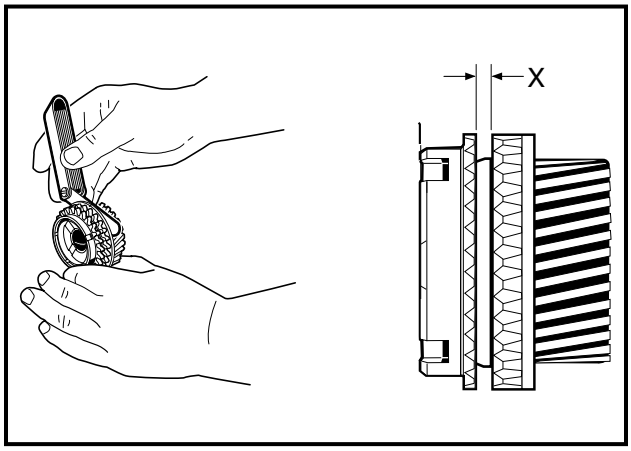


Figure 5-24 Synchronizer Ring

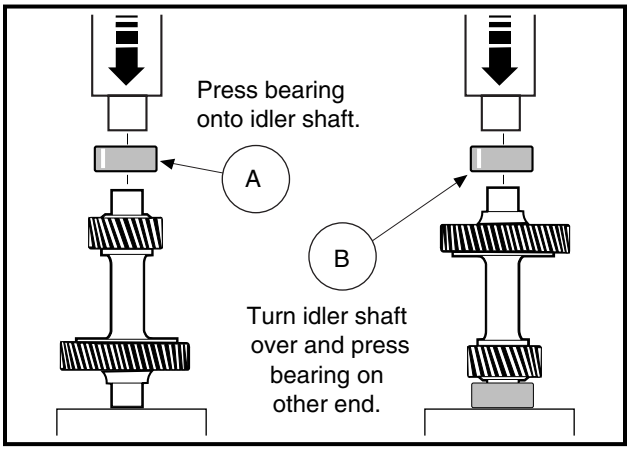


Figure 5-25 Idler Shaft

COMPONENT ASSEMBLY

See General Warning on page 1-1.

IDLER SHAFT ASSEMBLY

1. Press a new bearing (66) **(Figure 5-11, Page 5-7)** onto each end of the idler shaft **(Figure 5-25, Page 5-14)**. **See following CAUTION.**

CAUTION

- **Apply pressure against the inner race of the bearing only. Applying pressure anywhere else will damage the bearing.**

INTERMEDIATE GEAR ASSEMBLY

1. If the gear (58) was removed from the shaft, install the key (57) into the slot and then position the gear on the shaft with keyway properly aligned with key. Press gear into place on the key **(Figure 5-11, Page 5-7)**.
2. Press the bearing (59) onto the end of the shaft next to the large gear that was installed in step 1. **See preceding CAUTION.**
3. Press a new bearing (38) onto the other end of the shaft.

SYNCHRONIZER GEAR ASSEMBLY

1. **MC008C-ES00:**

   1.1. Press the synchronizer sleeve (47) onto the splines of the input shaft (51) **(Figure 5-11, Page 5-7)**. No particular orientation of the sleeve is necessary, but toward the short end of the shaft, the machined circular face surrounding the ends of the internal splines in the sleeve must be flush with the machined lip of the shaft at the ends of the shaft splines **(Figure 5-26, Page 5-15)**.

   1.2. Install the synchronizer springs (46) **(Figure 5-11, Page 5-7)** in the sleeve **(Figure 5-27, Page 5-15)**. **See following NOTE.**

NOTE: *Make sure the ends of the springs are positioned between the synchronizer insert slots **(Figure 5-27, Page 5-15)**.*

   1.3. Install the three synchronizer inserts (48) into the slots in the sleeve **(Figure 5-11, Page 5-7)**. Make sure the notched surfaces of the inserts are facing outward **(Figure 5-28, Page 5-17)**.

   1.4. Install the synchronizer clutch hub (49) **(Figure 5-11, Page 5-7)** onto the synchronizer sleeve. Make sure the chamfered end of the hub is oriented toward the long end of the input shaft **(Figure 5-29, Page 5-17).**

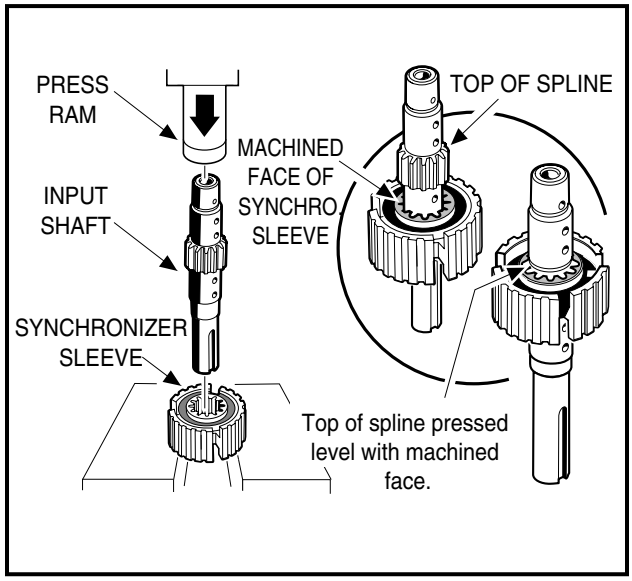


Figure 5-26 Synchronizer Gear Assembly

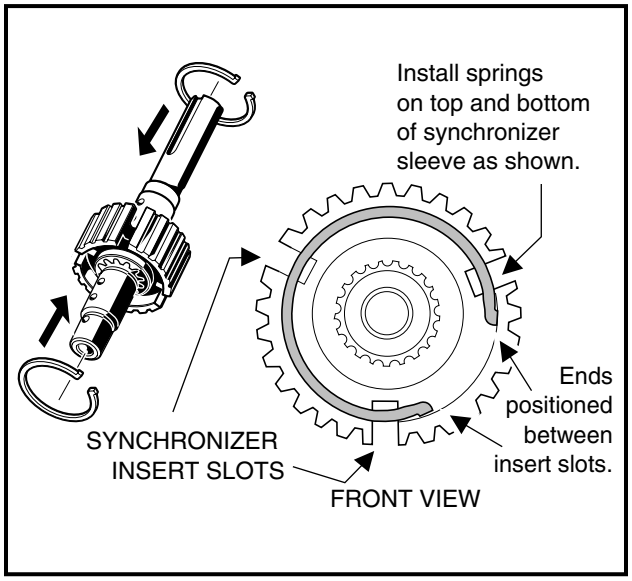


Figure 5-27 Synchronizer Springs

   1.5. On the long end of the shaft, install the synchronizer ring (45) **(Figure 5-11, Page 5-7)** with the smooth collar of the ring towards the clutch hub. Make sure the three notches in the collar mate with the synchronizer inserts in the synchronizer sleeve **(Figure 5-30, Page 5-18)**.

   1.6. Install a thrust washer (41) and two bearings (43) **(Figure 5-11, Page 5-7)**.

   1.7. Install the input gear assembly (52) with the smooth collar toward the synchronizer ring. The input gear should seat in the synchronizer ring.

   1.8. Install the thrust washer (53), then the spring washer (39). The spring washer should be oriented with the raised center toward the end of the shaft.

   1.9. Press a new bearing (38) onto the shaft (51) until it seats. Make sure the input gear turns freely **(Figure 5-11, Page 5-7)**. **See following CAUTION.**

Synchronizer Gear Assembly, Continued:

CAUTION

- **Apply pressure against the inner race of the bearing only. Applying pressure anywhere else will damage the bearing.**

1.10. Install remaining thrust washer (41) and the synchronizer ring (45) onto the other end of the input shaft. The smooth collar of the synchronizer ring should be oriented toward the clutch hub, and the notches in it should mate with the synchronizer inserts.

1.11. Install the narrow bearing (44), wide bearing (43), and input gear (42) onto the shaft. The smooth collar of the input gear should be oriented toward the synchronizer ring. The gear should seat inside the ring.

1.12. Install thrust plate (41) onto the shaft and the dowel pin (50) into the shaft.

1.13. Install the spur (governor drive) gear (40) onto the shaft with either side down. Mate the notch in the gear with the dowel pin.

1.14. Install the spring washer (39) onto shaft with the raised center toward the end of the shaft.

1.15. Press a new bearing (38) onto the end of the shaft (51) until it seats. Make sure the input gears turn freely **(Figure 5-11, Page 5-7)**. **See following CAUTION.**

1.16. Press a new bearing (54) onto the shaft (51) until it seats. Make sure the input gear turns freely **(Figure 5-12, Page 5-8)**. **See following CAUTION.**

CAUTION

- **Apply pressure against the inner race of the bearing only. Applying pressure anywhere else will damage the bearing.**

2. **MC008C-FS00:**

2.1. Press the synchronizer sleeve (47) onto the splines of the input shaft (70) **(Figure 5-12, Page 5-8)**. No particular orientation of the sleeve is necessary, but toward the short end of the shaft, the machined circular face surrounding the ends of the internal splines in the sleeve must be flush with the machined lip of the shaft at the ends of the shaft splines **(Figure 5-26, Page 5-15)**.

2.2. Install the synchronizer springs (46) **(Figure 5-12, Page 5-8)** in the sleeve **(Figure 5-27, Page 5-15)**. **See following NOTE.**

NOTE: *Make sure the ends of the springs are positioned between the synchronizer insert slots **(Figure 5-27, Page 5-15)**.*

2.3. Install the three synchronizer inserts (48) into the slots in the sleeve **(Figure 5-12, Page 5-8)**. Make sure the notched surfaces of the inserts are facing outward **(Figure 5-28, Page 5-17)**.

2.4. Install the synchronizer clutch hub (49) **(Figure 5-12, Page 5-8)** onto the synchronizer sleeve. Make sure the chamfered end of the hub is oriented toward the long end of the input shaft **(Figure 5-29, Page 5-17).**

2.5. On the long end of the shaft, install the synchronizer ring (45) **(Figure 5-12, Page 5-8)** with the smooth collar of the ring towards the clutch hub. Make sure the three notches in the collar mate with the synchronizer inserts in the synchronizer sleeve **(Figure 5-30, Page 5-18)**.

2.6. Install a thrust washer (41) and two bearings (43) **(Figure 5-12, Page 5-8)**.

2.7. Install the input gear assembly (52) with the smooth collar toward the synchronizer ring. The input gear should seat in the synchronizer ring.

2.8. Install the thrust washer (53), then the spring washer (39). The spring washer should be oriented with the raised center toward the end of the shaft.

2.9. Press a new sealed C3 bearing (68) onto the shaft (70) until it seats. Make sure the input gear turns freely **(Figure 5-12, Page 5-8)**. **See following CAUTION.**

CAUTION

- **Apply pressure against the inner race of the bearing only. Applying pressure anywhere else will damage the bearing.**

2.10. Install the external snap ring (69) on the shaft (70).

2.11. Install remaining thrust washer (41) and the synchronizer ring (45) onto the other end of the input shaft. The smooth collar of the synchronizer ring should be oriented toward the clutch hub, and the notches in it should mate with the synchronizer inserts.

2.12. Install the narrow bearing (44), wide bearing (43), and input gear (42) onto the shaft. The smooth collar of the input gear should be oriented toward the synchronizer ring. The gear should seat inside the ring.

2.13. Install thrust plate (41) onto the shaft and the dowel pin (50) into the shaft.

2.14. Install the spur (governor drive) gear (40) onto the shaft with either side down. Mate the notch in the gear with the dowel pin.

2.15. Install the spring washer (39) onto shaft with the raised center toward the end of the shaft.

2.16. Press a new bearing (38) onto the end of the shaft (51) until it seats. Make sure the input gears turn freely **(Figure 5-11, Page 5-7)**. **See following CAUTION.**

2.17. Press a new sealed bearing (67) onto the shaft (70) until it seats. Make sure the input gear turns freely **(Figure 5-12, Page 5-8)**. **See following CAUTION.**

CAUTION

- **Apply pressure against the inner race of the bearing only. Applying pressure anywhere else will damage the bearing.**

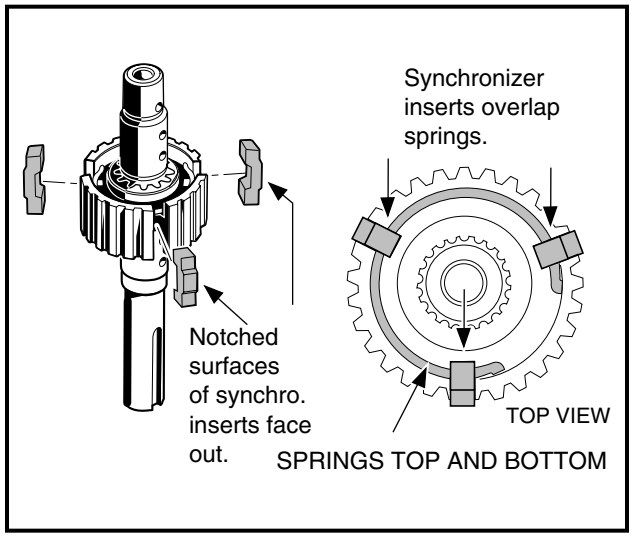


Figure 5-28 Synchronizer Inserts

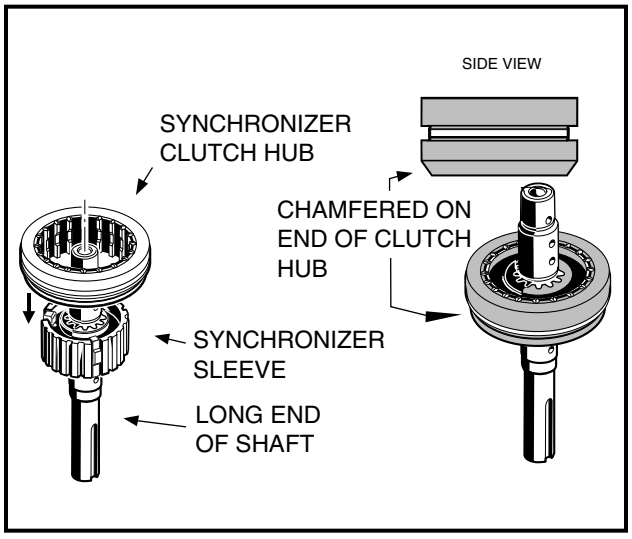


Figure 5-29 Synchronizer Clutch Hub

Synchronizer Gear Assembly, Continued:

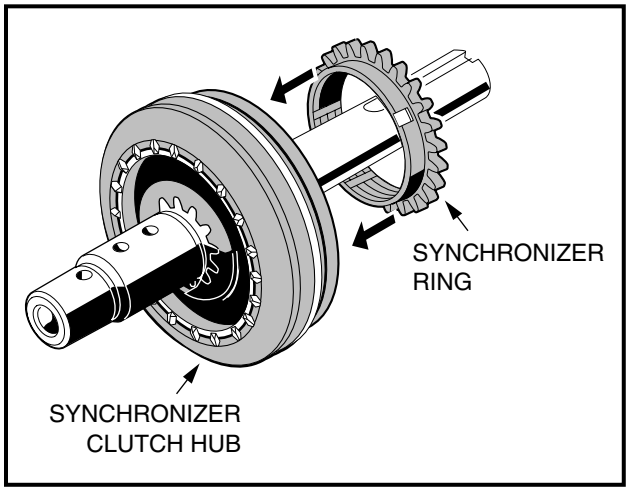


Figure 5-30 Synchronizer Ring

SHIFTER FORK ASSEMBLY

1. Install the spring (35) and ball (36) into the shifter fork (34) **(Figure 5-31, Page 5-18)**.
2. Use a No. 1 tip phillips screwdriver to press the ball and spring while inserting shift rod (33) into the shifter fork (34) **(Figure 5-32, Page 5-18)**. Remove screwdriver when the shift rod is inserted far enough for it to depress the ball and spring, then continue inserting rod until ball is positioned in the middle groove on the rod.

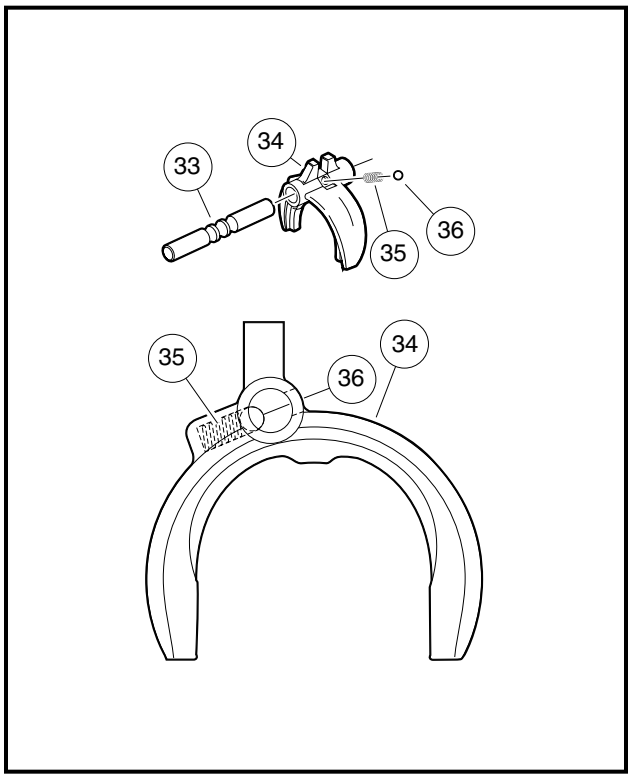


Figure 5-31 Align Spring, Ball and Insert

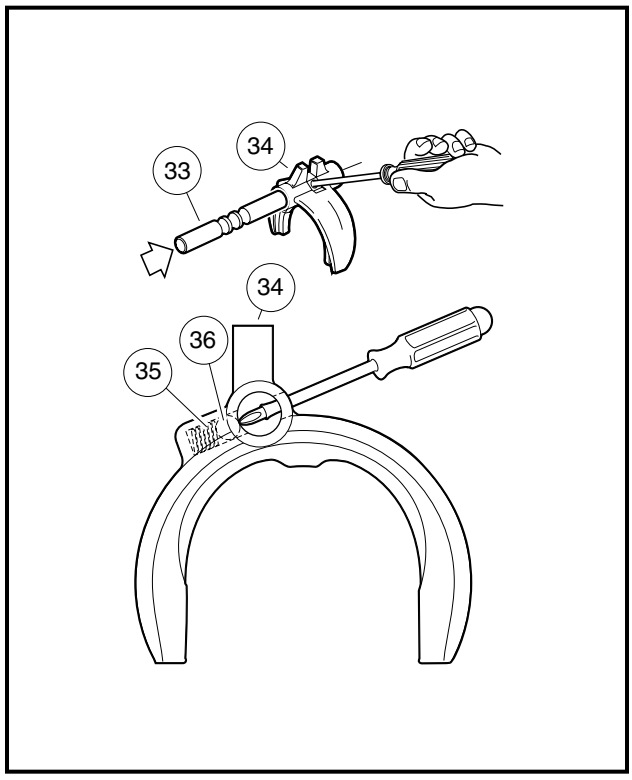


Figure 5-32 Insert Shift Rod Past Ball

DIFFERENTIAL GEAR CASE ASSEMBLY

1. If the bearings (79) were removed, press new ones onto the differential gear carrier case (84) and carrier case cover (87) **(Figure 5-14, Page 5-9)**. **See following CAUTION.**

CAUTION

- **Apply pressure against the inner race of the bearing only. Applying pressure anywhere else will damage the bearing.**

2. Install differential gear (91) into carrier case (84) **(Figure 5-14, Page 5-9)**. **See also Figure 5-33, Page 5-19**.
3. Start the differential pin (79) into the carrier case by lightly tapping it with a plastic or rubber hammer. Before the pin enters the inside of the carrier case, position the thrust plate (76) and idler gear (80) in the case and then continue tapping the pin through the thrust plate and idler gear **(Figure 5-34, Page 5-19)**.

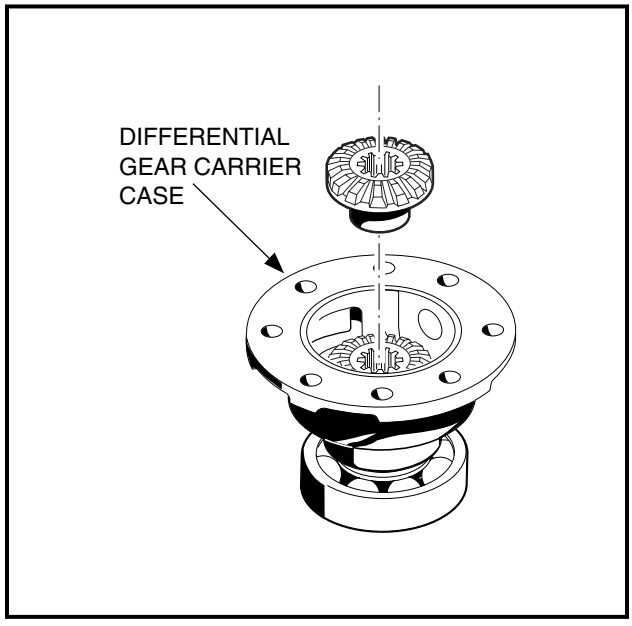


Figure 5-33 Differential Gear

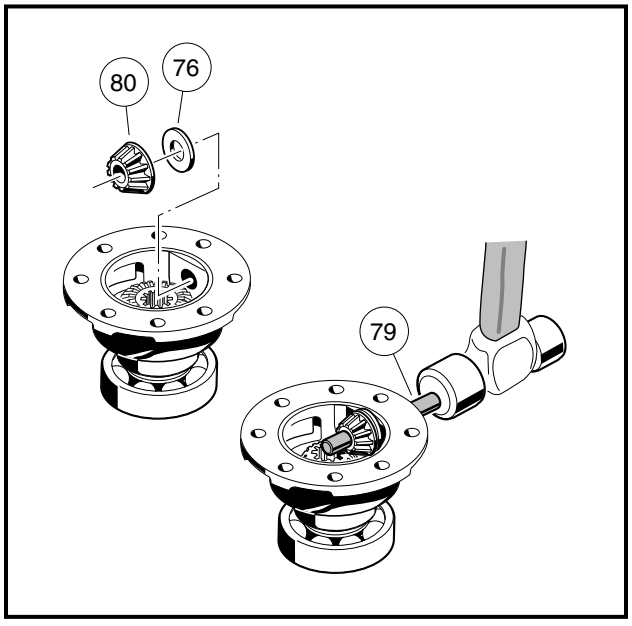


Figure 5-34 Idler Gear

4. Position the other thrust plate (76) and idler gear (80) in the carrier case. Continue to drive the pin through them and the wall of the carrier case until the ends of the pin are flush with the sides of the carrier case **(Figure 5-35, Page 5-20)**.
5. Install the thrust plate (77) and differential gear (81) into the carrier case cover (78) **(Figure 5-36, Page 5-20)**. Hold the thrust plate and differential gear in place and position the carrier case cover on the carrier case.
6. Position the output ring gear (73) on the carrier case, visually aligning the dowel hole in the carrier case with the dowel pin in the ring gear **(Figure 5-37, Page 5-20)**. Using a plastic or rubber mallet, tap the ring gear into place on the dowel pin.
7. Apply Loctite 277® on the eight mounting bolt threads. Install them through the ring gear, carrier case, and into the carrier case cover. Tighten to 18 ft-lb (24.4 N·m) in sequence shown **(Figure 5-38, Page 5-20)**.

Differential Gear Case Assembly, Continued:

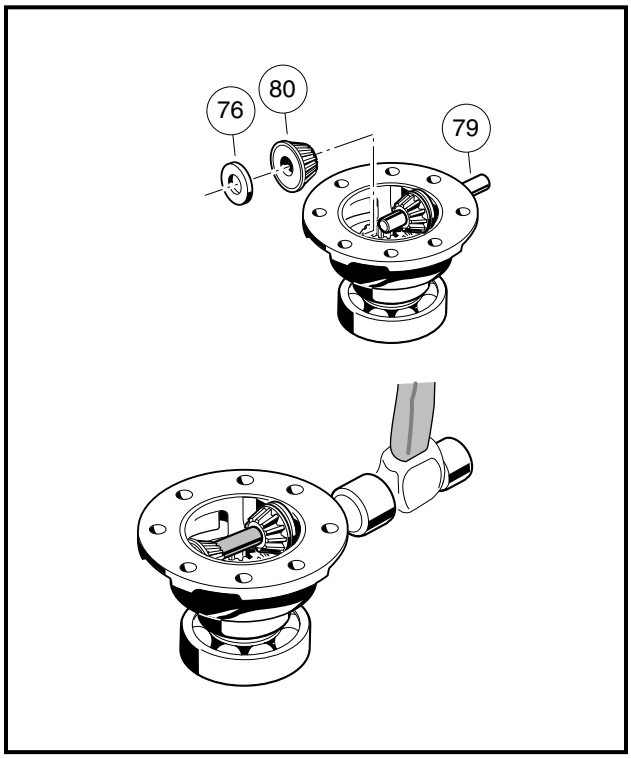


Figure 5-35 Second Idler Gear

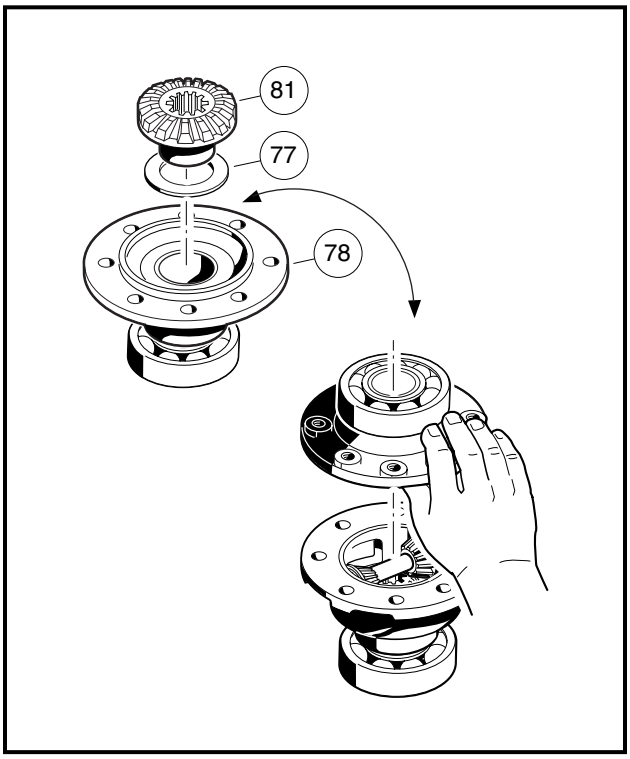


Figure 5-36 Carrier Case

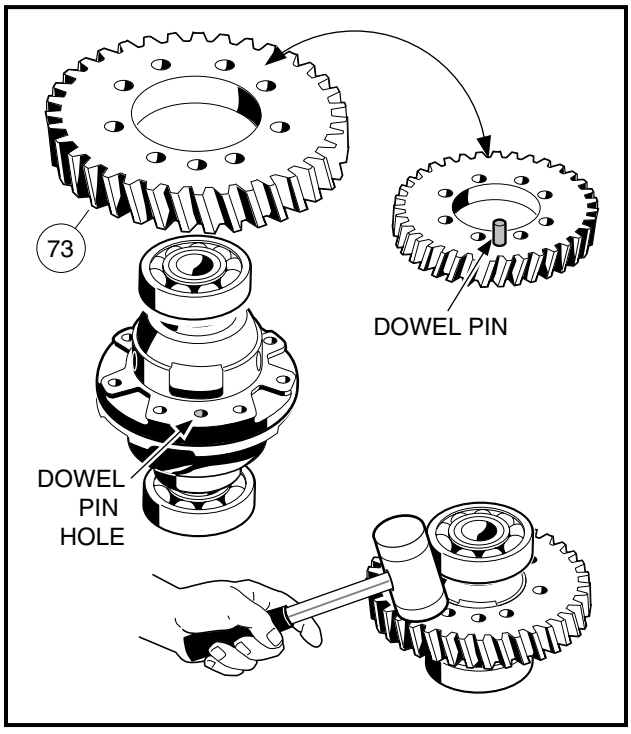


Figure 5-37 Ring Gear

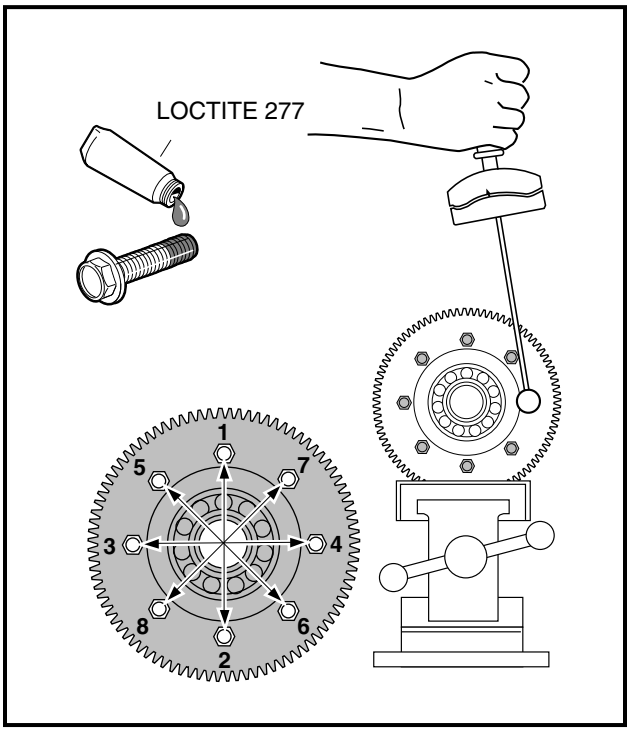


Figure 5-38 Retaining Bolts

GOVERNOR GEAR ASSEMBLY

The governor gear is not assembled before installing it in the unitized transaxle case. The governor gear shaft is installed into the case and then the rest of the governor gear assembly is installed on the shaft. Proceed with unitized transaxle assembly.

UNITIZED TRANSAXLE ASSEMBLY

See General Warning on page 1-1.

NOTE: *Although the following drawings show the transaxle being assembled in an upright position, laying the transaxle on its left (driver) side will simplify the assembly process.*

1. Make sure both parts of the case are clean and free of any contaminants. Make sure the machined mating surfaces are free of residue and are not scratched or damaged in any way.

2. Put a light coating of clean transmission oil on the outside edge of the seal to make installation easier. Press two new oil seals (13 and 22) **(Figure 5-3, Page 5-3)** into the left (driver) side case. Use an oil seal installation tool (CCI P/N 1014160) to install a new oil seal (55) **(Figure 5-11, Page 5-7)** into the right (passenger side) case. **See also Figure 5-39, Page 5-21**.

3. Position the governor gear shaft installation tool (CCI P/N 101933101) over the shaft bore in the inside of the left (driver) side case and insert the governor gear shaft into the tool, long end (from the groove) first **(Figure 5-40, Page 5-21)**. Make sure the shaft is started into the bore and then, using a plastic or rubber hammer, carefully tap the governor gear shaft into the bore until the end being tapped is flush with the end of the tool. Remove installation tool.

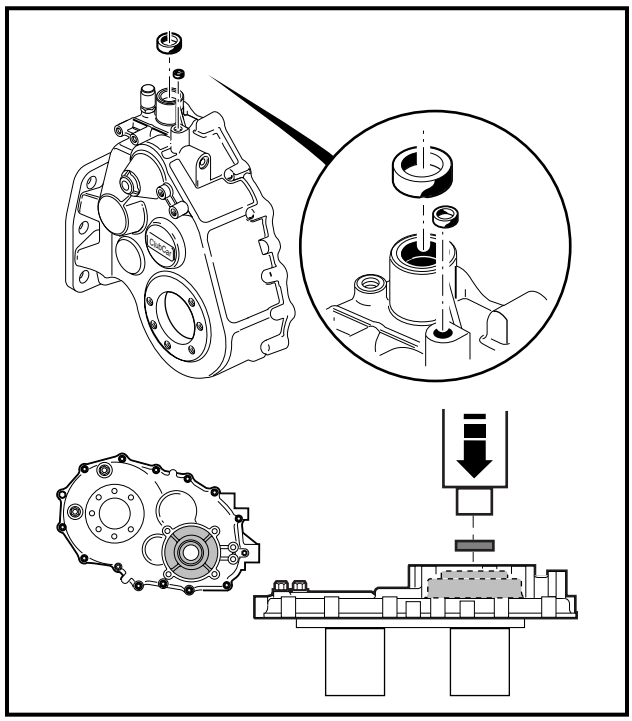


Figure 5-39 Install Seals

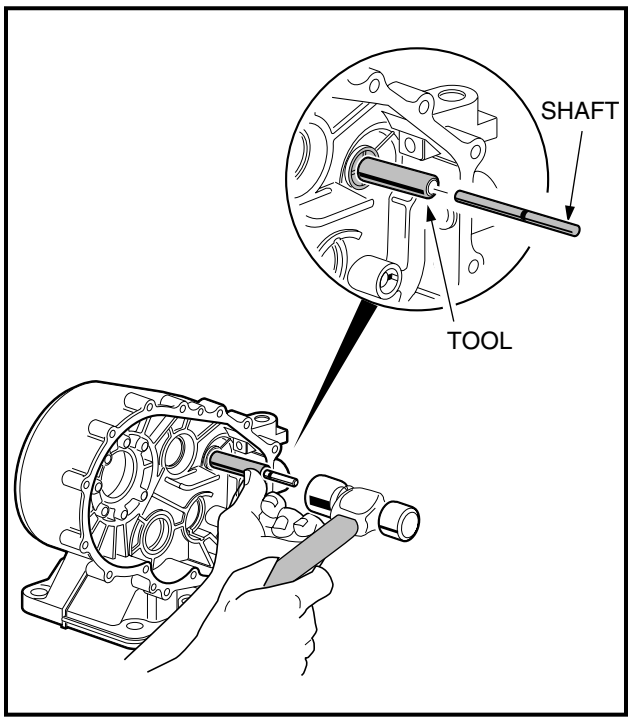


Figure 5-40 Governor Gear Shaft

Unitized Transaxle Assembly, Continued:

4. Install the washer, governor gear, and sleeve together onto the governor shaft **(Figure 5-41, Page 5-22)**. Make sure the sleeve is properly positioned within the flyweight brackets of the gear**,** then push them onto the shaft until the gear snaps into the groove on the shaft **(Figure 5-42, Page 5-22)**.

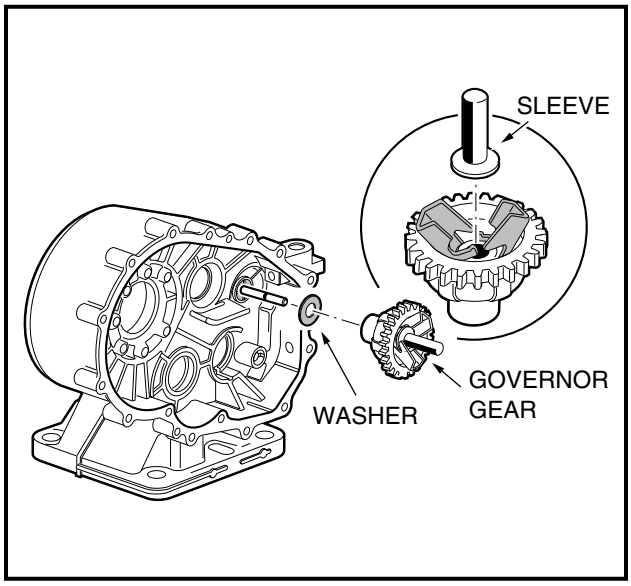


Figure 5-41 Position Governor Gear

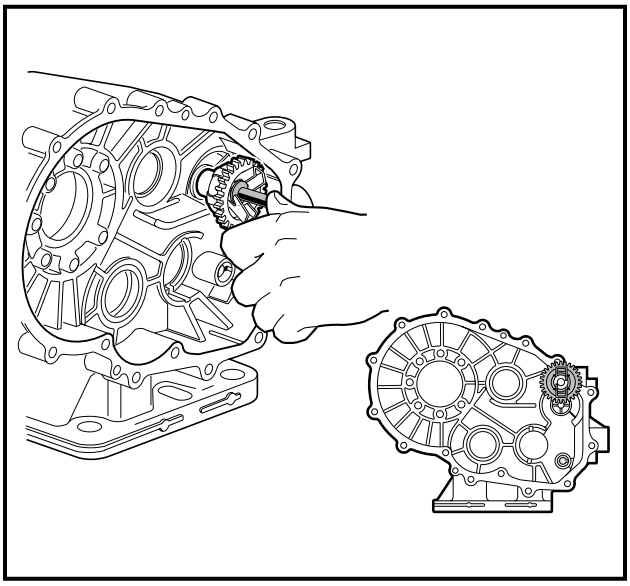


Figure 5-42 Install Governor Gear

5. Position the interior washer on the pivot arm, then install the pivot arm and washer into the left (driver side) case **(Figure 5-43, Page 5-22)**. Install the exterior washer and cotter pin on the pivot arm outside the case. Bend the legs of the cotter pin.
6. Install the shifter shaft into the left (driver side) case **(Figure 5-44, Page 5-22)**. Install the washer and use external snap ring pliers (0.070 tip) to install retaining ring on the shifter shaft outside of the case. Make sure the retaining ring is in the groove of the shaft.

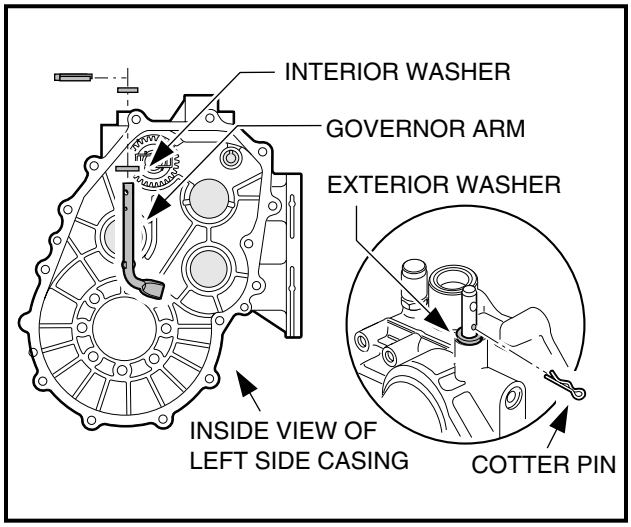


Figure 5-43 Pivot Arm

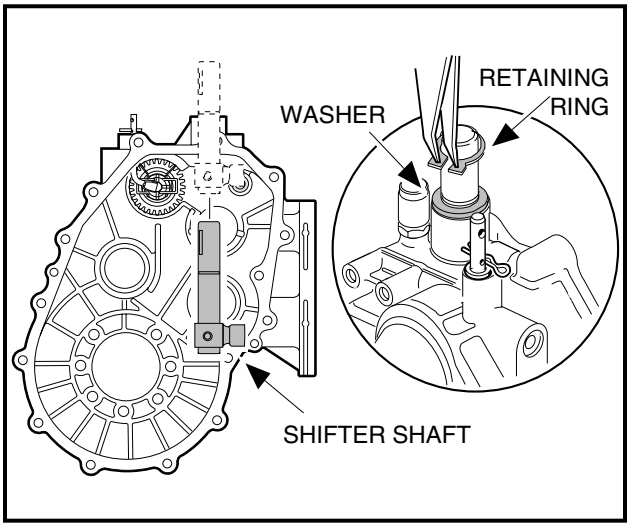


Figure 5-44 Insert Shifter Shaft

7. Install the gear assemblies into the left (driver side) case.

   7.1. Stand the left side case on the mounting plate, then install the differential gear case assembly **(Figure 5-45, Page 5-23)**. Do not seat the assembly in the bore, instead insert it far enough that it will not fall out.

   7.2. Install the idler gear assembly into case. Do not seat the assembly in the bore, instead insert it far enough that it will not fall out. No gears mesh at this time **(Figure 5-46, Page 5-23)**.

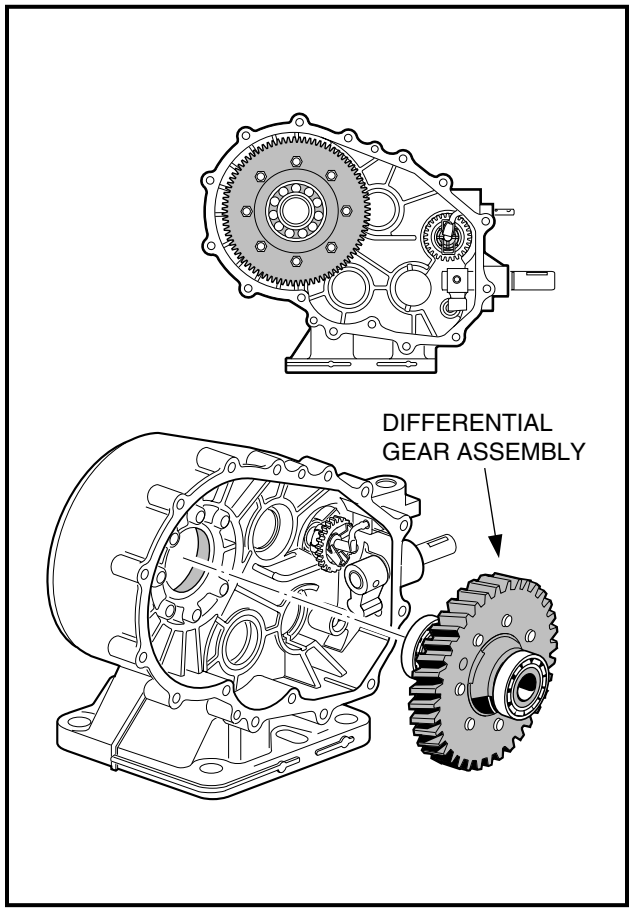


Figure 5-45 Differential Gear Assembly

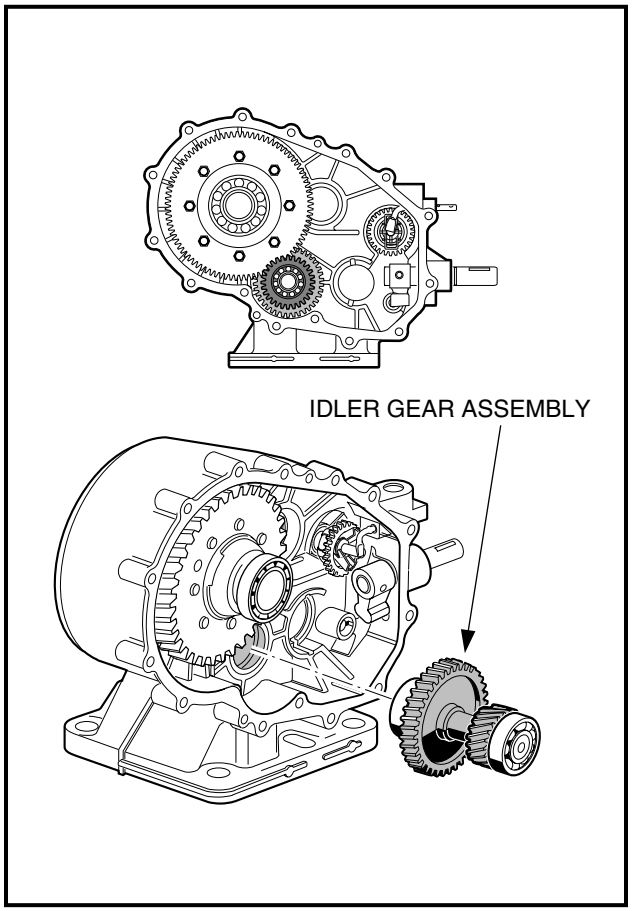


Figure 5-46 Idler Gear Assembly

   7.3. Install the oil guide with the baffle toward the case wall **(Figure 5-47, Page 5-24)**. Make sure the two tabs on the guide are positioned in the slots in the case.

   7.4. Position the shifter fork assembly on the synchronizer gear assembly, then install them together, bearing end first, into the bore containing the oil guide **(Figure 5-48, Page 5-24)**. Do not seat the assembly, instead make sure the spur gear (40) is meshed with the governor gear (63) **(Figure 5-11, Page 5-7)**, and that the shifter lever (14) **(Figure 5-3, Page 5-3)** is positioned in the bracket on the shifter fork. **See also Figure 5-49, Page 5-24**.

   7.5. Install the intermediate gear assembly into the case **(Figure 5-50, Page 5-24)**. Do not seat the assembly into the bore, instead make sure the output ring gear meshes with the input drive gear (52) on the synchronizer gear assembly and with the small gear on the idler shaft (65) **(Figure 5-11, Page 5-7)**.

Unitized Transaxle Assembly, Continued:

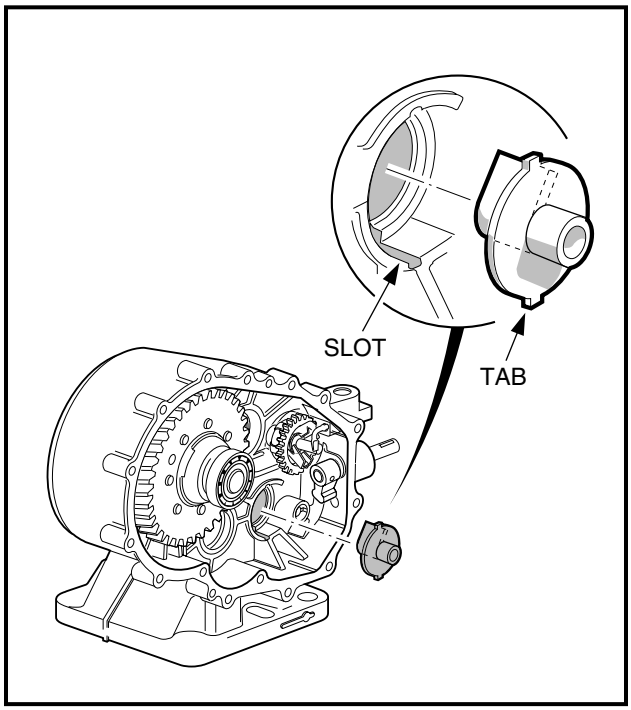


Figure 5-47 Oil Guide

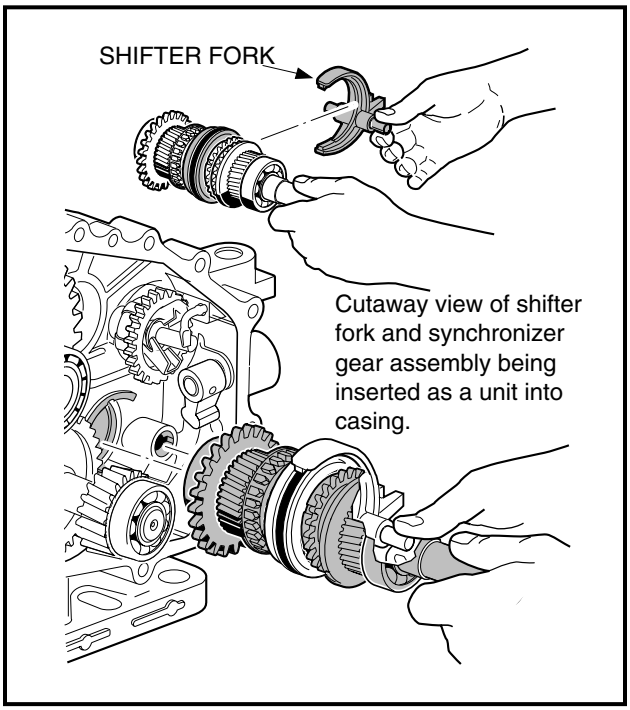


Figure 5-48 Synchronizer Ring Gear

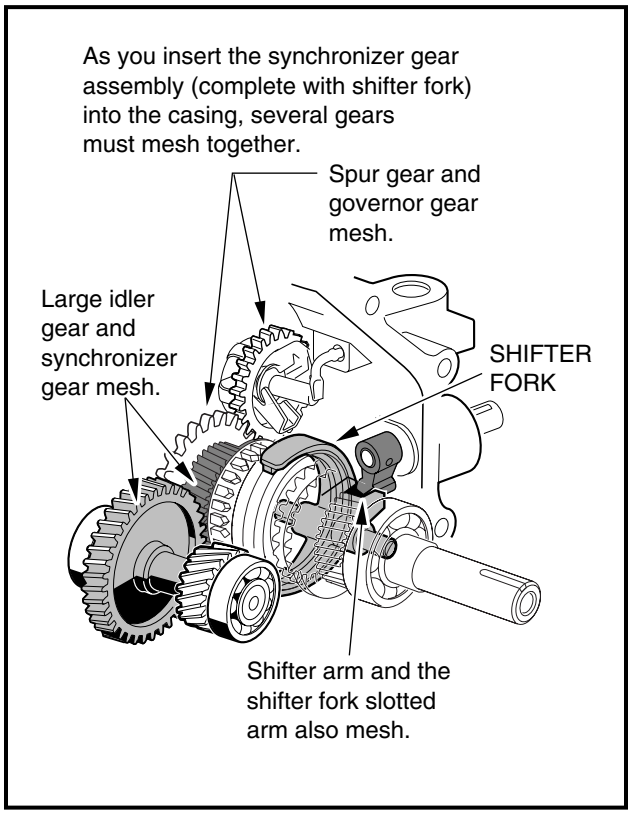


Figure 5-49 Gear Alignment

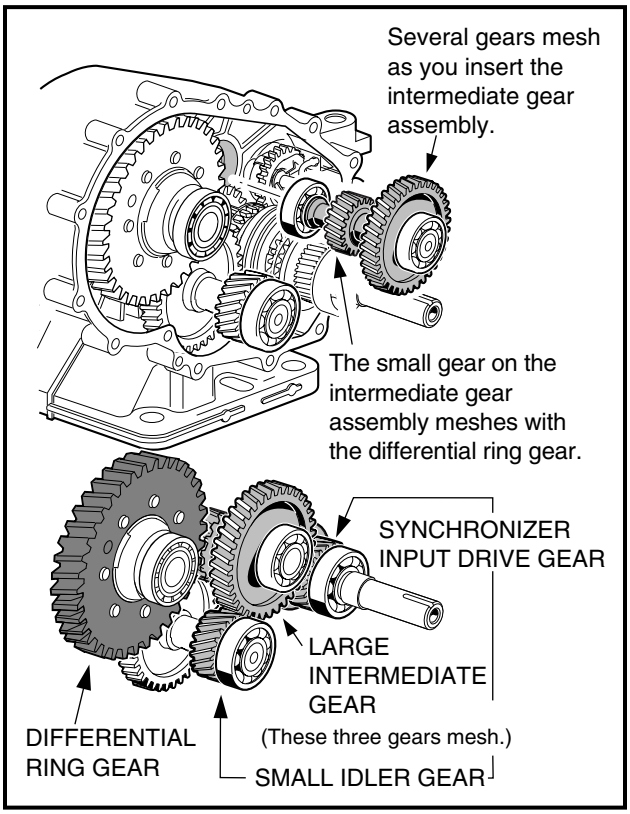


Figure 5-50 Gear Alignment

7.6. As a group, and keeping the gears meshed, work all of the gear assemblies into the bores until they are seated. When all of the assemblies are correctly seated, the outside edges of the input drive gear (52) and the intermediate gear (58) **(Figure 5-11, Page 5-7)** should be flush (in the same plane). Also, the outside surfaces of the idler gear bearing, the intermediate gear bearing, and the differential gear bearing should be flush **(Figure 5-51, Page 5-25)**. **See following CAUTION.**

CAUTION

- **If the edges of the input drive gear and intermediate gear are not flush, then the oil guide (37) (Figure 5-11, Page 5-7) may not be properly positioned in the bore.**

8. Make sure the mating surfaces of the left and right sides of the case are clean and free of oil, grease, or residue of any kind, and they are not scratched or damaged in any way **(Figure 5-52, Page 5-25)**.
9. Apply a continuous bead of Three Bond No. 1215 (CCI P/N 101928701) sealant to the mating surface around the complete profile of the right (passenger side) case. **See following CAUTION.**

CAUTION

- **Use only Three Bond No. 1215 sealant to seal case. Do not use a substitute.**
- **If the two sides of the case cannot be easily closed or do not make complete contact, do not force them together. Check that all internal components are properly seated and then try again.**

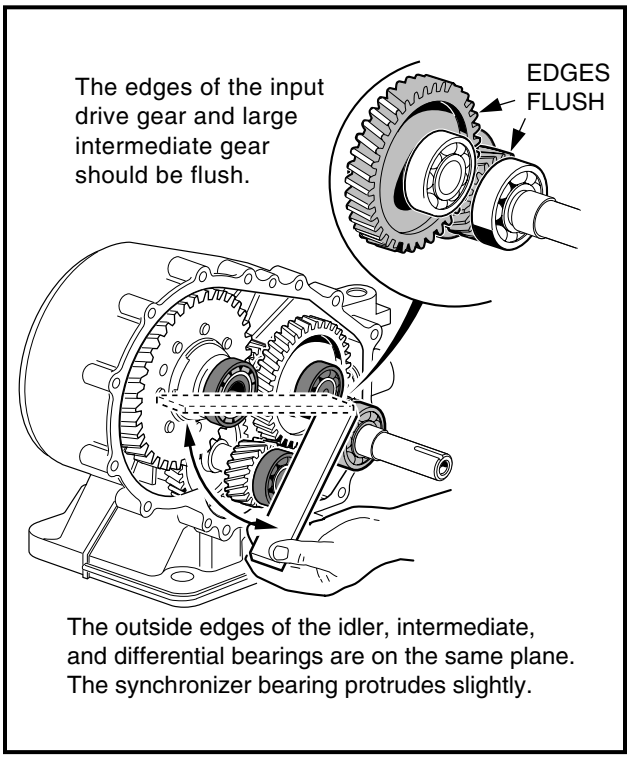


Figure 5-51 Gear Alignment

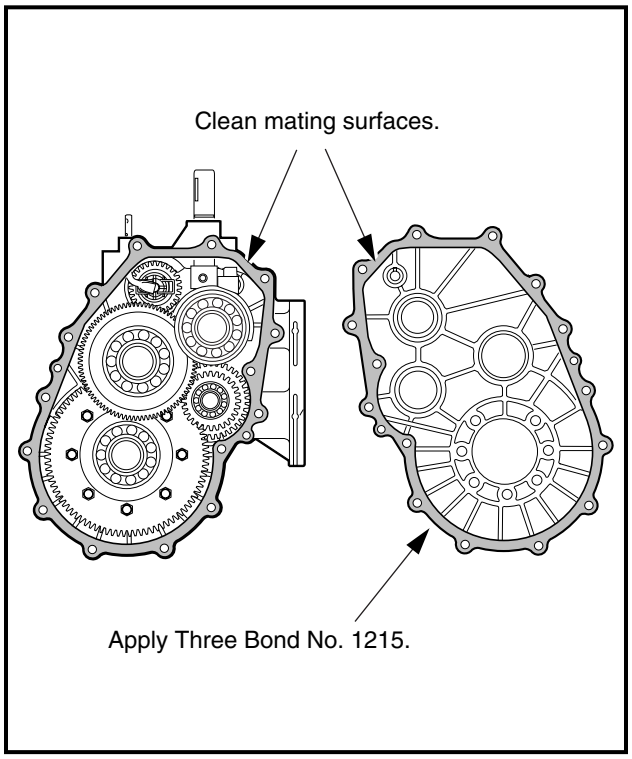


Figure 5-52 Prepare Mating Surfaces

10. Install and finger tighten the fifteen bolts (27) **(Figure 5-3, Page 5-3)** that secure the left and right sides of the case together. Then, in sequence shown, tighten the bolts to 17 ft-lb (23.1 N·m) **(Figure 5-53, Page 5-26)**.

Unitized Transaxle Assembly, Continued:

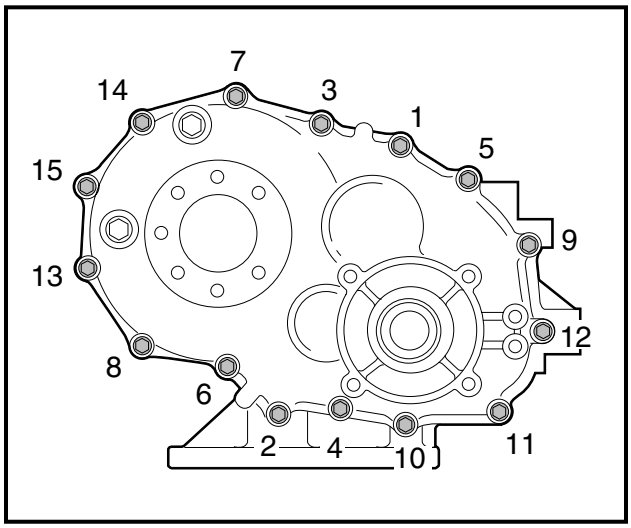


Figure 5-53 Casing Torque Sequence

AXLE TUBES

See Axle Tube Installation, Section 16, in the appropriate maintenance and service manual.

UNITIZED TRANSAXLE INSTALLATION

See Unitized Transaxle Installation, Section 16, in the appropriate maintenance and service manual.

LUBRICATION

See Lubrication, Section 16, in the appropriate maintenance and service manual.

SECTION 6 – MC010C-BS00 UNITIZED TRANSAXLE WITH DIFFERENTIAL LOCK

⚠ DANGER

- **See General Warning on page 1-1.**

⚠ WARNING

- **See General Warning on page 1-1.**

GENERAL INFORMATION

The MC010C-BS00 is a heavy-duty, fully-synchronized unitized transaxle with differential lock. With fully-synchronized internal gearing to change vehicle direction, wear and maintenance requirements on the engine, drive clutch, belt, and driven clutch are greatly reduced. All components rotate in the same direction; therefore, the engine and clutches are not subjected to reversing loads. Power is transferred from the engine through the drive clutch, the drive belt, the driven clutch, then through the unitized transaxle to the wheels.

TRANSAXLE MODELS AND IDENTIFICATION

The MC010C-BS00 transaxles have been supplied on models of Turf 272, Carryall 272, and XRT 1200 vehicles coupled with one of the FE350 engines. It was replaced with the MC012C-AS00 transaxle. Both operate the same internally, but utilize a few, slightly different gear components and have two different styles of axle and wheel hub designs. All parts are identified in their respective illustrated parts list (IPL) manuals.

The MC010C-BS00 transaxle is designed with the wheel hub permanently attached to the outside end of each axle shaft **(Figure 6-1, Page 6-1)**. The MC012C-AS00 transaxle is designed with a removable wheel bolt flange and attaches to the ends of the axle shafts using a splined coupling configuration **(Figure 6-2, Page 6-1)**. Both transaxles have different physical attachment provisions and dimensional differences and therefore are not interchangeable. Further, the MC010C-BS00 transaxle is not designed to handle the FE400 engine.

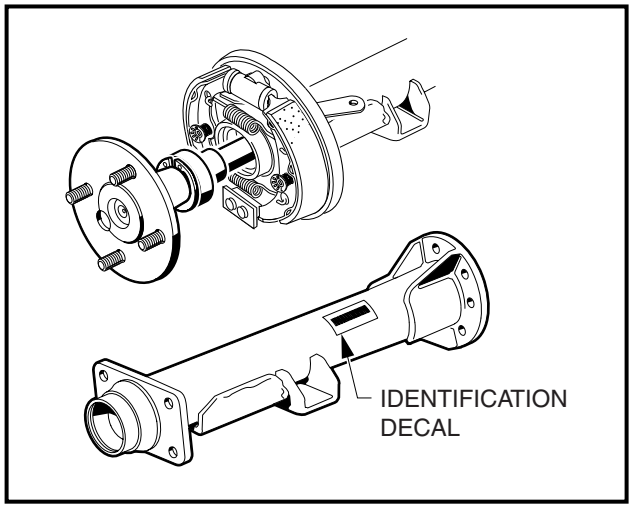


Figure 6-1 MC010C-BS00

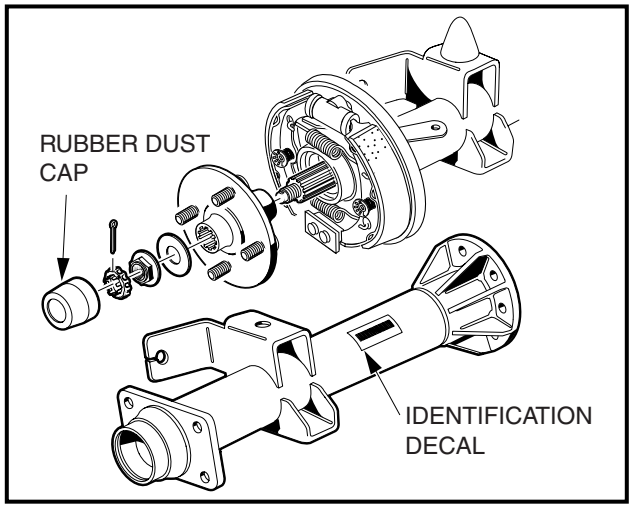


Figure 6-2 MC012C-AS00

Tools Required For This Section

Hydraulic floor jack (or chain hoist)	12 to 18 in. straight edge	17 mm socket, 3/8-in. drive
Jack stands (2) (one-ton capacity)	Small ball peen hammer (10 oz.)	7/16-in. combination wrench
Hydraulic press	Plastic or rubber mallet	1/2-in. combination wrench
Bench vise	Ratchet wrench, 3/8-in. drive	9/16-in. combination wrench
Standard slip joint pliers	Torque wrench, 3/8-in. drive	11/16-in. combination wrench (2)
External snap ring pliers (.070 in. tip)	3/8-in. Socket, 3/8-in. drive	17 mm combination wrench
External snap ring pliers (.047 in. tip)	7/16-in. Socket, 3/8-in. drive	Small flat blade screwdriver
90° Internal snap ring pliers (.090 in. tip)	10 mm Combination wrench	Medium flat blade screwdrivers (2)
Feeler gauge	1/2-in. Socket, 3/8-in. drive	No. 2 phillips head screwdriver
16 in. rolling head prybar	9/16-in. Socket, 3/8-in. drive	1/4-in. nut driver
Small punch or scratch awl	5/8-in. Socket, 3/8-in. drive	5/16-in. nut driver
1/4-in. diameter drift or metal rod	12 mm Socket, 3/8-in. drive	Small knife or wire snippers
Bearing puller wedge attachment (CCI P/N 1012812)	Axle seal tool (CCI P/N 1014162)	Governor gear shaft installation tool (CCI P/N 101933101)

AXLE SHAFT

See Axle Shaft and Oil Seal Removal, Section 16, in the appropriate maintenance and service manual.

UNITIZED TRANSAXLE REMOVAL

See Unitized Transaxle Removal, Section 16, in the appropriate maintenance and service manual.

UNITIZED TRANSAXLE DISASSEMBLY

See General Warning on page 1-1.

NOTE: *The following provides instructions for disassembling the unitized transaxle; however, the transaxle case can be separated and gears accessed without removing the axles or axle tubes from the case.*

1. Position the unitized transaxle case on a clean bench surface with the bottom lubrication plug over a pan suitable for draining lubrication oil.
2. Remove both the top and bottom lubrication port plugs and gaskets. Drain and dispose of the oil properly **(Figure 6-3, Page 6-3)**.

NOTE: *The lower plug is used for draining lubricant. When draining lubricant, remove both plugs to allow the lubricant to drain faster.*

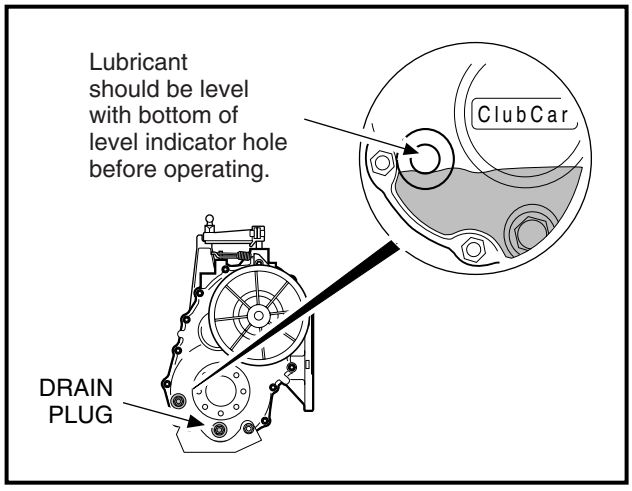


Figure 6-3 Lubricant Level

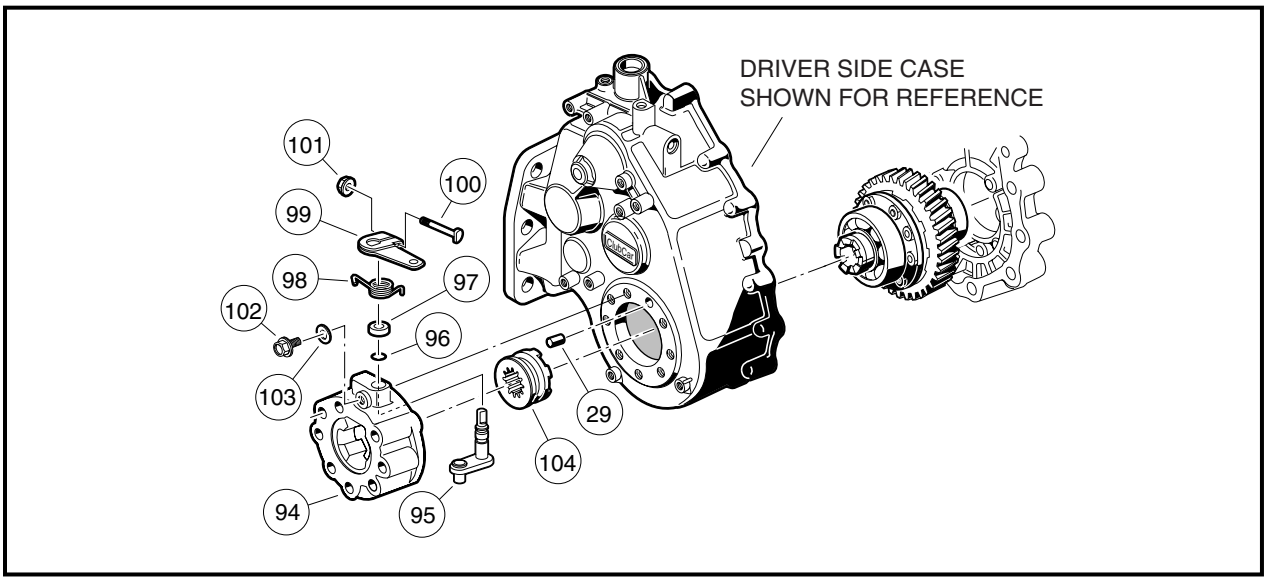


Figure 6-4 Differential Gear Case

3. Remove the differential lock housing (94) from the transaxle case **(Figure 6-4, Page 6-3)**.
4. Remove the four bolts (35) and remove the guard (34) **(Figure 6-5, Page 6-4)**.
5. Remove the fifteen bolts (28) that hold the transaxle housing together **(Figure 6-5, Page 6-4)**.
6. The transaxle is equipped with a slot for prying the housing apart. Use the slot to open the case. Pull the housing apart, making sure all gear assemblies inside the transaxle stay together in one (either) side of the case. **See following CAUTION**.

CAUTION

- **To prevent damage to the mating seal surfaces of the case, use care when separating the halves.**

Unitized Transaxle Disassembly, Continued:

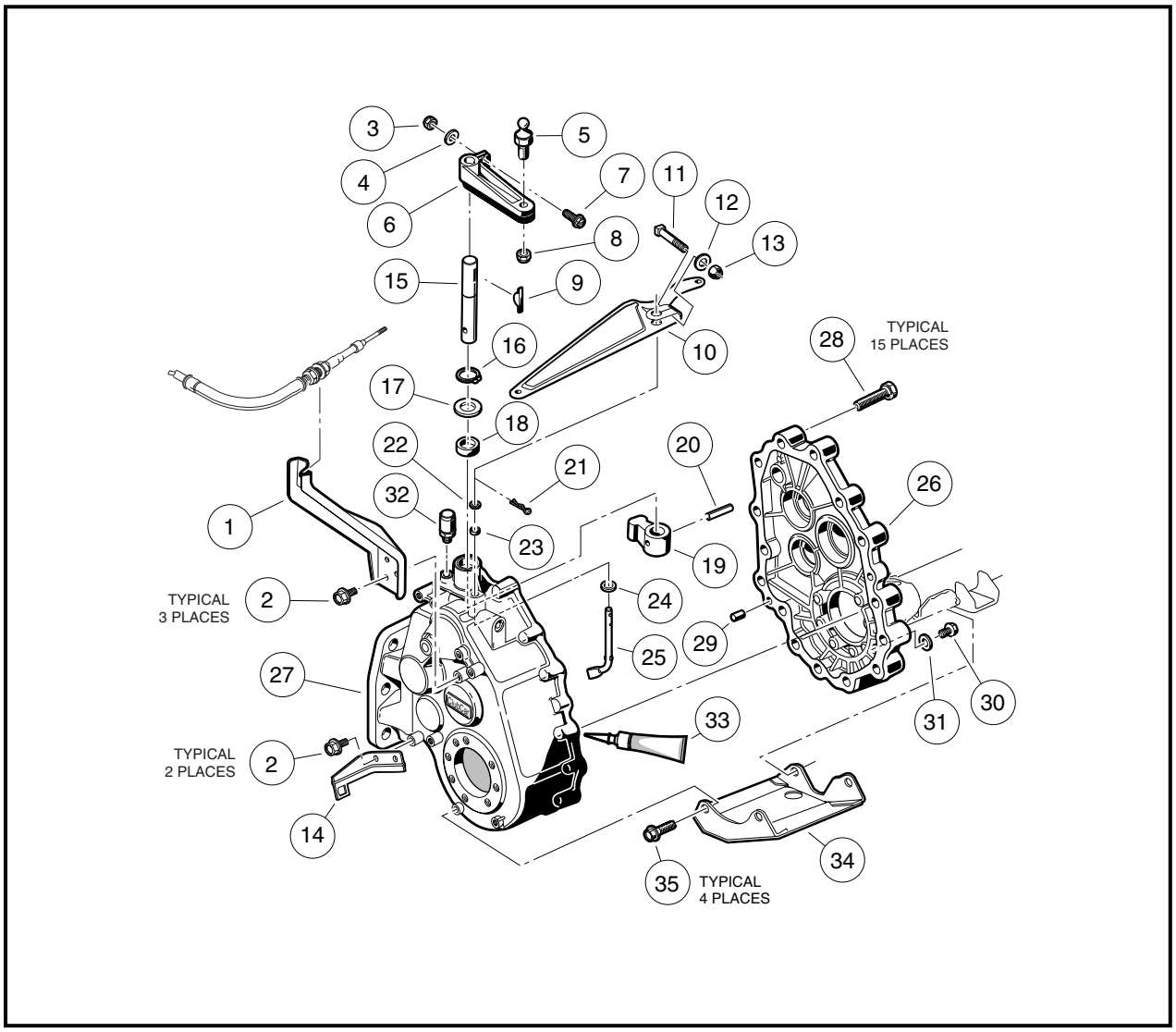


Figure 6-5 Transaxle Gear Casing and Brackets

7. Turn the case section containing the gearing on edge **(Figure 6-6, Page 6-5)**. While holding it in this position, gently rock all the gear assemblies to slightly loosen them in their seating. **See following CAUTION.**

CAUTION

- **To prevent damage to the gears, use extreme care when handling them.**

8. When all the gear assemblies are slightly loosened, remove the differential gear case assembly by gently rocking it while pulling it from the case **(Figure 6-7, Page 6-5)**.

9. Continue to rock and loosen the remaining gear assemblies until the intermediate gear assembly can be removed from the case. Then remove the idler shaft assembly **(Figure 6-8, Page 6-5)**.

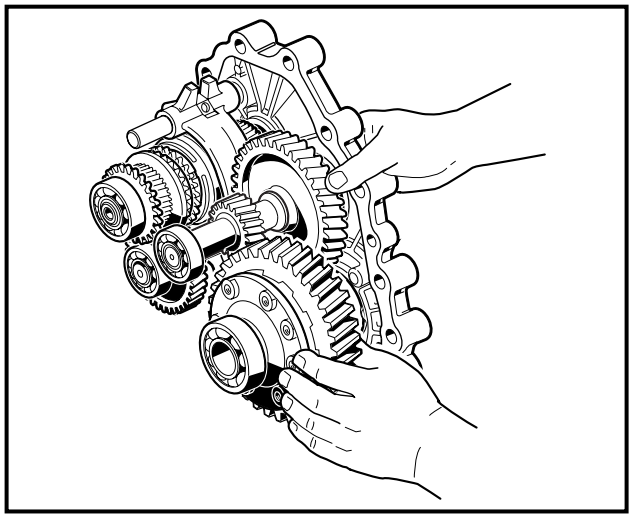


Figure 6-6 Loosen Gears

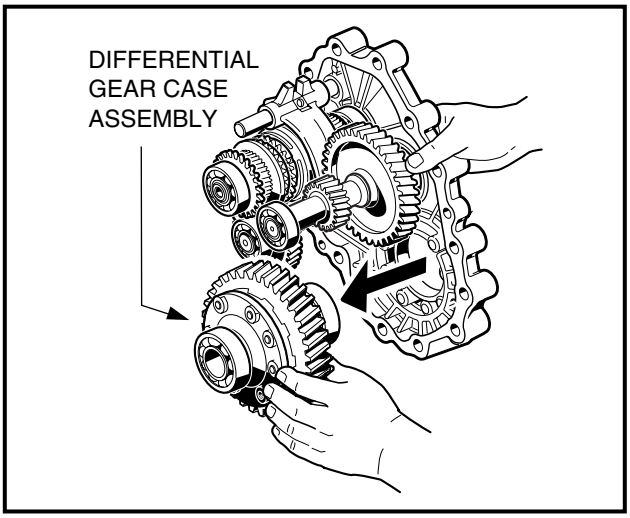


Figure 6-7 Remove Differential Gear Case

10. Remove the synchronizer gear assembly and shifter fork assembly as a unit **(Figure 6-8, Page 6-5)**.
11. Use a seal puller (CCI P/N 1012809) or rolling head prybar to remove the input shaft oil seal from the case **(Figure 6-9, Page 6-5)**.
12. Remove the oil flow guide from the case **(Figure 6-10, Page 6-6)**.
13. Remove the shifter shaft and oil seal from the case.
    13.1. Use snap ring pliers (0.047 tip) to remove the retaining ring (16) on the shifter shaft **(Figure 6-5, Page 6-4)**.
    13.2. Remove flat washer (17) from the shifter shaft on the outside of the case and remove the shifter shaft by pushing it through the case toward the interior of transaxle.
    13.3. Use a seal puller to remove the shifter shaft oil seal (18) from the case.

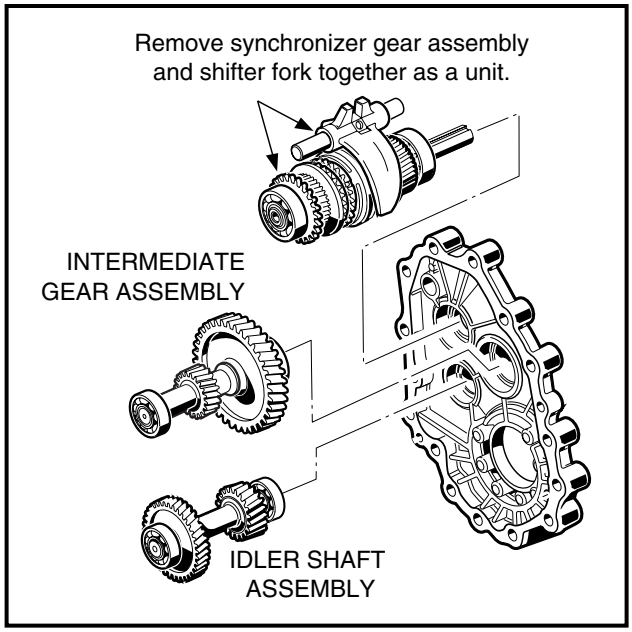


Figure 6-8 Remove Intermediate Gear

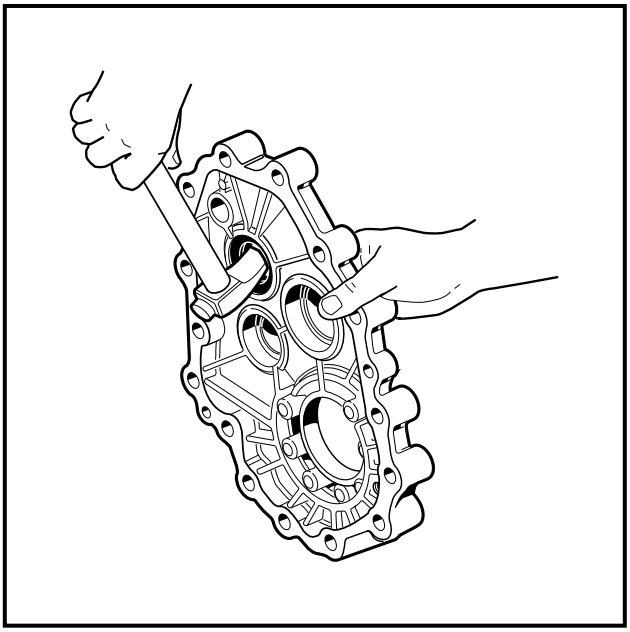


Figure 6-9 Input Shaft Oil Seal

Unitized Transaxle Disassembly, Continued:

14. Remove the breather (32) from the case **(Figure 6-5, Page 6-4)**.

15. Remove the governor assembly from the case.

    15.1. Remove the cotter pin (21) and flat washer (22) from the pivot arm (25) **(Figure 6-5, Page 6-4)**.

    15.2. Remove the pivot arm (25) and washer (24) by pulling them from the housing wall to the interior of the case.

    15.3. Use a small chisel or similar pointed instrument to pry the pivot arm oil seal (23) **(Figure 6-5, Page 6-4)** out of the case **(Figure 6-11, Page 6-6)**.

    15.4. Remove the governor gear assembly (66 and 67) and flat washer (65) **(Figure 6-16, Page 6-9)** by lightly tapping the gear shaft through the case wall, from the outside, with a hammer and drift. **See also Figure 6-12, Page 6-6.**

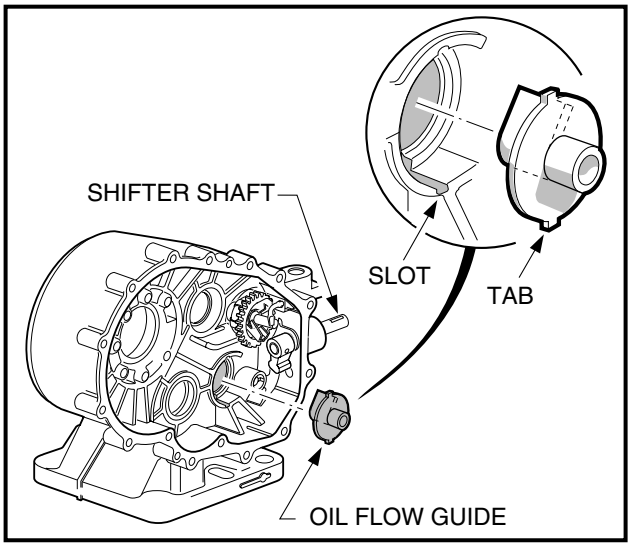


Figure 6-10 Oil Flow Guide

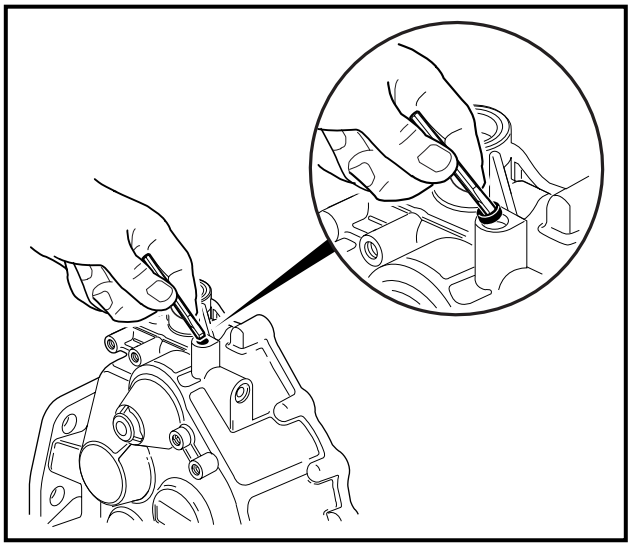


Figure 6-11 Pivot Arm Oil Seal

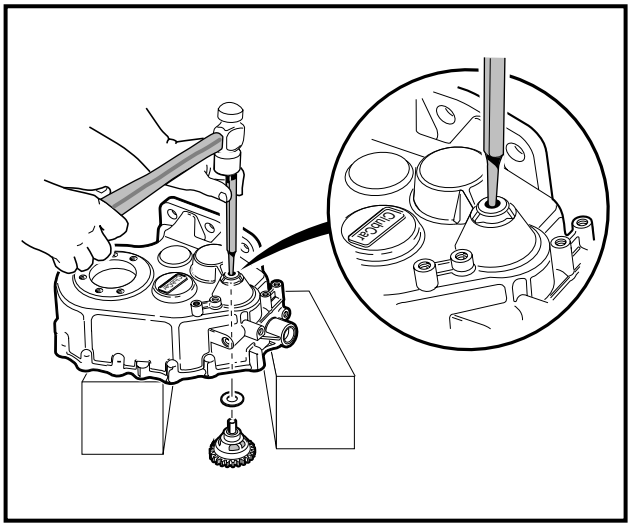


Figure 6-12 Remove Governor Gear

COMPONENT DISASSEMBLY

See General Warning on page 1-1.

DIFFERENTIAL GEAR LOCK HOUSING DISASSEMBLY

1. Rotate the arm (99) and remove the differential lock cog (104) **(Figure 6-13, Page 6-7)**.
2. Loosen, but do not remove, the differential lock arm retaining nut (101) and remove the arm (99) and spring (98) from the differential lock shaft (95).
3. Remove the spacer (97) from the differential lock shaft (95).
4. Remove the shaft retaining screw (102) and washer (103) from the differential lock housing.
5. Press the shaft (95) toward the center of the differential lock housing and remove it from the housing (94).
6. If necessary, gently pry the O-ring from the groove in the differential lock shaft with a small screwdriver **(Figure 6-40, Page 6-20)**.

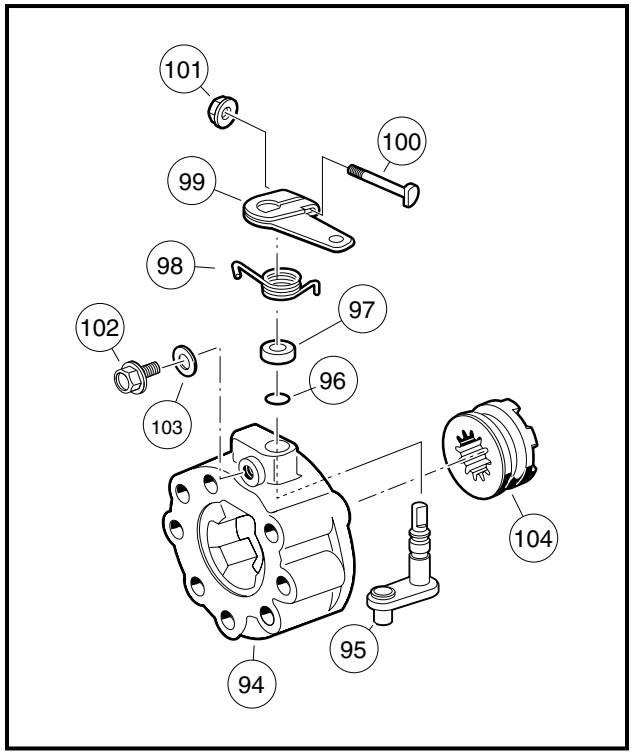


Figure 6-13 Differential Lock Housing Disassembly

GOVERNOR GEAR DISASSEMBLY

NOTE: *It will be necessary to disassemble the governor gear assembly in order to install it into the transaxle case.*

1. Secure the governor gear assembly in a vise as shown. Wrap shaft in a cloth to prevent damage **(Figure 6-14, Page 6-8)**.
2. Use two small screwdrivers to pry the gear and flyweight off the shaft.

Governor Gear Disassembly, Continued:

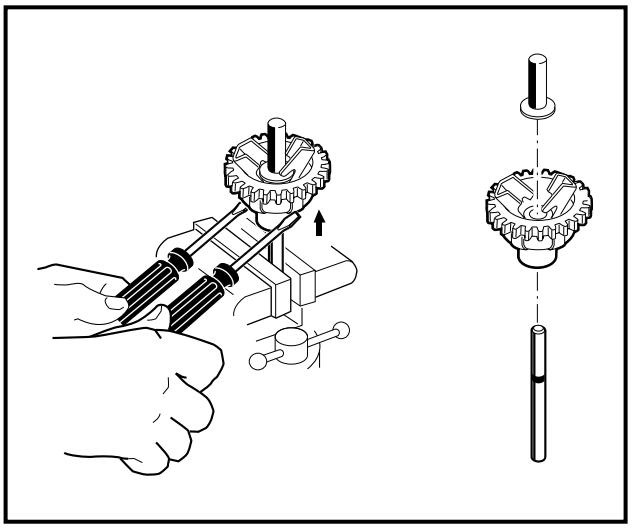


Figure 6-14 Pry Gear from Shaft

DIFFERENTIAL GEAR CASE DISASSEMBLY

CAUTION

- **Mark parts for identification as they are disassembled. Parts must be assembled in their original locations and orientations.**

1. Remove eight ring gear retaining bolts (72) **(Figure 6-15, Page 6-8)** and remove the ring gear from the assembly. It may be necessary to tap the ring gear off with a plastic or rubber mallet. **See following NOTE.**

NOTE: *Loctite® was applied to the bolts during assembly. It may be necessary to place the differential gear case in a vise to remove the bolts.*

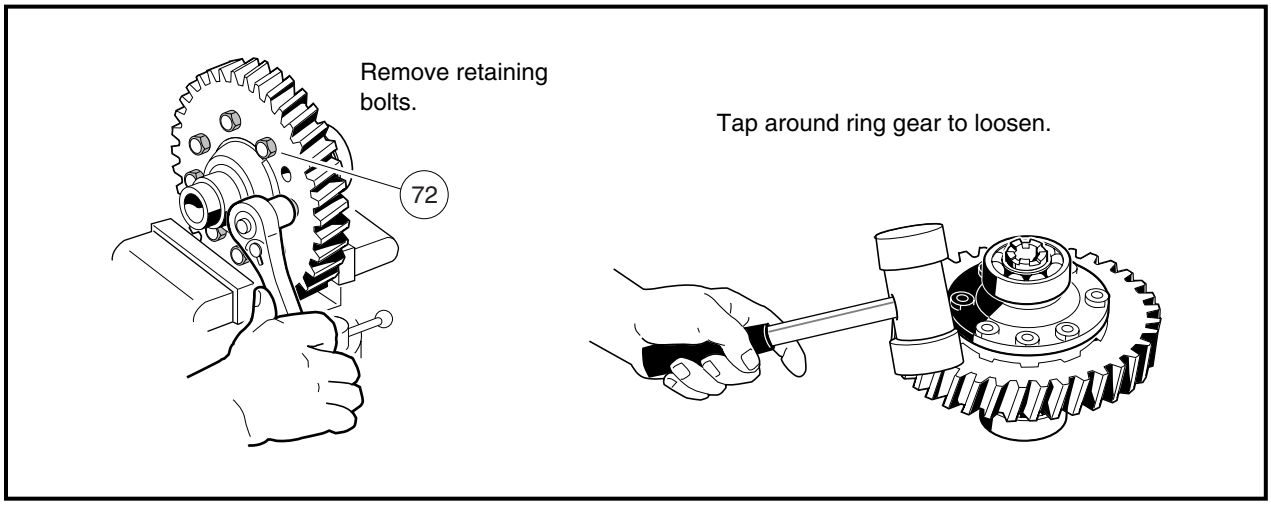


Figure 6-15 Remove Ring Gear

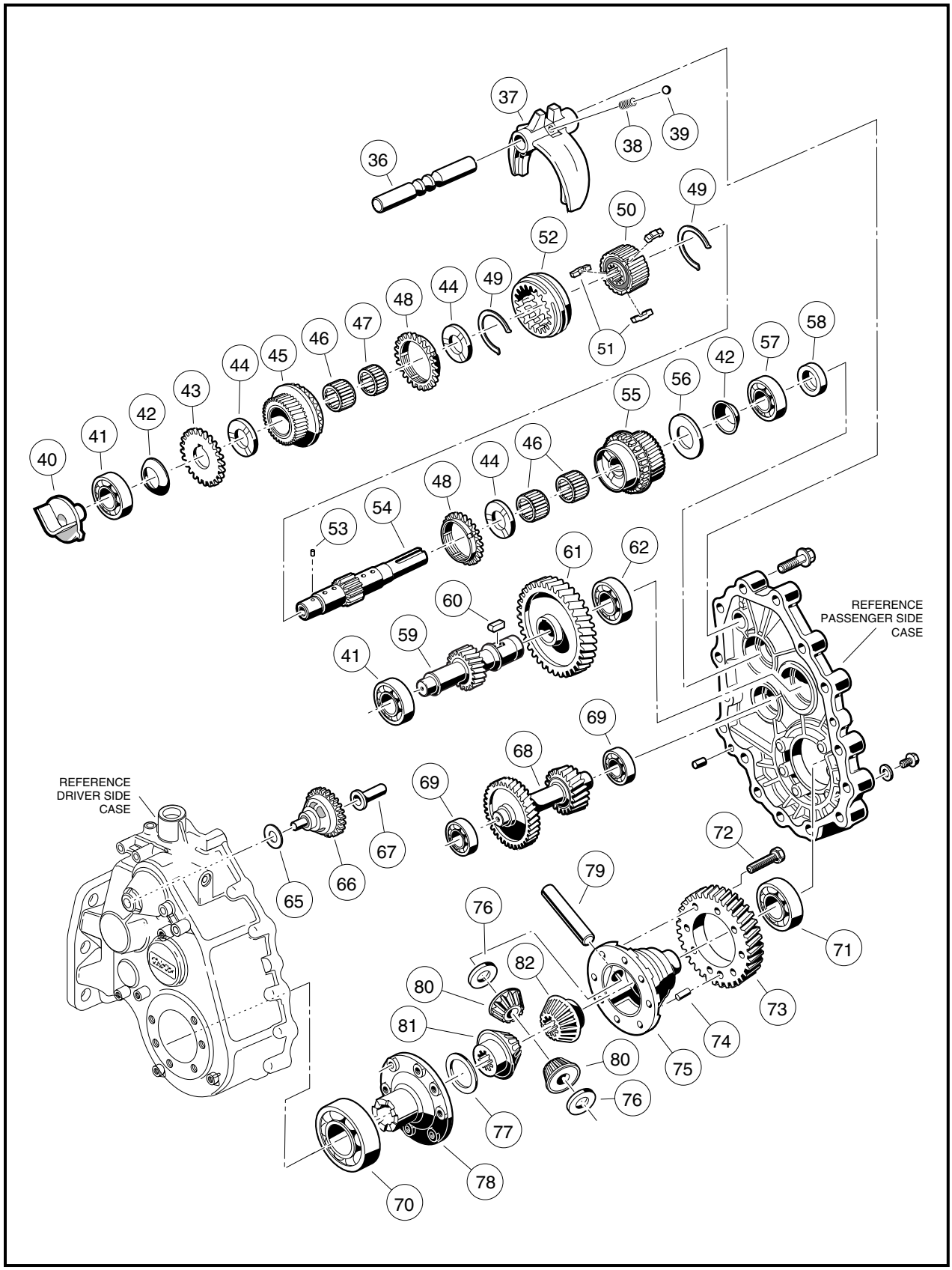


Figure 6-16 MC010C-BS00 Unitized Transaxle with Differential Lock

Differential Gear Case Disassembly, Continued:

2. Pull the cover (78) and thrust plate (77) from the differential gear carrier case **(Figure 6-16, Page 6-9)**.
3. Remove the differential gear (81) from the differential gear carrier case.
4. Remove the differential pin (79) **(Figure 6-16, Page 6-9)** by pushing it through from one side **(Figure 6-17, Page 6-10)**.
5. Remove the two differential idler gears (80) and two idler gear thrust plates (76) as the pin is driven through. **See following NOTE.**

NOTE: *It may be necessary to drive the differential pin out with a hammer and punch.*

6. Remove the differential gear (82) from the carrier case **(Figure 6-16, Page 6-9)**.
7. If the bearings (70 and 71) are to be removed, place a bearing puller wedge attachment (CCI P/N 1012812) between the bearing (71) and gear case (75) **(Figure 6-16, Page 6-9)** and press the bearing off as shown **(Figure 6-18, Page 6-10)**. Repeat the process for the bearing (70) on the carrier cover (78) **(Figure 6-16, Page 6-9). See following CAUTION.**

CAUTION

- **Do not tighten the bearing puller wedge attachment against the gearcase. This could damage the gearcase.**

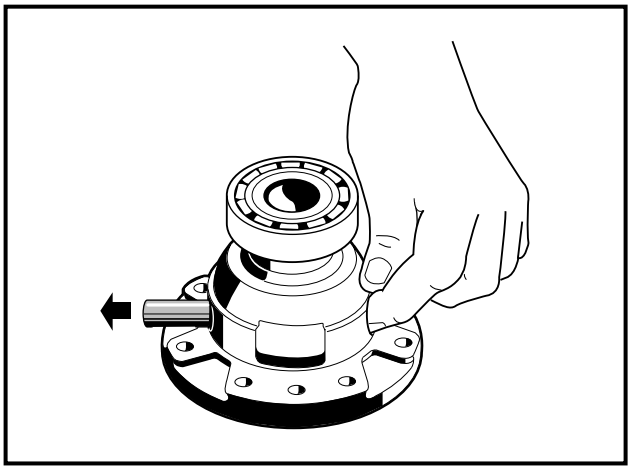


Figure 6-17 Differential Pin

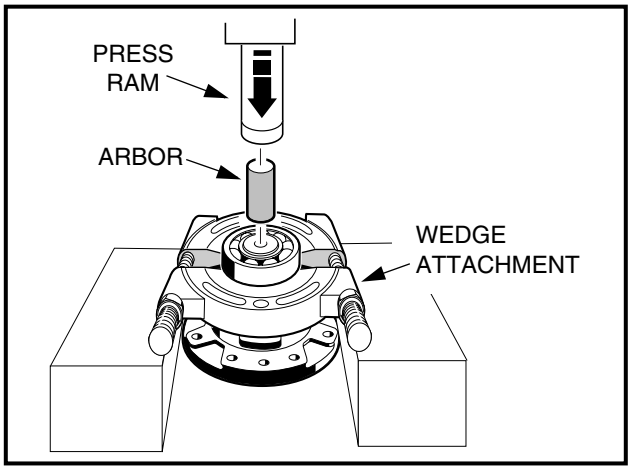


Figure 6-18 Remove Bearing

SHIFTER FORK DISASSEMBLY

1. Push the shift rod (36) out of the shifter fork (37) **(Figure 6-16, Page 6-9)**.
2. Shake the shifter fork (37) to remove the spring (38) and ball (39).

SYNCHRONIZER GEAR DISASSEMBLY

CAUTION

- **Mark parts for identification as they are disassembled. Parts must be assembled in their original locations and orientations.**
- **Do not tighten the bearing puller wedge attachment against the shaft. This could damage the shaft.**

1. Place a bearing puller wedge attachment (CCI P/N 1012812) between the bearing (41) and spur (governor drive) gear (43) **(Figure 6-16, Page 6-9)**, then press the bearing off the input shaft **(Figure 6-19, Page 6-11)**. **See preceding CAUTION.**

2. Pull the spring washer (42), spur gear (43), dowel pin (53), thrust plate (44), input gear assembly (45), large needle bearing (46), small needle bearing (47), synchronizer ring (48), and thrust plate (44) from the input shaft **(Figure 6-16, Page 6-9)**.

3. Place a bearing puller wedge attachment (CCI P/N 1012812) between the bearing (57) and input gear assembly (55) **(Figure 6-16, Page 6-9)** and press the bearing off the input shaft **(Figure 6-20, Page 6-11)**. **See following CAUTION.**

CAUTION

- **Do not tighten the bearing puller wedge attachment against the shaft. This could damage the shaft.**

4. Pull the spring washer (42), thrust washer (56), input gear assembly (55), two needle bearings (46), thrust plate (44), and synchronizer ring (48) from the input shaft **(Figure 6-16, Page 6-9)**.

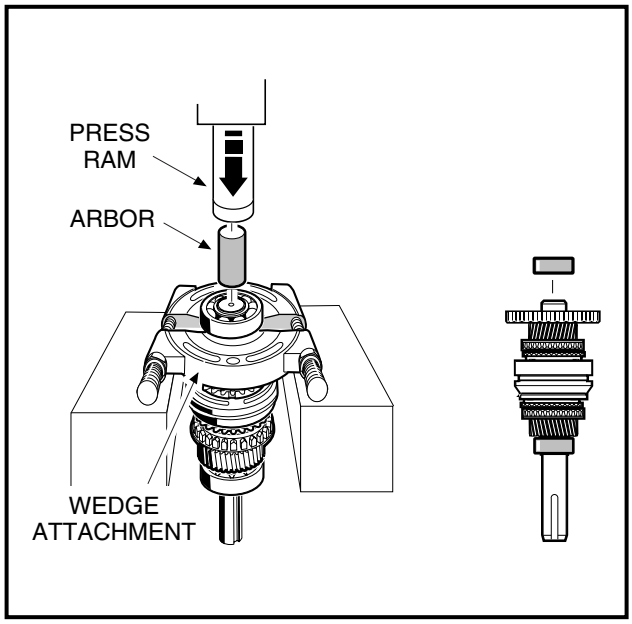


Figure 6-19 Remove Bearing

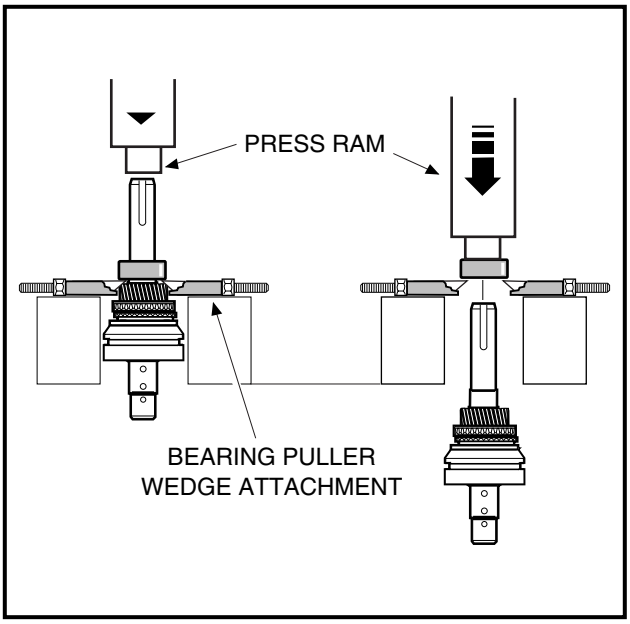


Figure 6-20 Remove Bearing

5. Use a small flat-blade screwdriver to remove two synchronizer springs (snap rings) (49), then slide the synchronizer clutch hub (52) from the input shaft (54) **(Figure 6-16, Page 6-9)**. **See following NOTE.**

NOTE: *There are three synchronizer inserts (51) set into slots in the synchronizer sleeve (50). These may fall free when the synchronizer clutch hub (52) is removed. Do not lose these inserts.*

6. Remove the three synchronizer inserts (51) from the synchronizer sleeve.

7. Press the synchronizer sleeve (50) from the input shaft.

INTERMEDIATE GEAR DISASSEMBLY

1. Place bearing puller wedge attachment (CCI P/N 1012812) between bearing (41) and shaft/pinion gear (59) **(Figure 6-16, Page 6-9)** and press bearing off shaft **(Figure 6-21, Page 6-12). See following CAUTION.**

CAUTION

- **Do not tighten the bearing puller wedge attachment against the shaft. This could damage the shaft.**

2. Place the bearing puller wedge attachment under the bearing (62) and press the bearing from the shaft **(Figure 6-16, Page 6-9)**. **See preceeding CAUTION.**
3. Press the gear (61) from the shaft (59), then remove the key (60).

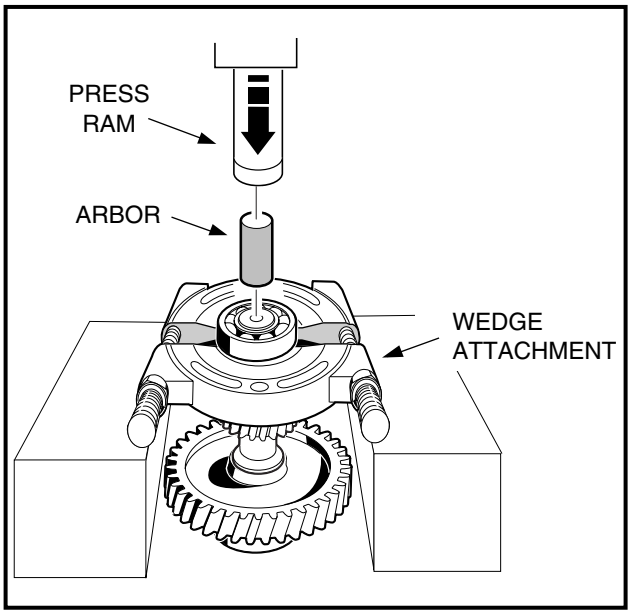


Figure 6-21 Remove Bearing

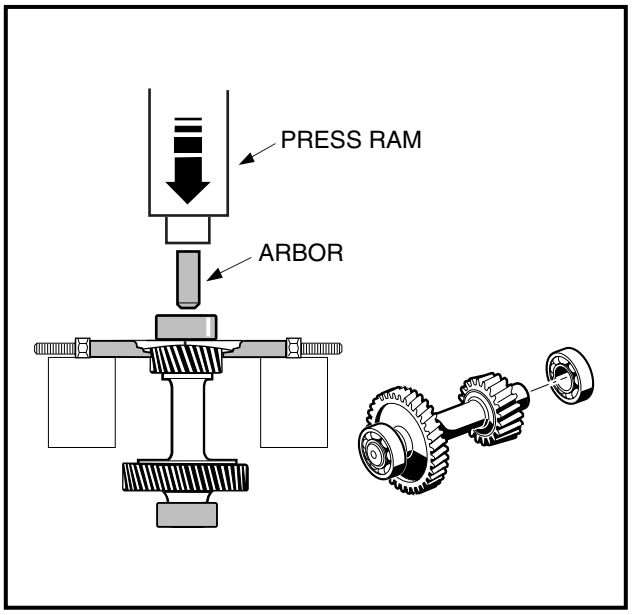


Figure 6-22 Remove Bearing

IDLER SHAFT DISASSEMBLY

1. Place a bearing puller wedge attachment (CCI P/N 1012812) between the bearing (69) and the small gear on the idler shaft (68) **(Figure 6-16, Page 6-9)**, then press the bearing off the shaft **(Figure 6-22, Page 6-12). See following CAUTION.**

CAUTION

- **Do not tighten the bearing puller wedge attachment against the shaft. The shaft could be damaged when pressing the bearing off.**

2. Place a bearing puller wedge attachment (CCI P/N 1012812) between the bearing and the larger gear on the idler shaft (68), then press the bearing off the shaft as shown **(Figure 6-16, Page 6-9)**.

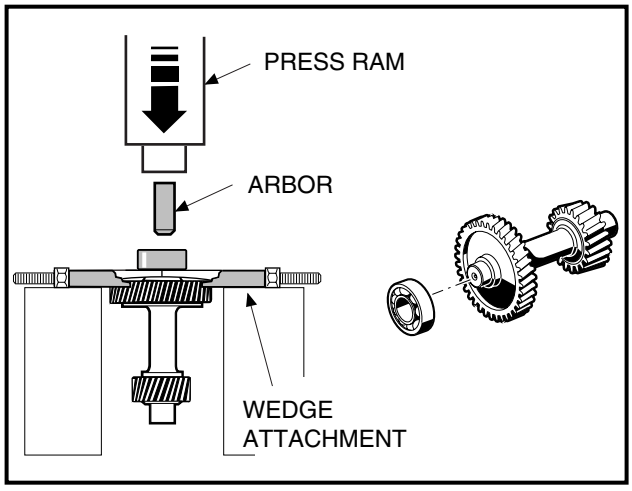


Figure 6-23 Remove Idler Shaft

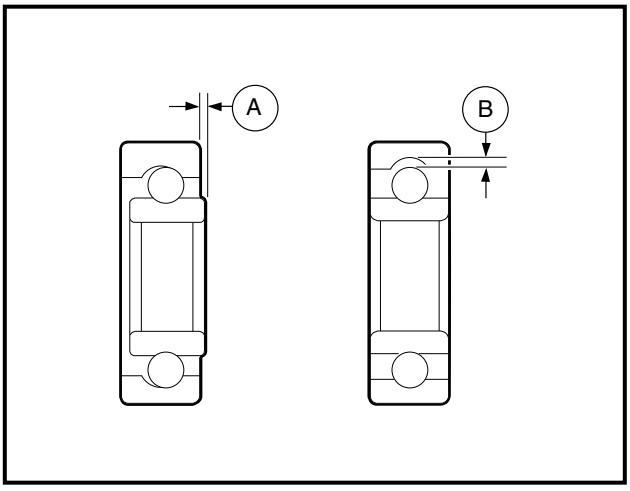


Figure 6-24 Inspect Bearings

UNITIZED TRANSAXLE COMPONENT INSPECTION

See General Warning on page 1-1.

1. Clean all of the component parts of the transaxle in a high flash-point solvent and dry them. Inspect all components for excessive wear or damage.
2. Inspect all bearings by spinning them by hand. Check the bearings for excessive axial (A) and radial (B) play **(Figure 6-24, Page 6-13)**. Replace bearings if they do not spin smoothly, if they are noisy, or if they have excessive play. Replace bearings if they are rusted, worn, cracked, pitted or discolored.
3. Gears should be inspected for tooth surface damage or fractures.
4. Synchronizer ring teeth should be inspected for severe wear, fractures, or other damage.
5. Using a feeler gauge, measure the distance X at several points around the assembly. The synchronizer ring should be replaced when X is 0.02-inch (0.5 mm) or less **(Figure 6-25, Page 6-13).**
6. Inspect the O-ring (96) on the differential lock shaft **(Figure 6-13, Page 6-7)**.

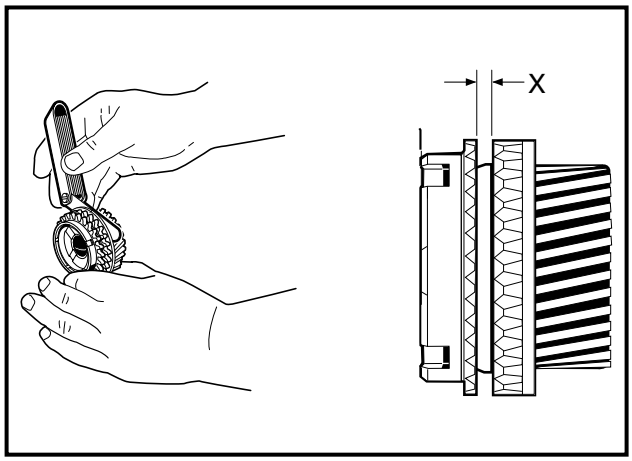


Figure 6-25 Synchronizer Ring

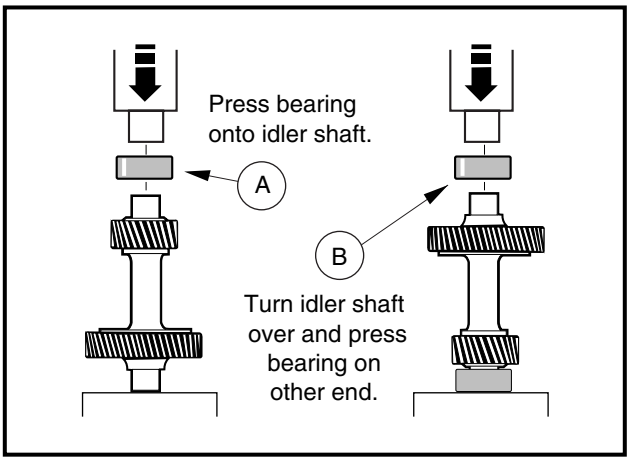


Figure 6-26 Idler Shaft

COMPONENT ASSEMBLY

See General Warning on page 1-1.

IDLER SHAFT ASSEMBLY

1. Press a new bearing (69) **(Figure 6-16, Page 6-9)** onto each end of the idler shaft **(Figure 6-26, Page 6-13)**. **See following CAUTION.**

CAUTION

- **Apply pressure against the inner race of the bearing only. Applying pressure anywhere else will damage the bearing.**

INTERMEDIATE GEAR ASSEMBLY

1. If the gear (61) was removed from the shaft, install the key (60) into the slot and then position the gear on the shaft with keyway properly aligned. Press gear into place on the key **(Figure 6-16, Page 6-9)**.
2. Press the bearing (62) onto the end of the shaft next to the large gear that was installed in step 1. **See following CAUTION.**

CAUTION

- **Apply pressure against the inner race of the bearing only. Applying pressure anywhere else will damage the bearing.**

3. Press a new bearing (41) onto the other end of the shaft.

SYNCHRONIZER GEAR ASSEMBLY

1. Press the synchronizer sleeve (50) onto the splines of the input shaft (54) **(Figure 6-16, Page 6-9)**. The machined circular face surrounding the ends of the internal splines in the sleeve must be flush with the machined lip of the shaft at the ends of the shaft splines **(Figure 6-27, Page 6-14)**.
2. Install the synchronizer springs (49) in the sleeve **(Figure 6-16, Page 6-9)**.

NOTE: *Make sure the ends of the springs are positioned between the synchronizer insert slots **(Figure 6-28, Page 6-14)**.*

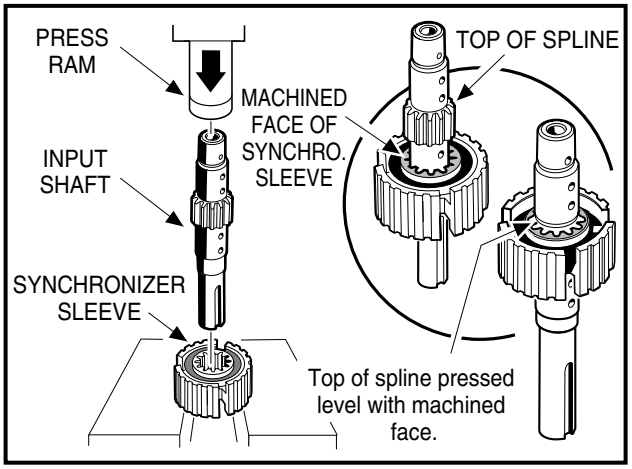


Figure 6-27 Synchronizer Gear Assembly

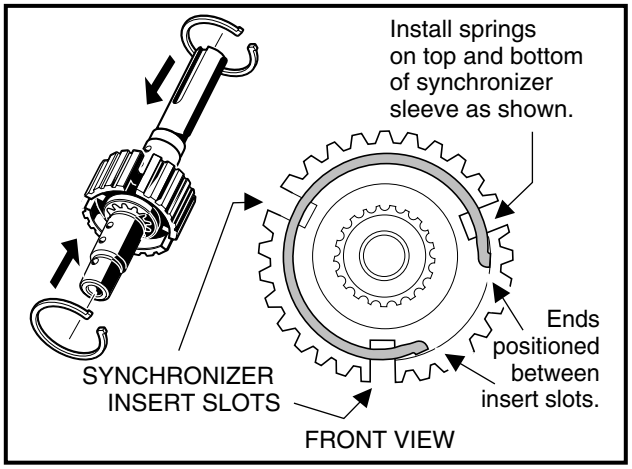


Figure 6-28 Synchronizer Springs

3. Install the three synchronizer inserts (51) into the slots in the sleeve **(Figure 6-16, Page 6-9)**. Make sure the notched surfaces of the inserts are facing outward **(Figure 6-29, Page 6-15)**.

4. Install the synchronizer clutch hub (52) **(Figure 6-16, Page 6-9)** onto the synchronizer sleeve. Make sure the chamfered end of the hub is oriented toward the long end of the input shaft **(Figure 6-30, Page 6-15)**.

5. On the long end of the shaft, install the synchronizer ring (48) **(Figure 6-16, Page 6-9)** with the smooth collar of the ring towards the clutch hub. Make sure the three notches in the collar mate with the synchronizer inserts in the synchronizer sleeve **(Figure 6-31, Page 6-16)**.

6. Install the thrust washer (44) and two bearings (46) **(Figure 6-16, Page 6-9)**.

7. Install the input gear assembly (55) with the smooth collar toward the synchronizer ring. The input gear should seat in the synchronizer ring **(Figure 6-16, Page 6-9)**.

8. Install the thrust washer (56), then the spring washer (42). The spring washer should be oriented with the raised center toward the end of the shaft.

9. Press new bearing (57) onto the shaft until it seats. Make sure the input gear turns freely. **See following CAUTION.**

CAUTION

- **Apply pressure against the inner race of the bearing only. Applying pressure anywhere else will damage the bearing.**

10. On the other end of the input shaft, install the thrust washer (44) and the synchronizer ring (48) **(Figure 6-16, Page 6-9)**. The smooth collar of the synchronizer ring should be oriented toward the clutch hub, and the notches in it should mate with the synchronizer inserts as shown **(Figure 6-29, Page 6-15)**.

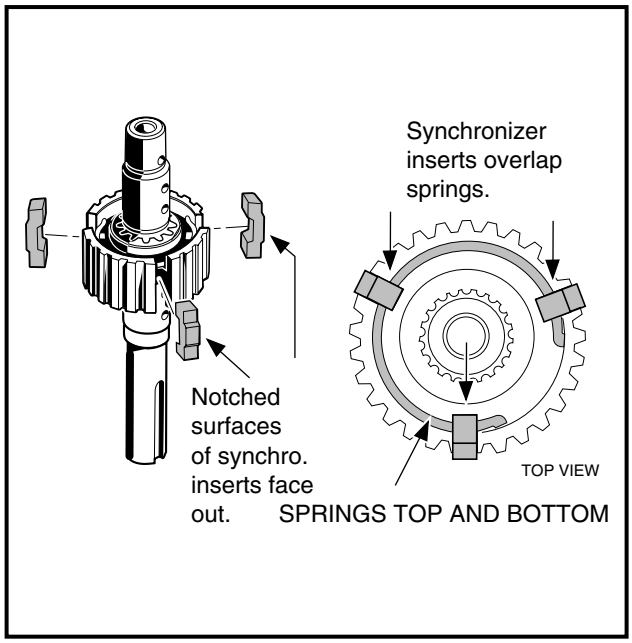


Figure 6-29 Synchronizer Inserts

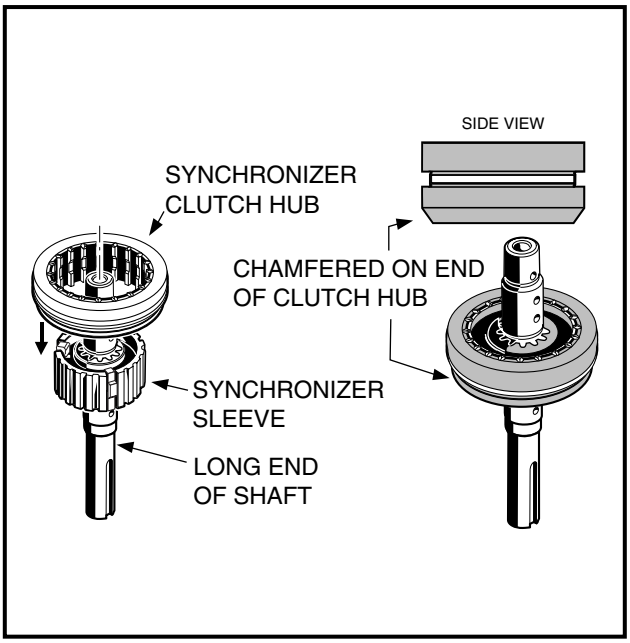


Figure 6-30 Synchronizer Clutch Hub

Synchronizer Gear Assembly, Continued:

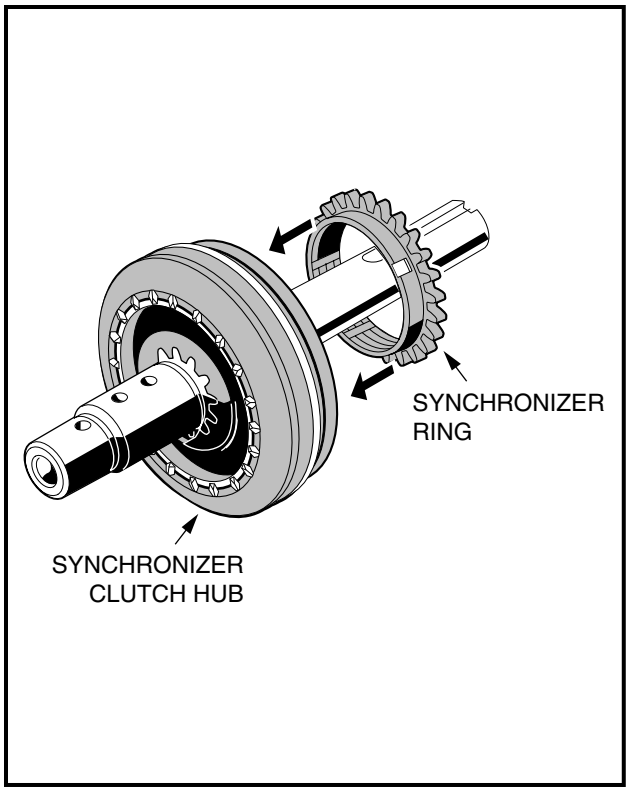


Figure 6-31 Synchronizer Ring

11. Install the narrow bearing (47), wide bearing (46), and input gear (45) onto the shaft. The smooth collar of the input gear should be oriented toward the synchronizer ring **(Figure 6-16, Page 6-9)**. The gear should seat inside the ring.
12. Install thrust plate (44) onto the shaft and the dowel pin (53) into the shaft.
13. Install the spur (governor drive) gear (43) onto the shaft with either side down. Mate the notch in the gear with the dowel pin.
14. Install the spring washer (42) onto shaft with the raised center toward the end of the shaft.
15. Press a new bearing (41) onto the end of the shaft until it seats **(Figure 6-16, Page 6-9)**. Make sure the input gears turn freely. **See following CAUTION.**

CAUTION

- **Apply pressure against the inner race of the bearing only. Applying pressure anywhere else will damage the bearing.**

SHIFTER FORK ASSEMBLY

1. Install the spring (35) and ball (36) into the shifter fork (34) **(Figure 6-32, Page 6-17)**.

2. Use a no. 1 tip phillips screwdriver to press the ball and spring while inserting shift rod (33) into the shifter fork (34) **(Figure 6-33, Page 6-17)**. Remove screwdriver when the shift rod is inserted far enough for it to depress the ball and spring, then continue to insert rod until the ball is positioned in the middle detent on the rod.

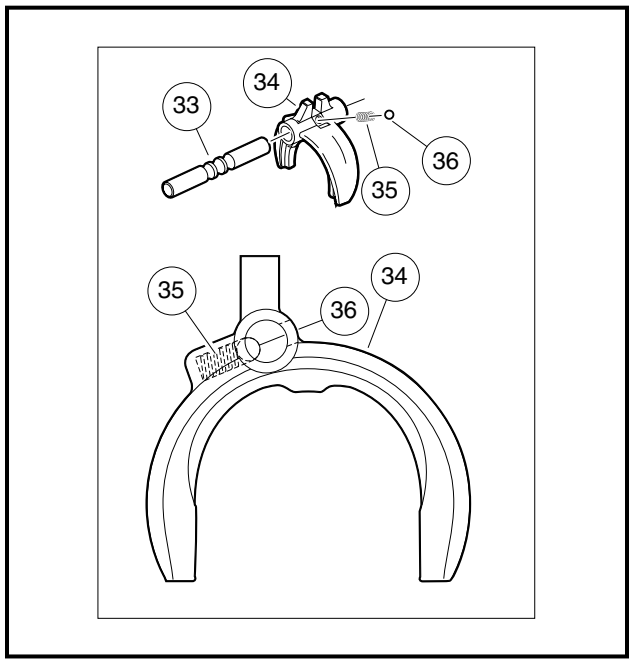


Figure 6-32 Align Spring and Ball and Insert

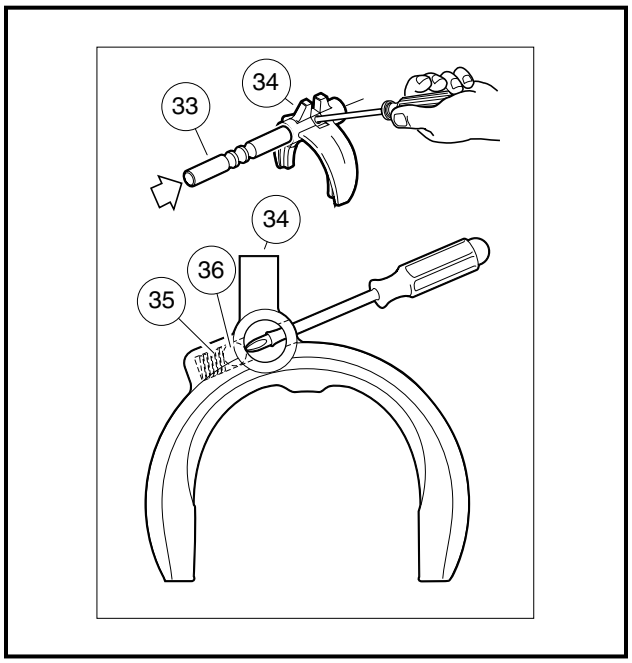


Figure 6-33 Insert Shift Rod Past Ball

DIFFERENTIAL GEAR CASE ASSEMBLY

1. If the bearings (70 or 71) were removed, press new ones onto the differential gear carrier case (75) and carrier case cover (78) **(Figure 6-16, Page 6-9)**. **See following CAUTION.**

CAUTION

- **Apply pressure against the inner race of the bearing only. Applying pressure anywhere else will damage the bearing.**

2. Install differential gear (82) into carrier case (75) **(Figure 6-16, Page 6-9)**. **See also Figure 6-34, Page 6-18**.
3. Start the differential pin (79) into the carrier case by lightly tapping it in with a plastic or rubber hammer. Before the pin enters the inside of the carrier case, position the thrust plate (76) and idler gear (80) in the case and continue tapping the pin through the thrust plate and idler gear **(Figure 6-35, Page 6-18)**.
4. Position the other thrust plate (76) and idler gear (80) in the carrier case. Continue to drive the pin (79) through them and the wall of the carrier case until the ends of the pin are flush with the sides of the carrier case **(Figure 6-36, Page 6-18)**.
5. Install the thrust plate (77) and differential gear (81) into the carrier case cover (78) **(Figure 6-37, Page 6-18)**. While holding the thrust plate and differential gear in place, position the carrier case cover on the carrier case.
6. Position the output ring gear (73) on the carrier case, visually aligning the dowel hole in the carrier case with the dowel pin in the ring gear **(Figure 6-38, Page 6-19)**. Use a plastic or rubber mallet to tap the ring gear into place on the dowel pin .

Differential Gear Case Assembly, Continued:

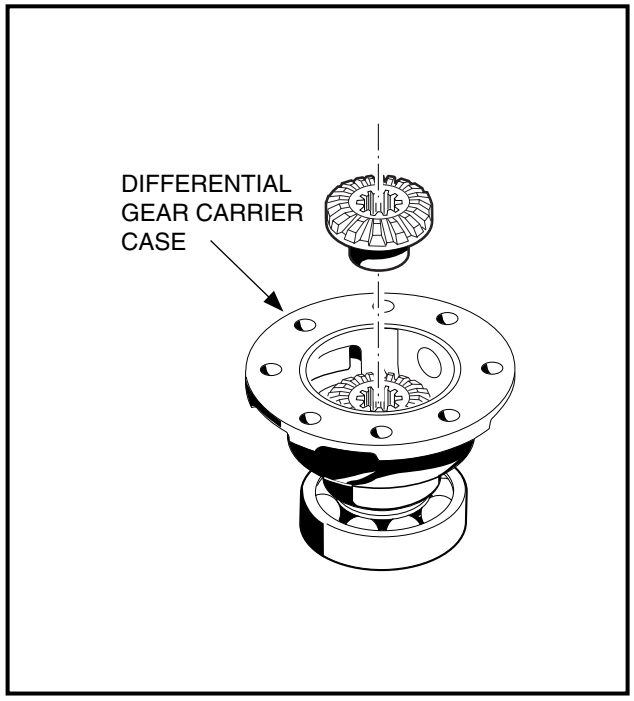


Figure 6-34 Differential Gear

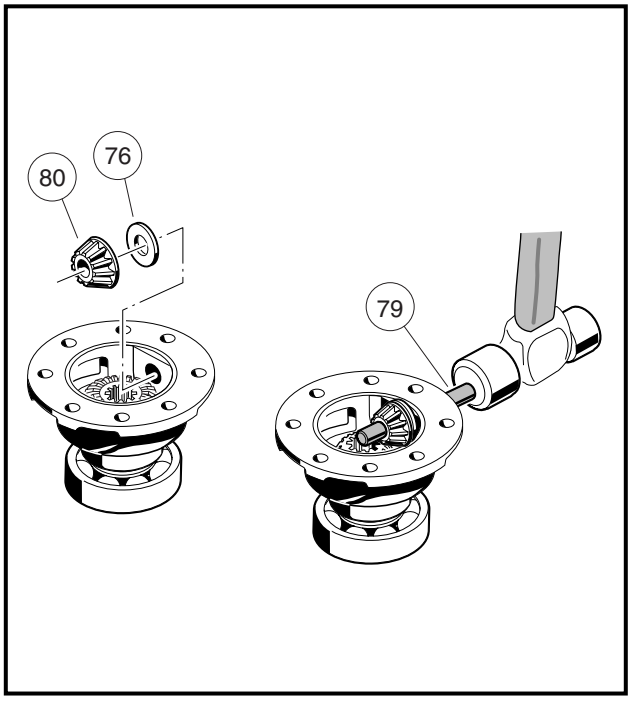


Figure 6-35 Idler Gear

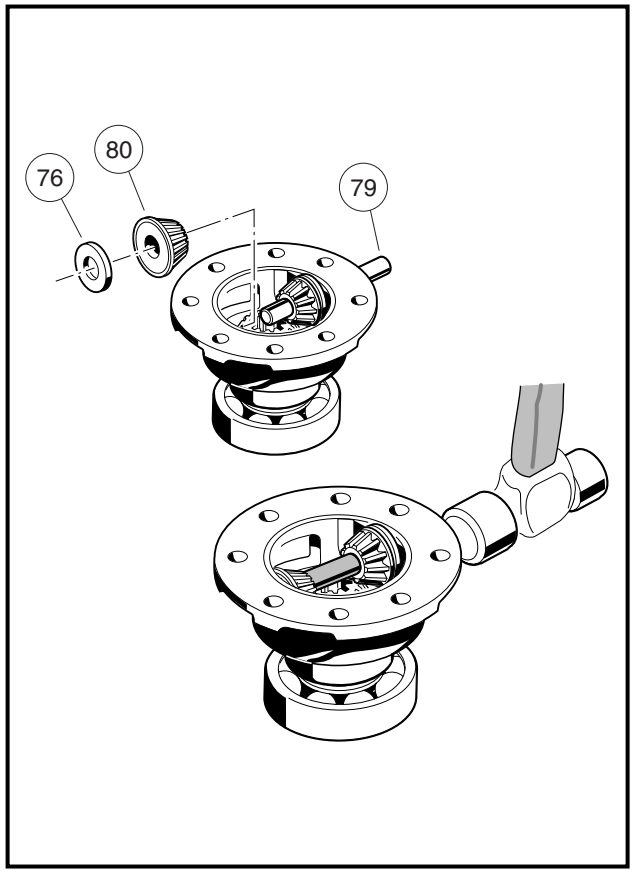


Figure 6-36 Second Idler Gear

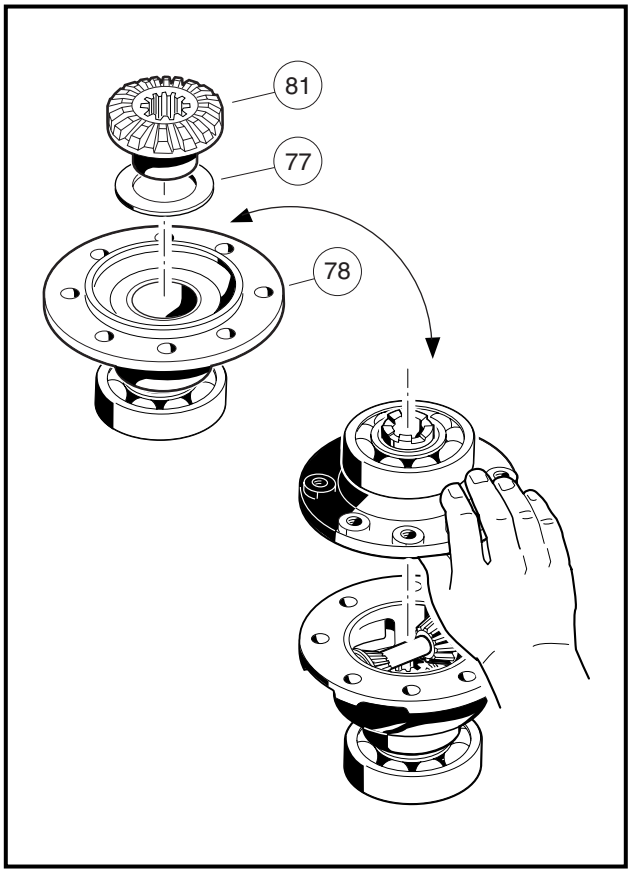


Figure 6-37 Carrier Case

7. Apply Loctite 277® on the threads of the eight mounting bolts and install them through the ring gear, carrier case, and carrier case cover. Tighten the bolts to 18 ft-lb (24.4 N·m) in the sequence shown **(Figure 6-39, Page 6-19)**.

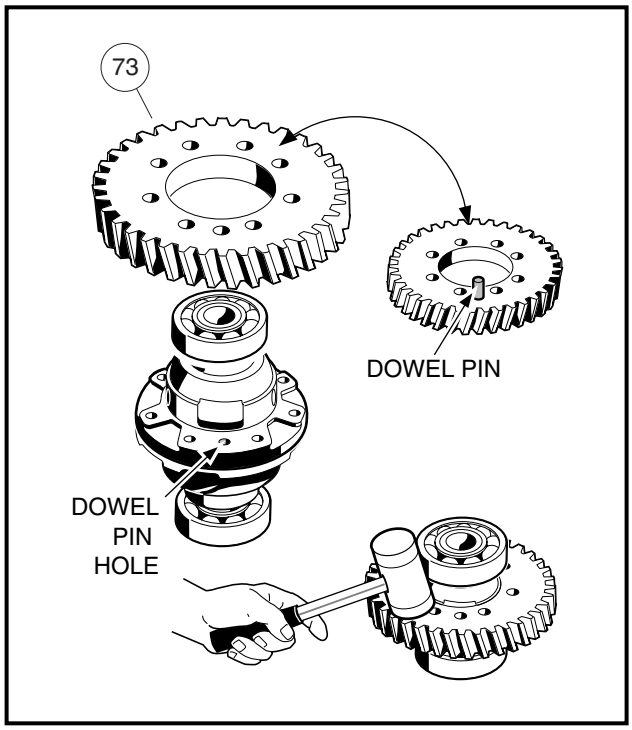


Figure 6-38 Ring Gear

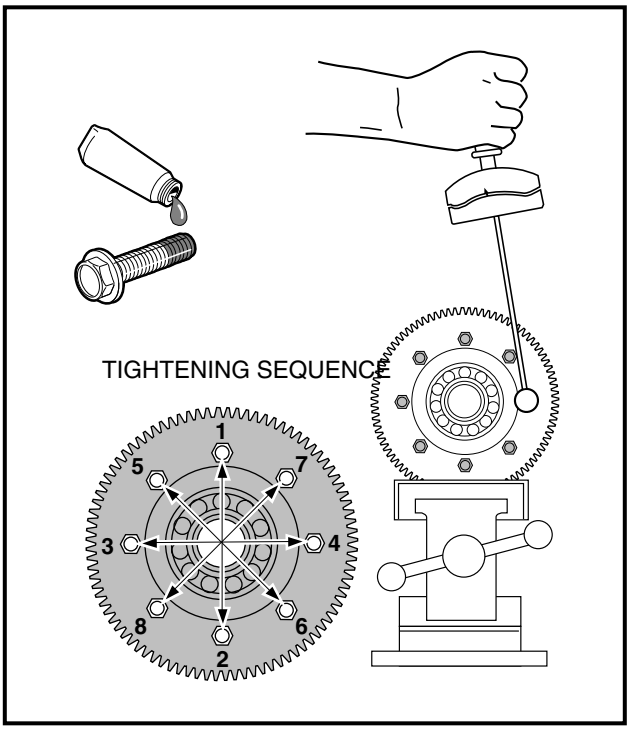


Figure 6-39 Retaining Bolts

GOVERNOR GEAR ASSEMBLY

The governor gear is not assembled before installing it in the unitized transaxle case. The governor gear shaft is installed into the case and then the rest of the governor gear assembly is installed on the shaft. Proceed with transaxle assembly.

DIFFERENTIAL GEAR LOCK HOUSING ASSEMBLY

1. If previously removed, slide the O-Ring into the top groove of the differential lock shaft **(Figure 6-40, Page 6-20)**.
2. Place the shaft (95) into the hole in the differential lock housing (94) **(Figure 6-41, Page 6-20)**.
3. Install the retaining screw (102) and washer (103) into the differential lock housing. Ensure that the screw is aligned with the second groove in the differential lock shaft before continuing to tighten the screw. Tighten the screw to 69 in-lb (7.8 N·m).
4. Place the spacer (97) onto the differential lock shaft.
5. Install the spring over the spacer so that the straight end of the spring will rest on the axle tube side of the differential lock housing.
6. Place the differential lock arm (99) on the shaft (95) and place the hooked end of the spring (98) on the arm.
7. Tighten the differential lock arm retainer nut (101) to 60 in-lb (6.8 N·m).

Differential Gear Lock Housing Assembly, Continued:

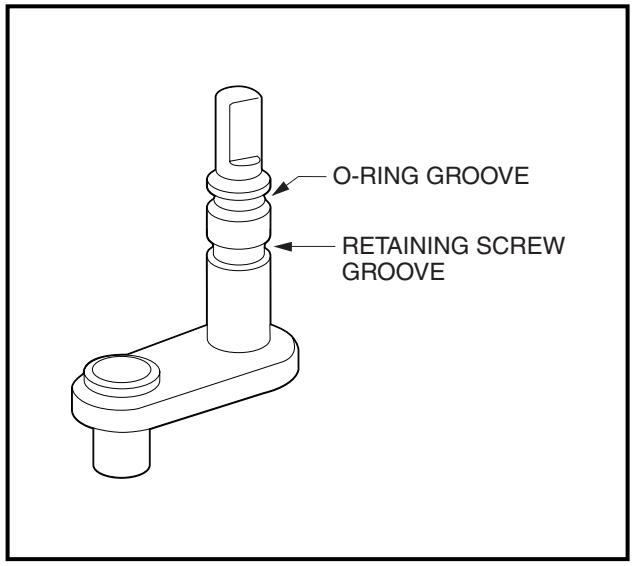


Figure 6-40 Differential Lock Shaft

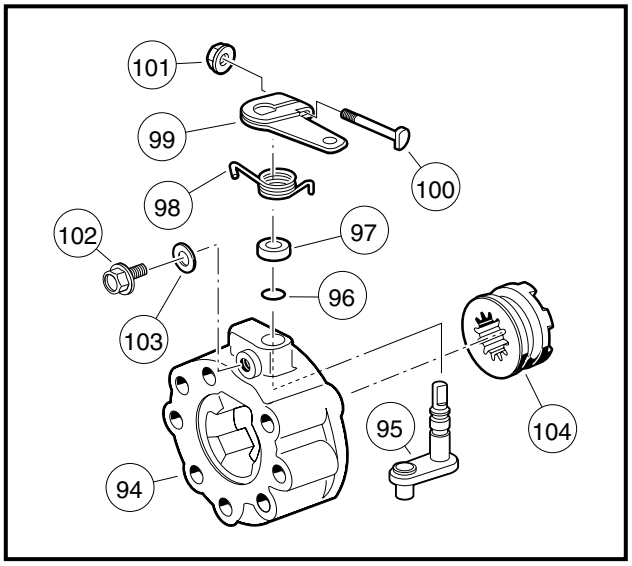


Figure 6-41 Differential Lock Housing Assembly

UNITIZED TRANSAXLE ASSEMBLY

See General Warning on page 1-1.

NOTE: *Although the following drawings show the transaxle being assembled in an upright position, laying the transaxle on its left (driver) side will simplify the assembly process.*

1. Make sure both parts of the case are clean and free of any contaminants. Make sure the machined mating surfaces are free of residue and are not scratched or damaged in any way.

2. Put a light coating of clean transmission oil on the outside edge of the seal to make installation easier. Press two new oil seals (18 and 23) **(Figure 6-5, Page 6-4)** into the left (driver) side case. Use an oil seal installation tool (CCI P/N 1014160) to install a new oil seal (58) **(Figure 6-16, Page 6-9)** into the right (passenger side) case. **See also Figure 6-42, Page 6-21**.

3. Position the governor gear shaft installation tool (CCI P/N 101933101) over the shaft bore in the inside of the left (driver) side case and insert the governor gear shaft into the tool, long end (from the groove) first **(Figure 6-43, Page 6-21)**. Make sure the shaft is started into the bore and then, using a plastic or rubber hammer, carefully tap the governor gear shaft into the bore until the end being tapped is flush with the end of the tool. Remove installation tool.

4. Install the washer, governor gear, and sleeve together onto the governor shaft **(Figure 6-44, Page 6-22)**. Make sure the sleeve is properly positioned within the flyweight brackets of the gear **(Figure 6-45, Page 6-22),** then push them onto the shaft until the gear snaps into the groove on the shaft.

5. Position the interior washer on the pivot arm and install the pivot arm and washer into the left (driver side) case **(Figure 6-46, Page 6-22)**. Install the exterior washer and cotter pin on the pivot arm outside the case. Bend the legs of the cotter pin.

6. Install the shifter shaft into the left (driver side) case **(Figure 6-47, Page 6-22)**. Install the washer and use external snap ring pliers (0.070 tip) to install retaining ring on the shifter shaft outside of the case. Make sure the retaining ring is in the groove of the shaft.

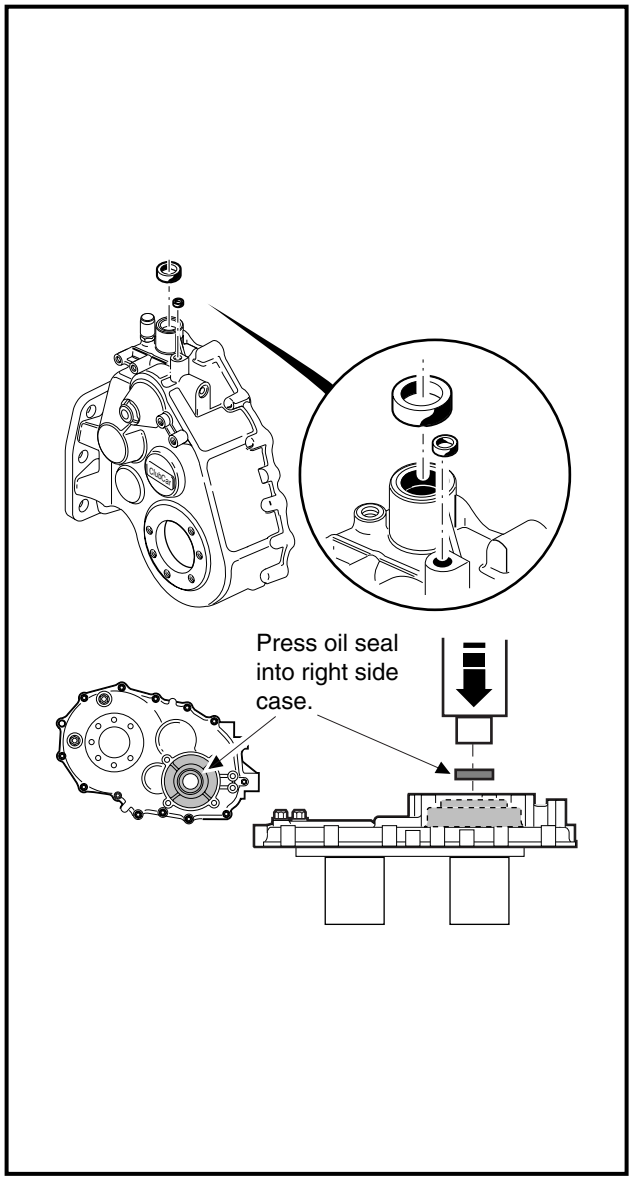


Figure 6-42 Install Seals

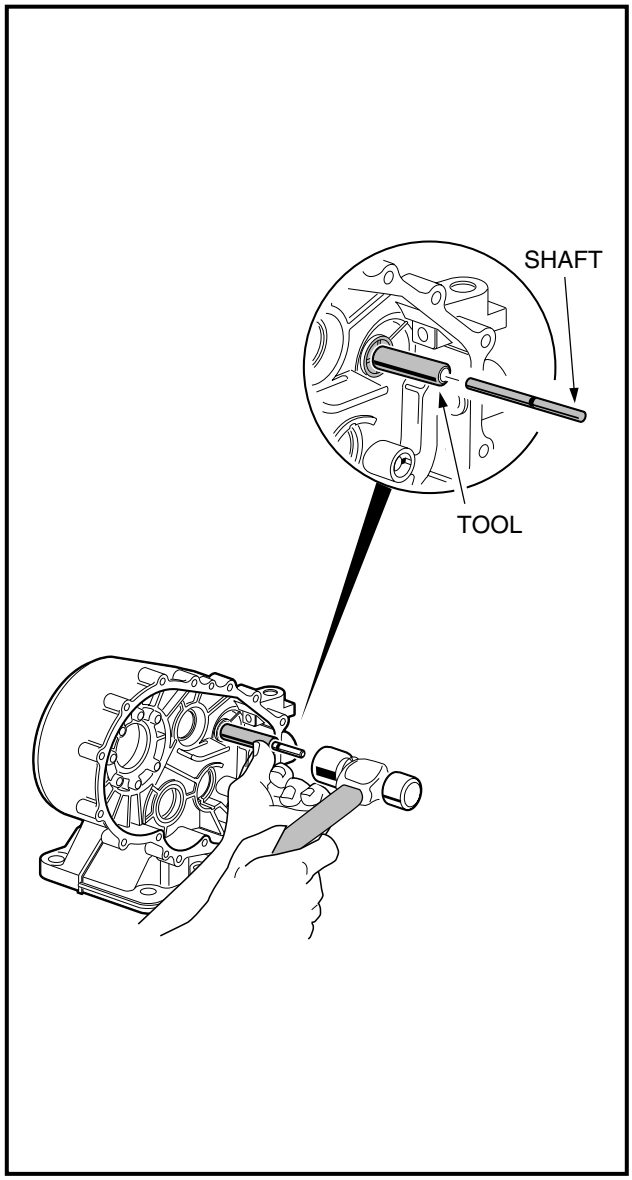


Figure 6-43 Governor Gear Shaft

7. Install the gear assemblies into the left (driver side) case.

   7.1. Stand the left side case on the mounting plate, then install the differential gear case assembly **(Figure 6-48, Page 6-23)**. Do not seat the assembly in the bore, instead insert it far enough that it will not fall out.

   7.2. Install the idler gear assembly into case. Do not seat the assembly in the bore, instead insert far enough that it will not fall out. No gears mesh at this point **(Figure 6-49, Page 6-23)**.

   7.3. Install the oil guide with the baffle toward the case wall **(Figure 6-50, Page 6-23)**. Make sure the two tabs on the guide are positioned in the slots in the case.

Unitized Transaxle Assembly, Continued:

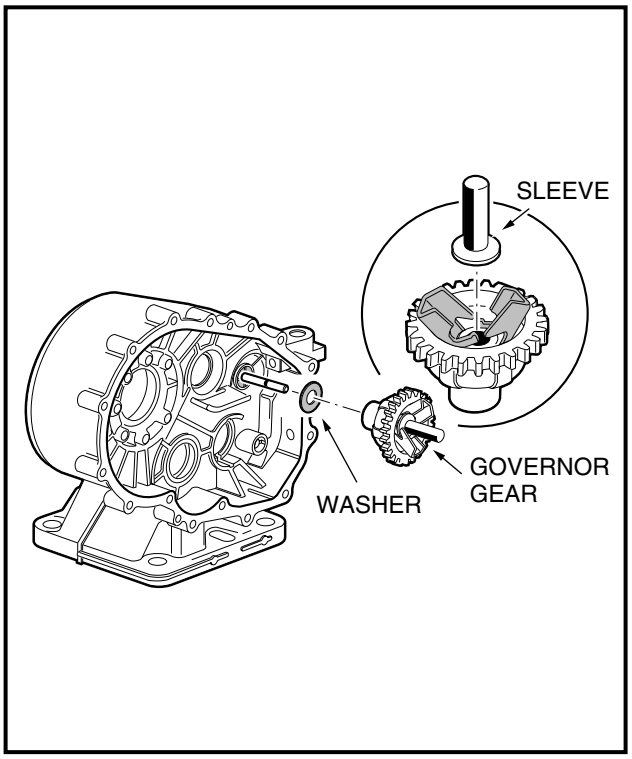


Figure 6-44 Position Governor Gear

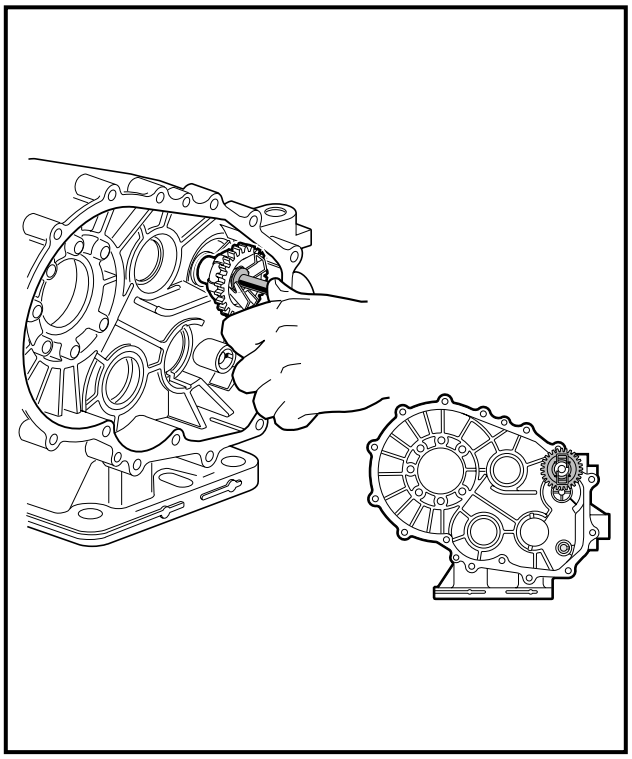


Figure 6-45 Install Governor Gear

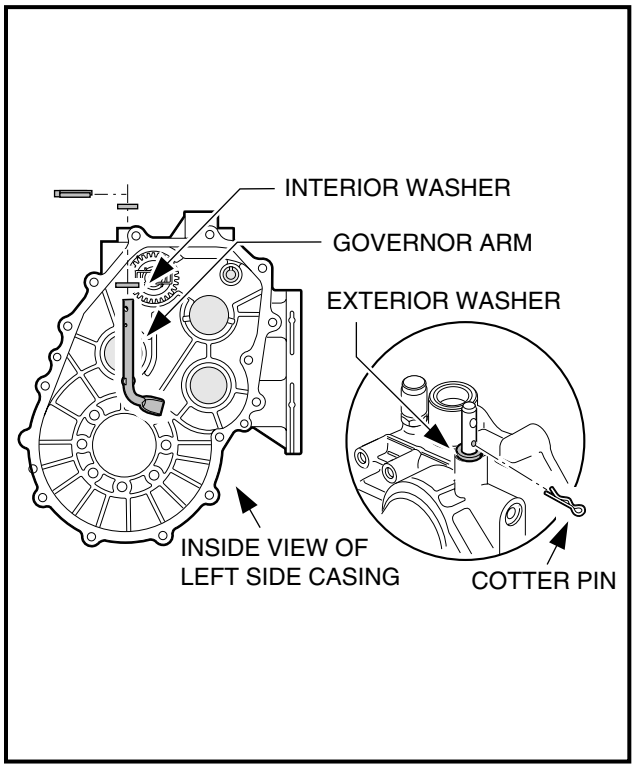


Figure 6-46 Pivot Arm

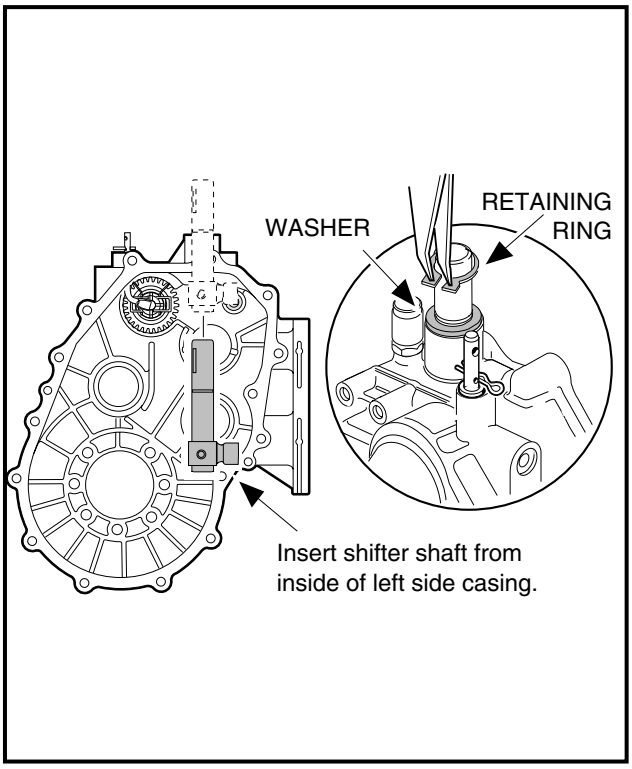


Figure 6-47 Insert Shifter Shaft

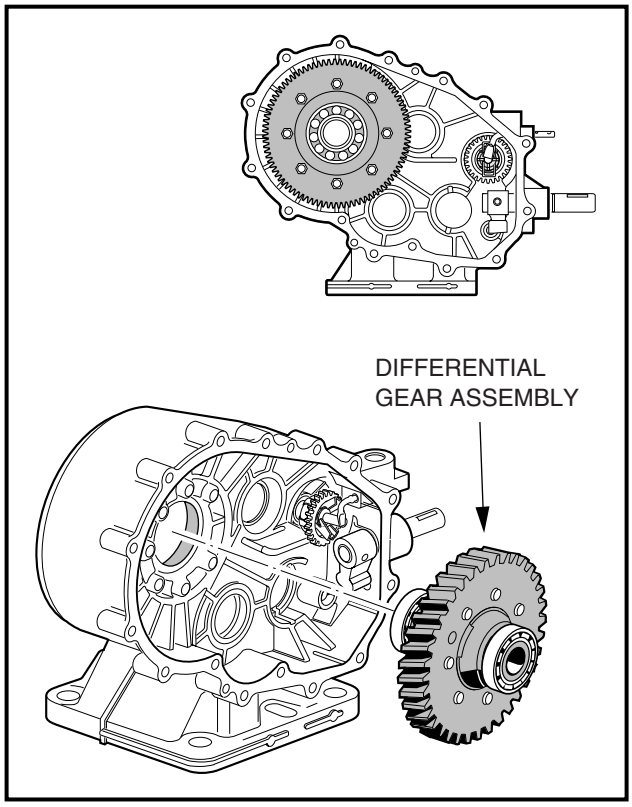


Figure 6-48 Differential Gear Assembly

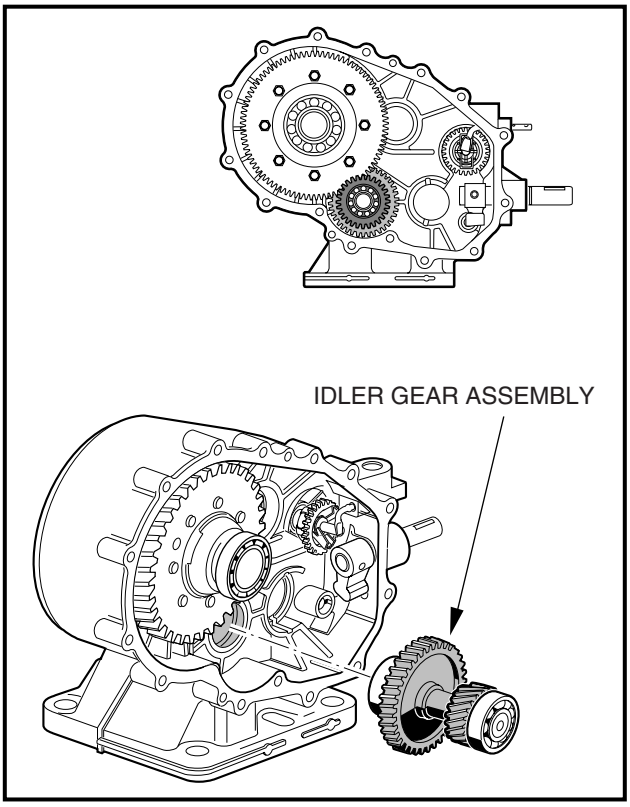


Figure 6-49 Idler Gear Assembly

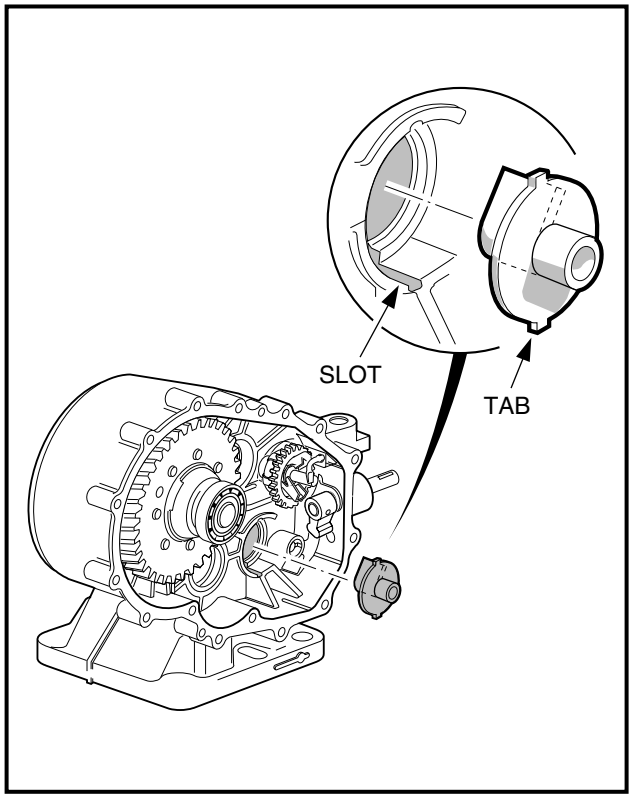


Figure 6-50 Oil Guide

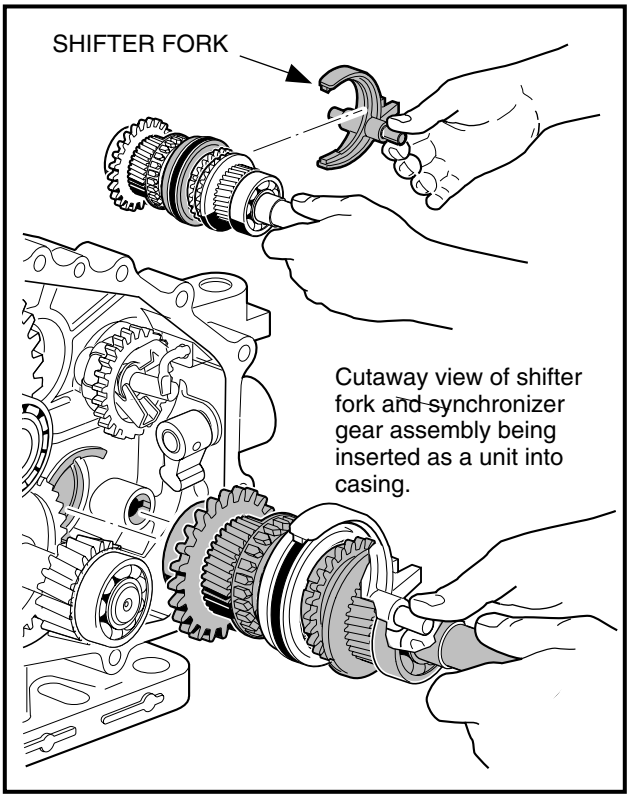


Figure 6-51 Synchronizer Ring Gear

Unitized Transaxle Assembly, Continued:

7.4. Position the shifter fork assembly on the synchronizer gear assembly as shown, and install them together, bearing end first, into the bore containing the oil guide **(Figure 6-51, Page 6-23)**. Do not seat the assembly, instead make sure the spur gear (43) is meshed with the governor gear (66) **(Figure 6-16, Page 6-9)**, and the shifter lever (19) **(Figure 6-5, Page 6-4)** is positioned in the bracket on the shifter fork. **See also Figure 6-52, Page 6-24**.

7.5. Install the intermediate gear assembly into the case as shown **(Figure 6-53, Page 6-24)**. Do not seat the assembly into the bore, instead make sure the output ring gear meshes with the input drive gear (55) on the synchronizer gear assembly and with the small gear on the idler shaft (68) **(Figure 6-16, Page 6-9)**.

7.6. Keep the gears meshed, as a group, and work all of the gear assemblies into the bores until they are seated. When all of the assemblies are correctly seated, the outside edges of the input drive gear (55) and the intermediate gear (61) **(Figure 6-16, Page 6-9)** should be flush (in the same plane) as shown **(Figure 6-54, Page 6-25)**. Also, the outside surfaces of the idler gear bearing, the intermediate gear bearing, and the differential gear bearing should be flush. **See following CAUTION.**

CAUTION

- **If the edges of the input drive gear and intermediate gear are not flush, then the oil guide (40) (Figure 6-16, Page 6-9) may not be properly positioned in the bore.**

8. Make sure the mating surfaces of the left and right sides of the case are clean and free of oil, grease, or residue of any kind, and they are not scratched or damaged in any way.

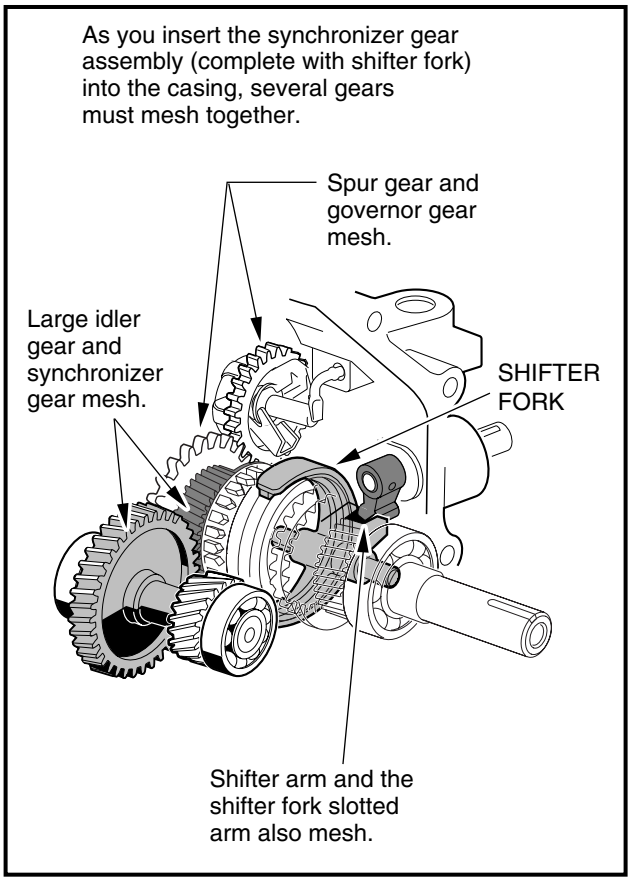


Figure 6-52 Gear Alignment

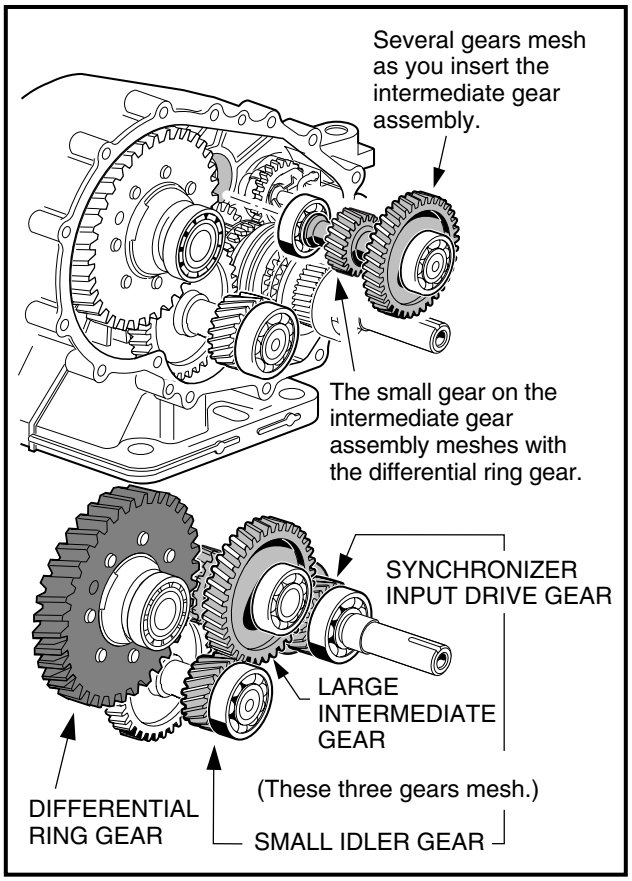


Figure 6-53 Gear Alignment

9. Apply a continuous bead of Three Bond No. 1215 (CCI P/N 101928701) sealant to the mating surface around the complete profile of the right (passenger side) case **(Figure 6-55, Page 6-25)**. **See following CAUTION.**

CAUTION

- **Use only Three Bond No. 1215 sealant to seal case. Do not use a substitute.**
- **If the two sides of the case cannot be easily closed or do not make complete contact, do not force them together. Check that all internal components are properly seated and then try again.**

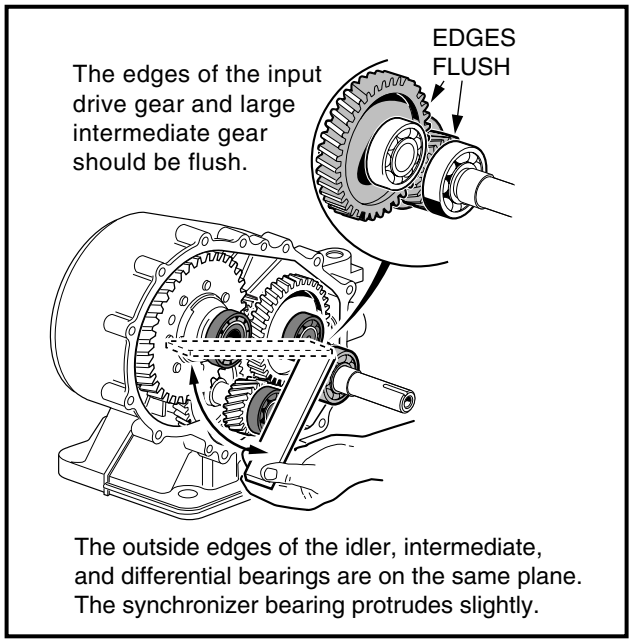


Figure 6-54 Gear Alignment

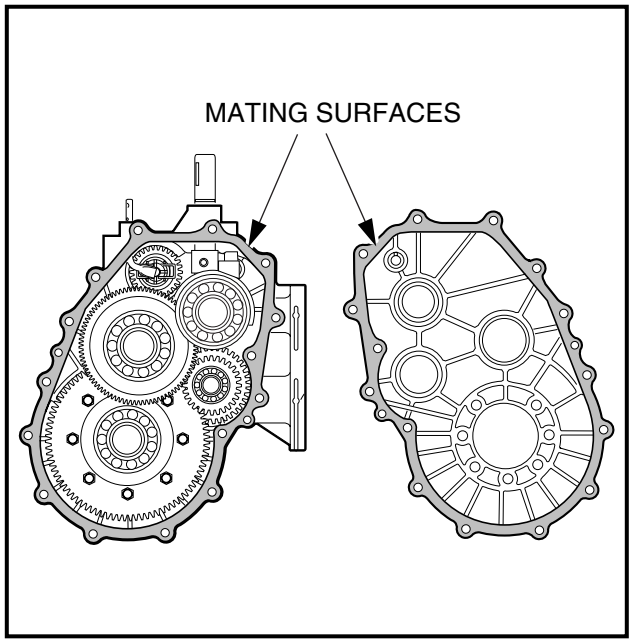


Figure 6-55 Prepare Mating Surfaces

10. Install and finger-tighten the fifteen bolts (28) **(Figure 6-5, Page 6-4)** that secure the left and right sides of the case together. Then, in sequence shown, tighten the bolts to 17 ft-lb (23.1 N·m) **(Figure 6-56, Page 6-25)**.

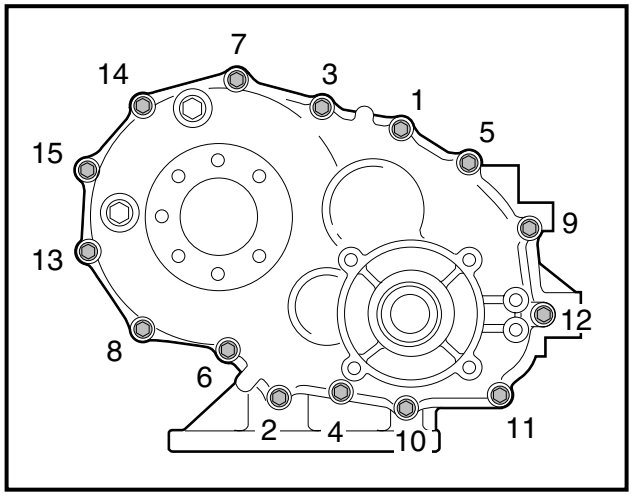


Figure 6-56 Casing Torgue Sequence

AXLE TUBES

See Axle Tube Installation, Section 16, in the appropriate maintenance and service manual.

UNITIZED TRANSAXLE INSTALLATION

See unitized Transaxle Installation, Section 16, in the appropriate maintenance and service manual.

LUBRICATION

See Lubrication, Section 16, in the appropriate maintenance and service manual.

SECTION 7 – MC012C-AS00 AND MC012C-BS00 UNITIZED TRANSAXLES WITH DIFFERENTIAL LOCKS

⚠ DANGER

- **See General Warning on page 1-1.**

⚠ WARNING

- **See General Warning on page 1-1.**

GENERAL INFORMATION

The MC012C-AS00 is a heavy-duty, fully-synchronized unitized transaxle with differential lock. With fully-synchronized internal gearing to change vehicle direction, wear and maintenance requirements on the engine, drive clutch, belt, and driven clutch are greatly reduced. All components rotate in the same direction; therefore, the engine and clutches are not subjected to reversing loads. Power is transferred from the engine through the drive clutch, the drive belt, the driven clutch, then through the unitized transaxle to the wheels.

TRANSAXLE MODELS AND IDENTIFICATION

The MC012C-AS00 and MC012C-BS00 transaxles have been supplied on models of Turf 272, Carryall 272 and 472, Pioneer 1200 and 1200SE, Cafe Express Deluxe and XRT 1200 vehicles coupled with either of the FE350 engines or the FE400 engine. They are the replacement for the previous MC010C-BS00 transaxle. All operate the same internally, but utilize a few, slightly different gear components and have two different styles of axle and wheel hub designs. All parts are identified in their respective illustrated parts list (IPL) manuals.

The MC012C-AS00 and MC012C-BS00 transaxles are designed with a removable wheel bolt flange and attaches to the ends of the axle shafts using a splined coupling configuration **(Figure 7-2, Page 7-1)**. The MC010C-BS00 transaxle is designed with the wheel hub permanently attached to the outside end of each axle shaft **(Figure 7-1, Page 7-1)**. All transaxles have different physical attachment provisions and dimensional differences and therefore are not interchangeable. Further, the MC012C-AS00 and MC012C-BS00 transaxles are designed specifically for both the FE350 and the FE400 engines.

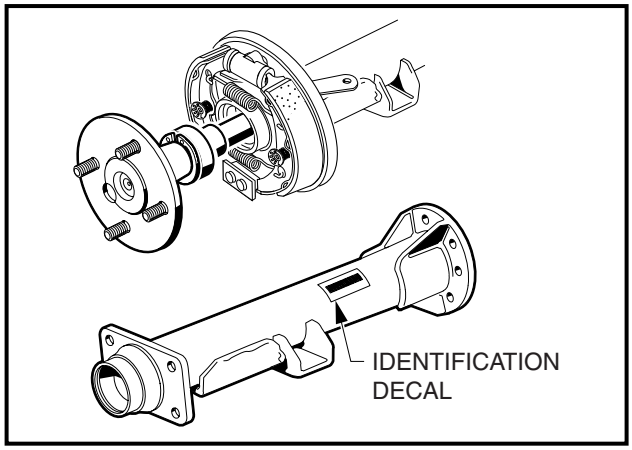


Figure 7-1 MC010C-BS00 Transaxle

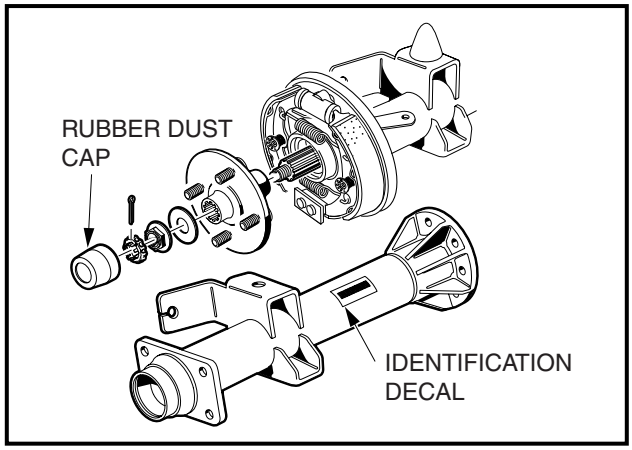


Figure 7-2 MC012C-AS00 and MC012C-BS00 Transaxle

Tools Required For This Section

Hydraulic floor jack (or chain hoist)	12 to 18-in. straight edge	17 mm socket, 3/8-in. drive
Jack stands (2) (one-ton capacity)	Small ball peen hammer (10 oz.)	7/16-in. combination wrench
Hydraulic press	Plastic or rubber mallet	1/2-in. combination wrench
Bench vise	Ratchet wrench, 3/8-in. drive	9/16-in. combination wrench
Standard slip joint pliers	Torque wrench, 3/8-in. drive	11/16-in. combination wrench (2)
External snap ring pliers (.070 in. tip)	3/8-in. Socket, 3/8-in. drive	17 mm combination wrench
External snap ring pliers (.047 in. tip)	7/16-in. Socket, 3/8-in. drive	Small flat blade screwdriver
90° Internal snap ring pliers (.090 in. tip)	10 mm Combination wrench	Medium flat blade screwdrivers (2)
Feeler gauge	1/2-in. Socket, 3/8-in. drive	No. 2 phillips-head screwdriver
16 in. rolling head prybar	9/16-in. Socket, 3/8-in. drive	1/4-in. nut driver
Small punch or scratch awl	5/8-in. Socket, 3/8-in. drive	5/16-in. nut driver
1/4-in. diameter drift or metal rod	12 mm Socket, 3/8-in. drive	Small knife or wire snippers
Bearing puller wedge attachment (CCI P/N 1012812)	Axle seal tool (CCI P/N 1014162)	Governor gear shaft installation tool (CCI P/N 101933101)

AXLE SHAFT

See Axle Shaft and Oil Seal Removal, Section 16, in the appropriate maintenance and service manual.

UNITIZED TRANSAXLE REMOVAL

See Unitized Transaxle Removal, Section 16, in the appropriate maintenance and service manual.

UNITIZED TRANSAXLE DISASSEMBLY

See General Warning on page 1-1.

NOTE: *The following information provides instructions for disassembling the unitized transaxle; however, the transaxle case can be separated and gears accessed without removing the axles or axle tubes from the case.*

1. Position the unitized transaxle case on a clean bench surface with the bottom lubrication plug over a pan suitable for draining lubrication oil.
2. Remove both the top and bottom lubrication port plugs and gaskets. Drain and dispose of the oil properly **(Figure 7-4, Page 7-3)**.

NOTE: *The lower plug is used for draining lubricant. When draining lubricant, remove both plugs to allow the lubricant to drain faster.*

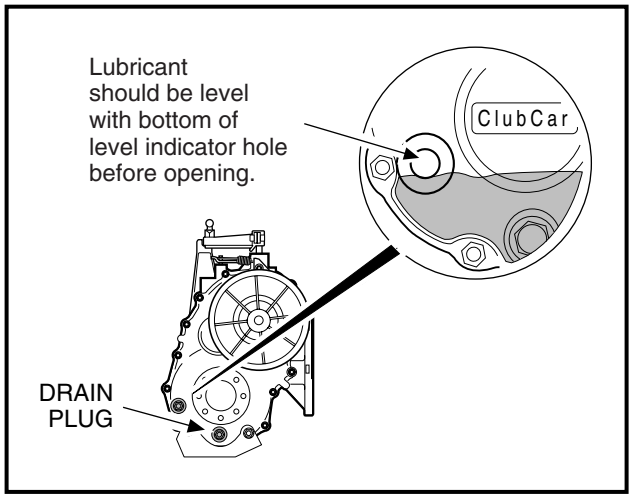


Figure 7-3 Lubricant Level

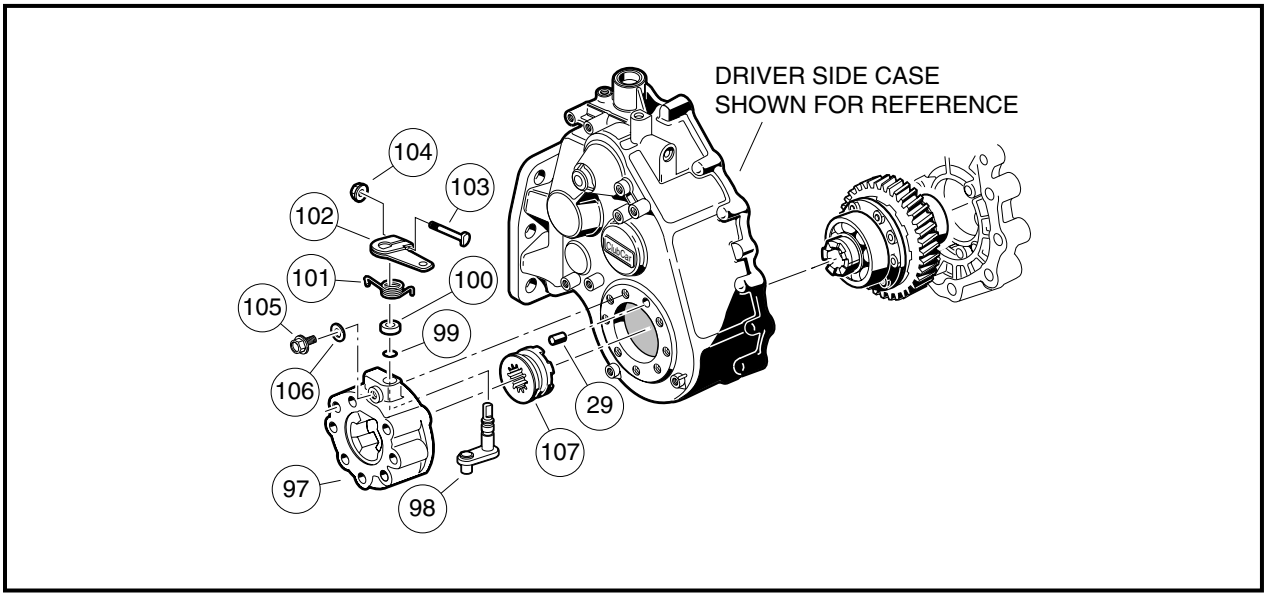


Figure 7-4 Differential Gear Case

3. Remove the differential lock housing (97) from the transaxle case **(Figure 7-4, Page 7-3)**.
4. Remove the four bolts (35) and remove the guard (34) **(Figure 7-5, Page 7-4)**.
5. Remove the fifteen bolts (28) that hold the transaxle housing together **(Figure 7-5, Page 7-4)**.
6. The unitized transaxle is equipped with a slot for prying the housing apart. Use the slot to open the case. Pull the housing apart, making sure all gear assemblies inside the transaxle stay together in one (either) side of the case. **See following CAUTION.**

CAUTION

- **To prevent damage to the mating seal surfaces of the case, use care when separating the halves.**

Unitized Transaxle Disassembly, Continued:

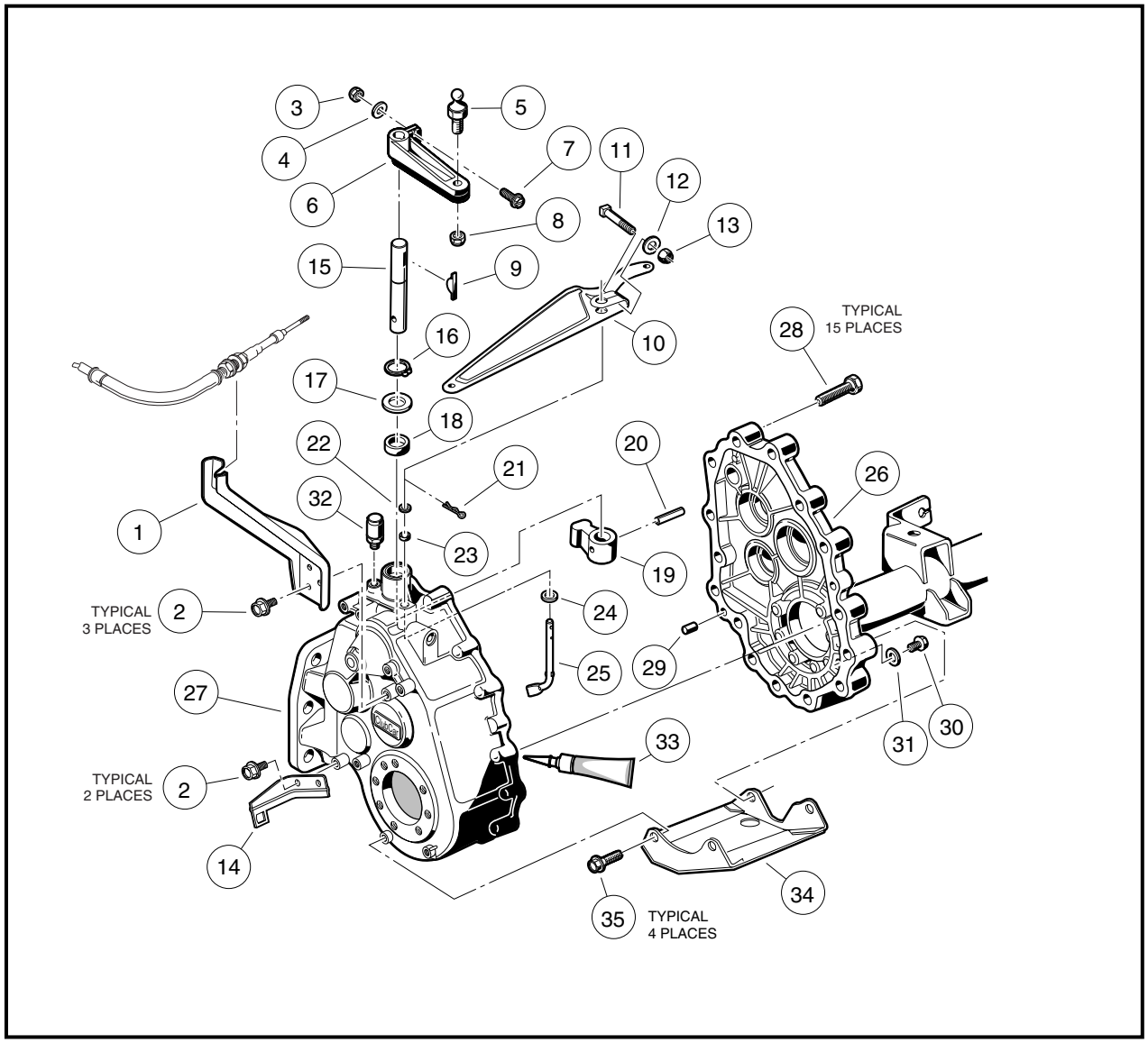


Figure 7-5 Transaxle Gear Casing and Brackets

7. Turn the case section containing the gearing on edge as shown **(Figure 7-6, Page 7-5)**. While holding it in this position, gently rock all the gear assemblies to slightly loosen them in their seating. **See following CAUTION.**

CAUTION

- **To prevent damage to the gears, use extreme care when handling them.**

8. When all the gear assemblies are slightly loosened, remove the differential gear case assembly by gently rocking it while pulling it from the case **(Figure 7-7, Page 7-5)**.
9. Continue to rock and loosen the remaining gear assemblies until the intermediate gear assembly can be removed from the case. Then remove the idler shaft assembly **(Figure 7-8, Page 7-5)**.

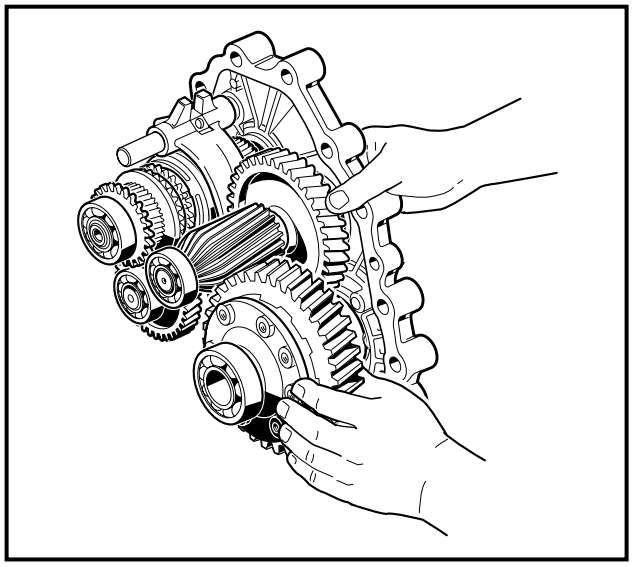


Figure 7-6 Loosen Gears

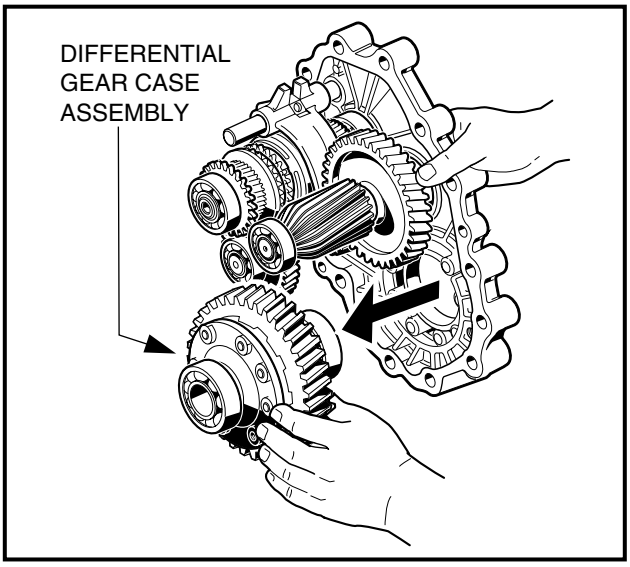


Figure 7-7 Remove Differential Gear Case

10. Remove the synchronizer gear assembly and shifter fork assembly as a unit from the case **(Figure 7-8, Page 7-5)**.
11. Use a seal puller (CCI P/N 1012809) or rolling head prybar to remove the input shaft oil seal from the case **(Figure 7-9, Page 7-5)**.
12. Remove the oil flow guide from the case **(Figure 7-10, Page 7-6)**.
13. Remove the shifter shaft and oil seal from the case **(Figure 7-10, Page 7-6)**.
    13.1. Use snap ring pliers (0.047 tip) to remove the retaining ring (16) on the shifter shaft **(Figure 7-5, Page 7-4)**.
    13.2. Remove flat washer (17) from the shifter shaft on the outside of the case as shown, then remove the shifter shaft by pushing it through the case toward the interior of transaxle **(Figure 7-5, Page 7-4)**.
    13.3. Use a seal puller to remove the shifter shaft oil seal (18) from the case **(Figure 7-5, Page 7-4)**.

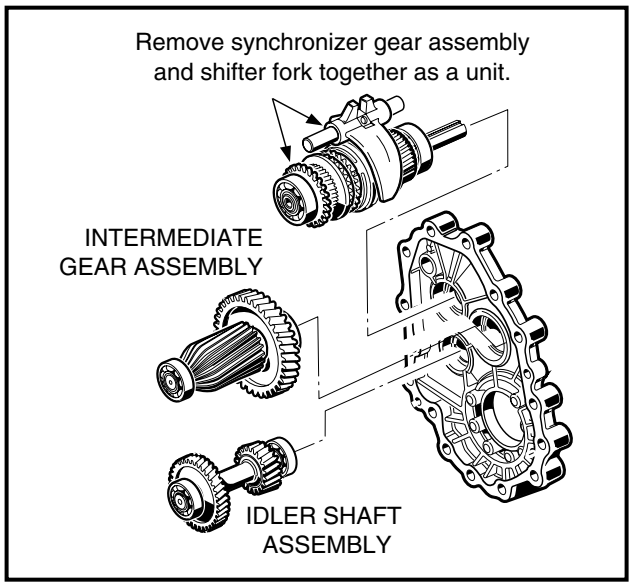


Figure 7-8 Remove Intermediate Gear

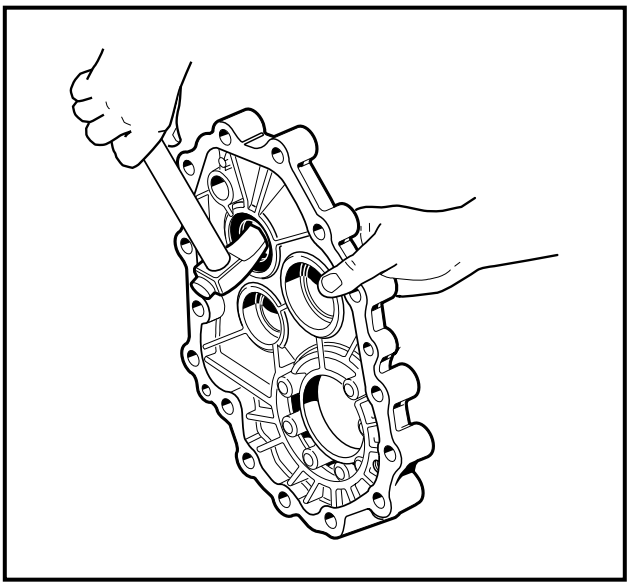


Figure 7-9 Input Shaft Oil Seal

Unitized Transaxle Disassembly, Continued:

14. Remove the breather (32) from the case **(Figure 7-5, Page 7-4)**.

15. Remove the governor assembly from the case.

    15.1. Remove the cotter pin (21) and flat washer (22) from the pivot arm (25) **(Figure 7-5, Page 7-4)**.

    15.2. Remove the pivot arm (25) by pulling it through the wall to the interior of the case, along with the inside support washer (24).

    15.3. Use a small chisel or similar pointed instrument to pry the pivot arm oil seal (23) **(Figure 7-5, Page 7-4)** out of the case **(Figure 7-11, Page 7-6)**.

    15.4. Remove the governor gear assembly (64 and 65) and flat washer (63) **(Figure 7-16, Page 7-9)** by lightly tapping the gear shaft through the case wall, from the outside, with a hammer and drift. **See also Figure 7-12, Page 7-6.**

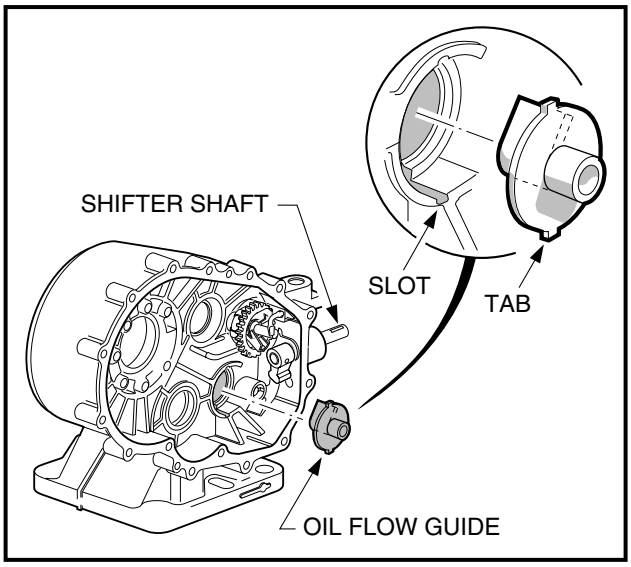


Figure 7-10 Oil Flow Guide

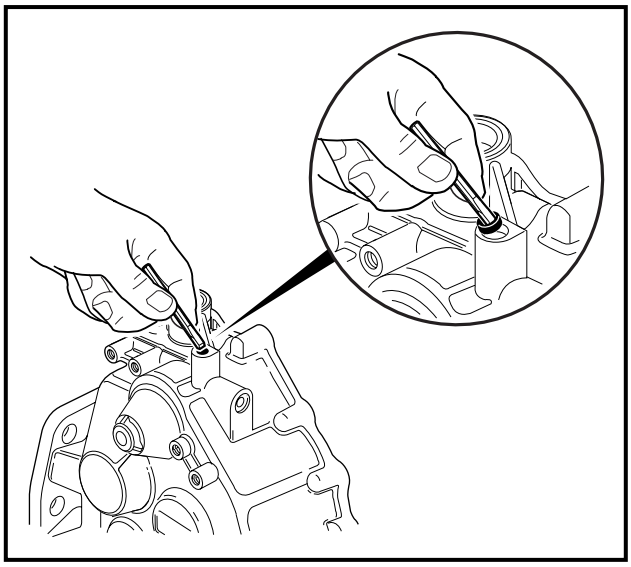


Figure 7-11 Pivot Arm Oil Seal

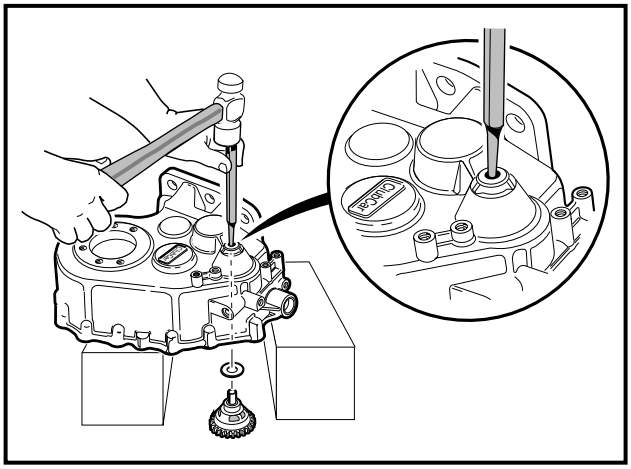


Figure 7-12 Remove Governor Gear

COMPONENT DISASSEMBLY

See General Warning on page 1-1.

DIFFERENTIAL GEAR LOCK HOUSING DISASSEMBLY

1. Rotate the arm (99) and remove the differential lock cog (104) **(Figure 7-13, Page 7-7)**.
2. Loosen, but do not remove, the differential lock arm retaining nut (101) and remove the arm (99) and spring (98) from the differential lock shaft (95).
3. Remove the spacer (97) from the differential lock shaft (95).
4. Remove the shaft retaining screw (102) and washer (103) from the differential lock housing.
5. Press the shaft (95) toward the center of the differential lock housing and remove the shaft from the housing (94).
6. If necessary, gently pry the O-ring from the groove in the differential lock shaft with a small screwdriver **(Figure 7-41, Page 7-23)**.

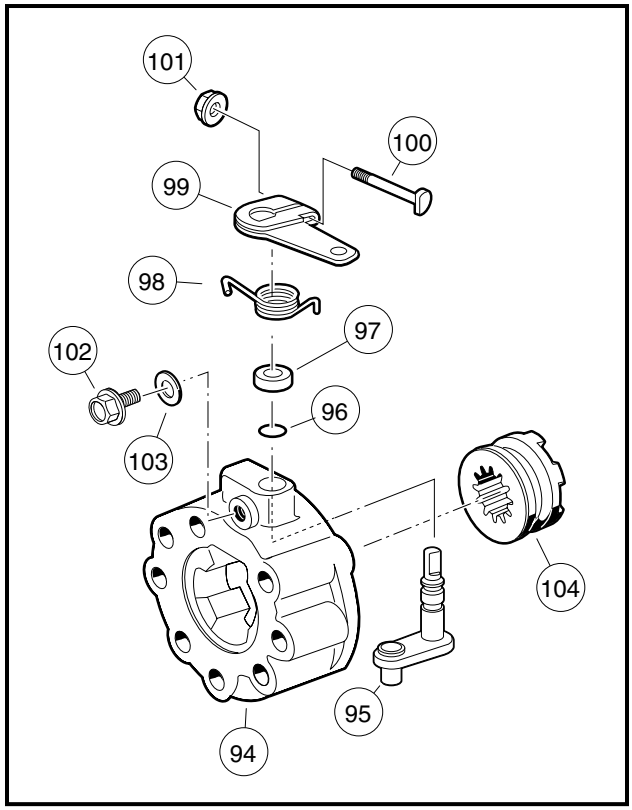


Figure 7-13 Differential Lock Housing Disassembly

GOVERNOR GEAR DISASSEMBLY

NOTE: *It is not necessary to disassemble the governor gear assembly in order to install it into the transaxle case.*

1. Secure the governor gear assembly in a vise as shown. Wrap shaft in a cloth to prevent damage **(Figure 7-14, Page 7-8)**.
2. Use two small screwdrivers to pry the gear and flyweight off the shaft as shown.

Governor Gear Disassembly Continued:

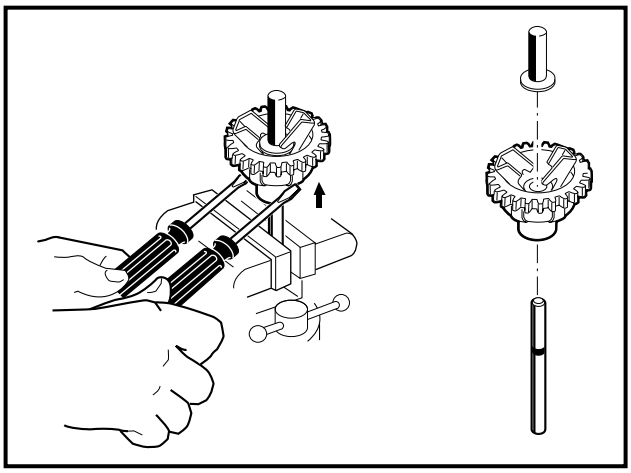


Figure 7-14 Pry Gear from Shaft

DIFFERENTIAL GEAR CASE DISASSEMBLY

CAUTION

- **Mark parts for identification as they are disassembled. Parts must be assembled in their original locations and orientations.**

1. **MC012C-AS00:**
   1.1. Remove eight ring gear retaining bolts (70) and remove the ring gear (71) from the assembly. It may be necessary to tap the ring gear off with a plastic or rubber mallet **(Figure 7-15, Page 7-8)**. **See following NOTE.**
2. **MC012C-BS00:**
   2.1. Remove eight ring gear retaining bolts (70) and remove the ring gear (86) from the assembly. It may be necessary to tap the ring gear off with a plastic or rubber mallet **(Figure 7-15, Page 7-8)**. **See following NOTE.**

NOTE: *Loctite® was applied to the bolts during assembly, it may be necessary to place the differential gear case in a vise to remove the bolts.*

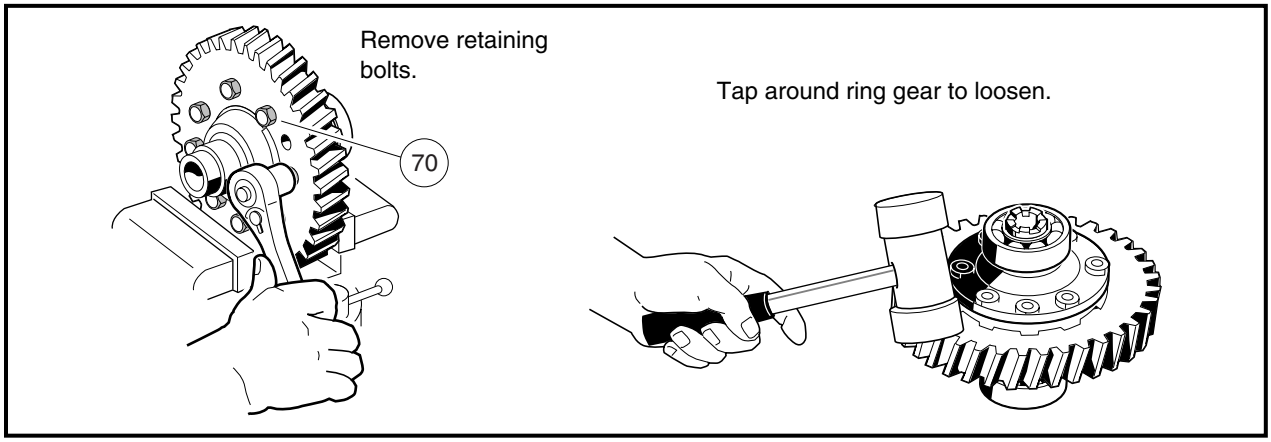
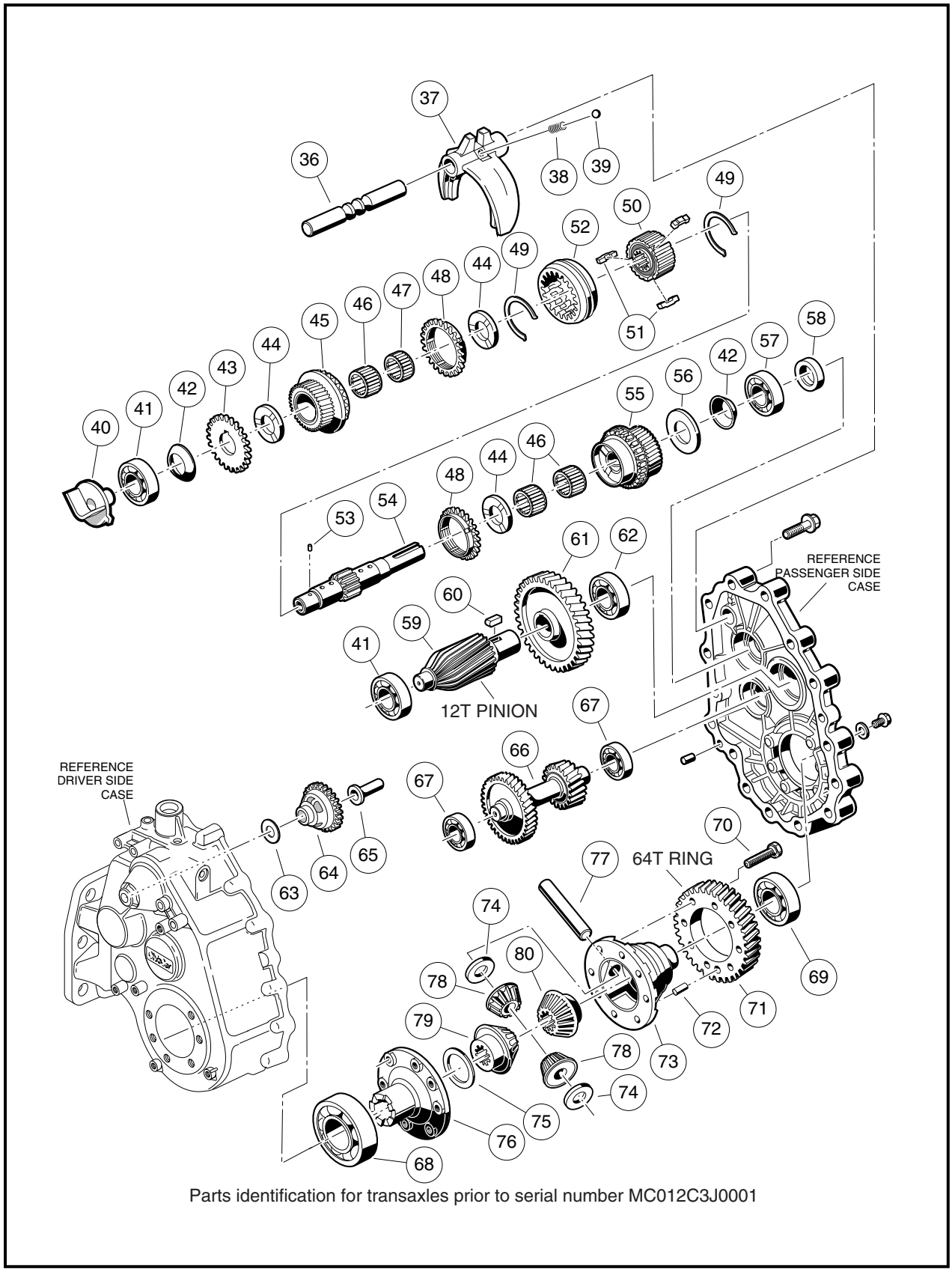


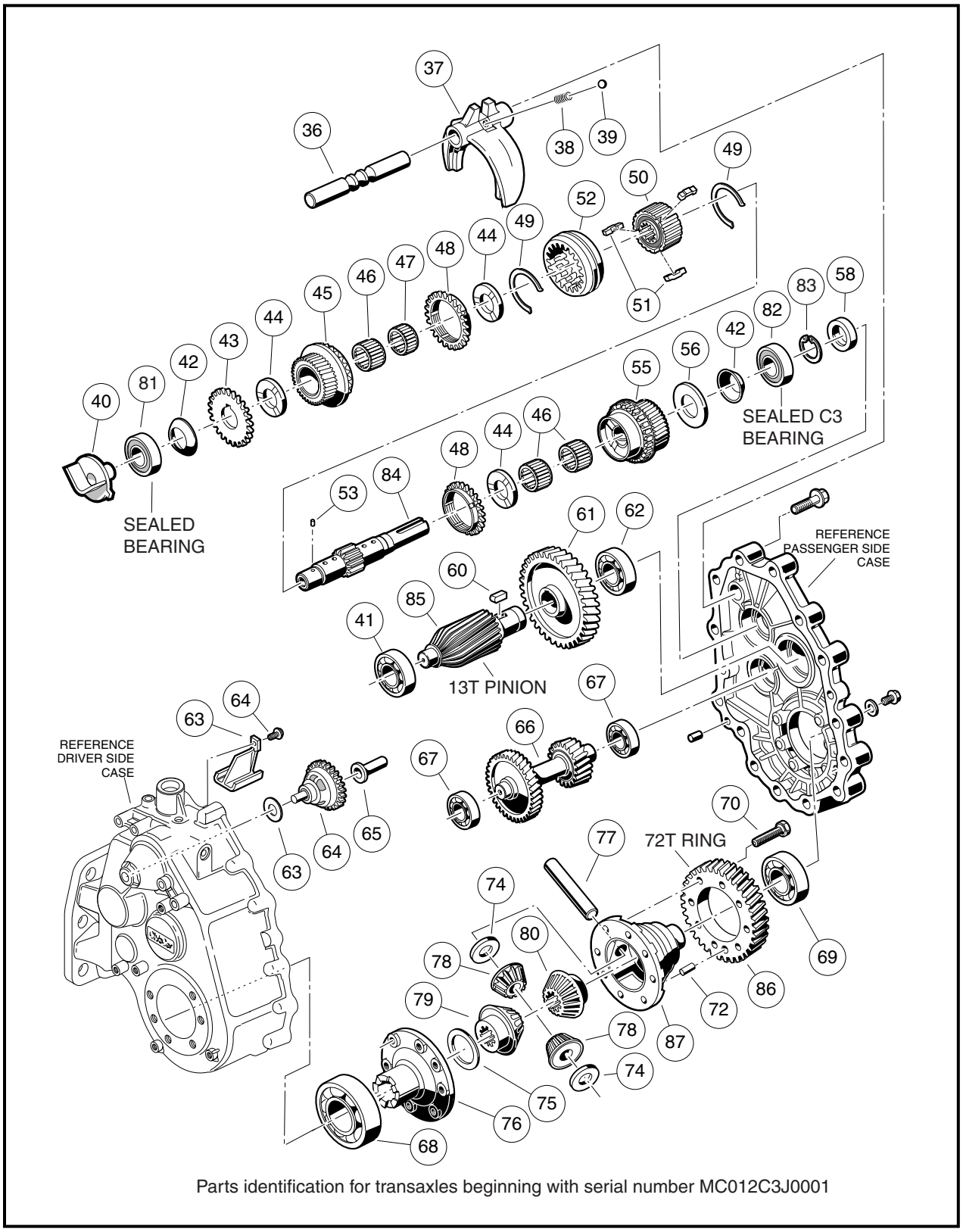
Figure 7-15 Remove Ring Gear



Parts identification for transaxles prior to serial number MC012C3J0001

Figure 7-16 MC012C-AS00 Unitized Transaxle with Differential Lock

Differential Gear Case Disassembly, Continued:



Parts identification for transaxles beginning with serial number MC012C3J0001

Figure 7-17 MC012C-BS00 Unitized Transaxle with Differential Lock

3. **MC012C-AS00:**

   3.1. Pull the cover (76) and thrust plate (75) from the differential gear carrier case (73) **(Figure 7-16, Page 7-9)**.

   3.2. Remove the differential gear (79) from the differential gear carrier case (73).

   3.3. Remove the differential pin (77) **(Figure 7-16, Page 7-9)** by pushing it through from one side **(Figure 7-18, Page 7-12)**.

   3.4. Remove the two differential idler gears (78) and two idler gear thrust plates (74) as the pin is driven through the case (73) **(Figure 7-16, Page 7-9)**. **See following NOTE.**

NOTE: *It may be necessary to drive the differential pin out with a hammer and punch.*

   3.5. Remove the remaining (opposite side) differential gear (80) from the gear carrier case (73).

   3.6. If bearings (68 and 69) are to be removed, place a bearing puller wedge attachment (CCI P/N 1012812) between the bearing (69) and gear case (73) **(Figure 7-16, Page 7-9)** and press the bearing off as shown **(Figure 7-19, Page 7-12)**. Repeat the process for the bearing (68) on the carrier cover (76) **(Figure 7-16, Page 7-9)**. **See following CAUTION.**

CAUTION

- **Do not tighten the bearing puller wedge attachment against the gear case. This could damage the gear case.**

4. **MC012C-BS00:**

   4.1. Pull the cover (76) and thrust plate (75) from the differential gear carrier case (87) **(Figure 7-17, Page 7-10)**.

   4.2. Remove the differential gear (79) from the differential gear carrier case (87).

   4.3. Remove the differential pin (77) **(Figure 7-17, Page 7-10)** by pushing it through from one side **(Figure 7-18, Page 7-12)**.

   4.4. Remove the two differential idler gears (78) and two idler gear thrust plates (74) as the pin is driven through the case (87) **(Figure 7-17, Page 7-10)**. **See following NOTE.**

NOTE: *It may be necessary to drive the differential pin out with a hammer and punch.*

   4.5. Remove the remaining (opposite side) differential gear (80) from the gear carrier case (87).

   4.6. If bearings (68 and 69) are to be removed, place a bearing puller wedge attachment (CCI P/N 1012812) between the bearing (69) and gear case (87) **(Figure 7-17, Page 7-10)** and press the bearing off as shown **(Figure 7-19, Page 7-12)**. Repeat the process for the bearing (68) on the carrier cover (76) **(Figure 7-16, Page 7-9)**. **See following CAUTION.**

CAUTION

- **Do not tighten the bearing puller wedge attachment against the gear case. This could damage the gear case.**

Differential Gear Case Disassembly, Continued:

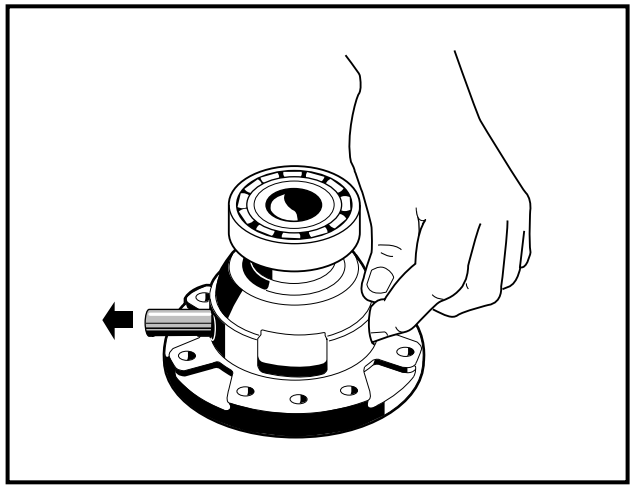


Figure 7-18 Differential Pin

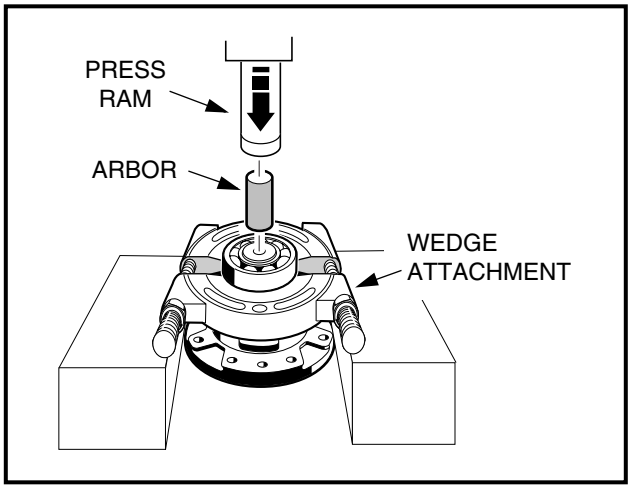


Figure 7-19 Remove Bearing

SHIFTER FORK DISASSEMBLY

1. Push the shift rod (36) out of the shifter fork (37) **(Figure 7-16, Page 7-9)**.
2. Shake the shifter fork (37) to remove the spring (38) and ball (39).

SYNCHRONIZER GEAR DISASSEMBLY

CAUTION

- **Mark parts for identification as they are disassembled. Parts must be reassembled in their original locations and orientations.**
- **Do not tighten the bearing puller wedge attachment against the shaft. This could damage the shaft.**

1. **MC012C-AS00:**
   1.1. Place a bearing puller wedge attachment (CCI P/N 1012812) between the bearing (41) and spur (governor drive) gear (43) **(Figure 7-16, Page 7-9)**, then press the bearing off the input shaft (54) as shown **(Figure 7-20, Page 7-13)**. **See preceding CAUTION.**
2. **MC012C-BS00:**
   2.1. Place a bearing puller wedge attachment (CCI P/N 1012812) between the sealed bearing (81) and spur (governor drive) gear (43) **(Figure 7-17, Page 7-10)**, then press the bearing off the input shaft (84) as shown **(Figure 7-20, Page 7-13)**. **See preceding CAUTION.**
3. Pull the spring washer (42), spur gear (43), dowel pin (53), thrust plate (44), input gear assembly (45), large needle bearing (46), small needle bearing (47), synchronizer ring (48), and thrust plate (44) from the input shaft **(Figure 7-16, Page 7-9)**.
4. **MC012C-AS00:**
   4.1. Place a bearing puller wedge attachment (CCI P/N 1012812) between the bearing (57) and input gear assembly (55) **(Figure 7-16, Page 7-9)**, then press the bearing off the input shaft (54) as shown **(Figure 7-21, Page 7-13)**. **See following CAUTION.**
5. **MC012C-BS00:**

5.1. Remove the external snap ring (83) from the input shaft (84) **(Figure 7-17, Page 7-10)**.

5.2. Place a bearing puller wedge attachment (CCI P/N 1012812) between the bearing (82) and input gear assembly (55) **(Figure 7-17, Page 7-10)**, then press the sealed C3 bearing off the input shaft (84) as shown **(Figure 7-21, Page 7-13)**. **See following CAUTION.**

CAUTION

- **Do not tighten the bearing puller wedge attachment against the shaft. This could damage the shaft.**

6. Pull the spring washer (42), thrust washer (56), input gear assembly (55), two needle bearings (46), thrust plate (44), and synchronizer ring (48) from the input shaft **(Figure 7-16, Page 7-9)**.

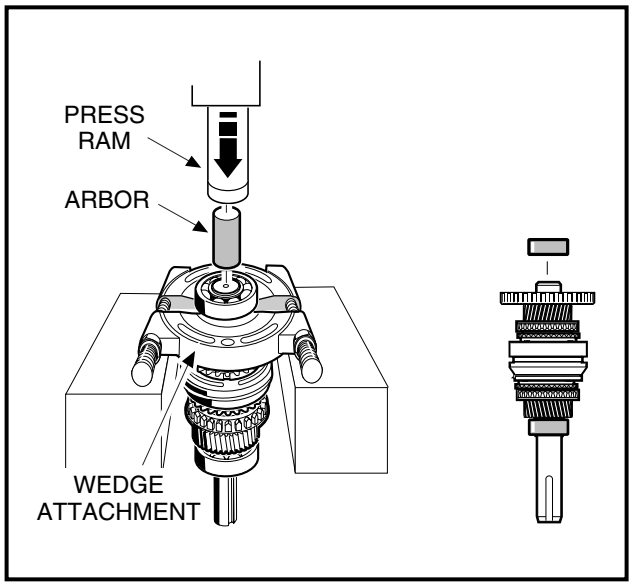


Figure 7-20 Remove Bearing

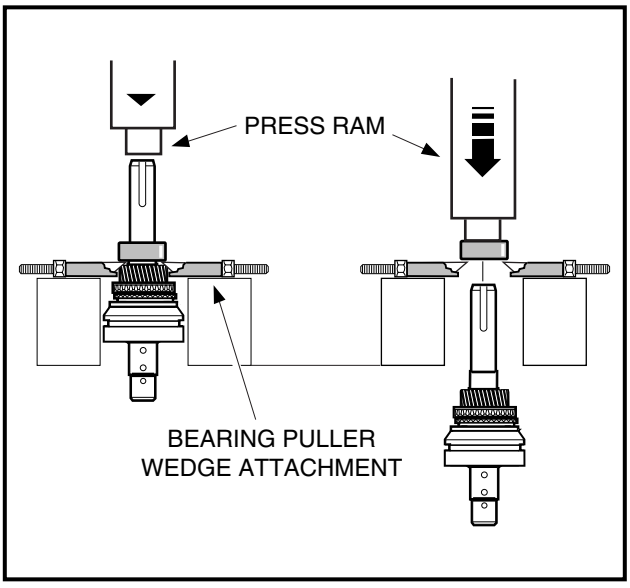


Figure 7-21 Remove Bearing

7. Use a small flat-blade screwdriver to remove two synchronizer springs (snap rings) (49), then slide the synchronizer clutch hub (52) from the input shaft (54) **(Figure 7-16, Page 7-9)**. **See following NOTE.**

NOTE: *There are three synchronizer inserts (51) set into slots in the synchronizer sleeve (50). These may fall free when the synchronizer clutch hub (52) is removed. Do not lose these inserts.*

8. Remove the three synchronizer inserts (51) from the synchronizer sleeve.

9. Press the synchronizer sleeve (50) from the input shaft.

INTERMEDIATE GEAR DISASSEMBLY

1. Place a bearing puller wedge attachment (CCI P/N 1012812) between bearing (41) and shaft/pinion gear (59) **(Figure 7-16, Page 7-9)**, then press bearing off shaft **(Figure 7-22, Page 7-14)**. **See following CAUTION.**

CAUTION

- **Do not tighten the bearing puller wedge attachment against the shaft. This could damage the shaft.**

Intermediate Gear Disassembly, Continued:

2. Place the bearing puller wedge attachment under the bearing (62) and press the bearing from the shaft **(Figure 7-16, Page 7-9)**. **See preceding CAUTION.**
3. Press the gear (61) from the shaft (59), then remove the key (60).

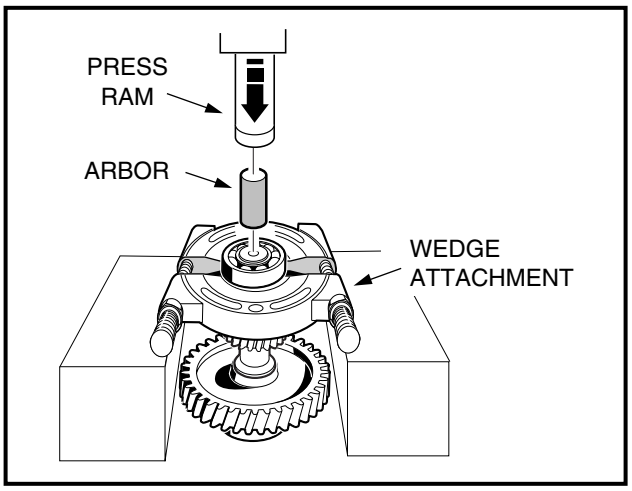


Figure 7-22 Remove Bearing

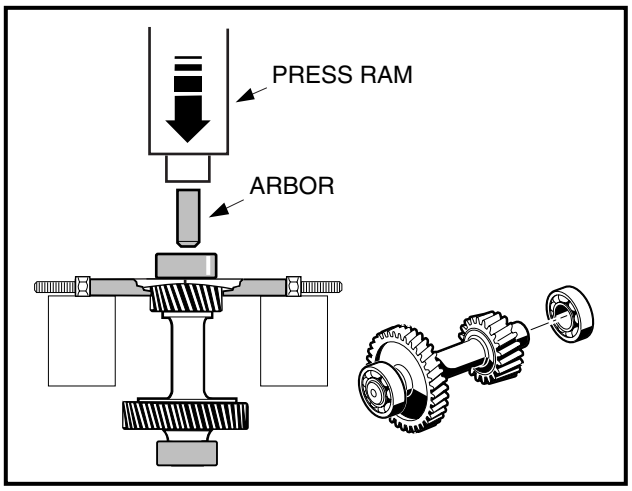


Figure 7-23 Remove Bearing

IDLER SHAFT DISASSEMBLY

1. Place a bearing puller wedge attachment (CCI P/N 1012812) between the bearing (67) **(Figure 7-16, Page 7-9)** and the small gear on the idler shaft (66), then press the bearing off the shaft **(Figure 7-23, Page 7-14)**. **See following CAUTION.**

CAUTION

- **Do not tighten the bearing puller wedge attachment against the shaft. The shaft could be damaged when pressing the bearing off.**

2. Place a bearing puller wedge attachment (CCI P/N 1012812) between the bearing and the larger gear on the idler shaft (66) **(Figure 7-16, Page 7-9)**, then press the bearing off the shaft as shown **(Figure 7-24, Page 7-14)**.

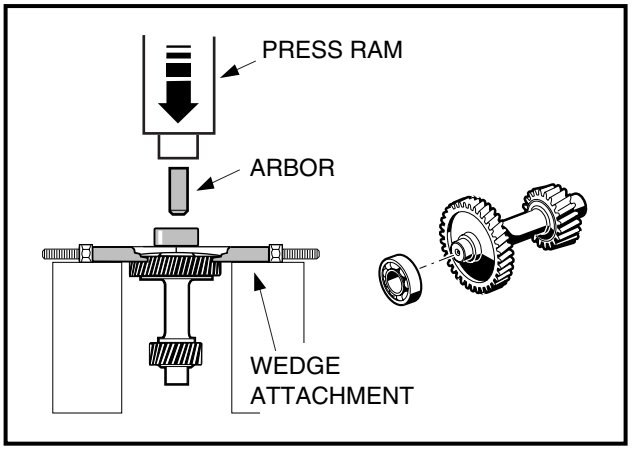


Figure 7-24 Remove Idler Shaft

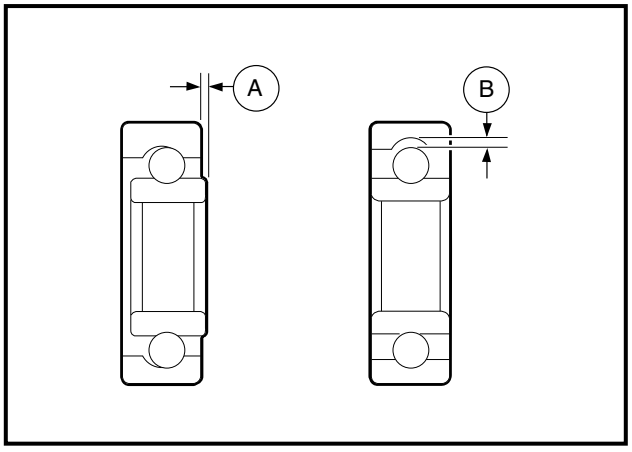


Figure 7-25 Inspect Bearings

UNITIZED TRANSAXLE COMPONENT INSPECTION

See General Warning on page 1-1.

1. Clean all of the component parts of the transaxle in a high flash-point solvent and then dry them. Inspect all components for excessive wear or damage.
2. Inspect all bearings by spinning them by hand. Check the bearings for excessive axial (A) and radial (B) play **(Figure 7-25, Page 7-14)**. Replace bearings if they do not spin smoothly, if they are noisy, or if they have excessive play. Replace bearings if they are rusted, worn, cracked, pitted or discolored.
3. Gears should be inspected for tooth surface damage or fractures.
4. Synchronizer ring teeth should be inspected for severe wear, fractures, or other damage.
5. Using a feeler gauge, measure the distance X at several points around the assembly. The synchro ring should be replaced when X is 0.02 inch (0.5 mm) or less **(Figure 7-26, Page 7-15).**
6. Inspect the O-ring (96) on the differential lock shaft **(Figure 7-13, Page 7-7)**.

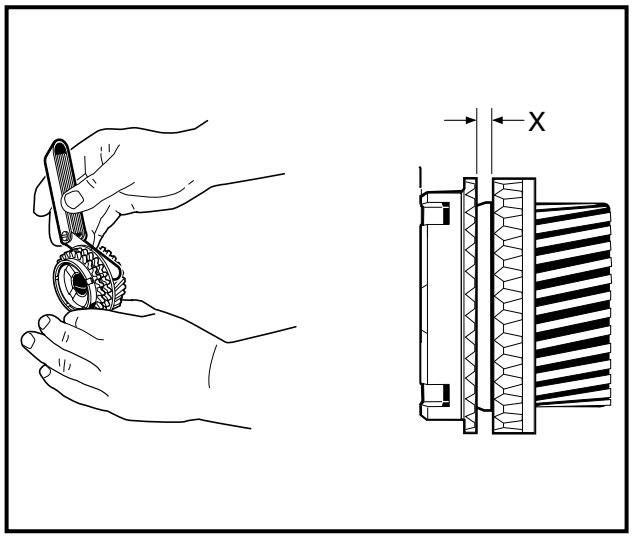


Figure 7-26 Synchronizer Ring

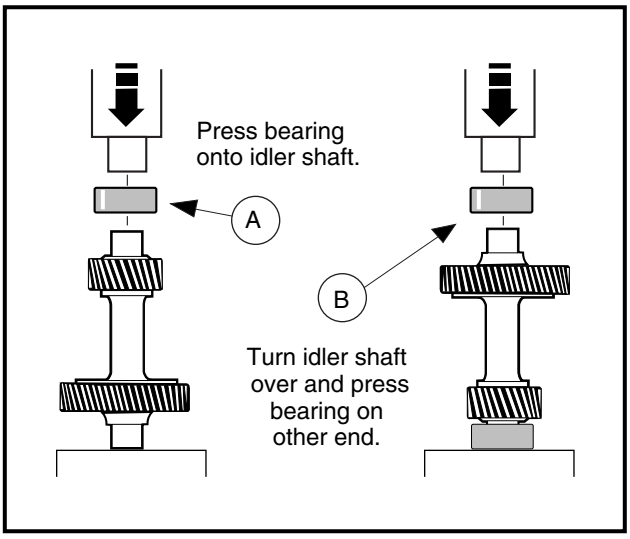


Figure 7-27 Idler Shaft

COMPONENT ASSEMBLY

See on page 1-1.

IDLER SHAFT ASSEMBLY

1. Press a new bearing (67) **(Figure 7-16, Page 7-9)** onto each end of the idler shaft **(Figure 7-27, Page 7-15)**. **See following CAUTION.**

CAUTION

- **Apply pressure against the inner race of the bearing only. Applying pressure anywhere else will damage the bearing.**

INTERMEDIATE GEAR ASSEMBLY

1. If the gear (61) was removed from the shaft, install the key (60) into the slot and then position the gear on the shaft with keyway properly aligned with key. Press gear into place on the key **(Figure 7-16, Page 7-9)**.
2. Press the bearing (62) onto the end of the shaft next to the large gear that was installed in step one. **See following CAUTION.**

CAUTION

- **Apply pressure against the inner race of the bearing only. Applying pressure anywhere else will damage the bearing.**

3. Press a new bearing (41) onto the other end of the shaft.

SYNCHRONIZER GEAR ASSEMBLY

1. **MC012C-AS00:**
   1.1. Press the synchronizer sleeve (50) onto the splines of the input shaft (54) **(Figure 7-16, Page 7-9)**. No particular orientation of the sleeve is necessary, but toward the short end of the shaft, the machined circular face surrounding the ends of the internal splines in the sleeve must be flush with the machined lip of the shaft at the ends of the shaft splines **(Figure 7-28, Page 7-16)**.
   1.2. Install the synchronizer springs (49) **(Figure 7-16, Page 7-9)** in the sleeve **(Figure 7-29, Page 7-16)**.

NOTE: *Make sure the ends of the springs are positioned between the synchronizer insert slots **(Figure 7-29, Page 7-16)**.*

   1.3. Install the three synchronizer inserts (51) into the slots in the sleeve **(Figure 7-16, Page 7-9)**. Make sure the notched surfaces of the inserts are facing outward **(Figure 7-30, Page 7-18)**.
   1.4. Install the synchronizer clutch hub (52) **(Figure 7-16, Page 7-9)** onto the synchronizer sleeve. Make sure the chamfered end of the hub is oriented toward the long end of the input shaft **(Figure 7-31, Page 7-18)**.

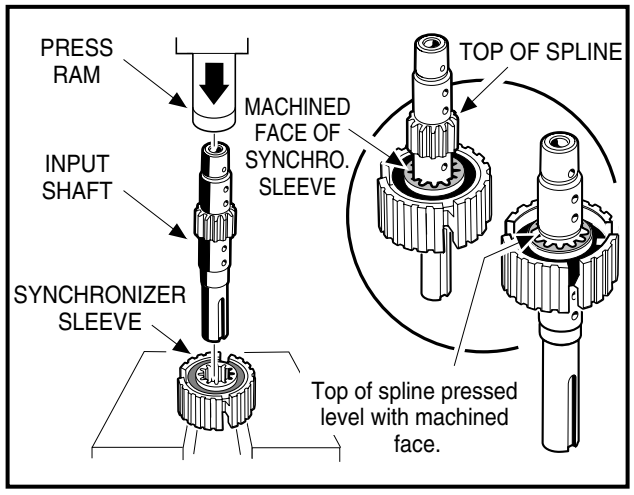


Figure 7-28 Synchronizer Gear Assembly

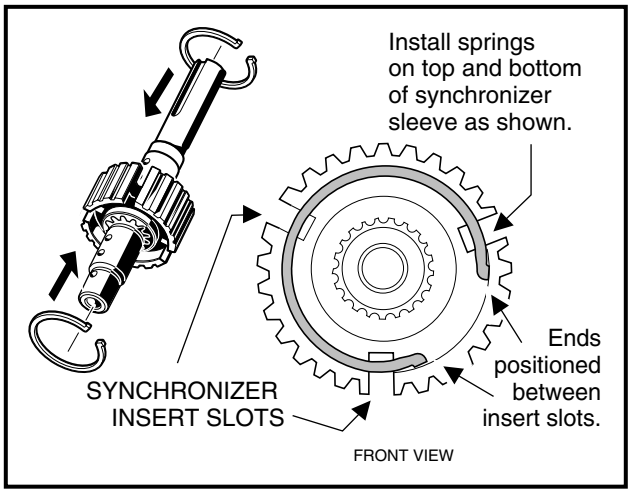


Figure 7-29 Synchronizer Springs

1.5. On the long end of the shaft (54), install the synchronizer ring (48) **(Figure 7-16, Page 7-9)** with the smooth collar of the ring towards the clutch hub. Make sure the three notches in the collar mate with the synchronizer inserts in the synchronizer sleeve **(Figure 7-32, Page 7-19)**.

1.6. Install the thrust washer (44) and two bearings (46) **(Figure 7-16, Page 7-9)**.

1.7. Install the input gear assembly (55), with the smooth collar toward the synchronizer ring. The input gear should seat in the synchronizer ring.

1.8. Install the thrust washer (56) and then the spring washer (42). The spring washer should be oriented with the raised center toward the end of the shaft.

1.9. Press a new bearing (57) onto the shaft until it seats. Make sure the input gear turns freely. **See following CAUTION.**

CAUTION

- **Apply pressure against the inner race of the bearing only. Applying pressure anywhere else will damage the bearing.**

1.10. On the other end of the input shaft (54), install one thrust washer (44), and the synchronizer ring (48) **(Figure 7-16, Page 7-9)**. The smooth collar of the synchronizer ring should be oriented toward the clutch hub, and the notches in it should mate with the synchronizer inserts as shown **(Figure 7-31, Page 7-18)**.

1.11. Install the narrow bearing (47), wide bearing (46), and input gear (45) onto the shaft. The smooth collar of the input gear should be oriented toward the synchronizer ring **(Figure 7-16, Page 7-9)**. The gear should seat inside the ring.

1.12. Install remaining thrust washer (44) onto the shaft and the dowel pin (53) into the shaft (54) as shown.

1.13. Install the spur (governor drive) gear (43) onto the shaft with either side down. Mate the notch in the gear with the dowel pin as shown.

1.14. Install the spring washer (42) onto shaft with the raised center toward the end of the shaft.

1.15. Press a new bearing (41) onto the end of the shaft until it seats **(Figure 7-16, Page 7-9)**. Make sure the input gears turn freely. **See following CAUTION.**

CAUTION

- **Apply pressure against the inner race of the bearing only. Applying pressure anywhere else will damage the bearing.**

2. **MC012C-BS00:**

2.1. Press the synchronizer sleeve (50) onto the splines of the input shaft (84) **(Figure 7-17, Page 7-10)**. No particular orientation of the sleeve is necessary, but toward the short end of the shaft, the machined circular face surrounding the ends of the internal splines in the sleeve must be flush with the machined lip of the shaft at the ends of the shaft splines **(Figure 7-28, Page 7-16)**.

2.2. Install the synchronizer springs (49) **(Figure 7-17, Page 7-10)** in the sleeve **(Figure 7-29, Page 7-16)**.

NOTE: *Make sure the ends of the springs are positioned between the synchronizer insert slots **(Figure 7-29, Page 7-16)**.*

2.3. Install the three synchronizer inserts (51) into the slots in the sleeve **(Figure 7-17, Page 7-10)**. Make sure the notched surfaces of the inserts are facing outward **(Figure 7-30, Page 7-18)**.

2.4. Install the synchronizer clutch hub (52) **(Figure 7-17, Page 7-10)** onto the synchronizer sleeve. Make sure the chamfered end of the hub is oriented toward the long end of the input shaft **(Figure 7-31, Page 7-18)**.

2.5. On the long end of the shaft (84), install the synchronizer ring (48) **(Figure 7-17, Page 7-10)** with the smooth collar of the ring towards the clutch hub. Make sure the three notches in the collar mate with the synchronizer inserts in the synchronizer sleeve **(Figure 7-32, Page 7-19)**.

2.6. Install the thrust washer (44) and two bearings (46) **(Figure 7-17, Page 7-10)**.

2.7. Install the input gear assembly (55), with the smooth collar toward the synchronizer ring. The input gear should seat in the synchronizer ring.

2.8. Install the thrust washer (56) and then the spring washer (42). The spring washer should be oriented with the raised center toward the end of the shaft.

2.9. Press a new sealed C3 bearing (82) onto the shaft until it seats. Make sure the input gear turns freely. **See following CAUTION.**

CAUTION

- **Apply pressure against the inner race of the bearing only. Applying pressure anywhere else will damage the bearing.**

2.10. Install the external snap ring (83) on the shaft (84).

2.11. On the other end of the input shaft (84), install one thrust washer (44), and the synchronizer ring (48) **(Figure 7-17, Page 7-10)**. The smooth collar of the synchronizer ring should be oriented toward the clutch hub, and the notches in it should mate with the synchronizer inserts as shown **(Figure 7-31, Page 7-18)**.

2.12. Install the narrow bearing (47), wide bearing (46), and input gear (45) onto the shaft. The smooth collar of the input gear should be oriented toward the synchronizer ring **(Figure 7-17, Page 7-10)**. The gear should seat inside the ring.

2.13. Install remaining thrust washer (44) onto the shaft and the dowel pin (53) into the shaft (54) as shown.

2.14. Install the spur (governor drive) gear (43) onto the shaft with either side down. Mate the notch in the gear with the dowel pin as shown.

2.15. Install the spring washer (42) onto shaft with the raised center toward the end of the shaft.

2.16. Press a new sealed bearing (81) onto the end of the shaft until it seats **(Figure 7-17, Page 7-10)**. Make sure the input gears turn freely. **See following CAUTION.**

CAUTION

- **Apply pressure against the inner race of the bearing only. Applying pressure anywhere else will damage the bearing.**

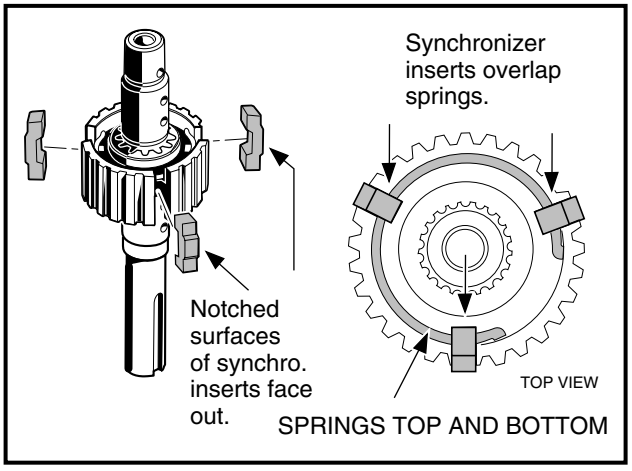


Figure 7-30 Synchronizer Inserts

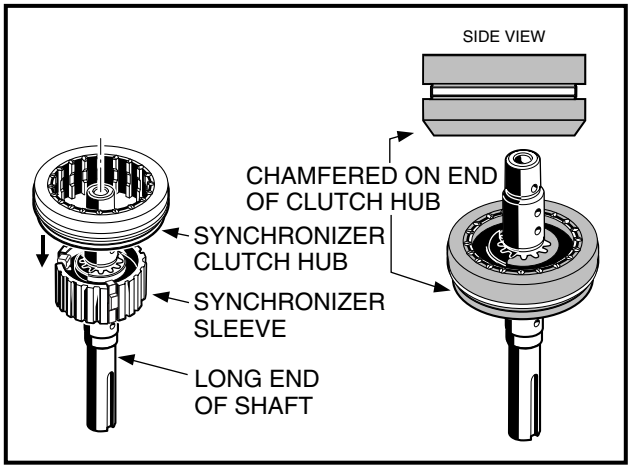


Figure 7-31 Synchronizer Clutch Hub

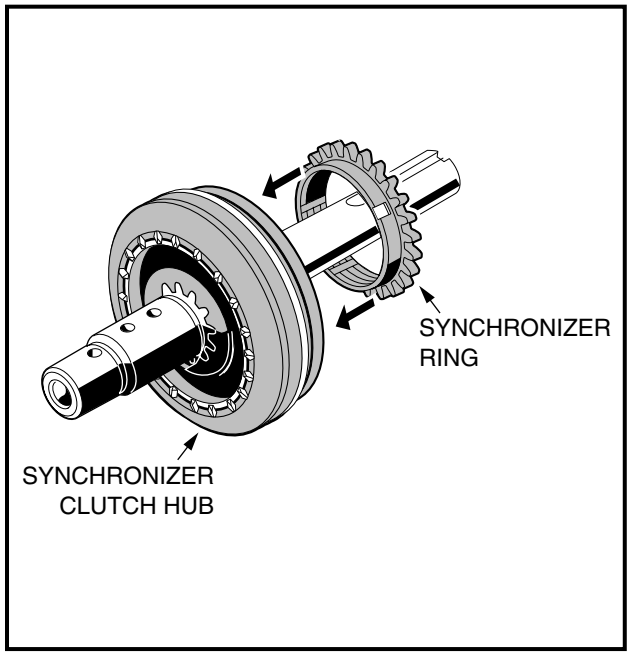


Figure 7-32 Synchronizer Ring

SHIFTER FORK ASSEMBLY

1. Install the spring (35) and ball (36) into the shifter fork (34) as shown **(Figure 7-33, Page 7-19)**.
2. Use a no. 1 tip phillips screwdriver to press the ball and spring while inserting shift rod (33) into the shifter fork (34) **(Figure 7-34, Page 7-19)**. Remove screwdriver when the shift rod is inserted far enough for it to depress the ball and spring, then continue to insert rod until the ball is positioned in the middle detent on the rod.

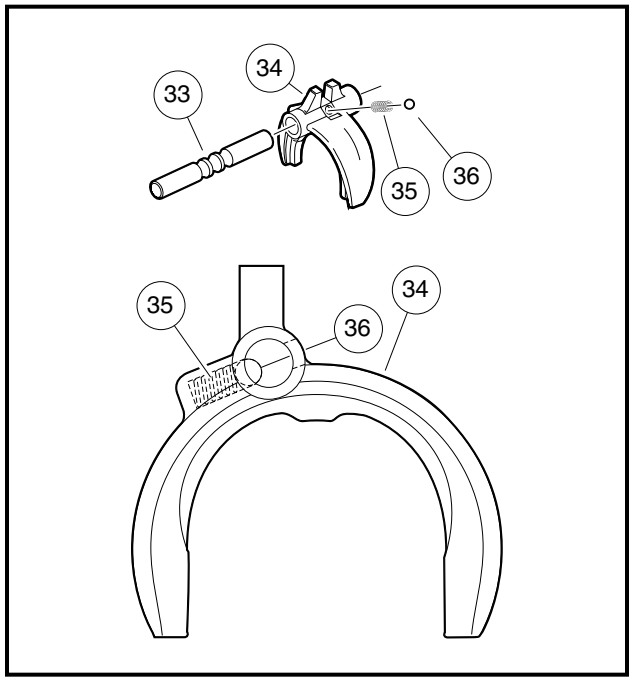


Figure 7-33 Align Spring and Ball and Insert

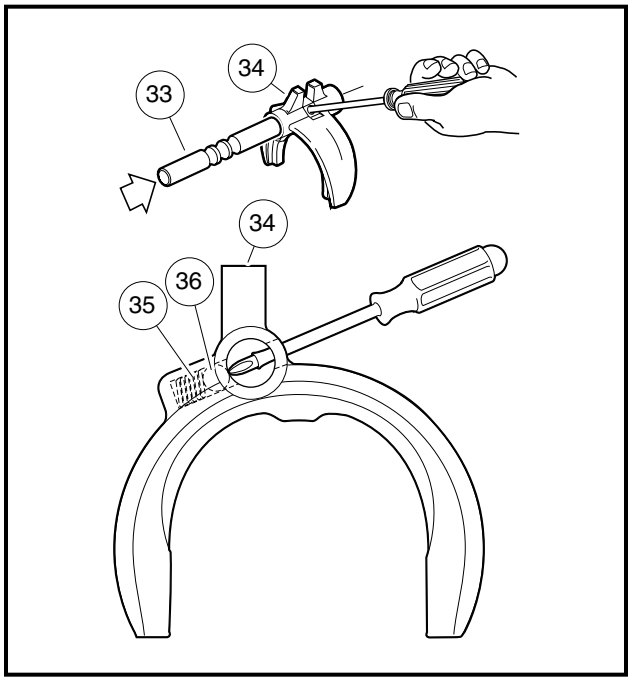


Figure 7-34 Insert Shift Rod Past Ball

DIFFERENTIAL GEAR CASE ASSEMBLY

1. **MC012C-AS00:**
   1.1. If the bearings (68 or 69) were removed, press new ones onto the differential gear carrier case (73) and carrier case cover (76) **(Figure 7-16, Page 7-9)**. **See following CAUTION.**

CAUTION

- **Apply pressure against the inner race of the bearing only. Applying pressure anywhere else will damage the bearing.**

   1.2. Install differential gear (80) into carrier case (73) **(Figure 7-16, Page 7-9)**. **Also see Figure 7-35, Page 7-21**
   1.3. Start the differential pin (77) into the gear carrier case (73) by lightly tapping it in with a plastic or rubber hammer. Before the pin enters the inside of the carrier case, position one thrust plate (74) and idler gear (78) in the case and continue tapping the pin through the thrust plate and idler gear **(Figure 7-36, Page 7-21)**.
   1.4. Position the remaining thrust plate (74) and idler gear (78) in the carrier case. Continue to drive the pin (77) through them and the wall of the carrier case until the ends of the pin are flush with the sides of the carrier case **(Figure 7-37, Page 7-21)**.
   1.5. Install the thrust plate (75) and differential gear (79) into the carrier case cover (76) **(Figure 7-38, Page 7-21)**. While holding the thrust plate and differential gear in place, position the carrier case cover on the carrier case.
   1.6. Position the output ring gear (71) on the carrier case, visually aligning the dowel hole in the carrier case with the dowel pin in the ring gear **(Figure 7-16, Page 7-9)**. Using a plastic or rubber mallet, tap the ring gear into place on the dowel pin **(Figure 7-39, Page 7-22)**.
   1.7. Apply Loctite 277® on the threads of the eight mounting bolts and install them through the ring gear, carrier case, and carrier case cover. Tighten the bolts to 18 ft-lb (24.4 N·m) in the sequence shown **(Figure 7-40, Page 7-22)**.

2. **MC012C-BS00:**
   2.1. If the bearings (68 or 69) were removed, press new ones onto the differential gear carrier case (87) and carrier case cover (76) **(Figure 7-17, Page 7-10)**. **See following CAUTION.**

CAUTION

- **Apply pressure against the inner race of the bearing only. Applying pressure anywhere else will damage the bearing.**

   2.2. Install differential gear (80) into carrier case (87) **(Figure 7-17, Page 7-10)**. **Also see Figure 7-35, Page 7-21**
   2.3. Start the differential pin (77) into the gear carrier case (87) by lightly tapping it in with a plastic or rubber hammer. Before the pin enters the inside of the carrier case, position one thrust plate (74) and idler gear (78) in the case and continue tapping the pin through the thrust plate and idler gear **(Figure 7-36, Page 7-21)**.
   2.4. Position the remaining thrust plate (74) and idler gear (78) in the carrier case. Continue to drive the pin (77) through them and the wall of the carrier case until the ends of the pin are flush with the sides of the carrier case **(Figure 7-37, Page 7-21)**.

2.5. Install the thrust plate (75) and differential gear (79) into the carrier case cover (76) **(Figure 7-38, Page 7-21)**. While holding the thrust plate and differential gear in place, position the carrier case cover on the carrier case.

2.6. Position the output ring gear (86) on the carrier case, visually aligning the dowel hole in the carrier case with the dowel pin in the ring gear **(Figure 7-17, Page 7-10)**. Using a plastic or rubber mallet, tap the ring gear into place on the dowel pin **(Figure 7-39, Page 7-22)**.

2.7. Apply Loctite 277® on the threads of the eight mounting bolts and install them through the ring gear, carrier case, and carrier case cover. Tighten the bolts to 18 ft-lb (24.4 N·m) in the sequence shown **(Figure 7-40, Page 7-22)**.

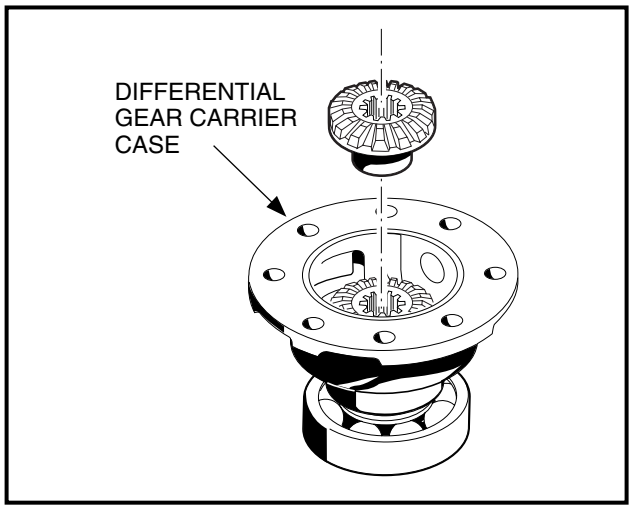


Figure 7-35 Differential Gear

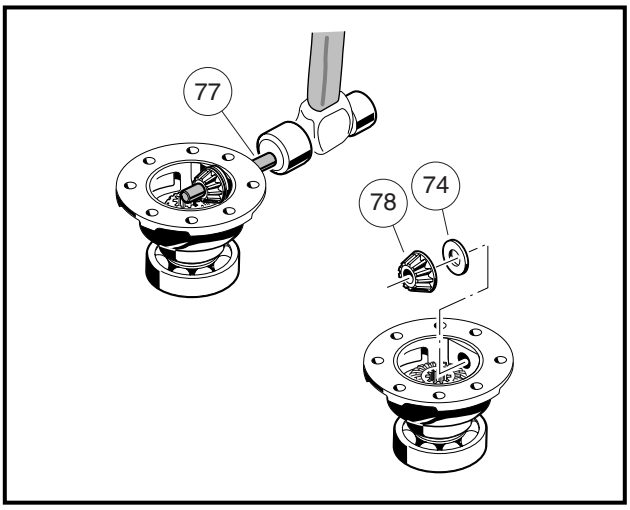


Figure 7-36 Idler Gear

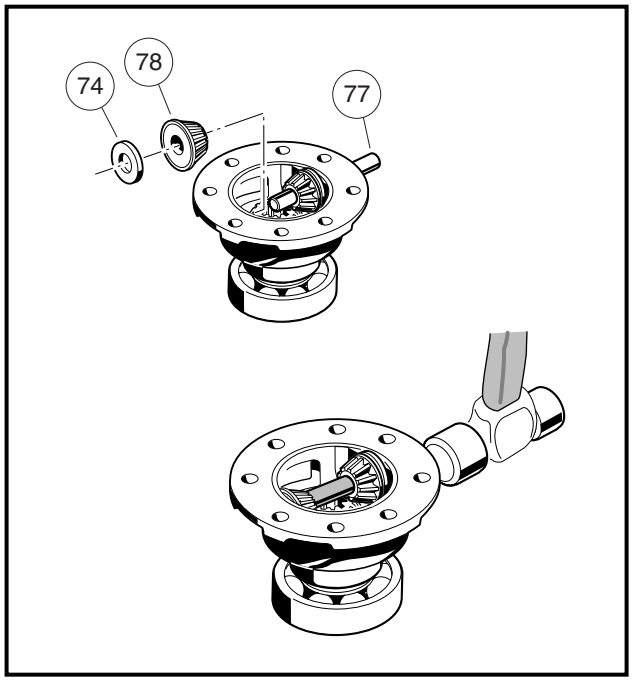


Figure 7-37 Second Idler Gear

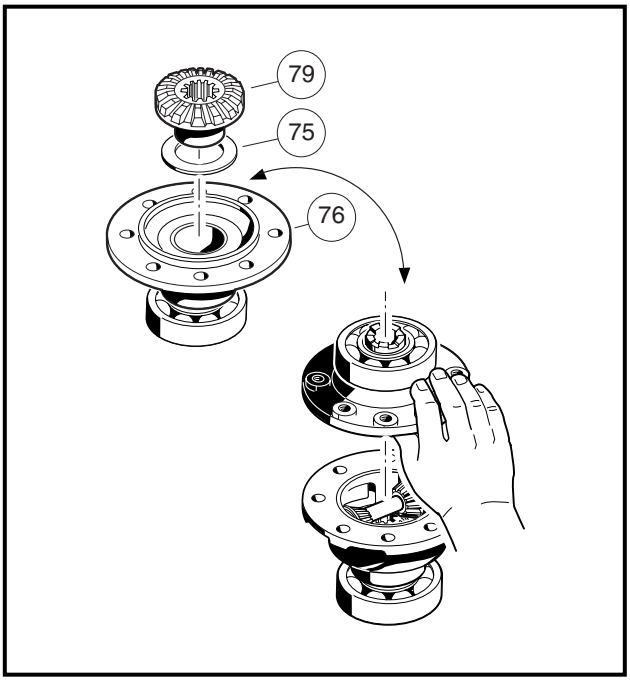


Figure 7-38 Carrier Case

Differential Gear Case Assembly, Continued:

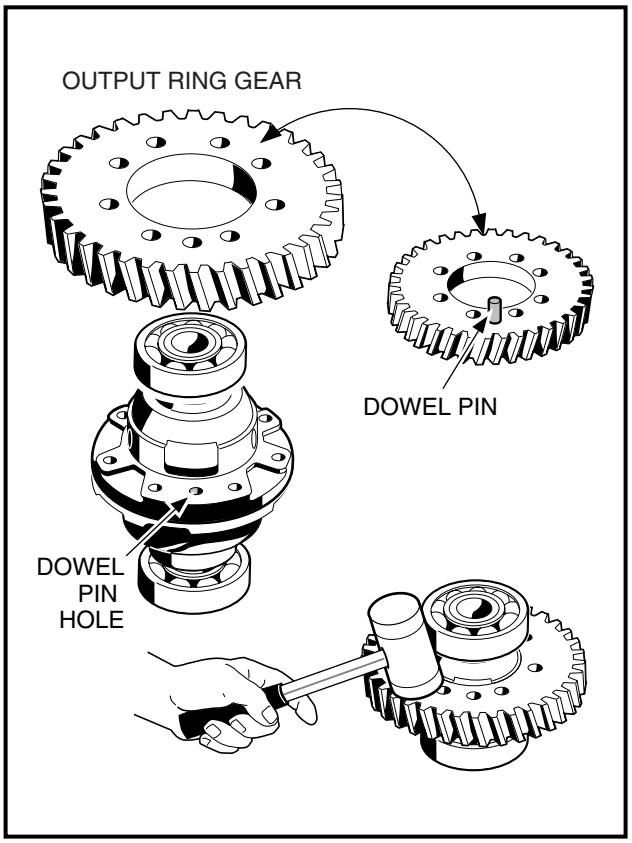


Figure 7-39 Ring Gear

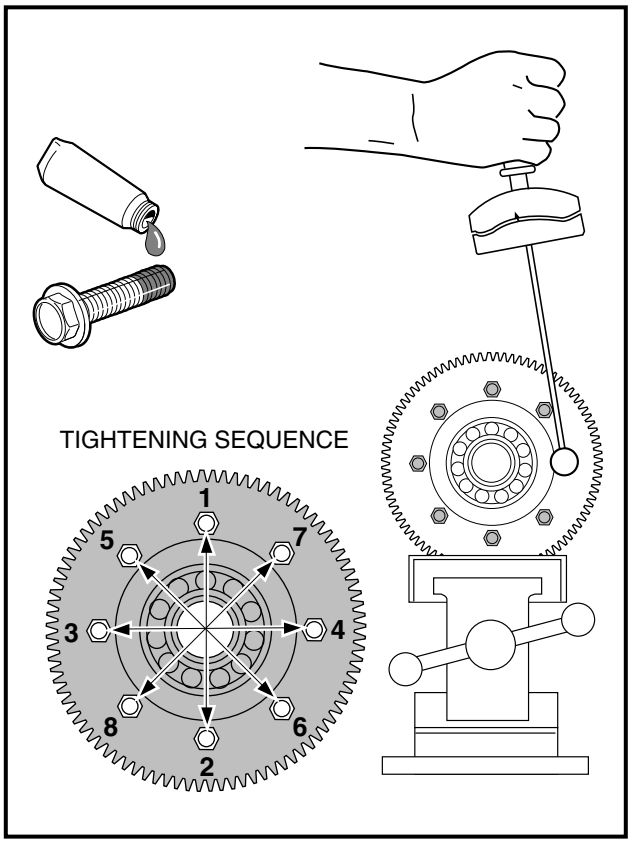


Figure 7-40 Retaining Bolts

GOVERNOR GEAR ASSEMBLY

The governor gear is not assembled before installing it in the unitized transaxle case. The governor gear shaft is installed into the case and then the rest of the governor gear assembly is installed on the shaft. Proceed with transaxle assembly.

DIFFERENTIAL GEAR LOCK HOUSING ASSEMBLY

1. If previously removed, slide the O-Ring into the top groove of the differential lock shaft **(Figure 7-41, Page 7-23)**.
2. Place the shaft (95) into the hole in the differential lock housing (94) **(Figure 7-42, Page 7-23)**.
3. Install the retaining screw (102) and washer (103) into the differential lock housing. Ensure that the screw is aligned with the second groove in the differential lock shaft before continuing to tighten the screw. Tighten the screw to 69 in-lb (7.8 N·m).
4. Place the spacer (97) onto the differential lock shaft.
5. Install the spring over the spacer so that the straight end of the spring will rest on the axle tube side of the differential lock housing.
6. Place the differential lock arm (99) on the shaft (95) and place the hooked end of the spring (98) on the arm.
7. Tighten the differential lock arm retainer nut (101) to 60 in-lb (6.8 N·m).

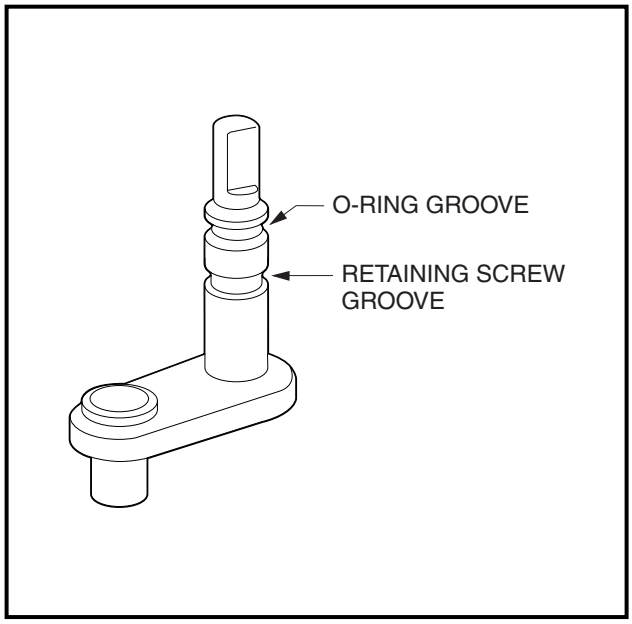


Figure 7-41 Differential Lock Shaft

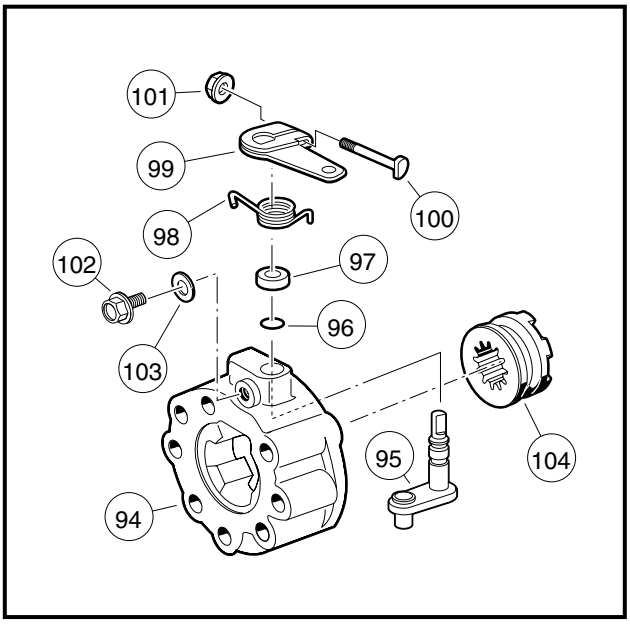


Figure 7-42 Differential Lock Housing Assembly

UNITIZED TRANSAXLE ASSEMBLY

See General Warning on page 1-1.

NOTE: *Although the following drawings show the transaxle being assembled in an upright position, laying the transaxle on its left (driver) side will simplify the assembly process.*

1. Make sure both parts of the case are clean and free of any contaminants. Make sure the machined mating surfaces are free of residue and are not scratched or damaged in any way.
2. Put a light coating of clean transmission oil on the outside edge of the seal to make installation easier. Press two new oil seals (18 and 23) **(Figure 7-5, Page 7-4)** into the top of the left (driver) side case. Use an oil seal installation tool (CCI P/N 1014160) to install a new oil seal (58) **(Figure 7-16, Page 7-9)** into the right (passenger side) case. **See also Figure 7-43, Page 7-24**.
3. Position the governor gear shaft installation tool (CCI P/N 101933101) over the shaft bore in the inside of the left (driver) side case and insert the governor gear shaft into the tool, long end (from the groove) first, as shown **(Figure 7-44, Page 7-24)**. Make sure the shaft is started into the bore, then using a plastic or rubber hammer, carefully tap the governor gear shaft into the bore until the end being tapped is flush with the end of the tool. Remove installation tool.
4. Install the washer, governor gear, and sleeve together onto the governor shaft **(Figure 7-45, Page 7-25)**. Make sure the sleeve is properly positioned within the flyweight brackets of the gear **(Figure 7-46, Page 7-25),** then push them onto the shaft until the gear snaps into the groove on the shaft.
5. Position the interior washer on the pivot arm and install the pivot arm and washer into the left (driver side) case **(Figure 7-47, Page 7-25)**. Install the exterior washer and cotter pin on the pivot arm outside the case. Bend the legs of the cotter pin.
6. Install the shifter shaft into the left (driver side) case **(Figure 7-48, Page 7-25)**. Install the washer and use external snap ring pliers (0.070 tip) to install retaining ring on the shifter shaft outside of the case. Make sure the retaining ring is in the groove of the shaft.

Unitized Transaxle Assembly, Continued:

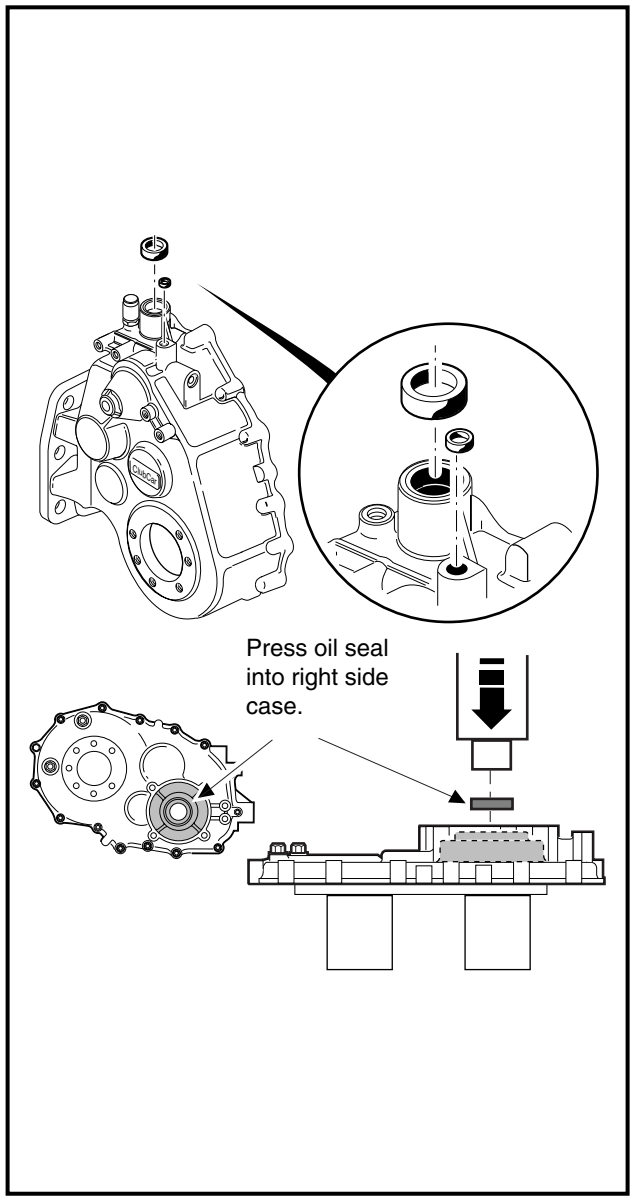


Figure 7-43 Install Seals

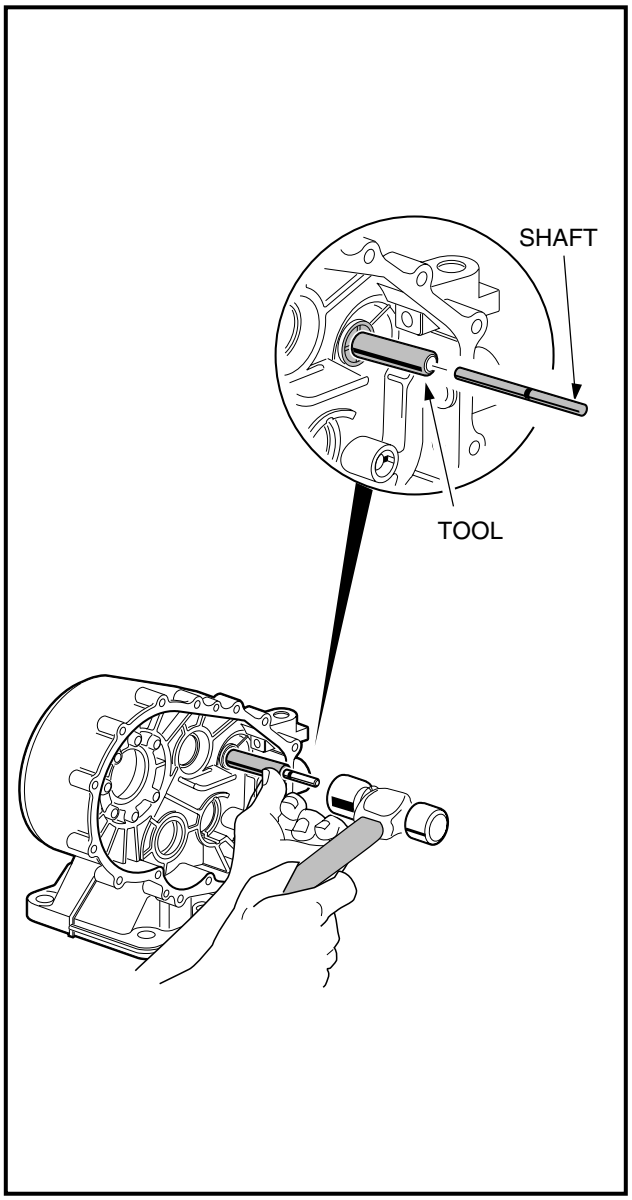


Figure 7-44 Governor Gear Shaft

7. Install the gear assemblies into the left (driver side) case.

   7.1. Stand the left (driver) side case on the mounting plate, then install the differential gear case assembly **(Figure 7-49, Page 7-26)**. Do not seat the assembly in the bore. Instead, insert it far enough that it will not fall out.

   7.2. Install the idler gear assembly into case. Do not seat the assembly in the bore. Instead, insert far enough that it will not fall out. No gears mesh at this point **(Figure 7-50, Page 7-26)**.

   7.3. Install the oil guide with the baffle toward the case wall **(Figure 7-51, Page 7-26)**. Make sure the two tabs on the guide are positioned in the slots in the case.

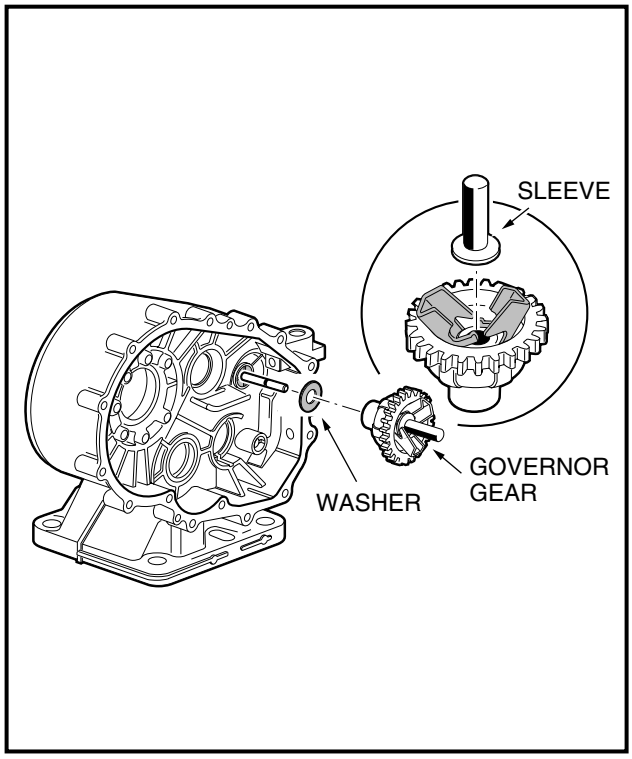


Figure 7-45 Position Governor Gear

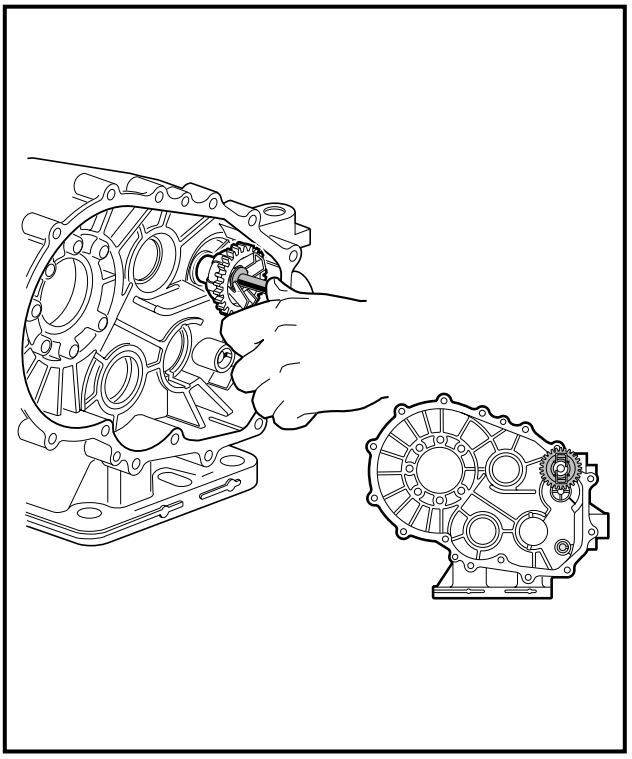


Figure 7-46 Install Governor Gear

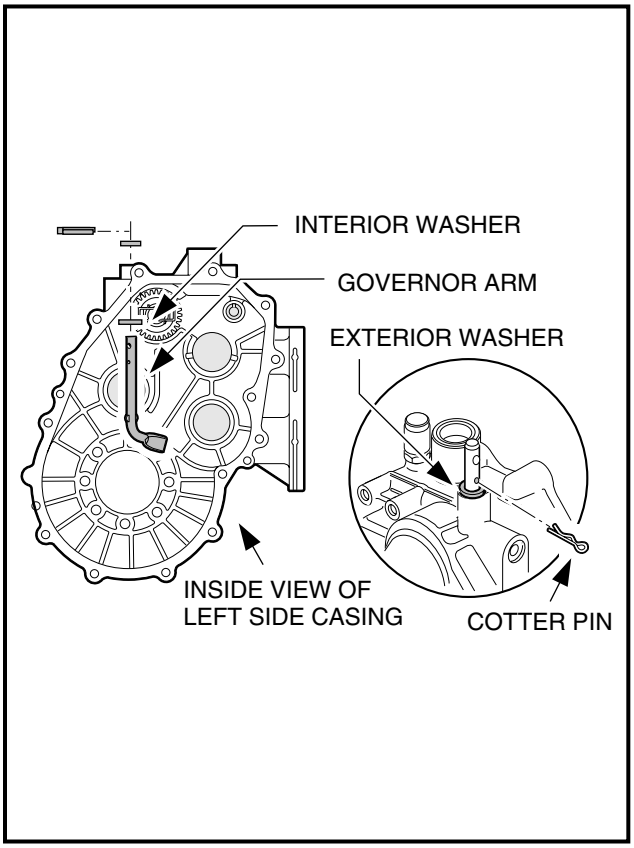


Figure 7-47 Pivot Arm

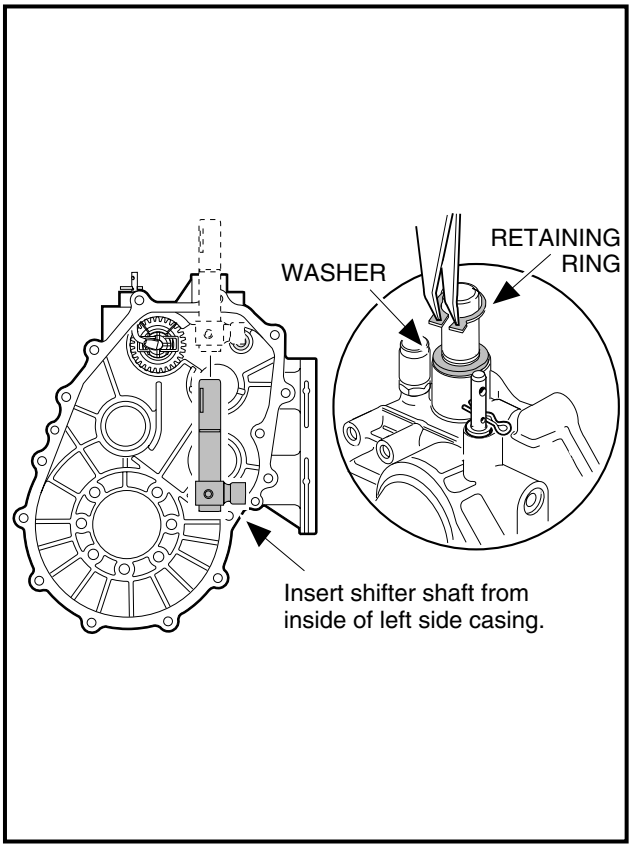


Figure 7-48 Insert Shifter Shaft

Unitized Transaxle Assembly, Continued:

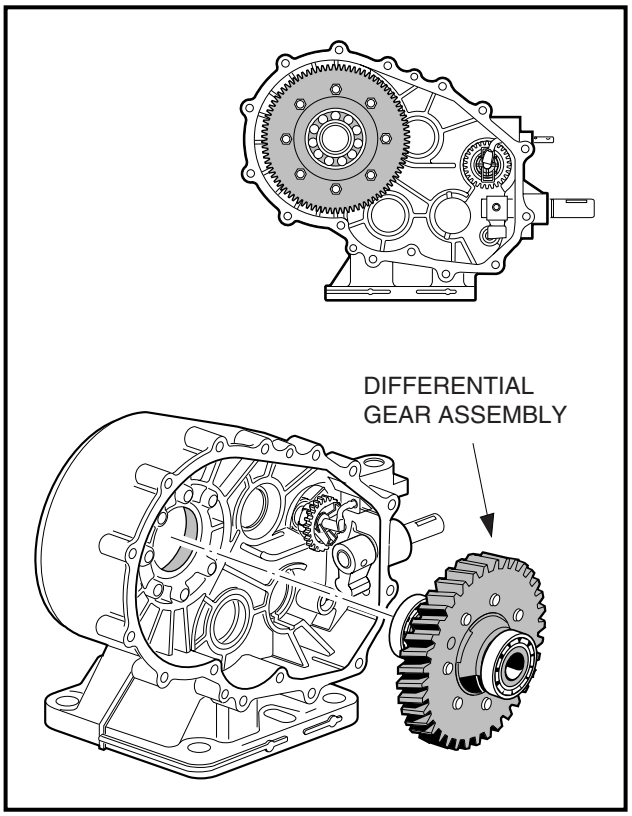


Figure 7-49 Differential Gear Assembly

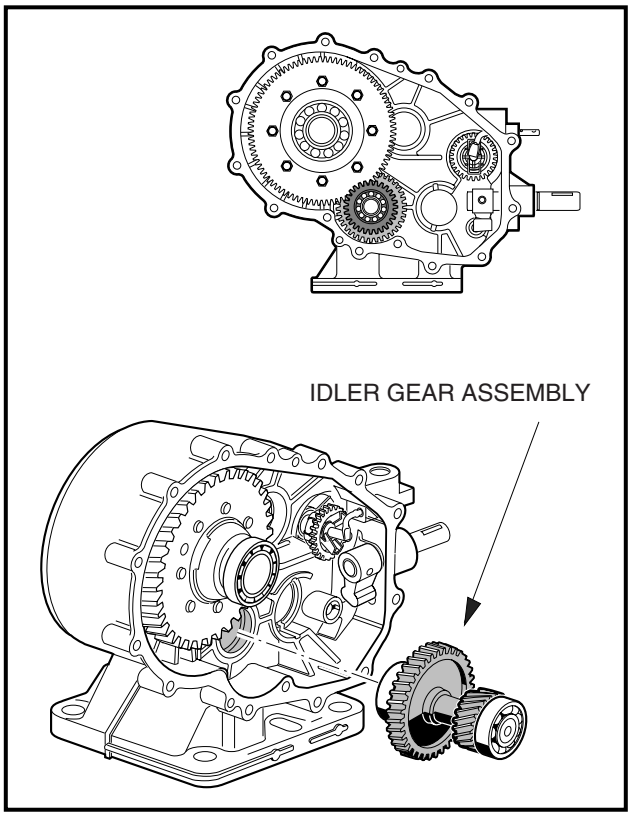


Figure 7-50 Idler Gear Assembly

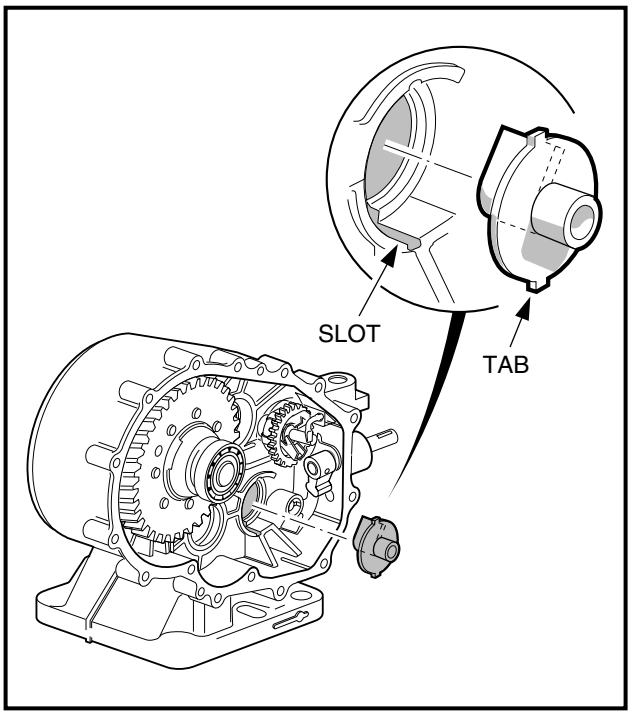


Figure 7-51 Oil Guide

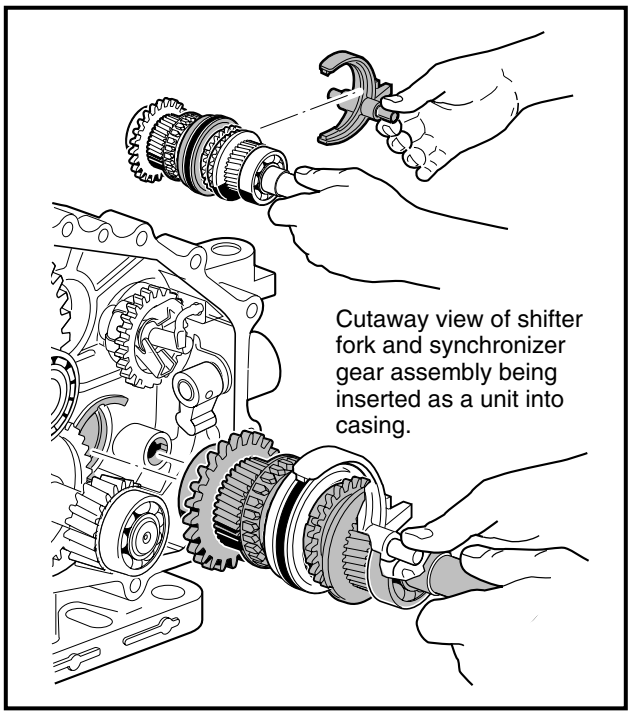


Figure 7-52 Synchronizer Ring Gear

7.4. Position the shifter fork assembly on the synchronizer gear assembly and install them together, bearing end first, into the bore containing the oil guide **(Figure 7-52, Page 7-26)**. Do not seat the assembly, but make sure the spur gear (43) is meshed with the governor gear (64) **(Figure 7-16, Page 7-9)**, and the shifter lever (19) **(Figure 7-5, Page 7-4)** is positioned in the bracket on the shifter fork. **See also Figure 7-53, Page 7-27**.

7.5. Install the intermediate gear assembly into the case **(Figure 7-54, Page 7-27)**. Do not seat the assembly into the bore. Instead make sure the output ring gear meshes with the input drive gear (55) on the synchronizer gear assembly and with the small gear on the idler shaft (66) **(Figure 7-16, Page 7-9)**.

7.6. Keep the gears meshed as a group and work all of the gear assemblies into the bores until they are seated. When all of the assemblies are correctly seated, the outside edges of the input drive gear (55) and the intermediate gear (61) **(Figure 7-16, Page 7-9)** should be flush (on the same plane) **(Figure 7-55, Page 7-28)**. Also, the outside surfaces of the idler gear bearing, the intermediate gear bearing, and the differential gear bearing should be flush **(Figure 7-55, Page 7-28)**. **See following CAUTION.**

CAUTION

- **If the edges of the input drive gear and intermediate gear are not flush, then the oil guide (40) (Figure 7-16, Page 7-9) may not be properly positioned in the bore.**

8. Make sure the mating surfaces of the left and right sides of the case are clean and free of oil, grease, or residue of any kind, and they are not scratched or damaged in any way.

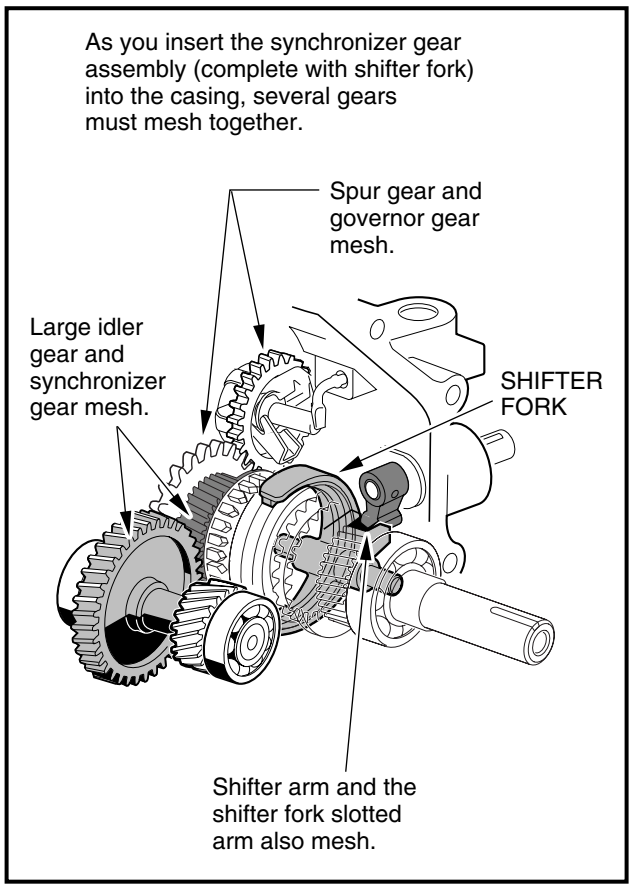


Figure 7-53 Gear Alignment

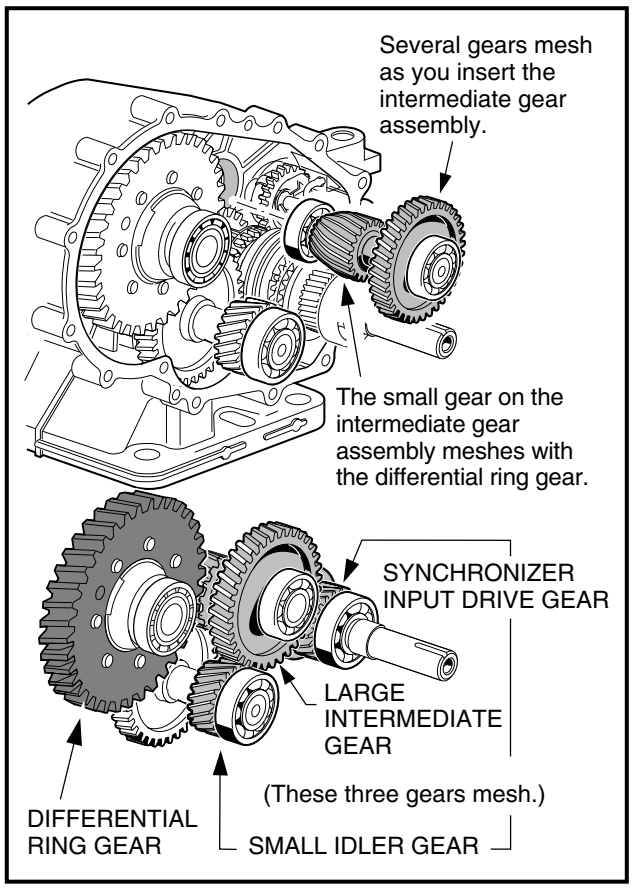


Figure 7-54 Gear Alignment

Unitized Transaxle Assembly, Continued:

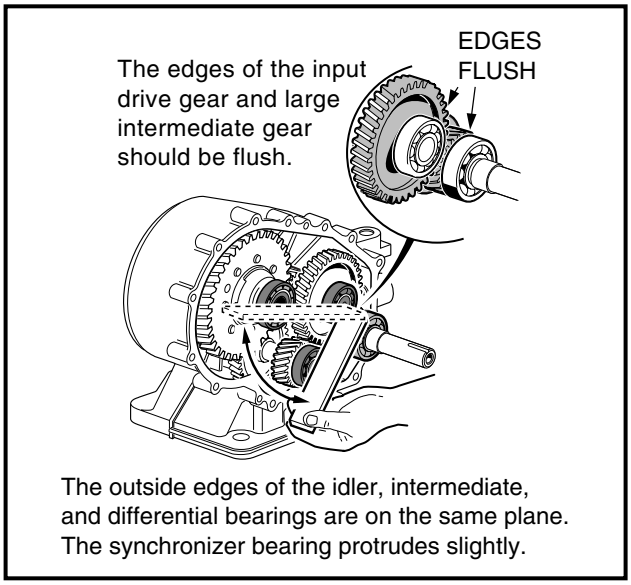


Figure 7-55 Assembly Gear Alignment

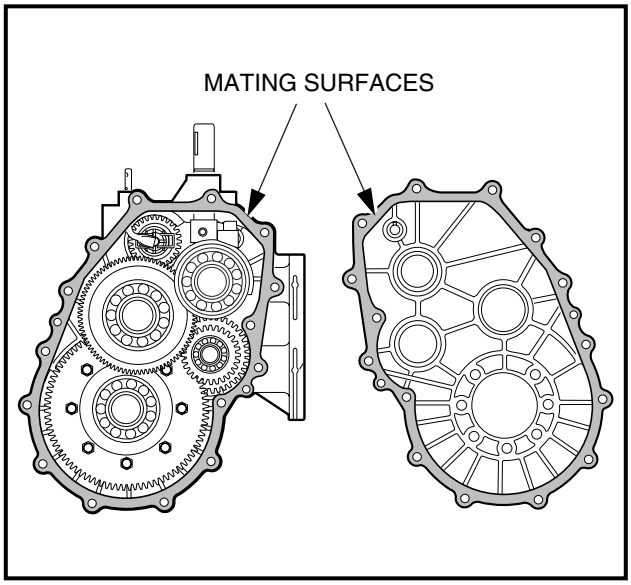


Figure 7-56 Prepare Mating Surfaces

9. Apply a continuous bead of Three Bond No. 1215 (CCI P/N 101928701) sealant to the mating surface, around the complete profile of the right (passenger side) case **(Figure 7-56, Page 7-28)**. **See following CAUTION.**

CAUTION

- **Use only Three Bond No. 1215 sealant to seal case. Do not use a substitute.**
- **If the two sides of the case cannot be easily closed or do not make complete contact, do not force them together. Check that all internal components are properly seated and then try again.**

10. Install and finger-tighten the fifteen bolts (28) **(Figure 7-5, Page 7-4)** that secure the left and right sides of the case together. Then, in sequence shown, tighten the bolts to 17 ft-lb (23.1 N·m) **(Figure 7-57, Page 7-28)**.

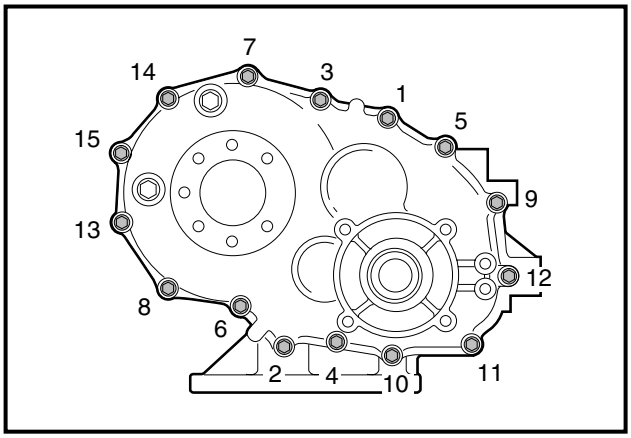


Figure 7-57 Casing Torque Sequence

AXLE TUBES

See Axle Tube Installation, Section 16, in the appropriate maintenance and service manual.

UNITIZED TRANSAXLE INSTALLATION

See Unitized Transaxle Installation, Section 16, in the appropriate maintenance and service manual.

LUBRICATION

See Lubrication, Section 16, in the appropriate maintenance and service manual.

SECTION 8 – TRANSMISSION MODELS 420317 AND 420682

⚠ DANGER

- **See General Warning on page 1-1.**

⚠ WARNING

- **See General Warning on page 1-1.**

GENERAL INFORMATION

The 420317 and 420682 model transmissions are designed for both forward and reverse power with splined input, front and rear output shafts.

MODEL IDENTIFICATION

The gasoline engine transmission (Model 420317) is equipped with a governing ground speed control feature. The diesel engine transmission (Model 420682) does not have a governing ground speed control feature. With the exception of the governing ground speed control, both transmissions are identical. The procedures in this manual can be used for both transmissions **(Figure 8-1, Page 8-1)**.

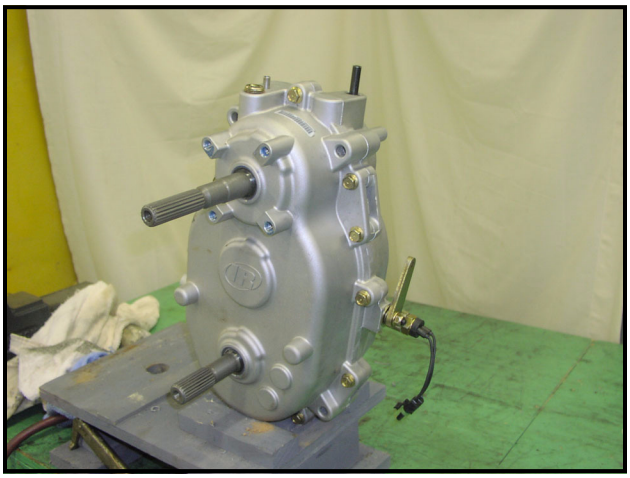


Figure 8-1 Transmission with Ground Speed Governor

SERVICE FIXTURE

Before disassembly and assembly of either transmission it is recommended that a fixture be constructed to hold the transmission in place. A simple wooden fixture can be made and clamped or fastened to a clean working surface or bench top **(Figure 8-2, Page 8-2)**.

Service Fixture, Continued:

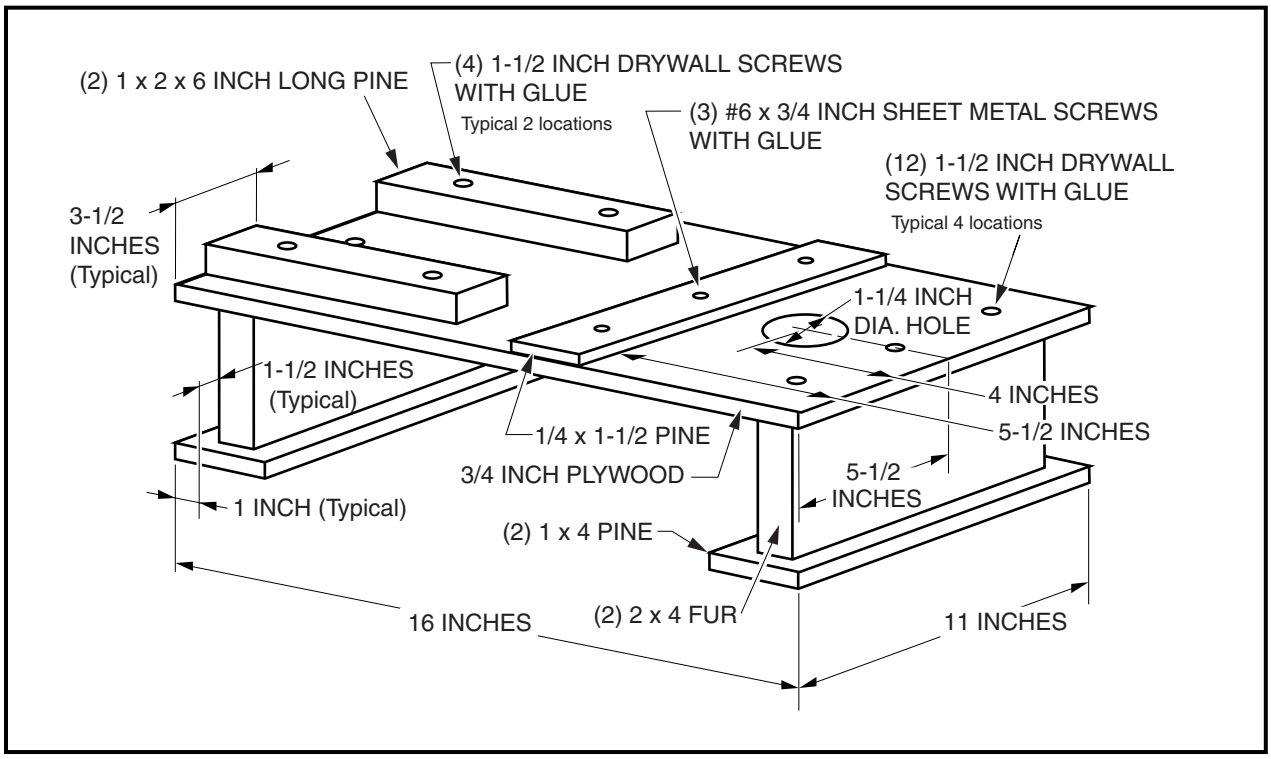


Figure 8-2 Wooden Service Fixture

Tools Required For This Section

Hydraulic press	Plastic or rubber mallet	7/16 in. combination wrench
External snap ring pliers (.070 in. tip)	Ratchet wrench, 3/8 in. drive	1/2 in. combination wrench
External snap ring pliers (.047 in. tip)	Torque wrench, 3/8 in. drive	9/16 in. combination wrench
Bearing puller wedge attachment (CCI 1012812)	12 mm Socket, 3/8 in. drive	Small flat blade screwdriver
Medium flat blade screwdriver	No. 2 phillips head screwdriver	

TRANSMISSION REMOVAL

See Transmission Removal, Section 14, in the appropriate maintenance and service manual.

TRANSMISSION DISASSEMBLY

See General Warning on page 1-1.

1. Position the transmission case on the service fixture with the drain plug over the right side edge allowing the transmission base to rest on the fixture. Remove the drain plug at the base of the housing and drain and dispose of the oil properly **(Figure 8-3, Page 8-3)**.

Figure 8-3 Drain Transmission Oil

2. Position a service fixture, built like the one illustrated, with the through hole for the output shaft located to the right on a work bench. Clamp or secure the fixture to a work bench surface. Position the transmission housing with the front output shaft down and the housing bolt heads up **(Figure 8-4, Page 8-3)**. **See following NOTE.**

NOTE: *It will be easier to disassemble and assemble the transmission if a fixture like or similar to the one illustrated is provided. The transmission case must be secure on a flat surface with the front output shaft in a downward position.*

3. Remove hex-head case bolts **(Figure 8-5, Page 8-3)**.

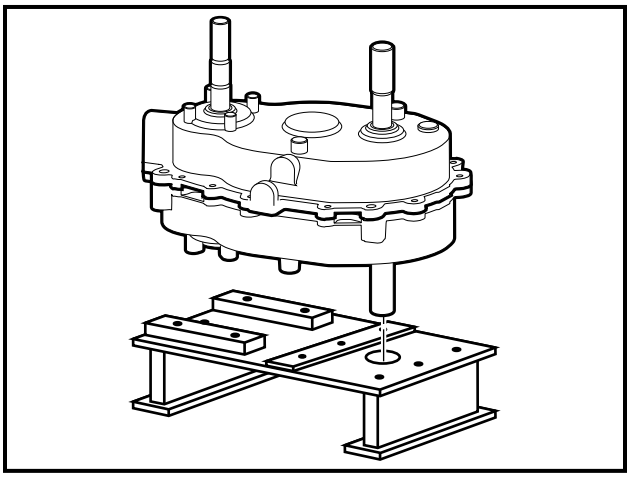


Figure 8-4 Position Case on Fixture

Figure 8-5 Remove Case Bolts

4. Separate the case halves. **See following NOTE.**

NOTE: *Use pry bars or two box-end wrenches positioned back to back then squeezing the two together, leveraging the ends in opposing directions forcing the case halves apart* ***(Figure 8-6, Page 8-4)****.*

5. Remove the neutral sensing switch, plunger and spring from the case **(Figure 8-7, Page 8-4)**.
6. Remove the top half of the case **(Figure 8-8, Page 8-4)**.

Transmission Disassembly, Continued:

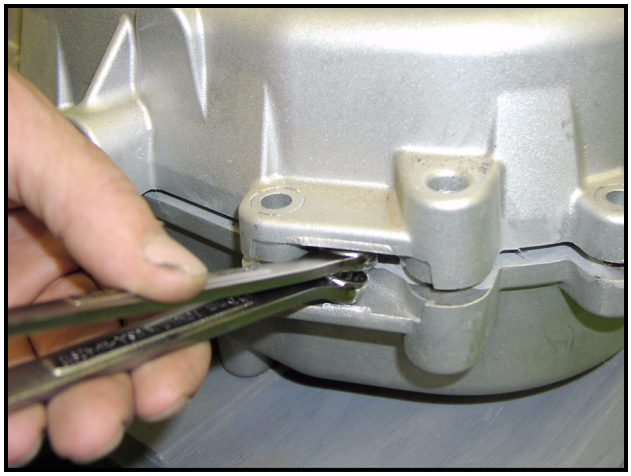


Figure 8-6 Separate Case Halves

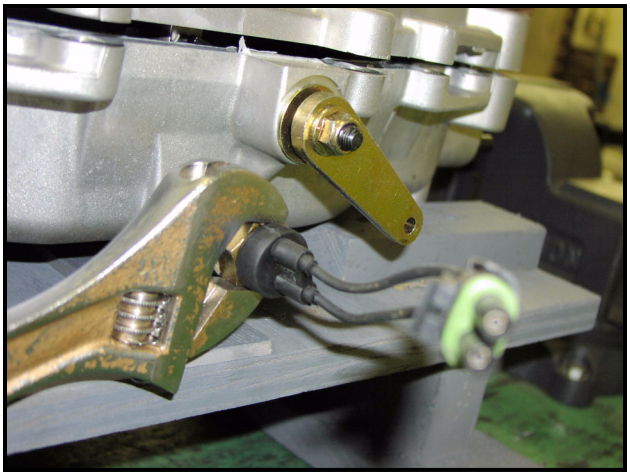


Figure 8-7 Neutral Sensing Switch

7. Remove the input shaft, gear and ground speed governor assembly **(Figure 8-9, Page 8-4)**. **See following NOTES.**

NOTE: *Observe the location of the ground speed governor yoke bracket on the governor control.*

The input shaft bearing next to the ground speed governor control is press fit into the back case cavity and slip fit onto the input shaft journal. The input shaft bearing next to the input helical gear and front case is slip fit into the case cavity and press fit onto the input shaft journal.

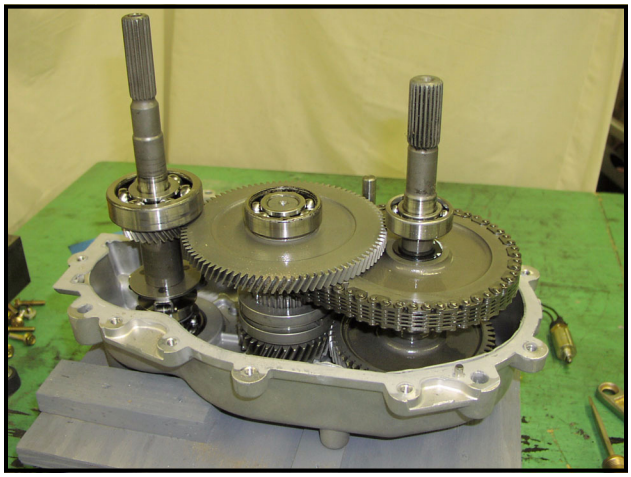


Figure 8-8 Remove Top Half of Case

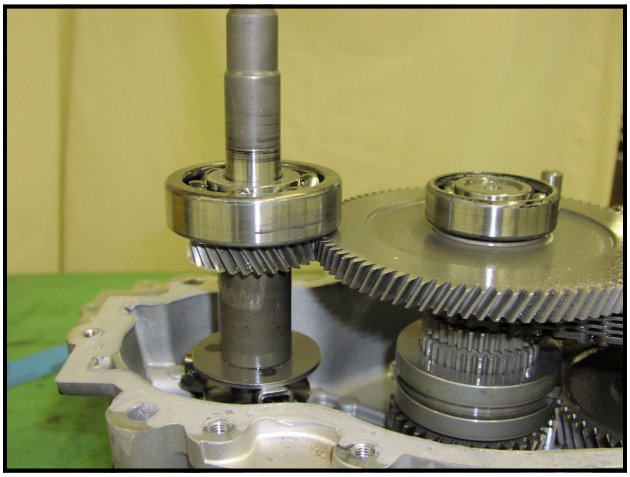


Figure 8-9 Input Shaft, Gear and Governor Assembly

8. Remove the ground speed governor yoke bracket from the governor shaft **(Figure 8-10, Page 8-5)**.

9. Remove the ground speed governor shaft and seal from the case by tapping gently with a small hammer from inside the case **(Figure 8-11, Page 8-5)**. **See following CAUTION.**

CAUTION

- **Removing the seal may require replacing it with a new one.**

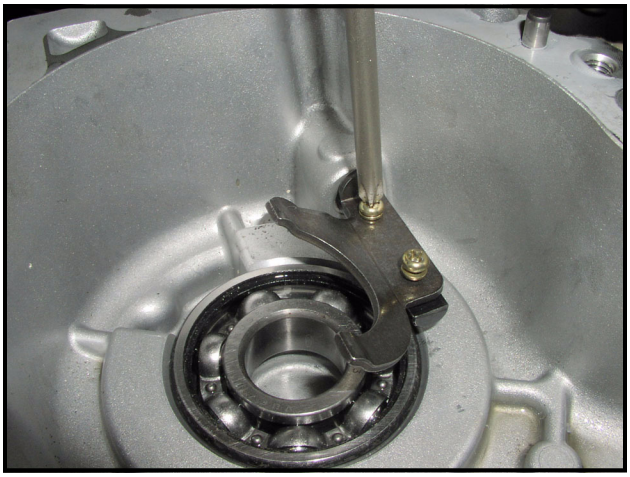


Figure 8-10 Ground Speed Governor Yoke Bracket

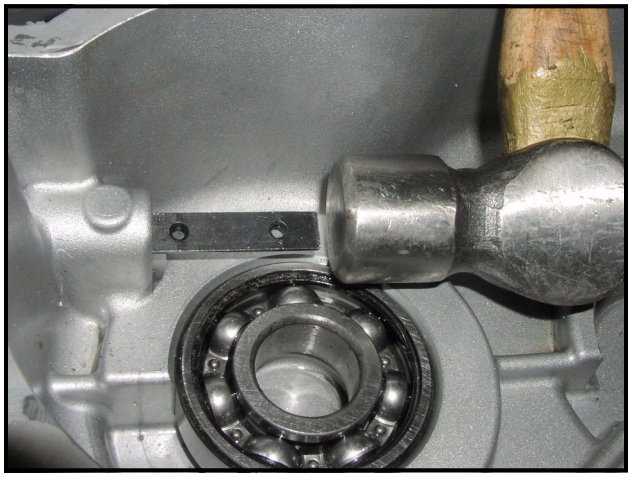


Figure 8-11 Ground Speed Governor Shaft

10. Remove the input shaft bearing from the case cavity **(Figure 8-12, Page 8-5)**.

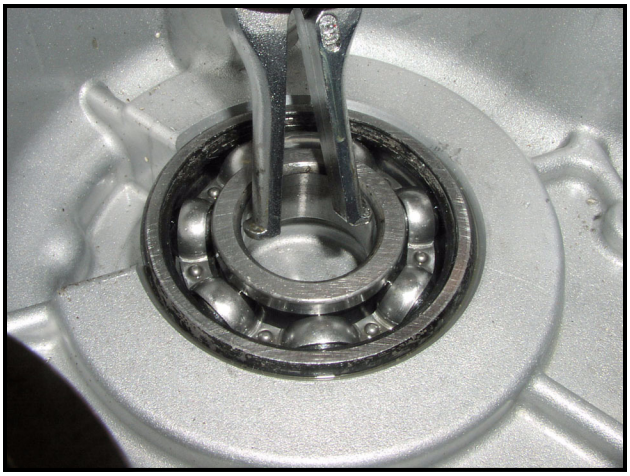


Figure 8-12 Remove Input Shaft Bearing from Case

11. Press the input shaft helical gear bearing from the shaft if the bearing is worn or damaged and replace with a new bearing. **See Input Shaft Disassembly on page 8-8. See following CAUTION.**

CAUTION

- **If the input shaft helical gear bearing is removed for any reason, either with a press or with a bearing puller, the bearing must be replaced with a new bearing.**

12. Lift the intermediate and output shafts and gear assemblies slightly so that the shaft bearings are free from the back side case.

Transmission Disassembly, Continued:

13. Hold the shafts and gear assemblies up and move them away from the engagement gear fork.
14. Rotate the bell crank arm downward allowing the shifter fork and gear fork shaft pin to separate **(Figure 8-13, Page 8-6)**.
15. Lift the gear fork from the transmission **(Figure 8-14, Page 8-6)**. **See following NOTE.**

NOTE: *The large end of the shifter fork yoke operates the engagement gear on the intermediate shaft. It is not necessary to remove the shifter arm on the case to remove the fork* ***(Figure 8-14, Page 8-6)****.*

16. Lift the intermediate and output shafts and gear assemblies from the case **(Figure 8-15, Page 8-6)**.
17. Remove the back half of the case from the service fixture and cover the fixture with a heavy cloth.

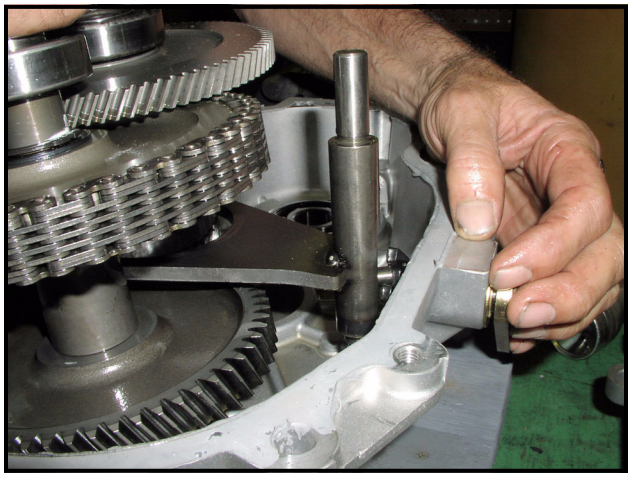


Figure 8-13 Remove Engagement Gear Fork

Figure 8-14 Engagement Gear Fork

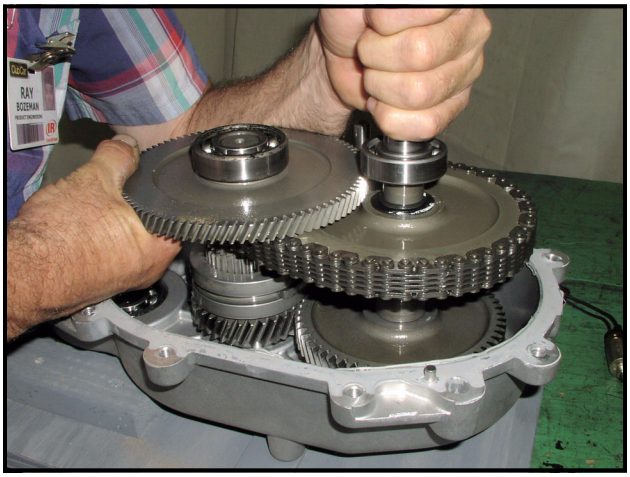


Figure 8-15 Remove Intermediate and Output Shafts and Gear Assemblies

18. Position the intermediate and output shaft gear assembly onto the fixture covered with a heavy cloth to reduce the change of damage to gear and sprocket teeth **(Figure 8-16, Page 8-7)**.

19. Separate the intermediate and output gear assemblies by removing the chain drive from the large sprocket on the output shaft **(Figure 8-17, Page 8-7) and (Figure 8-18, Page 8-7)**. **See following NOTE.**

NOTE: *Gradually work the chain off of the larger sprocket by sliding it toward the shaft end of the large sprocket and away from the helical gear. Move the chain gradually all around the large sprocket contact area until the two assemblies can be separated.*

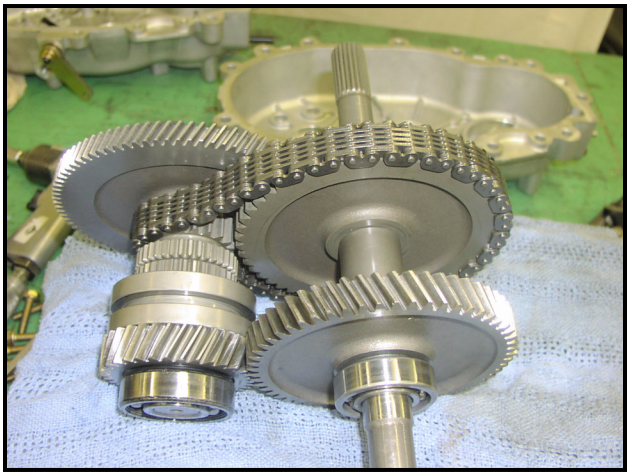


Figure 8-16 Position Gear Assemblies onto Fixture

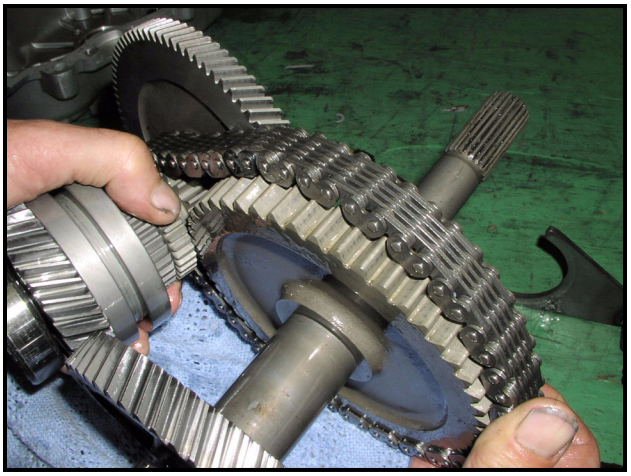


Figure 8-17 Remove Chain from Large Sprocket

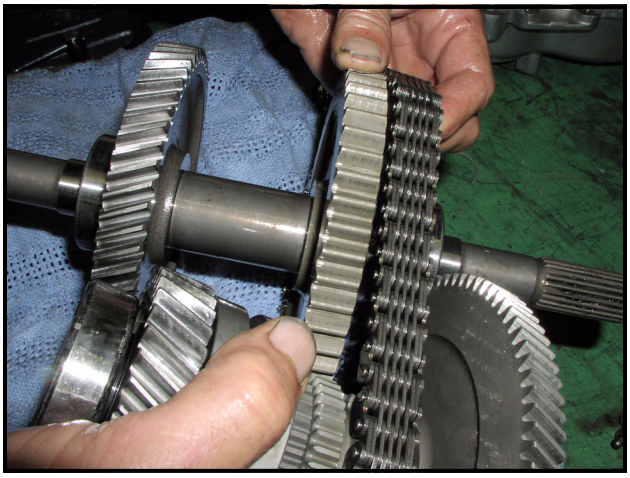


Figure 8-18 Gradually Move Chain

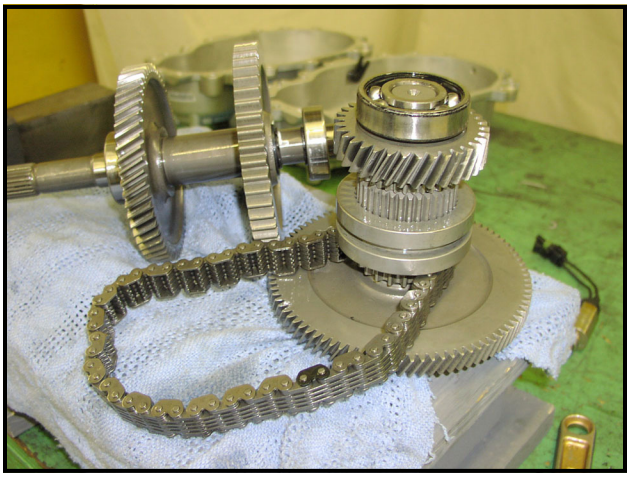


Figure 8-19 Separate Intermediate and Output Gear Assemblies

20. Remove the chain from the intermediate gear assembly small sprocket and the output gear assembly large sprocket **(Figure 8-19, Page 8-7)**.

INPUT SHAFT DISASSEMBLY

NOTE: *The input shaft is a sub-assembly and is provided with the ground speed governor assembly and helical gear and requires a new bearing pressed onto the helical gear end of the shaft and a new bearing pressed into the case for the opposite shaft end. There are no individual replacement parts available for the input shaft assembly.*

1. If the input shaft is to be re-used, press the old bearing from the helical gear end of the shaft, using a hydraulic press and bearing puller (CCI P/N 1012812), or three-jaw screw type bearing puller **(Figure 8-20, Page 8-8)**. **See following CAUTION.**

CAUTION

- **If the input shaft helical gear bearing is removed for any reason, either with a press or with a bearing puller, the bearing must be replaced with a new bearing.**

Figure 8-20 Remove Old Input Shaft Bearing

Figure 8-21 Press-On New Input Shaft Bearing

INPUT SHAFT ASSEMBLY

1. Press a new bearing onto the input shaft, pushing the inner race until bearing seats against the helical gear hub **(Figure 8-21, Page 8-8)**. **See following CAUTION.**

CAUTION

- **Do not press bearing against the outer race or bearing area.**

INTERMEDIATE SHAFT DISASSEMBLY

1. Position a bearing puller wedge attachment between the large helical gear and the intermediate shaft bearing and support the wedge attachment on press blocks to clear gear **(Figure 8-22, Page 8-9)**.
2. Position a bar or socket slightly smaller in diameter than the intermediate shaft and press the bearing from the helical gear and intermediate shaft **(Figure 8-23, Page 8-9)**. **See following CAUTION.**

CAUTION

- **Be careful to position the wedge attachment on the press blocks and NOT under the gear.**

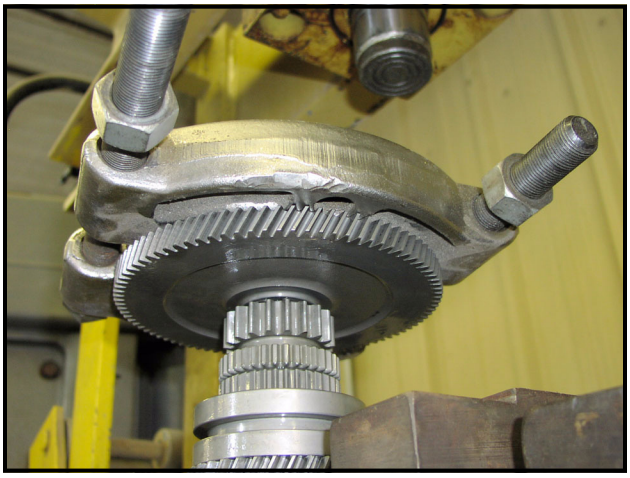


Figure 8-22 Position Large Helical Gear and Bearing

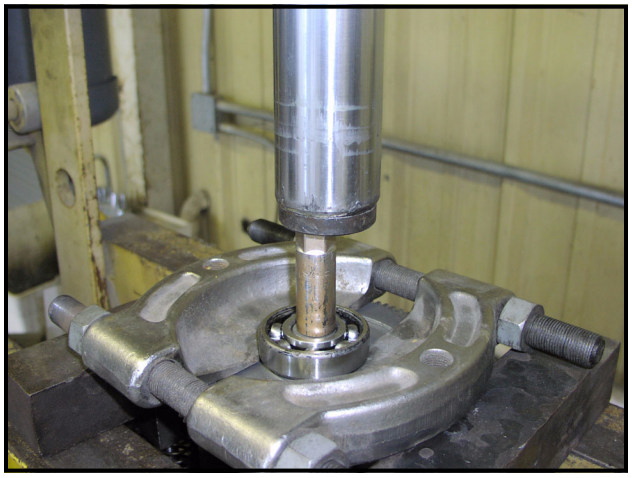


Figure 8-23 Remove Large Helical Gear Bearing

3. Remove the E-clip and flat washer from the intermediate shaft and the large helical gear and slide the gear from the splined shaft **(Figure 8-24, Page 8-9)**.

4. Remove the E-clip and splined-cut washer from the intermediate shaft and small chain sprocket **(Figure 8-25, Page 8-9)**. **See following NOTE.**

NOTE: *The splined-cut washer is specially designed for this application* ***(Figure 8-26, Page 8-10)****.*

Figure 8-24 E-Clip and Washer on Large Helical

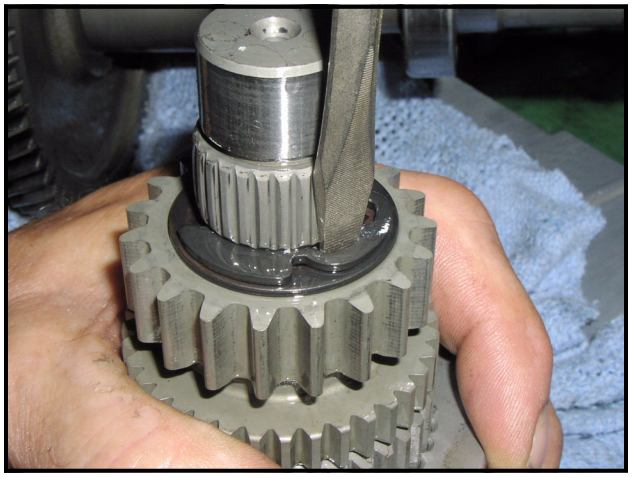


Figure 8-25 E-Clip and Splined-Cut Washer on Small Chain Sprocket

5. Slide the sprocket and engagement gear from the shaft and two needle bearing assemblies **(Figure 8-27, Page 8-10)**.

Intermediate Shaft Disassembly, Continued:

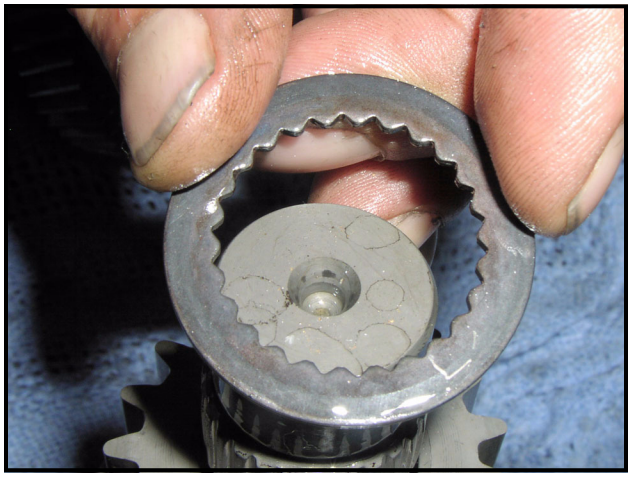


Figure 8-26 Special Splined-Cut Flat Washer

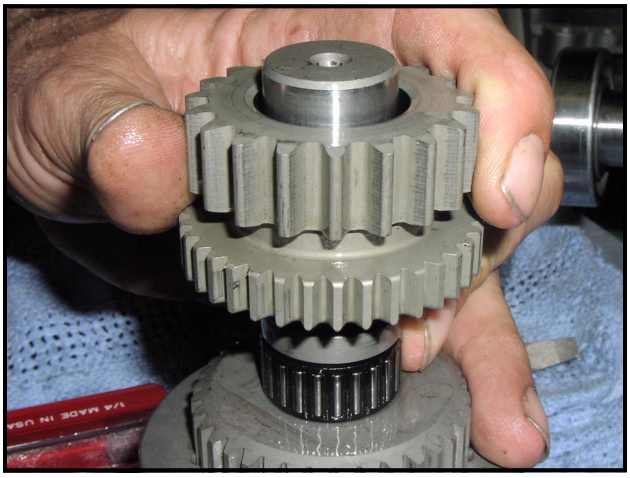


Figure 8-27 Small Sprocket and Engagement Gear

6. Slide the engagement dog gear from the intermediate gear assembly shaft **(Figure 8-27, Page 8-10)**.
7. Remove the two needle bearing assemblies from the intermediate shaft. **See following NOTE.**

NOTE: *The two needle bearing assemblies are held together in flexible nylon strips. Find where the strips ends butt together and gently spread the strips outward far enough to clear the splined portion of the shaft and remove the two needle bearing assemblies. Do not try to spread the strips wide enough to clear the diameter of the shaft. Spread only enough to clear the slightly larger diameter splined portion of the shaft and slide the bearing assemblies along the shaft* ***(Figure 8-29, Page 8-10)****.*

8. Remove the engagement dog ring from the intermediate shaft **(Figure 8-28, Page 8-10)**.

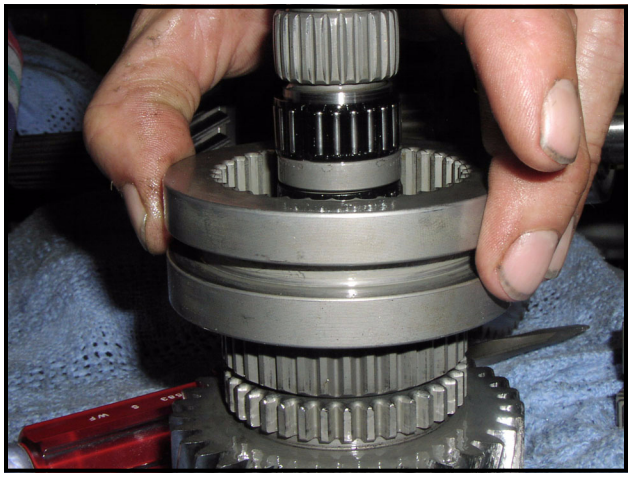


Figure 8-28 Engagement Gear

Figure 8-29 Remove Needle Bearing Assemblies

9. Position a bearing puller wedge attachment between the small helical gear and the intermediate shaft bearing, and support the wedge attachment on press blocks to clear the gear **(Figure 8-30, Page 8-11)**. **See following CAUTION.**

CAUTION

- **Be careful to position the wedge attachment between the bearing and gear and NOT under the snap ring between the two.**

10. Position a bar or socket slightly smaller in diameter than the intermediate shaft and press the bearing from the helical gear and intermediate shaft **(Figure 8-31, Page 8-11)**.

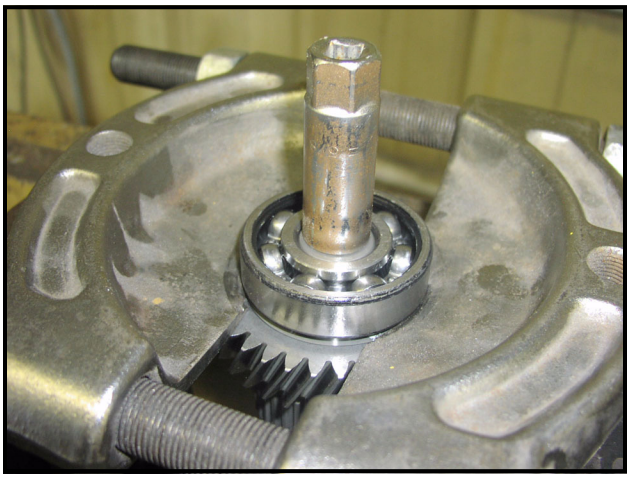


Figure 8-30 Position Small Helical Gear and Bearing

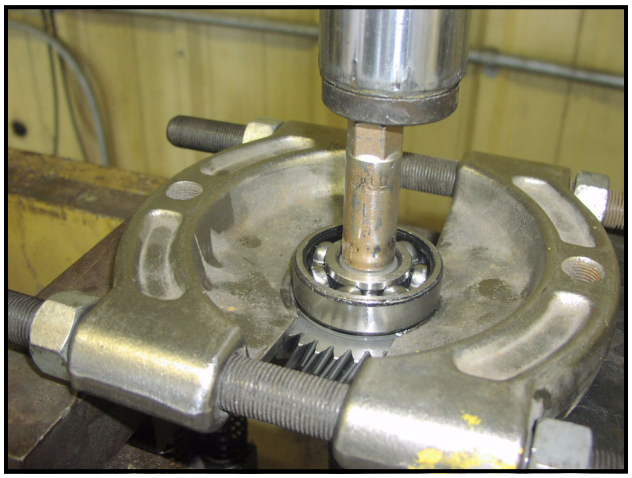


Figure 8-31 Remove Small Helical Gear Bearing

11. Remove the snap ring and flat washer next to the small helical gear **(Figure 8-32, Page 8-11)**.
12. Slide the small helical and engagement gear assembly from the intermediate shaft and two needle bearing assemblies **(Figure 8-33, Page 8-11)**.
13. Slide the two needle bearing assemblies off the intermediate shaft **(Figure 8-34, Page 8-12)**.

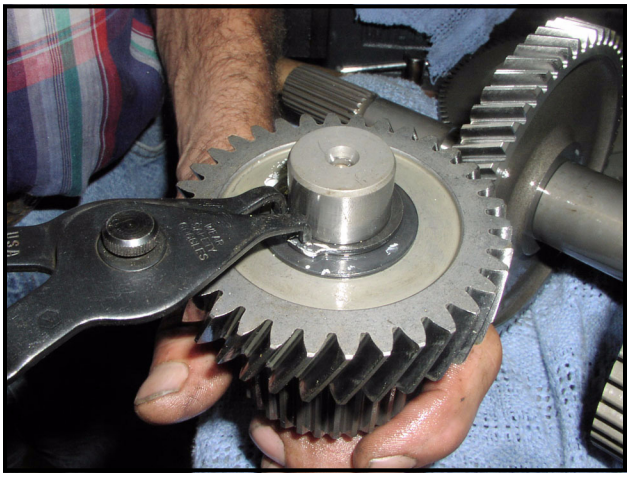


Figure 8-32 Remove Snap Ring and Flat Washer

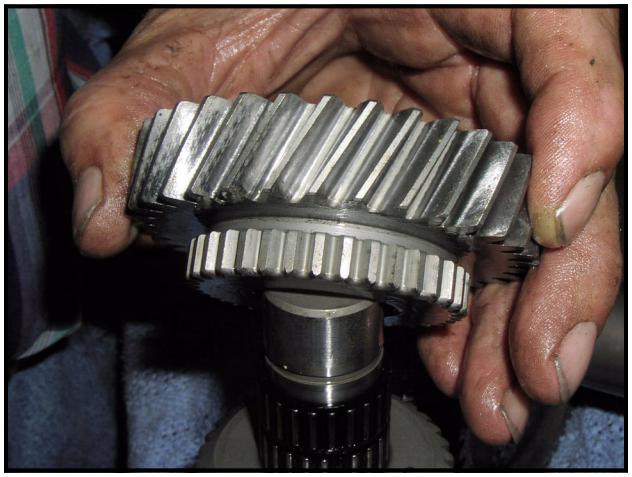


Figure 8-33 Remove Small Helical and Engagement Gear Assembly from Intermediate Shaft

Intermediate Shaft Disassembly, Continued:

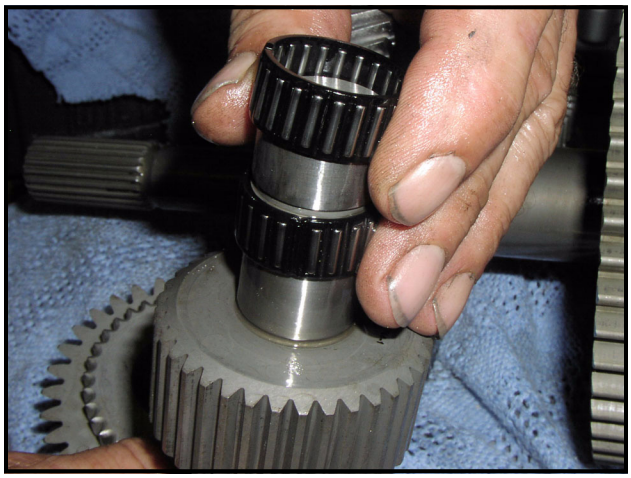


Figure 8-34 Remove Needle Bearing Assemblies

OUTPUT SHAFT DISASSEMBLY

1. Position a bearing puller wedge attachment between the large chain sprocket and the output shaft bearing and support the wedge attachment on press blocks to clear the gear **(Figure 8-35, Page 8-12)**.
2. Position a bar or socket slightly smaller in diameter than the output shaft and press the bearing from the large chain sprocket and shaft.
3. Remove the snap ring and flat washer from the large chain sprocket and output shaft **(Figure 8-36, Page 8-12)**.
4. Remove the splined chain sprocket from the output shaft **(Figure 8-37, Page 8-13)**.
5. Position a bearing puller wedge attachment between the large helical gear and the output shaft bearing and support the wedge attachment on press blocks to clear the gear **(Figure 8-38, Page 8-13)**.

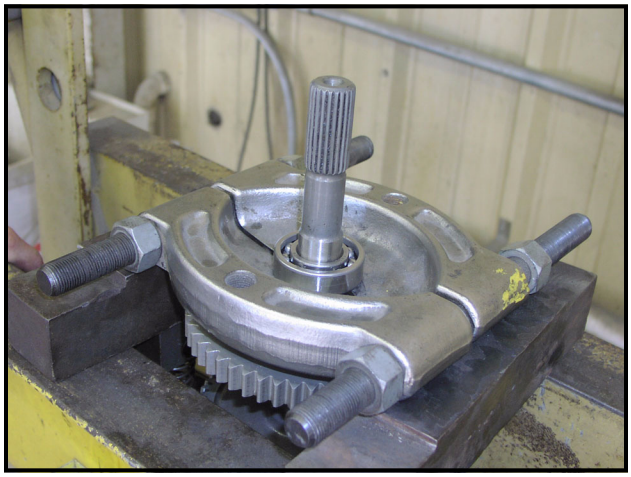


Figure 8-35 Position Puller Between Large Chain Sprocket and Bearing

Figure 8-36 Snap Ring and Washer on Chain Sprocket

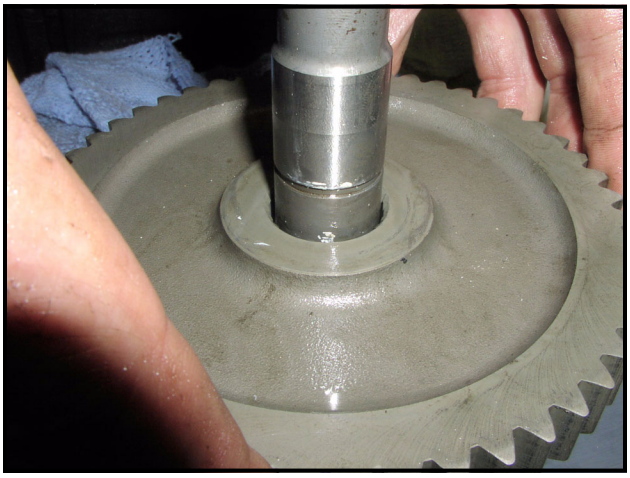


Figure 8-37 Remove Splined Chain Sprocket

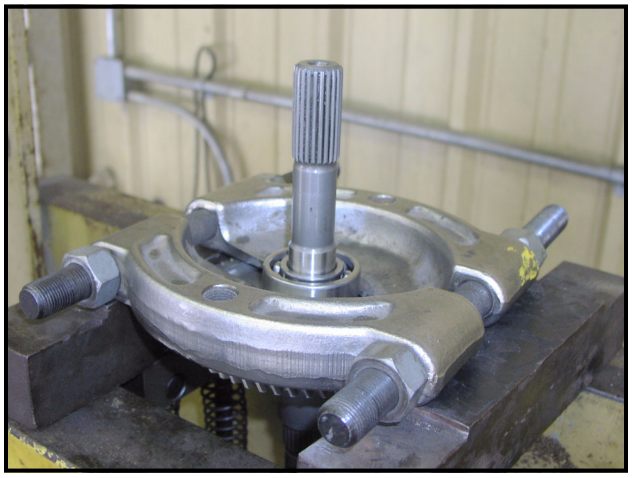


Figure 8-38 Position Puller Between Large Helical Gear and Bearing

6. Press the output shaft through the bearing from the large chain sprocket.
7. Remove the snap ring and flat washer from the shaft and large helical gear **(Figure 8-39, Page 8-13)**.
8. Remove the large helical gear from the splined output shaft **(Figure 8-40, Page 8-13)**.

Figure 8-39 Remove Snap Ring and Flat Washer

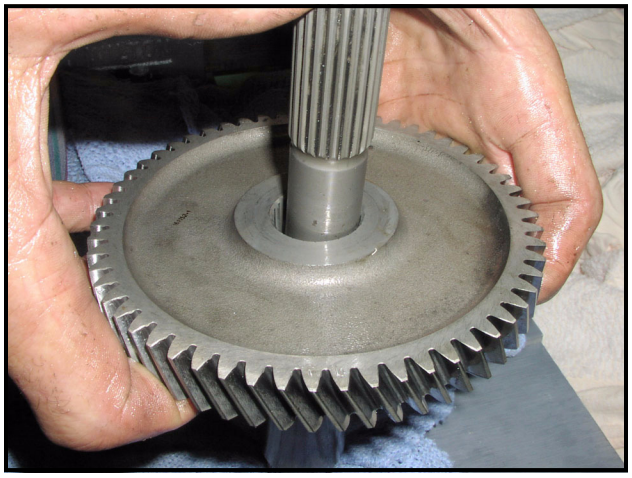


Figure 8-40 Remove Large Helical Gear

SHIFTER SHAFT REMOVAL

1. Remove the locknut from the D-shaped bellcrank arm **(Figure 8-41, Page 8-14)**.
2. Remove the shifter shaft snap ring **(Figure 8-42, Page 8-14)**.

Shifter Shaft Removal, Continued:

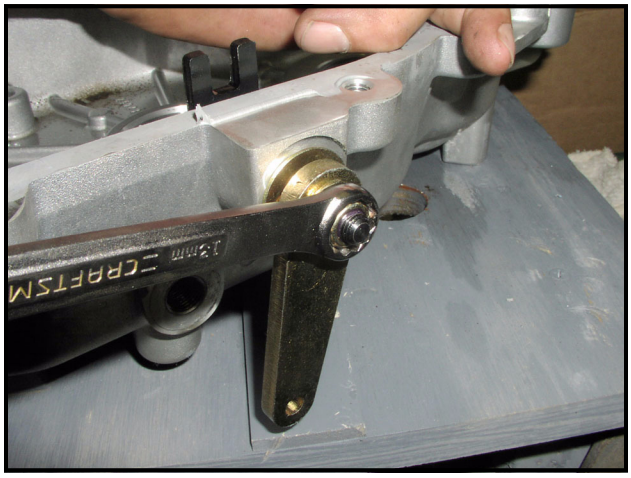


Figure 8-41 Bell Crank Arm on Shifter Shaft

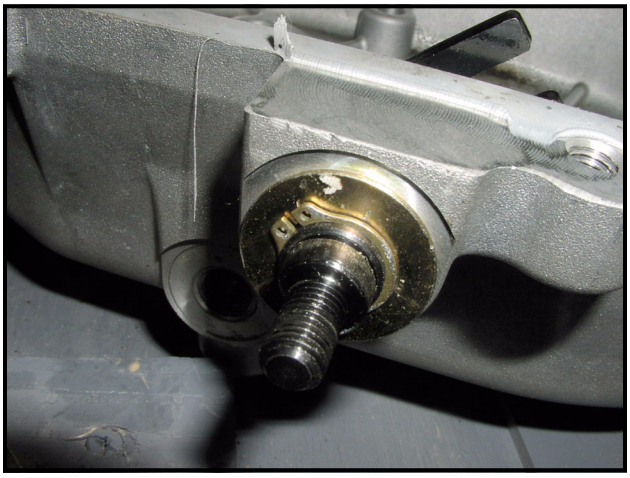


Figure 8-42 Shifter Shaft Snap Ring

3. Slide the shifter shaft and fork to the inside of the case and remove the shaft **(Figure 8-43, Page 8-14)**.
4. Use a small bearing puller and remove the shifter shaft seal from the case **(Figure 8-44, Page 8-14)**.

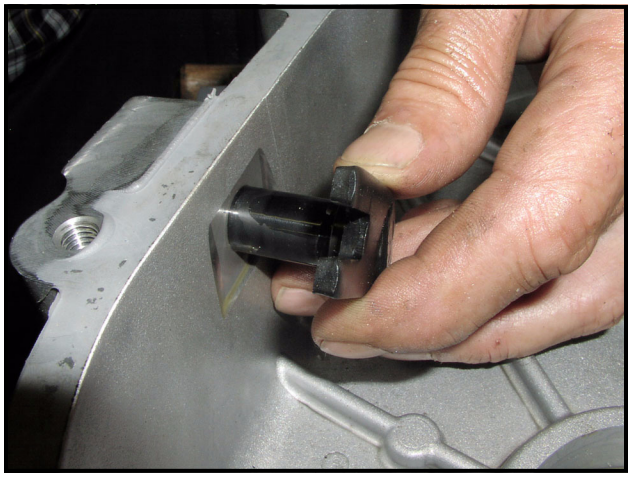


Figure 8-43 Shifter Shaft and Fork

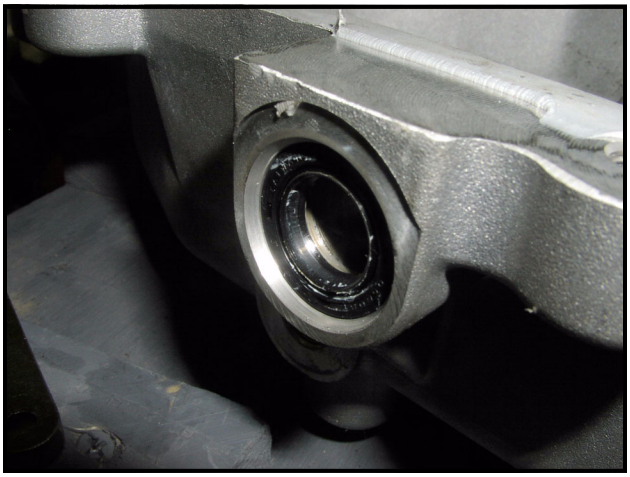


Figure 8-44 Shifter Shaft Seal

SHIFTER SHAFT INSTALLATION

1. Slide a new shifter shaft seal into the case and seat it by tapping on it using a small socket or tube slightly smaller than the outside diameter of the seal **(Figure 8-44, Page 8-14)**.
2. Slide a new shifter shaft and fork from inside the case and through the seal.
3. Install a new snap ring onto the shifter shaft next to the shaft seal **(Figure 8-42, Page 8-14)**.
4. Install bell crank arm onto the D-shaped end of the shifter shaft.
5. Install a nylon locknut onto the shifter shaft and tighten nut to 16 ft-lb (22 N·m) **(Figure 8-41, Page 8-14)**.

CASE INSPECTION

1. Inspect case for cracks and worn bearing cavities.
2. If any bearing seat has become worn or damaged, both halves will have to be replaced.

SHAFT SEAL REMOVAL

1. Position a case half with shaft seals up.
2. Use a socket or thick wall tube slightly smaller in diameter than the seal and gently drive the seal from outside to inside the case to remove each seal **(Figure 8-45, Page 8-15)**. **See following NOTE.**

NOTE: *The case does not have a seal landing area but rather provided with a clean bore.*

3. Clean and remove any dirt and debris from the seal area.

SHAFT SEAL INSTALLATION

1. Position a case half with shaft seals up.
2. Position seals with lips to the inside of the case and gently drive the seals flush with the outside of the case using a seal installation tool, socket or thick wall tube slightly smaller in diameter than the seal **(Figure 8-46, Page 8-15)**. **See following NOTE.**

NOTE: *The seals have a light press fit dimension and the bores do not have seal landing areas. Take care to only drive the seals flush with the outside of the case.*

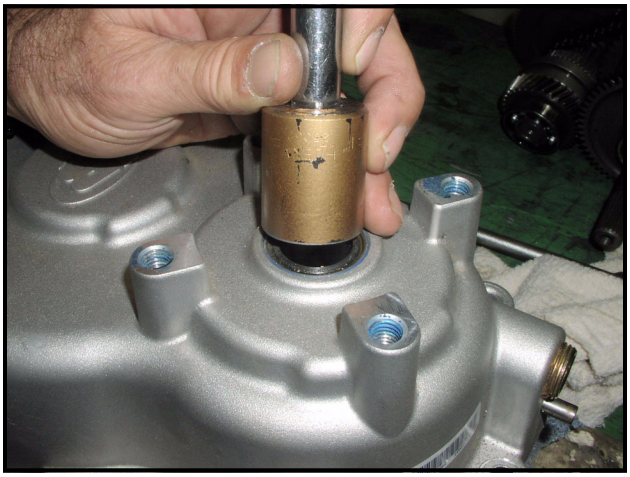


Figure 8-45 Remove Shaft Seals from Case

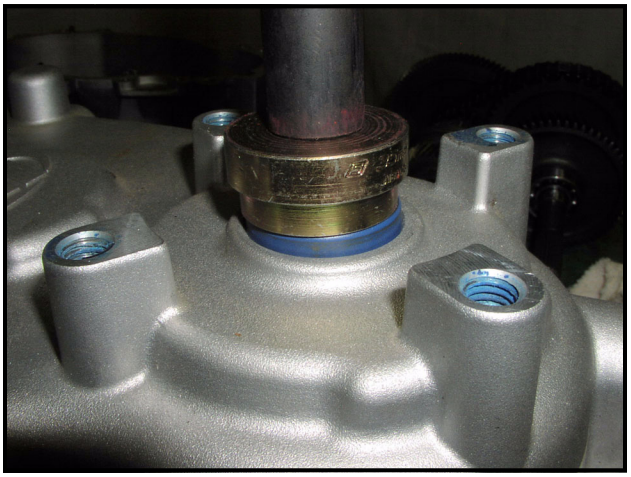


Figure 8-46 Install Shaft Seals in Case

OUTPUT SHAFT ASSEMBLY

1. Inspect the output shaft for worn splined areas and shaft journals and replace the shaft if necessary.
2. Position the shaft so that the helical gear spline is to the right of the center portion of the shaft. Slide the large helical gear onto the output shaft and up against the center hub **(Figure 8-47, Page 8-16)**.
3. Position the opposite end of the output shaft down through the shaft hole in the service fixture with the helical gear up.
4. Install a flat washer onto the output shaft against the helical gear hub **(Figure 8-48, Page 8-16)**.
5. Install a snap ring onto the output shaft and helical gear **(Figure 8-49, Page 8-16)**.
6. Reposition the output shaft with the helical gear shaft end down through the shaft hole in the service fixture **(Figure 8-50, Page 8-16)**.
7. Install the large chain sprocket onto the splined portion of the output shaft opposite the helical gear **(Figure 8-51, Page 8-16)**.

Figure 8-47 Slide Large Helical Gear onto Shaft

Figure 8-48 Helical Gear Flat Washer

Figure 8-49 Helical Gear Snap Ring

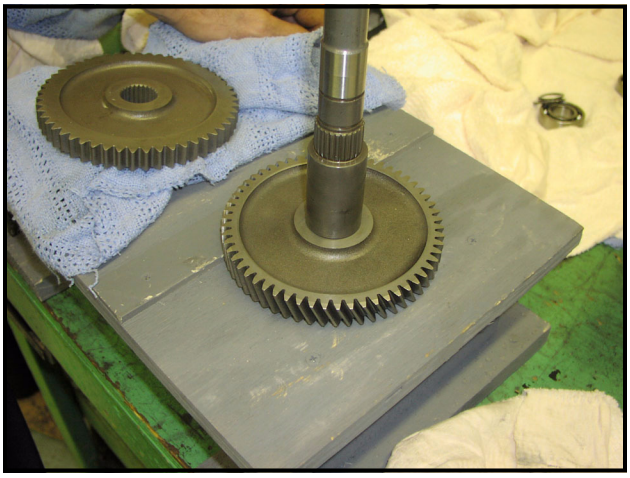


Figure 8-50 Reosition Output Shaft in Fixture

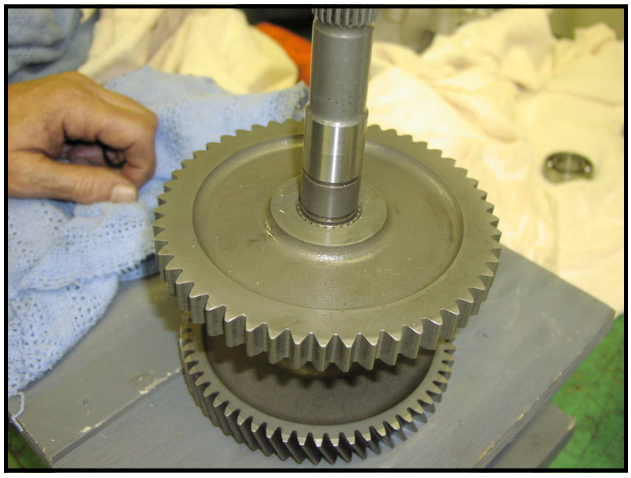


Figure 8-51 Large Chain Sprocket

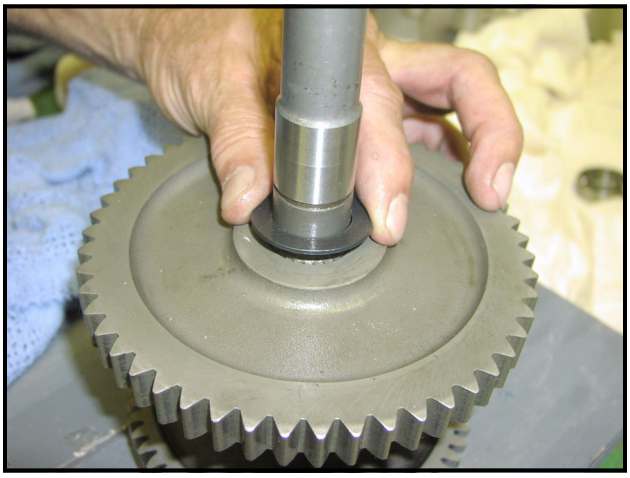


Figure 8-52 Chain Sprocket Flat Washer

8. Install the chain sprocket flat washer **(Figure 8-52, Page 8-16)**.
9. Install the chain sprocket snap ring **(Figure 8-53, Page 8-17)**.
10. Install the chain sprocket bearing snap ring **(Figure 8-54, Page 8-17)**.

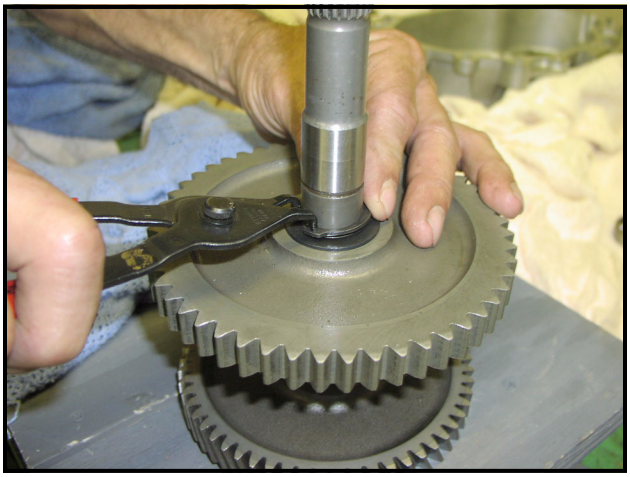


Figure 8-53 Chain Sprocket Snap Ring

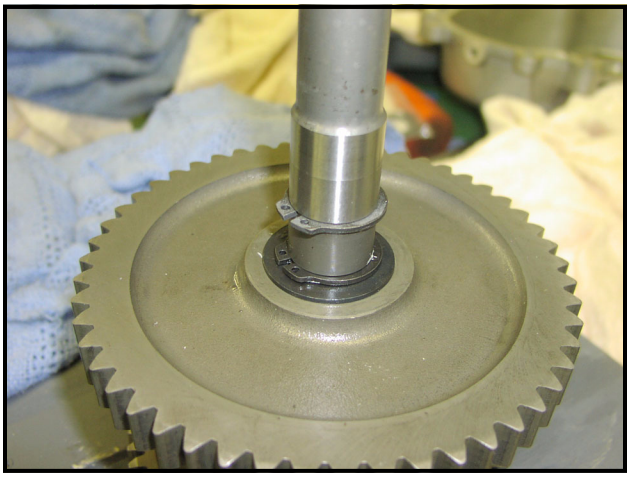


Figure 8-54 Large Chain Sprocket Bearing Snap Ring

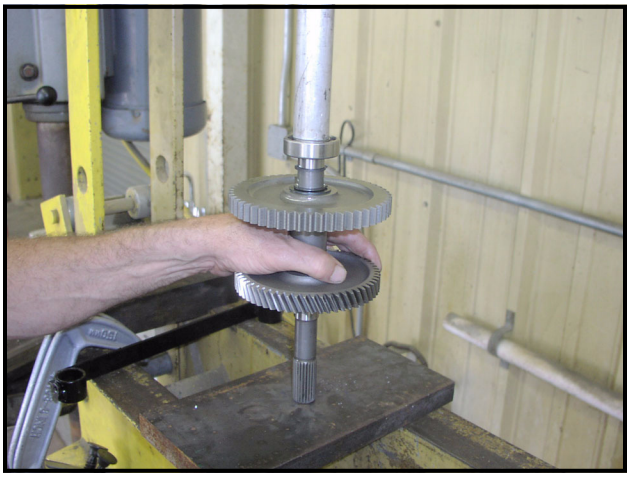


Figure 8-55 Chain Sprocket End Up On Press

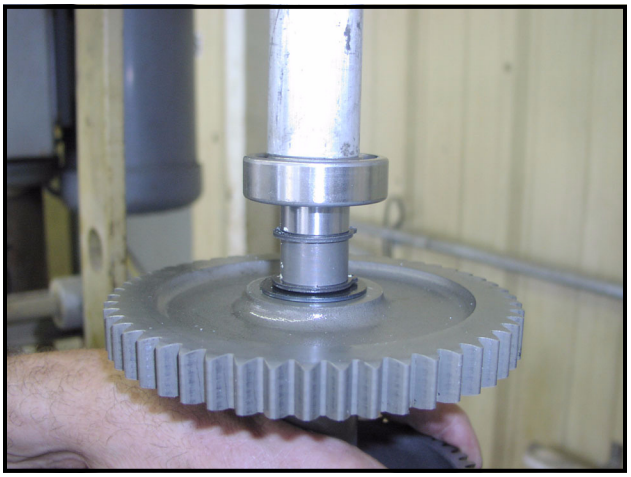


Figure 8-56 Chain Sprocket Bearing On Shaft

11. Position the output shaft with the large helical gear splined end down against a metal plate on a press platen. Hold the shaft on the center hub and slide a bearing over the large chain sprocket splined end of the shaft and against the chain sprocket bearing race. Slide a tube over the shaft to fit against the inner race of the bearing **(Figure 8-55, Page 8-17)**.
12. Press the large chain sprocket bearing onto the output shaft **(Figure 8-56, Page 8-17)**. **See following CAUTION.**

CAUTION

- **Be sure to press only on the inner race of the bearing.**
- **Be careful to press bearing only until it seats snuggly against the shaft snap ring. Excess pressure could fracture or break the snap ring, or damage the snap ring groove in the shaft.**

Output Shaft Assembly, Continued:

13. Position the output shaft with the large chain sprocket splined end down against a metal plate on a press platen. Hold the shaft on the center hub and slide a bearing over the helical gear splined end of the shaft and against the helical gear bearing race **(Figure 8-57, Page 8-18)**.
14. Press the large helical gear bearing onto the output shaft **(Figure 8-58, Page 8-18)**.
15. Place a protective cloth over the service fixture.
16. Place the output shaft assembly on the fixture and make sure that the completed assembly is oriented correctly **(Figure 8-59, Page 8-18)**.

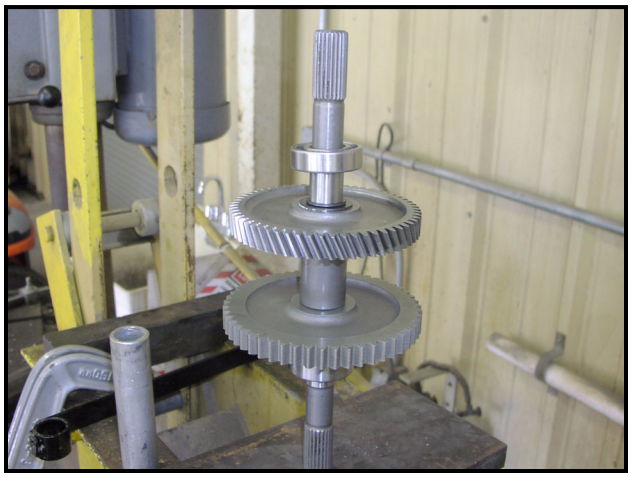


Figure 8-57 Helical Gear End Up On Press

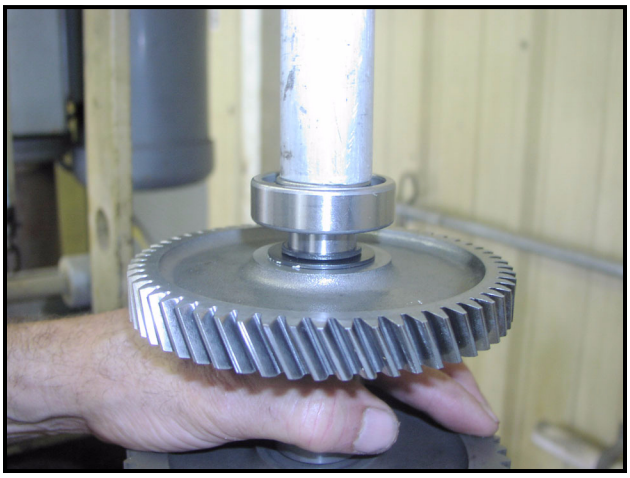


Figure 8-58 Helical Gear Bearing On Shaft

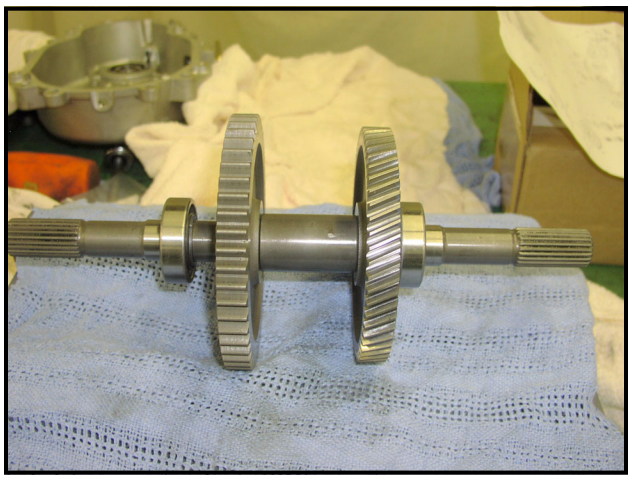


Figure 8-59 Completed Output Shaft Assembly

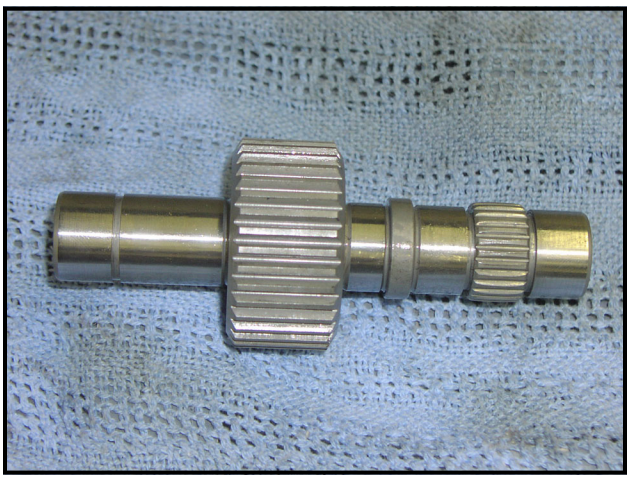


Figure 8-60 Inspect Intermediate Shaft

INTERMEDIATE SHAFT ASSEMBLY

1. Inspect the intermediate shaft for worn splined areas and shaft journals. Replace the shaft if necessary.
2. Install bearings on the shaft for the small chain sprocket **(Figure 8-61, Page 8-19)**. **See following CAUTION.**

CAUTION

- **Slide the bearing assemblies onto the shaft and open just enough to pass the splined and bearing race journals. Do not open them wide enough to clear the diameter of the shaft.**

3. Position the intermediate shaft with the small chain sprocket end up and the small helical gear end down through the shaft hole in the service fixture **(Figure 8-62, Page 8-19)**.
4. Install the small chain sprocket onto the shaft and needle bearing assemblies **(Figure 8-63, Page 8-19)**.
5. Install the splined flat washer against the small chain sprocket **(Figure 8-64, Page 8-19)**.

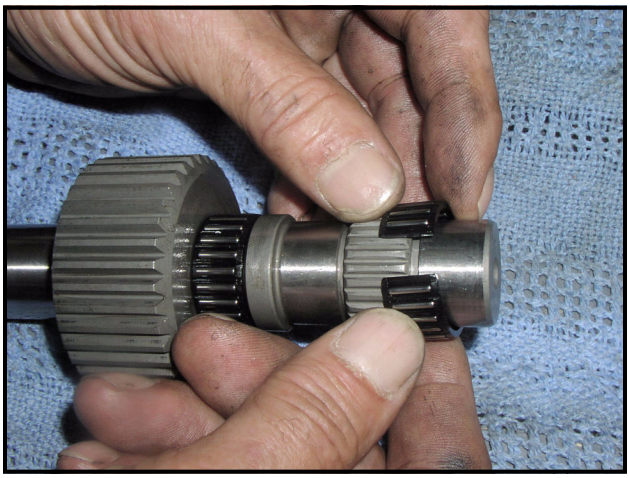


Figure 8-61 Bearings For Small Chain Sprocket

Figure 8-62 Position The Intermediate Shaft

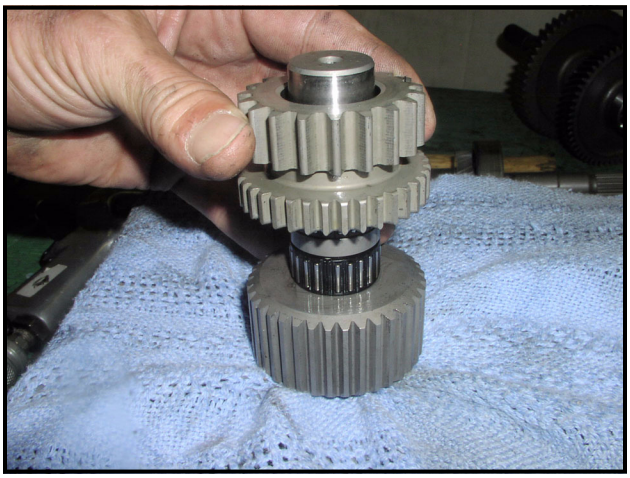


Figure 8-63 Small Chain Sprocket Gear

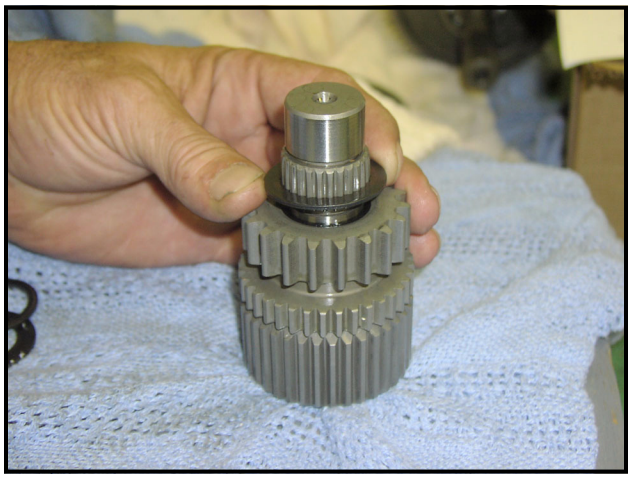


Figure 8-64 Splined Washer on Small Chain Sprocket

6. Install an E-clip onto the shaft and chain sprocket **(Figure 8-65, Page 8-20)**.
7. Install large helical gear onto splined intermediate shaft next to the small chain sprocket **(Figure 8-66, Page 8-20)**.

8. Install an E-clip onto the intermediate shaft to secure the large helical gear **(Figure 8-67, Page 8-20)**.
9. Check the orientation of components for proper assembly **(Figure 8-68, Page 8-20)**.

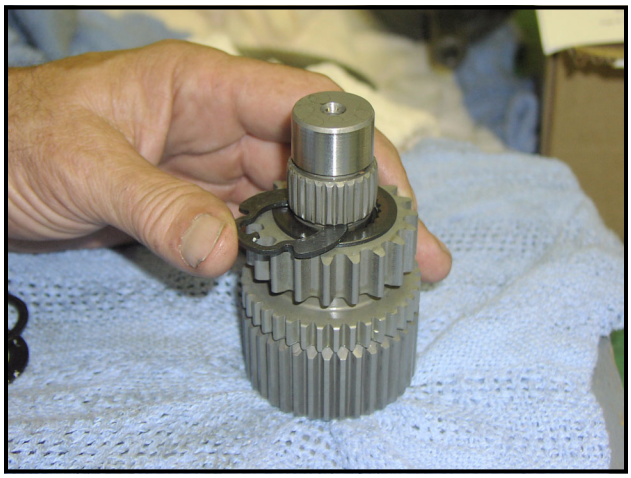


Figure 8-65 E-Clip on Small Chain Sprocket

Figure 8-66 Large Helical Gear

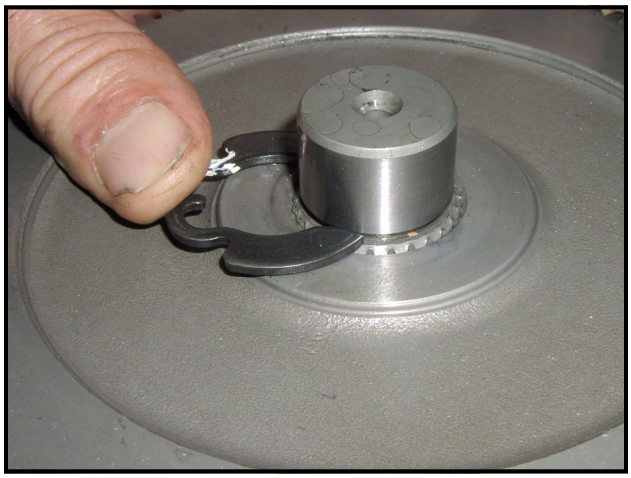


Figure 8-67 E-Clip on Large Helical Gear

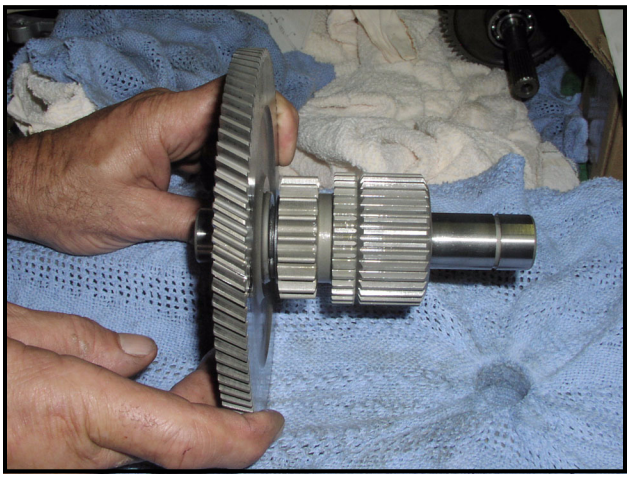


Figure 8-68 Assembly Orientation

10. Position the intermediate shaft with the small helical gear end up and large helical gear down against the service fixture, and slide new roller bearing assemblies onto the gear race **(Figure 8-69, Page 8-21)**.
11. Slide the splined engagement gear ring onto the splined intermediate shaft and small chain sprocket **(Figure 8-70, Page 8-21)**.
12. Install the small helical gear onto intermediate shaft **(Figure 8-71, Page 8-21)**.
13. Install the flat washer on helical gear **(Figure 8-72, Page 8-21)**.
14. Install the snap ring onto shaft to secure the small helical gear **(Figure 8-73, Page 8-21)**.
15. Position the large helical gear end of intermediate shaft against a steel plate on a press platen and press a new bearing onto small helical gear bearing race until the bearing inner race is flush with the end of the intermediate shaft **(Figure 8-74, Page 8-21)**.

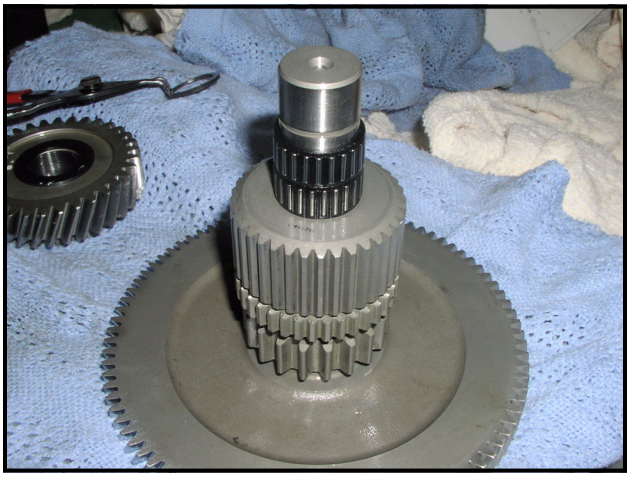


Figure 8-69 Small Helical Gear Bearings

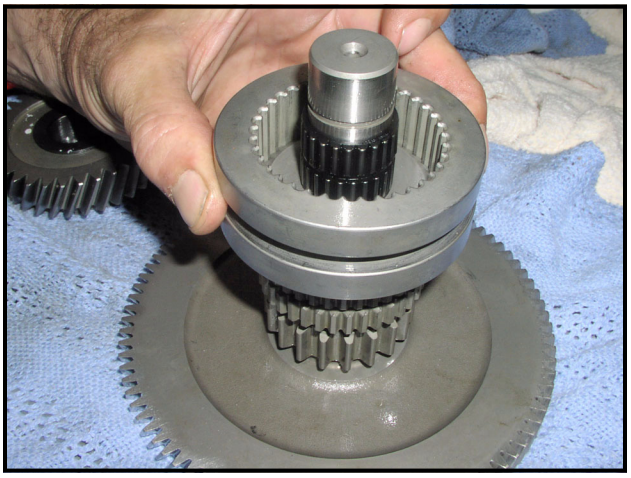


Figure 8-70 Splined Engagement Gear

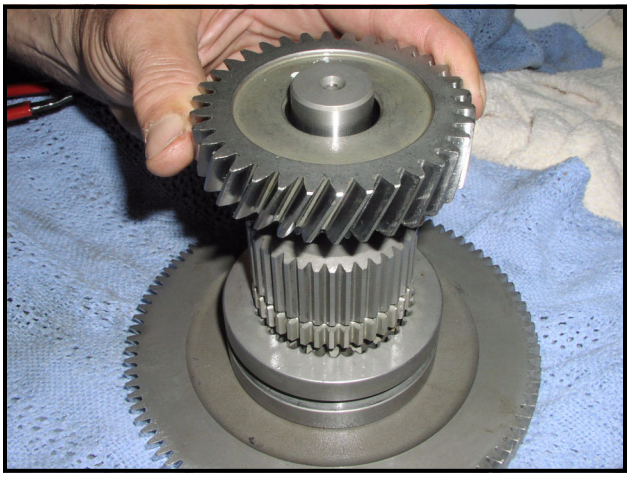


Figure 8-71 Small Helical Gear

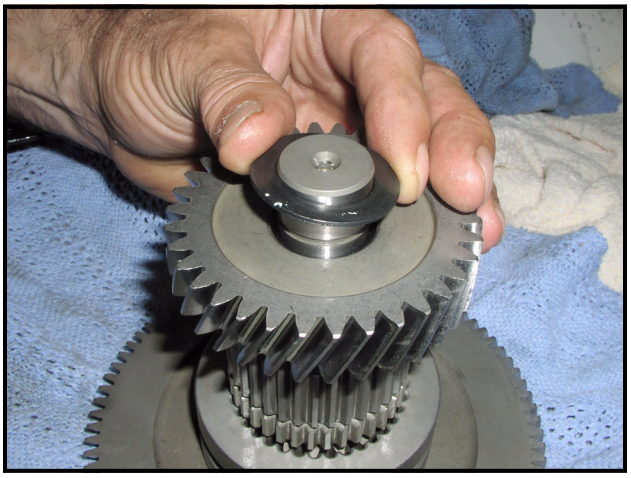


Figure 8-72 Flat Washer on Small Helical Gear

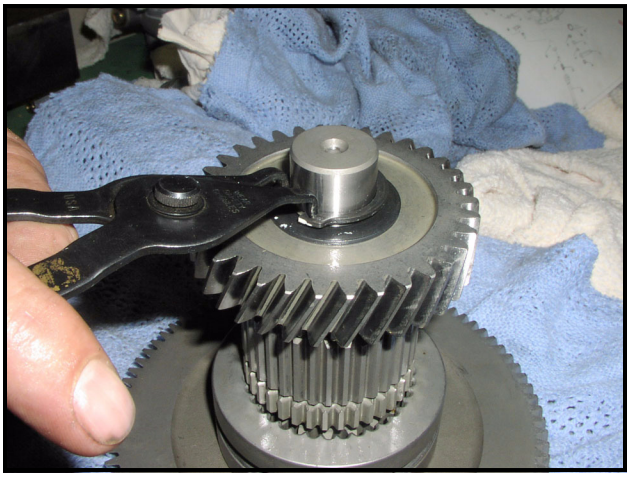


Figure 8-73 Snap Ring on Small Helical Gear

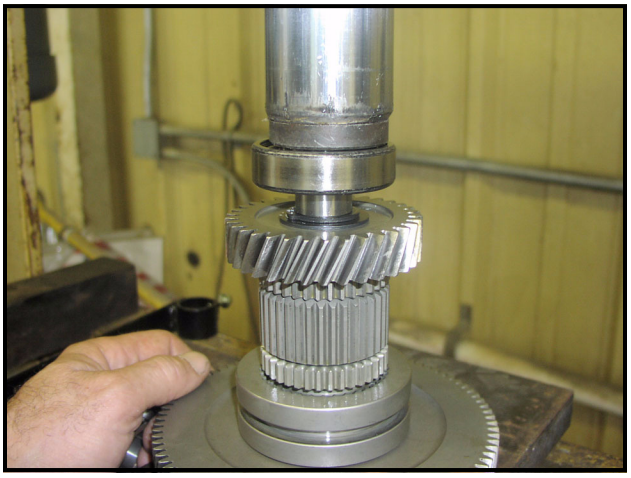


Figure 8-74 Small Helical Gear Bearing

Intermediate Shaft Assembly, Continued:

16. Position the small helical gear end of intermediate shaft against a steel plate on a press platen **(Figure 8-75, Page 8-22)**.
17. Press a new bearing onto large helical gear bearing race until the bearing inner race is flush with the end of the intermediate shaft.

Figure 8-75 Large Helical Gear Bearing

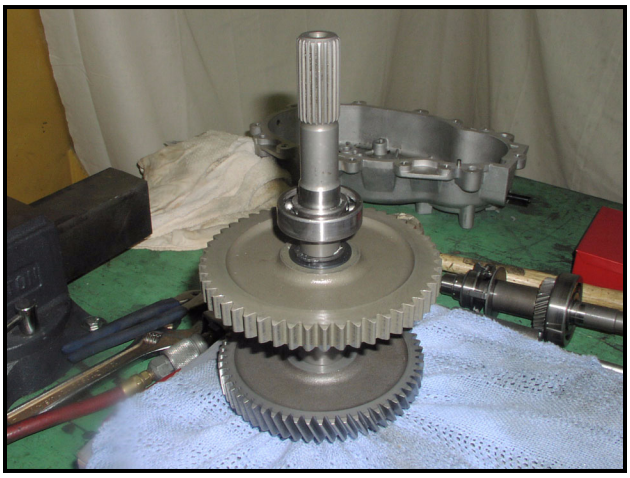


Figure 8-76 Output Shaft Assembly on Fixture

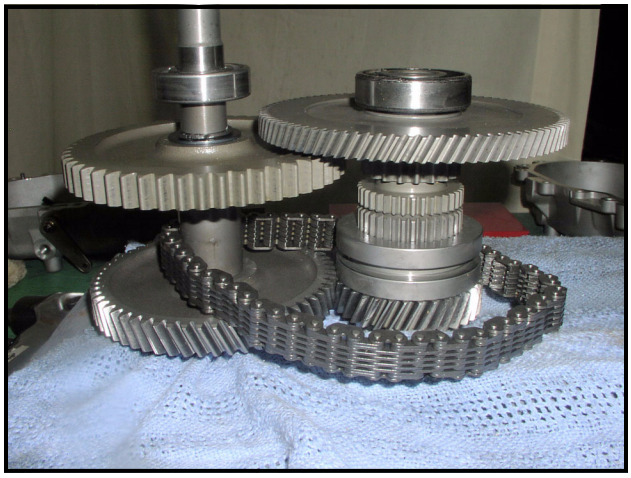


Figure 8-77 Shafts and Gears Assembly

Figure 8-78 Attach Chain

INTERMEDIATE AND OUTPUT SHAFT ASSEMBLY

1. Position the output shaft assembly on the service fixture with the large chain sprocket and bearing up and the helical gear end of the output shaft down through the shaft hole in the service fixture **(Figure 8-76, Page 8-22)**.
2. Slip the chain over the large chain sprocket on the output shaft **(Figure 8-77, Page 8-22)**.
3. Place the small helical gear end of the intermediate shaft down into the chain and lift up on the chain, placing it on the small sprocket and slide the intermediate shaft assembly next to the output shaft.
4. Begin working the chain onto the large chain sprocket, lifting it up as it's being attached to the sprocket. **See following NOTE.**

NOTE: *It may be necessary to move the gears and shafts around a little to provide enough slack for the chain to be attached.*

TRANSMISSION ASSEMBLY

See General Warning on page 1-1.

CAUTION

- **Make sure that the inside of both halves of the transmission case are clean and free of old oil, dirt, old gasket material and debris.**

1. Position case (back half) onto the service fixture with the output shaft bearing port directly over the shaft hole in the fixture and the fixture positioned with the shaft hole to the left on the work bench. Clamp or bolt the fixture to a clean working surface or bench top **(Figure 8-79, Page 8-23)**. **See following NOTE.**

NOTE: *Positioning the through hole in the fixture to the left allows easy access to the shifter shaft and related components during assembly.*

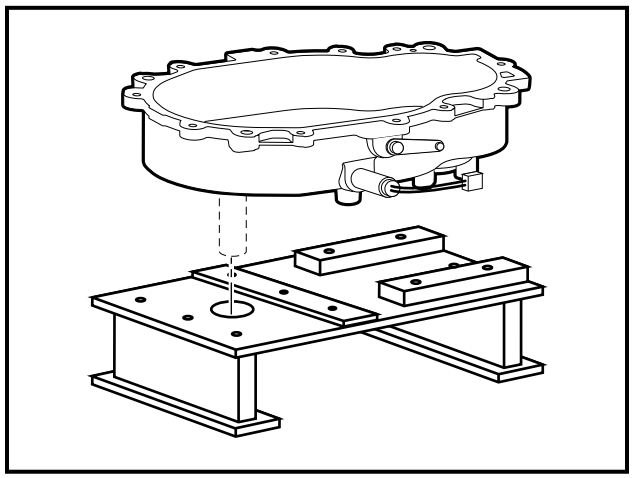


Figure 8-79 Position Back Half on Fixture

2. Install the ground speed governor shaft yoke bracket and tighten screws and lock washers to 15 in-lb (1.7 N·m) **(Figure 8-80, Page 8-24)**.
3. Install the intermediate and output shaft and gear assembly into the back case, aligning the front output shaft down through the case and seal and through the service fixture **(Figure 8-81, Page 8-24)**. **See following CAUTION and NOTE.**

CAUTION

- **Be careful when passing the front output shaft through the shaft seal to not damage or dislodge the seal from the case. See following NOTE.**

NOTE: *Allow the front output shaft and intermediate shaft bearings to rest at the edge of the case cavities. Do not tap on the shafts to seat the bearings at this stage.*

Transmission Assembly, Continued:

4. Gently lift the engagement ring up as far as it will go with gears meshed. Hold it in position and slide the engagement fork into the groove in the engagement ring gear, and allow the engagement fork shaft to fit down into the case cavity provided.

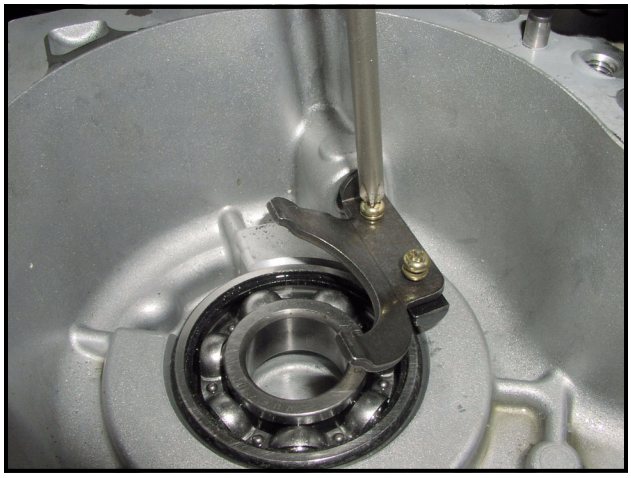


Figure 8-80 Governor Shaft Yoke Bracket

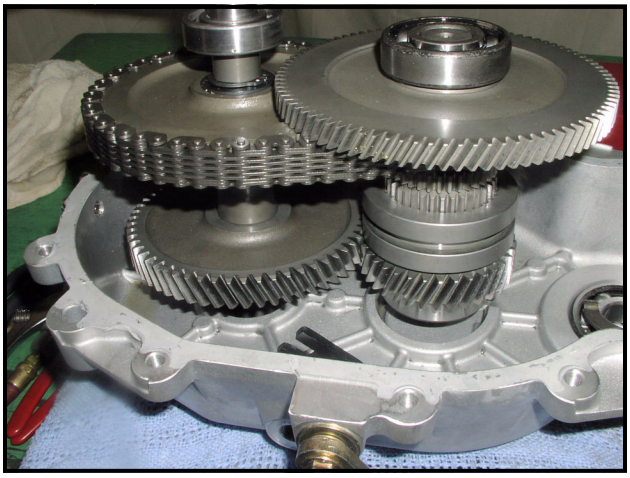


Figure 8-81 Intermediate and Output Shaft and Gears

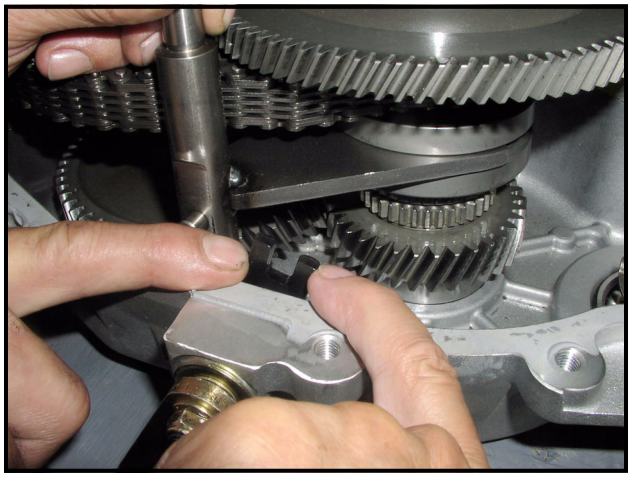


Figure 8-82 Gear Shifter Fork and Engagement Fork

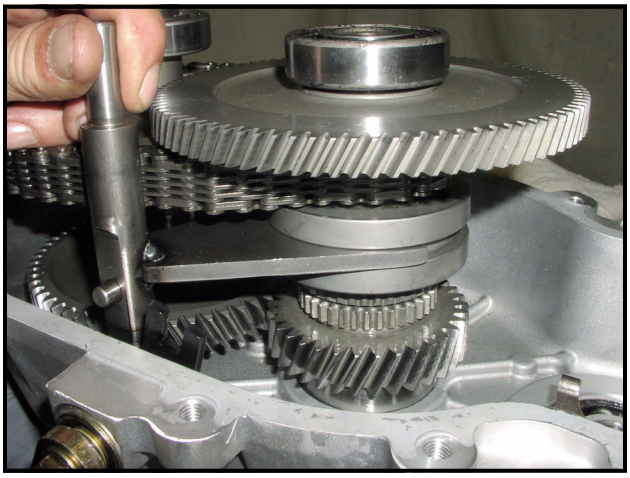


Figure 8-83 Engagement Gear and Fork Held Upward

5. Position the gear shifter bell crank arm down and slightly to the left, with the shifter arm fork up and slightly to the right **(Figure 8-82, Page 8-24)**.
6. Hold the engagement gear fork into place, lifting it and holding the engagement gear up, and leaning it slightly to the left, away from the shifter arm fork **(Figure 8-83, Page 8-24)**.
7. Hold the engagement gear fork shaft up with one hand and at the same time move the fork shaft and pin to the right. Turn the shifter bell crank arm so that the shifter arm fork interlaces with the engagement fork shaft pin **(Figure 8-84, Page 8-25)**.
8. Allow the engagement fork and gear to drop down to its lowest position, causing the shifter arm bell crank to rotate upward and rest parallel with the case edge **(Figure 8-85, Page 8-25)**.
9. Tap gently on the top of both shafts with a rubber mallet until the bearings are seated in the case cavities.

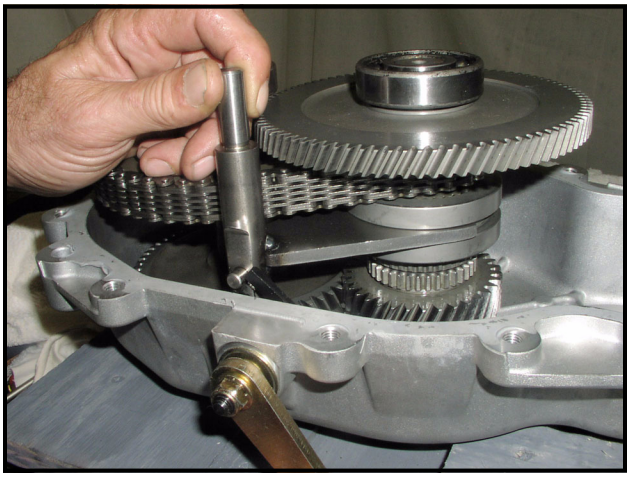


Figure 8-84 Shifter Fork and Engagement Gear Shaft Pin

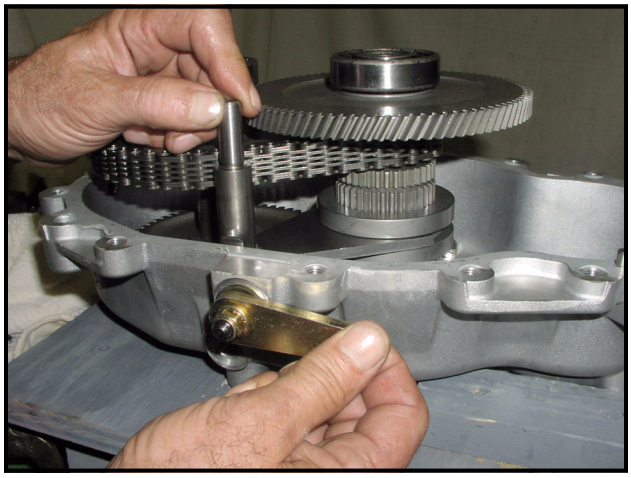


Figure 8-85 Engagement Fork and Gear in Position

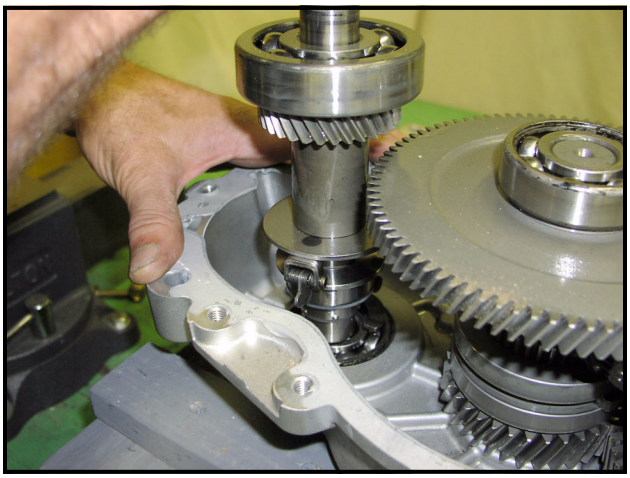


Figure 8-86 Install Input Shaft

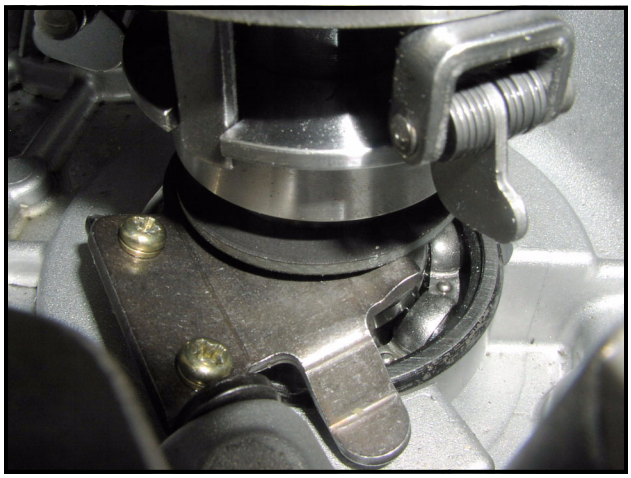


Figure 8-87 Ground Speed Governor Yoke Bracket

10. Install the input shaft into the bearing in the case cavity **(Figure 8-86, Page 8-25)**. **See following CAUTION.**

CAUTION

- **Make sure that the ground speed governor yoke bracket is below the fiber washer on the shaft control mechanism (Figure 8-87, Page 8-25).**

11. Fit the front half of the case onto the back half, allowing the input shaft and rear output shaft to pass through the shaft seals. **See following CAUTION.**

CAUTION

- **Be careful when passing the input and rear output shafts through the shaft seals to not damage or dislodge the seals from the case.**

Transmission Assembly, Continued:

12. Install the neutral limit switch and detent barrel assembly and tighten to 21 ft-lb (28 N·m) **(Figure 8-88, Page 8-26)**.

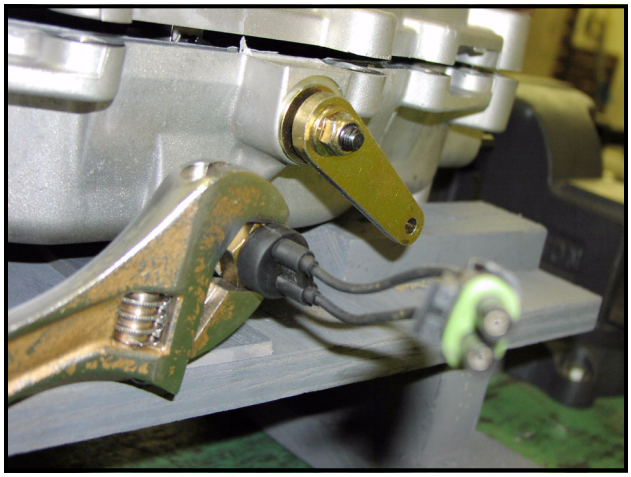


Figure 8-88 Neutral Limit Switch

Figure 8-89 Transmission Case Assembly

13. Apply a 1/8-inch (2 mm) wide coat of Three Bond sealant or Loctite 5699 Gasket Eliminator to the bottom half of the case. **See following CAUTION.**

CAUTION

- **Apply adjacent to the inside edge of the case only.**

14. Gently press on the case and allow the bearings to begin seating in the case. Gently tap on the case at positions close to each shaft area to help seat the bearings and sealant **(Figure 8-89, Page 8-26)**.
15. Install the case bolts and tighten the middle area of the case in a criss-cross pattern first, then the ends of the case also in a criss-cross pattern to 25 ft-lb (34 N·m) **(Figure 8-90, Page 8-26)**.
16. Install the drain plug and washer and tighten to 8 ft-lb (11 N·m).

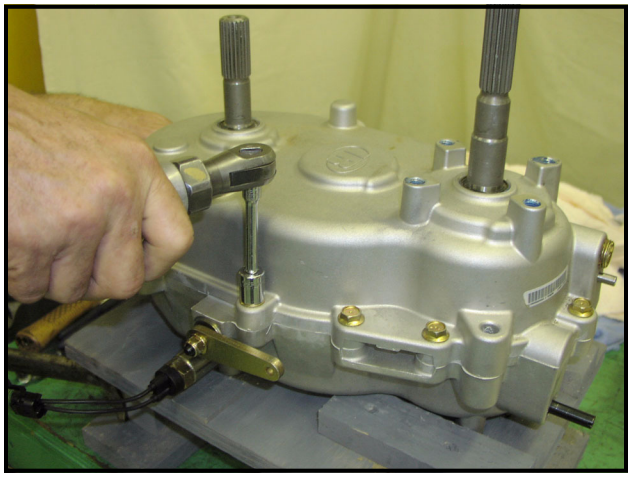


Figure 8-90 Install Case Bolts

17. Remove the fill and level plugs and fill the case through the top fill plug with 20 ounces (600 mL) of Mobil 424, Exxon Hydraul 560, or Esso Hydraul 56 lubricant. **See following NOTE.**

NOTE: *When the proper amount of lubricant has been added, the lubricant should be level with the level plug on the side of the case.*

18. Install the level plug using a small amount of Loctite 545 thread sealant on the threads and tighten to 20 ft-lb (27 N·m).
19. Install the fill plug on the top of the case using a small amount of Loctite 545 thread sealant on the threads and tighten to 20 ft-lb (27 N·m).

TRANSMISSION INSTALLATION

See Transmission Installation, Section 14, in the appropriate maintenance and service manual.

SECTION 9 – FRONT DIFFERENTIAL MODELS 6203-01-139-S AND 6203-01-189-S

⚠ DANGER

- **See General Warning on page 1-1.**

⚠ WARNING

- **See General Warning on page 1-1.**

GENERAL INFORMATION

The front differential provides power to the front left and right half shafts which in turn drive the front left and right wheels. It is designed with an electromagnet assembly located in the right front output cover plate. The electromagnet is connected to the vehicle's electrical system and must be electrically energized to work properly. For electrical testing and system diagrams refer to Sections 11a, 11b, 12a, and 12b in the appropriate maintenance and service manual.

Information in this Section 9 provides procedures to disassemble, replace parts, and assemble the front differential. It does not include any electrical testing or service information other than the removal and replacement of appropriate electromagnet components.

The front differential has a left output splined hub and a right output splined hub. The left output side has the serial and model number label **(Figure 9-1, Page 9-1)**. The right output side is equipped with the electromagnet coil, coil connector plug, and backlash adjustment screw **(Figure 9-2, Page 9-1)**.

Figure 9-1 Front Differential – Left Front Output

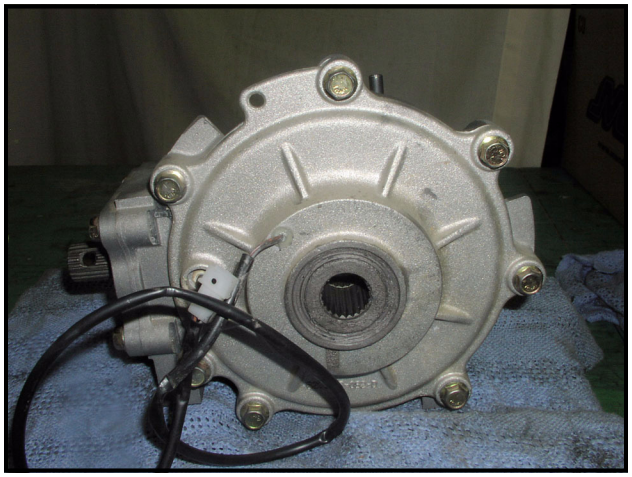


Figure 9-2 Front Differential – Right Front Output

AXLE HALF SHAFT REMOVAL

See Half Shaft Removal, Section 14, in the appropriate maintenance and service manual.

FRONT DIFFERENTIAL REMOVAL

See Front Differential Removal, Section 14, in the appropriate maintenance and service manual.

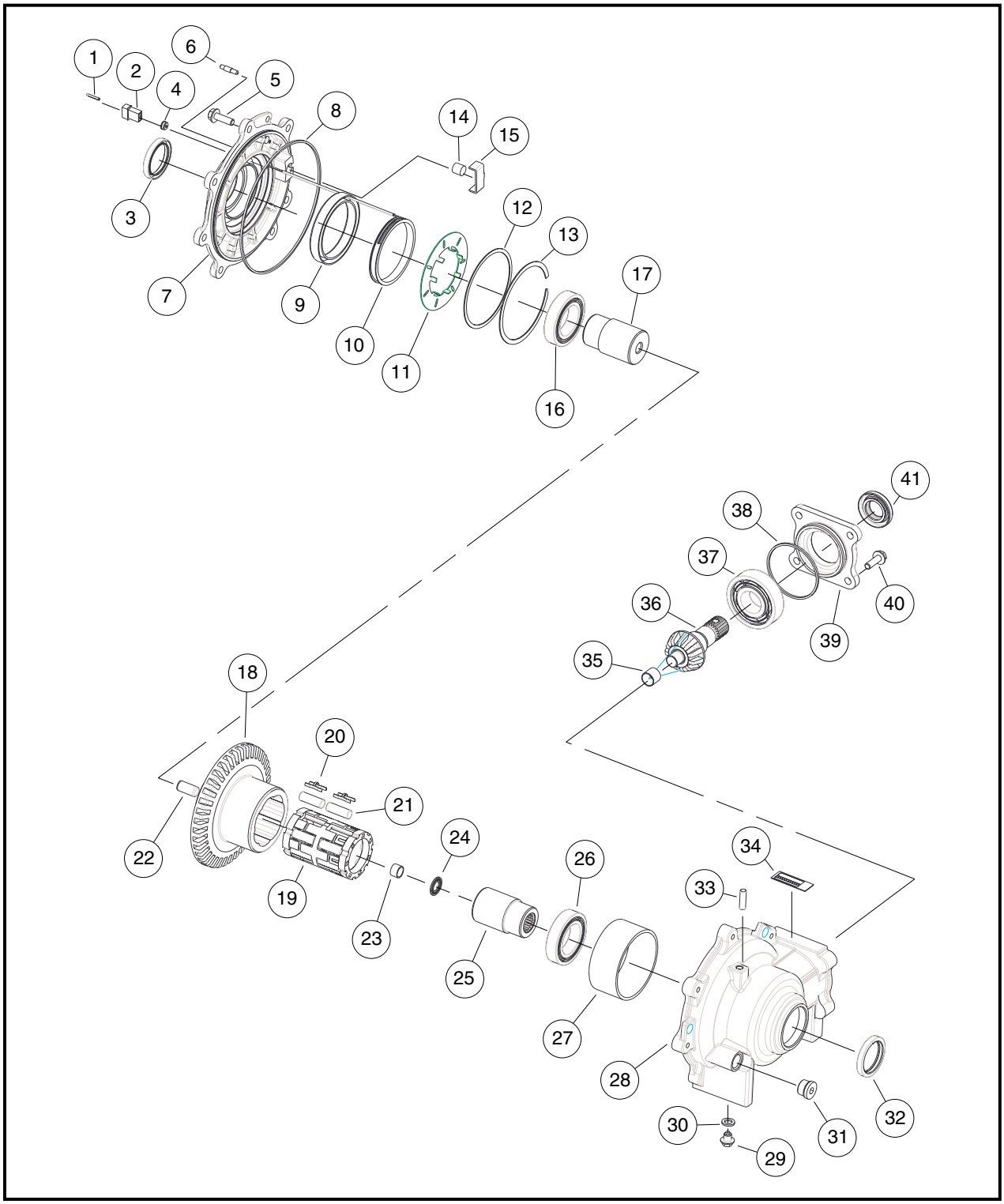


Figure 9-3 Front Differential

TOOLS REQUIRED FOR THIS SECTION

Hydraulic press	Plastic or rubber mallet	11 mm socket, 3/8 in. drive
Bearing puller wedge attachment (P/N CCI 1012812)	Axle seal tool (P/N CCI 1014162)	13 mm Socket, 3/8 in. drive
Small ball peen hammer (10 oz.)	Ratchet wrench, 3/8 in. drive	Small flat blade screwdriver
Oil drain pan or tray	Torque wrench, 3/8 in. drive	Medium flat blade screwdriver

FRONT DIFFERENTIAL COIL AND OUTPUT COVER

See General Warning on page 1-1.

COIL AND OUTPUT COVER REMOVAL

NOTE: *If the electrical coil wires are damaged beyond repair, or coil fails to operate properly, the entire output cover plate must be replaced. The electrical coil, as a component, is not replaceable.*

1. Position the front differential case over a pan or container suitable for draining oil and remove the drain plug from the bottom of the case. Drain the oil from the case and dispose of the oil properly **(Figure 9-4, Page 9-3)**.
2. Position differential case on a clean solid surface with the coil and output cover up.
3. Remove bolts from the output cover **(Figure 9-5, Page 9-3)**.

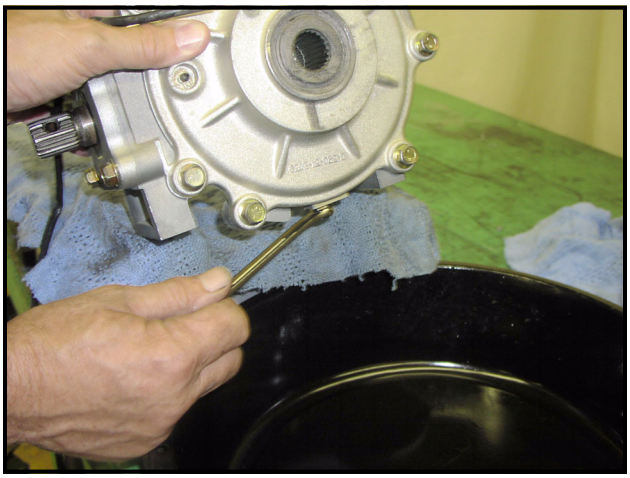


Figure 9-4 Remove Drain Plug and Drain Oil

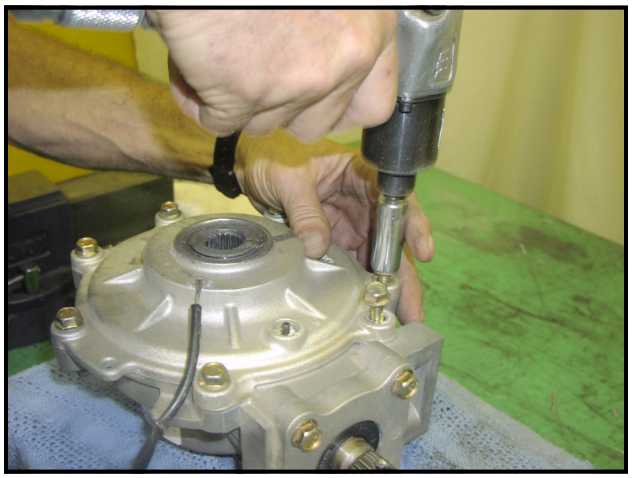


Figure 9-5 Remove Coil and Output Cover

Coil and Output Cover Removal, Continued:

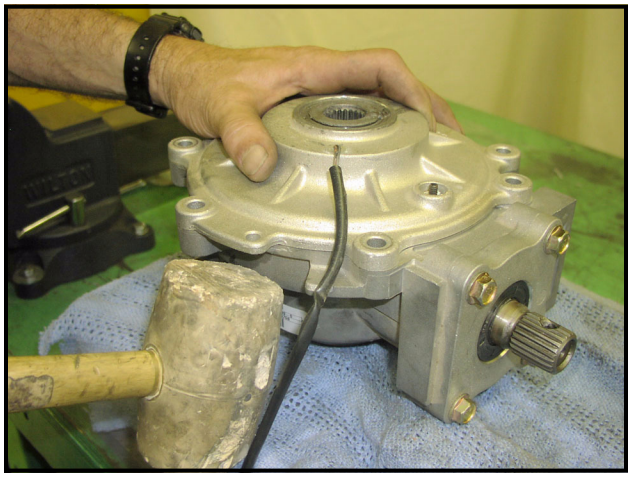


Figure 9-6 Coil Cover Plate Flange

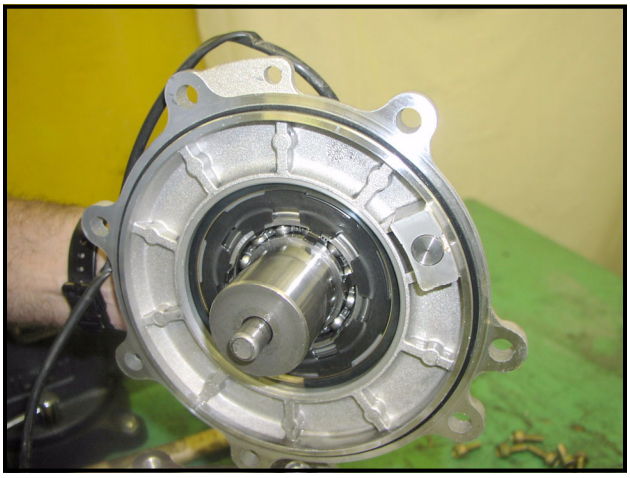


Figure 9-7 Coil Cover Plate and Male Hub

4. Gently tap on the output cover flange with a plastic or rubber mallet to loosen the cover **(Figure 9-6, Page 9-4)**
5. Remove output cover, coil, and male splined hub **(Figure 9-7, Page 9-4)**.

Coil and Output Cover Disassembly

1. Position the output cover on a clean solid surface with the splined hub up **(Figure 9-8, Page 9-4)**.
2. Remove the thrust plate from the cover.
3. Remove the retaining ring from around the inside edge of the cover flange **(Figure 9-9, Page 9-4)**.

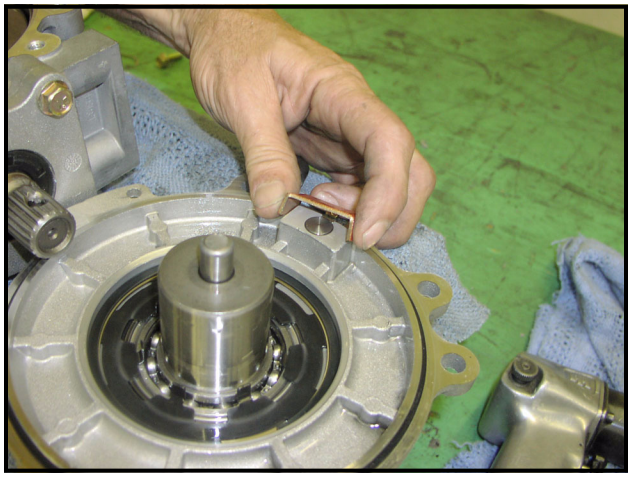


Figure 9-8 Thrust Plate

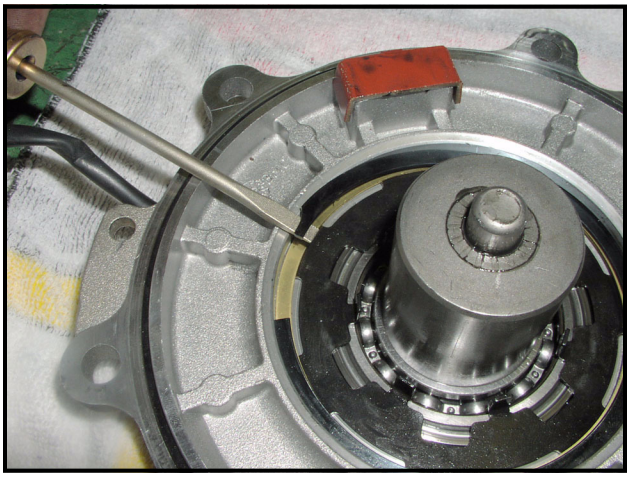


Figure 9-9 Cover Retaining Ring

4. Remove armature plate shim **(Figure 9-10, Page 9-5)**.
5. Remove armature plate **(Figure 9-11, Page 9-5)**.

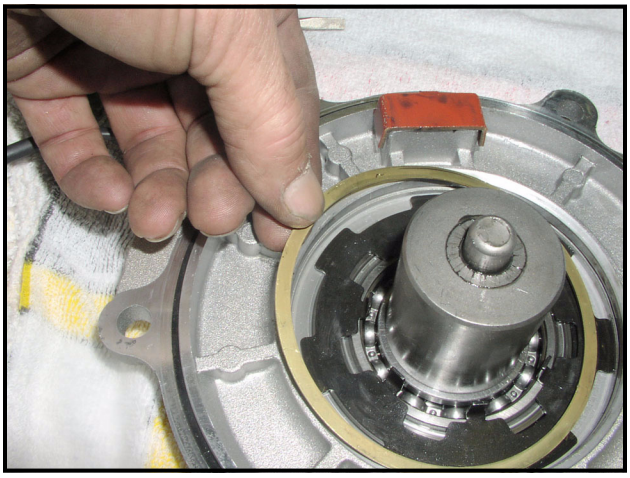


Figure 9-10 Armature Plate Shim

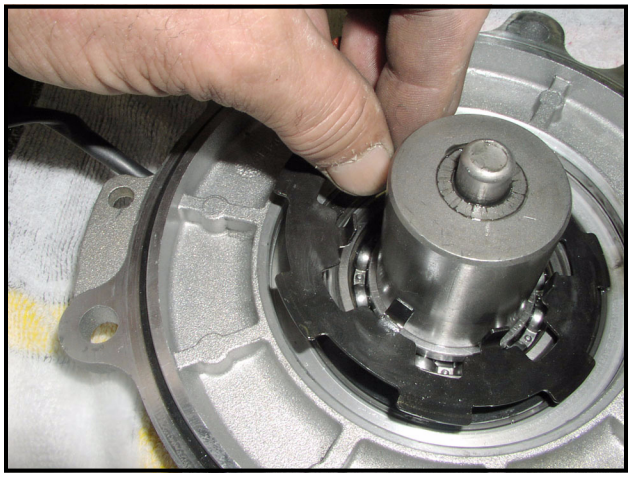


Figure 9-11 Armature Plate

6. Hold the output cover vertical by holding the splined hub **(Figure 9-12, Page 9-5)**.
7. Use a small diameter wooden or rubber mallet, or wooden or fiberglass tool handle, and gently tap the hub and bearing from the cover **(Figure 9-13, Page 9-5)**.

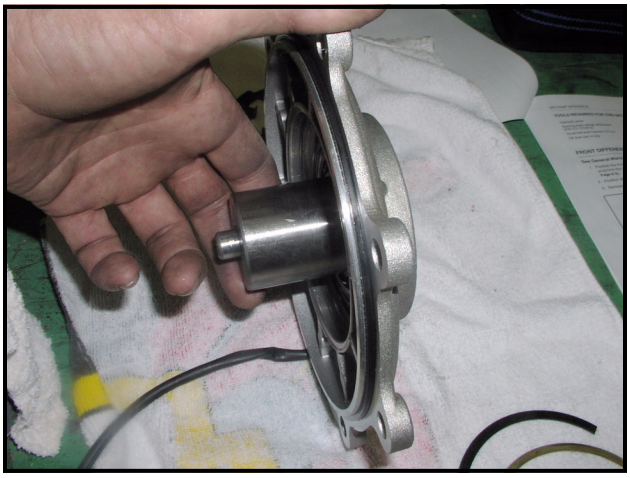


Figure 9-12 Right Splined Male Hub and Bearing

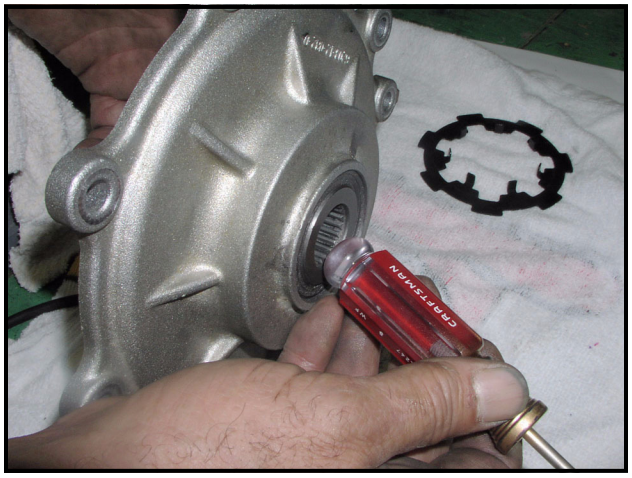


Figure 9-13 Remove Hub and Bearing From Cover

Coil and Output Cover Assembly

1. Position a new coil and output cover on a clean solid surface and install the male hub and bearing into the bearing cavity by gently tapping the dowel pin end of the hub **(Figure 9-14, Page 9-6)**.
2. Position armature plate around hub and bearing **(Figure 9-11, Page 9-5)**. **See following NOTE.**

NOTE: *The seven tabs on the armature plate fit into the ring gear hub when assembled. Aligning the ring gear tab slots with the pinion gear shaft helps to establish a match location between the ring gear hub and the armature plate tabs.*

3. Install the armature plate shim **(Figure 9-10, Page 9-5)**.
4. Install the armature retaining ring **(Figure 9-9, Page 9-4)**.

Coil and Output Cover Assembly, Continued:

5. Install the thrust plate on the output cover **(Figure 9-15, Page 9-6)**. **See following NOTE.**

NOTE: *Apply a small amount of clean gear grease under the thrust plate before slipping it onto the thrust button. The grease will act as an adhesive and will help hold the plate in place when the plate is turned upside down for installation.*

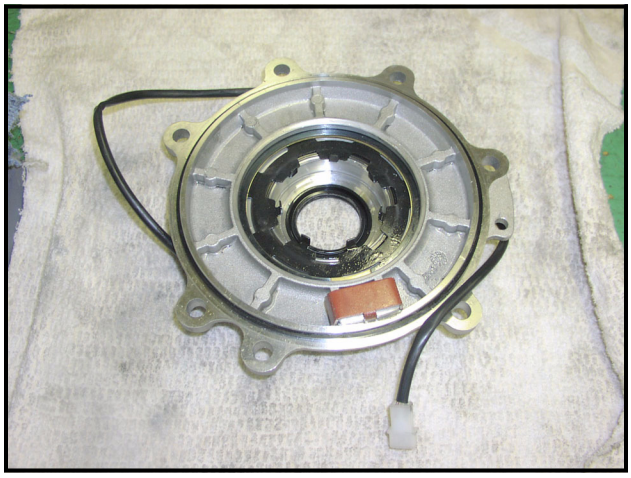


Figure 9-14 Output Hub and Bearing

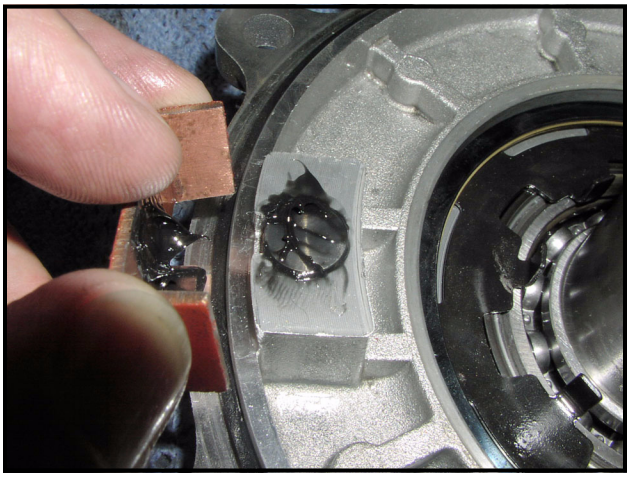


Figure 9-15 Install Thrust Plate

6. Install the needle sized roller thrust bearing onto the male pin of the hub **(Figure 9-16, Page 9-7)**. **See following NOTE.**

NOTE: *Apply a small amount of clean gear grease under the thrust bearing before slipping it onto the hub pin. The grease will act as an adhesive and will help hold the bearing in place when the plate is turned upside down for installation.*

COIL AND OUTPUT COVER INSTALLATION

1. Position the ring gear and housing assembly on a clean solid surface with the ring gear hub up.
2. Use the pinion gear shaft and turn the gear so that one of the tab slots in the ring gear hub and bearing cage assembly is in line with the pinion gear shaft **(Figure 9-17, Page 9-7)**.
3. Position the armature plate on the hub cover so that one of the tabs will align with the pinion shaft and corresponding slot in the ring gear hub bearing and cage assembly. **See following NOTE.**

NOTE: *Make sure that the large rubber O-ring gasket is on the cover flange.*

4. Gently place the coil and output cover plate, with the armature tabs seating down into the tab slots in the ring gear bearing and cage assembly, down onto the case and tighten the case bolts in a criss-cross pattern to 17 ft-lb (23 N·m).
5. Adjust the backlash set screw. **See Backlash Adjustment on page 9-7.**

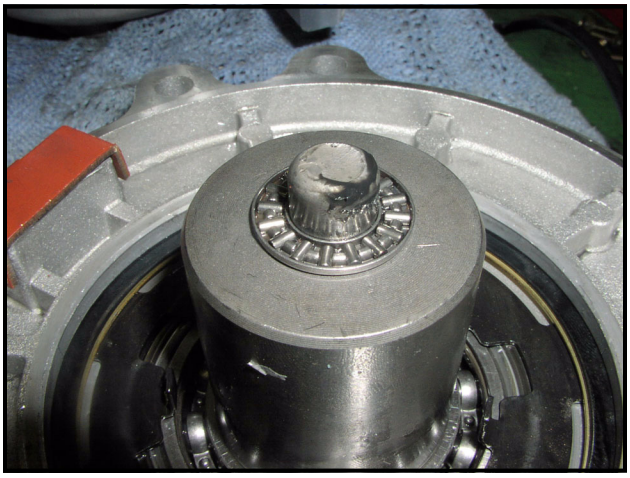


Figure 9-16 Install Roller Thrust Bearing

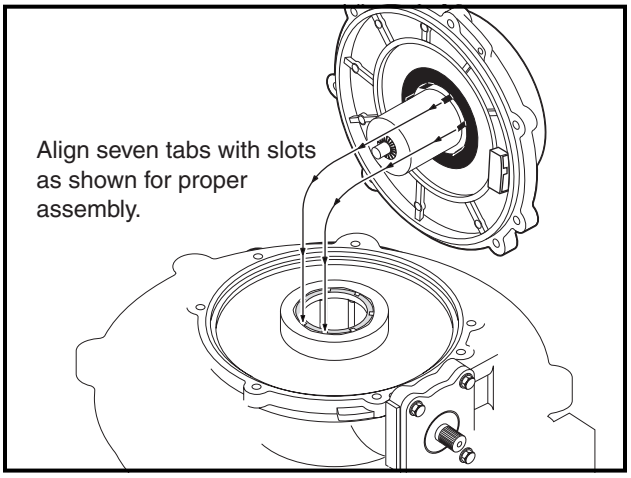


Figure 9-17 Align Armature Plate Tabs and Ring Gear Bearing Cage Slots

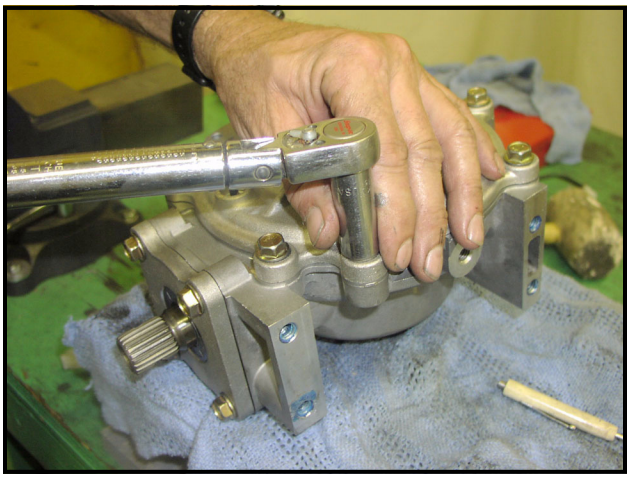


Figure 9-18 Install Cover and Torque Bolts

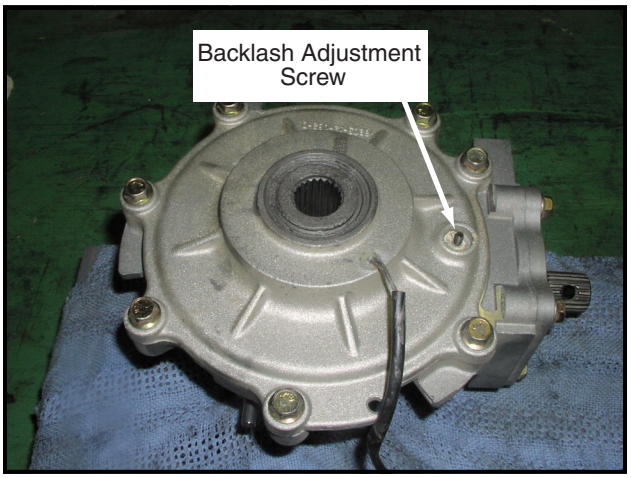


Figure 9-19 Backlash Adjustment Set Screw

Backlash Adjustment

1. Locate the backlash adjustment set screw on the right front, coil side, of the differential **(Figure 9-19, Page 9-7)**.
2. Use a 3/32-inch Allen wrench and turn the screw clockwise until it stops (do not apply torque).

NOTE: *When the screw stops, the splined shaft of the pinion gear should not be movable by hand in either direction.*

3. Turn the Allen wrench and set screw counterclockwise slowly while turning the pinion gear shaft clockwise. Continue this process until the pinion gear shaft can rotate four complete turns freely and without any tight spots.

NOTE: *The set screw should only have to be turned 1/4 to 1/2 of a full turn from its stop position to achieve the proper backlash set.*

FRONT DIFFERENTIAL

See General Warning on page 1-1.

FRONT DIFFERENTIAL DISASSEMBLY

1. Position the front differential case over a pan or container suitable for draining oil and remove the drain plug from the bottom of the case. Drain the oil from the case and dispose of the oil properly **(Figure 9-4, Page 9-3)**.
2. Position differential case on a clean solid surface with the coil and output cover up.
3. Remove bolts from the output cover **(Figure 9-5, Page 9-3)**.
4. Gently tap on the output cover flange with a plastic or rubber mallet to loosen the cover **(Figure 9-6, Page 9-4)**
5. Remove output cover, coil, and male splined hub **(Figure 9-7, Page 9-4)**.
6. Remove ring gear with roll cage and roller bearing assembly **(Figure 9-20, Page 9-8)**.
7. Remove the needle sized roller thrust bearing **(Figure 9-21, Page 9-8)**.

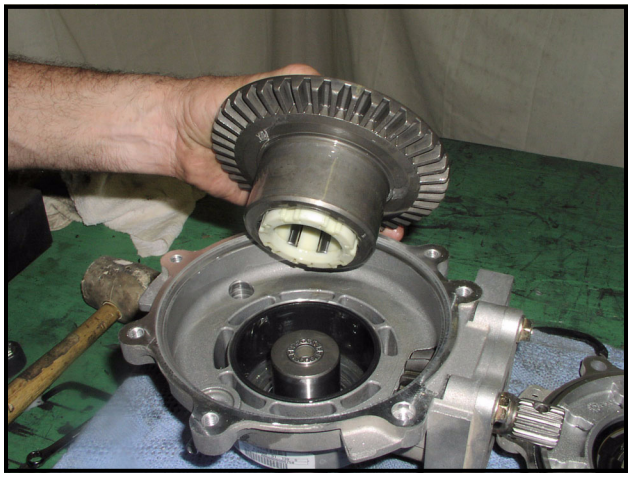


Figure 9-20 Ring Gear with Roller Bearings

Figure 9-21 Thrust Bearing on Output Hub

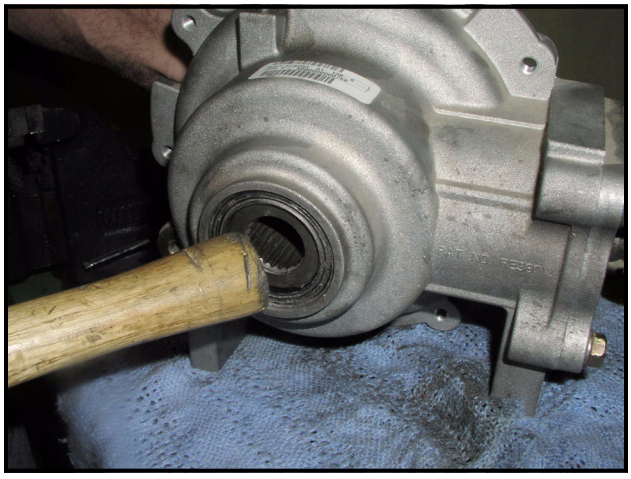


Figure 9-22 Remove Gearcase Hub and Bearing

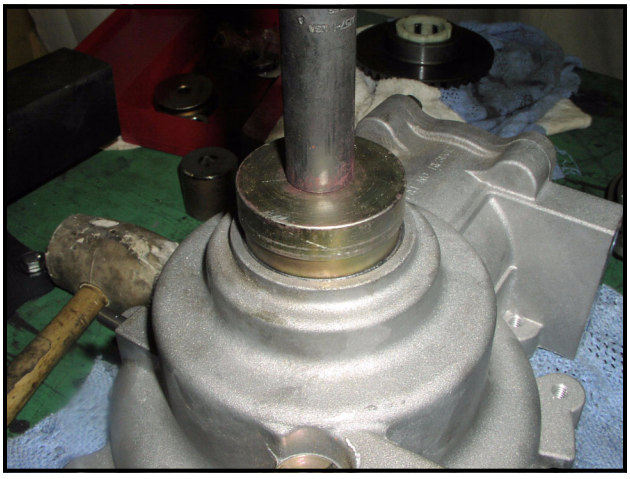


Figure 9-23 Gearcase Output Hub Seal

8. Use a small diameter wooden or rubber mallet, or wooden or fiberglass tool handle, and gently tap the hub and bearing from the gearcase **(Figure 9-22, Page 9-8)**.

9. Remove gear case hub seal by gently driving the seal from the outside of the case **(Figure 9-23, Page 9-8)**. **See following NOTE.**

NOTE: *The seal cavity does not have a seal seat for controlling depth of insertion or removal.*

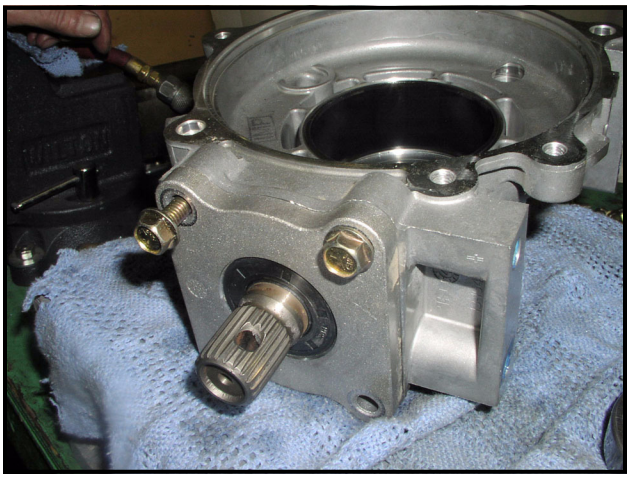


Figure 9-24 Input Cover Plate Bolts

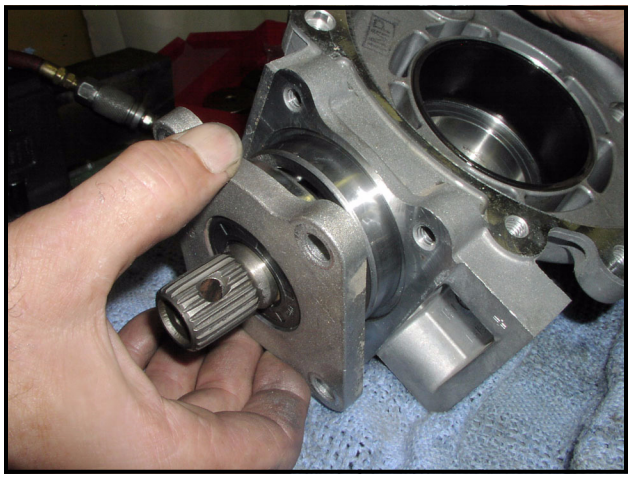


Figure 9-25 Remove Input Cover Plate

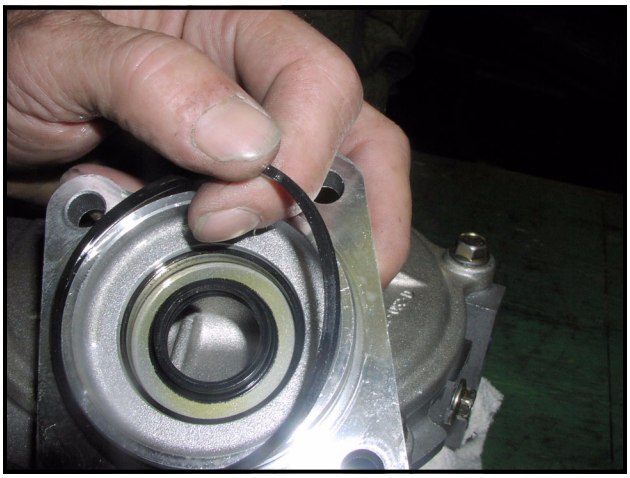


Figure 9-26 Input Cover Plate O-Ring Seal

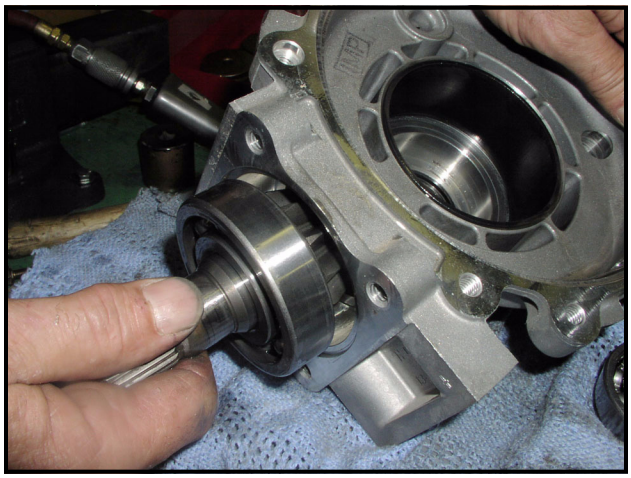


Figure 9-27 Pinion Shaft and Bearing

10. Remove input cover plate bolts **(Figure 9-24, Page 9-9)**.

11. Gently slide the cover plate and seal off of the splined shaft of the pinion gear **(Figure 9-25, Page 9-9)**.

12. Inspect the O-ring seal for damaged areas **(Figure 9-26, Page 9-9)**.

13. Gently slide the pinion gear shaft and bearing from the gearcase **(Figure 9-27, Page 9-9)**.

Front Differential Disassembly, Continued:

14. Hold the pinion gear and shaft and gently turn the outside bearing race. The bearing should roll easily with no rough or flat spots and no excess play. Replace with a new bearing if necessary **(Figure 9-31, Page 9-11)**. **See following NOTE.**

NOTE: *To replace the pinion gear bearing, press the old bearing off, using a hydraulic press, and press a new bearing onto the shaft.*

15. Inspect the pinion shaft seal in the cover plate for damaged or worn areas that could be providing for oil leaks **(Figure 9-28, Page 9-10)**. **See following NOTE.**

NOTE: *If damaged, worn or leaking lubrication oil, replace the seal.*

Input Shaft Seal Removal

1. Place the input cover plate and seal between jaws of a heavy duty vise **(Figure 9-28, Page 9-10)**. **See following NOTE.**

NOTE: *Make sure the jaws of the vise do not rest against or damage the O-ring shoulder on the back of the input cover plate.*

2. Push the seal out of the cover plate using a seal installation tool or large socket slightly smaller in diameter than the seal. Press the seal out from the outside of the cover plate. **See following NOTE.**

NOTE: *There is no seal seat in the cover plate.*

Input Shaft Seal Installation

1. Position a new three-lip seal on the cover plate **(Figure 9-29, Page 9-10)**.
2. Press a new seal into the input cover plate, using a seal installation tool, until the surface of the seal is flush with the input cover plate **(Figure 9-30, Page 9-11)**.

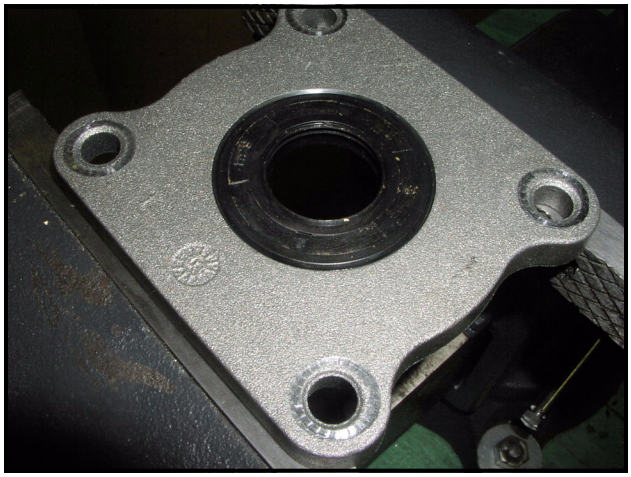


Figure 9-28 Input Cover Plate and Shaft Seal

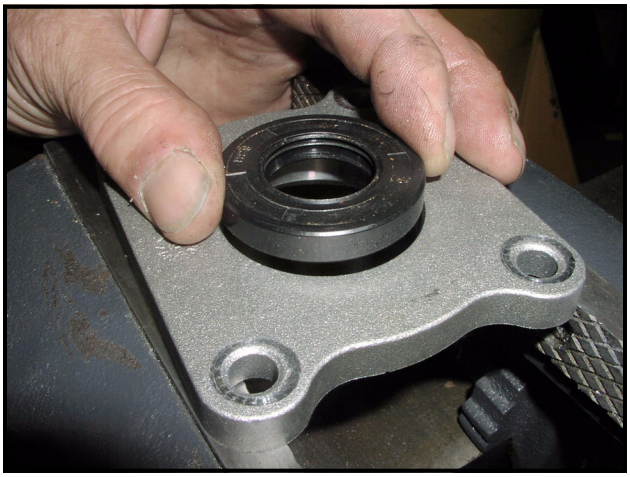


Figure 9-29 Position New Seal on Cover Plate

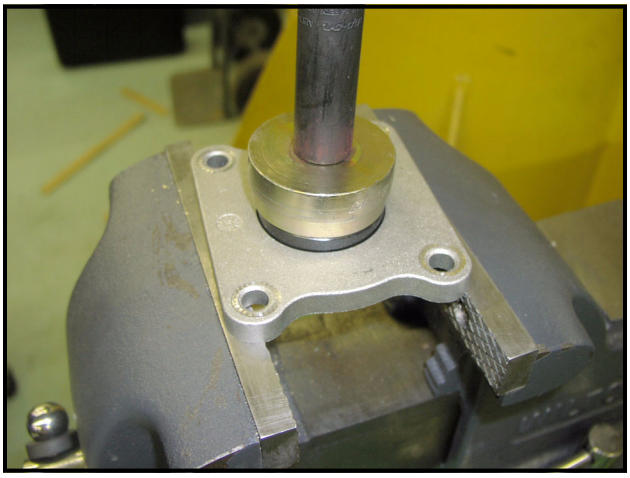


Figure 9-30 Install New Input Shaft Seal

3. Inspect the pinion gear and splined portion of the shaft. If the gear is worn, damaged, or the splined portion is worn or damaged, replace the pinion and shaft with a new one. **See following NOTE.**

NOTE: *If the pinion gear bearing is removed for any reason, it must be replaced with a new bearing.*

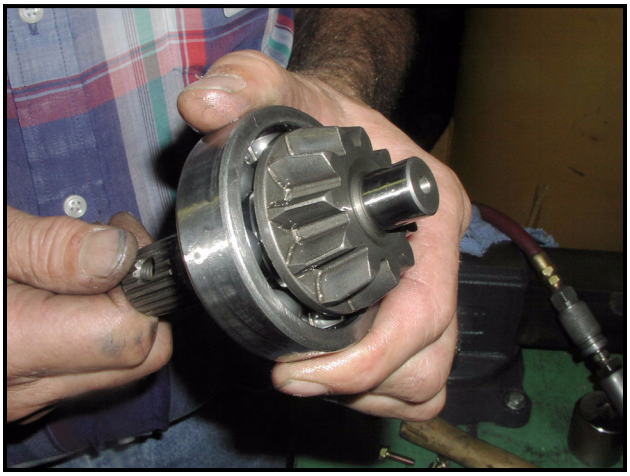


Figure 9-31 Inspect Pinion Gear Bearing

Figure 9-32 Inspect Pinion Gear Shaft Bushing

4. Inspect the pinion gear shaft bushing inside the gearcase **(Figure 9-32, Page 9-11)**. **See following NOTE.**

NOTE: *If the pinion shaft bushing is worn it will require a new gearcase, which is provided with a new bushing. The bushing is not available as a replacement component.*

Clutch and Ring Gear Disassembly

1. Position the ring gear and clutch cage with roller bearings on a clean solid surface **(Figure 9-33, Page 9-12)**.
2. Gently raise the clutch cage and the first level of roller bearings to a height where the roller bearings begin to release from the cage **(Figure 9-34, Page 9-12)**. **See following NOTE.**

NOTE: *The clutch cage has two levels of roller bearings, with seven rollers in each layer. They are held in place against the inside of the ring gear hub with spring clips.*

Clutch and Ring Gear Disassembly, Continued:

3. Remove the first level of roller bearings from the clutch cage **(Figure 9-35, Page 9-12)**.
4. Gently raise the clutch cage and bring the second level of roller bearings to a height where the roller bearings begin to release from the cage **(Figure 9-36, Page 9-12)**.
5. Lift the clutch cage from the inside of the ring gear hub. **See following NOTE.**

NOTE: *Observe how the clutch cage is positioned into the ring gear hub.*

6. Remove the fourteen spring clips from the clutch cage. **See following NOTE.**

NOTE: *Inspect each spring for broken pieces. The springs are fabricated from spring steel material and when damaged will fracture and usually break apart. Look for fragments along the clutch cage and inside of the ring gear hub.*

7. Inspect the clutch cage for cracked and broken segments.

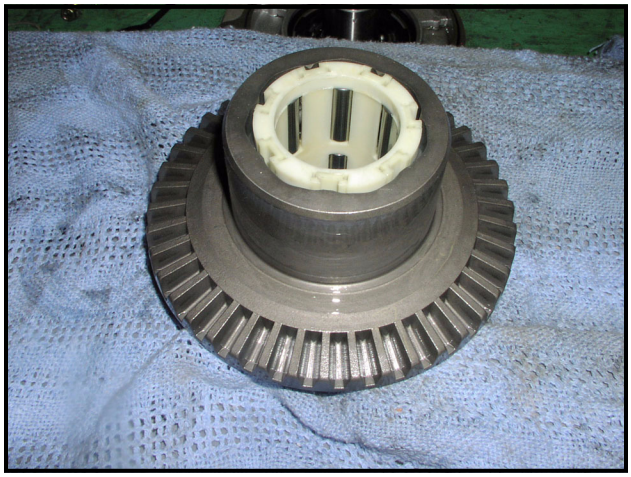


Figure 9-33 Ring Gear and Clutch Cage

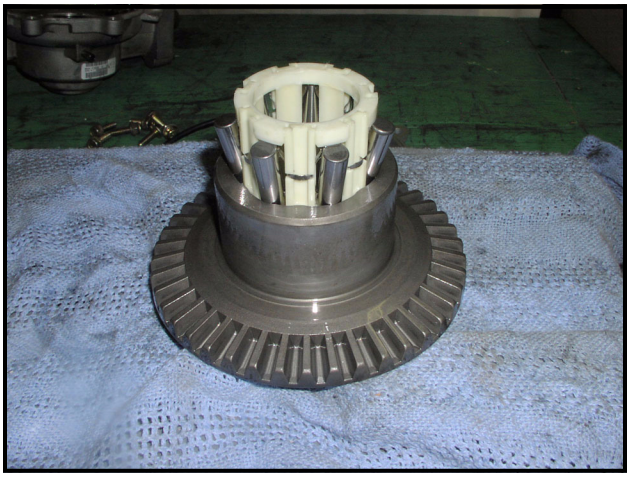


Figure 9-34 Clutch Cage and Roller Bearings

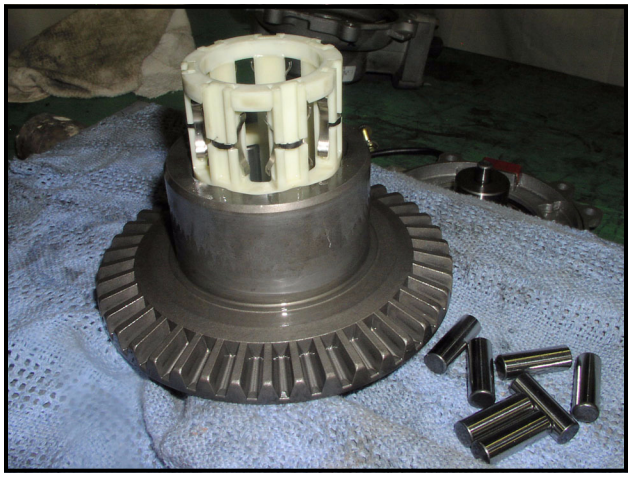


Figure 9-35 Remove First Level of Roller Bearings

Figure 9-36 Second Level of Roller Bearing

Clutch and Ring Gear Assembly

CAUTION

- **If the clutch bearing cage is damaged or any segments broken, the cage must be replaced. Use all new roller bearings when replacing the clutch cage.**
- **If any roller bearings need replacing, replace the entire set of fourteen bearings.**
- **If the ring gear or inside walls of the hub are damaged or badly worn, the ring gear and hub must be replaced.**
- **If any of the spring clips are damaged or broken, replace the entire set of fourteen clips.**

1. Position the ring gear with the gear down against a clean solid surface.
2. Position a clutch cage and roller bearings close to the ring gear and hub **(Figure 9-37, Page 9-13)**.
3. Slide a clutch cage into the ring gear hub deep enough to allow insertion of roller bearings into the spring clips and hold them into place **(Figure 9-38, Page 9-13)**.

CAUTION

- **Make sure the seven ridges in the ring gear hub align with the seven clutch cage tab slots.**

4. Assemble the first level of roller bearings into the clutch cage and ring gear hub and slide the clutch cage down to the second (or top) bearing level **(Figure 9-39, Page 9-14)**.
5. Assemble the second (or top) level of roller bearings into the clutch cage **(Figure 9-40, Page 9-14)**.
6. Complete the assembly of clutch and ring gear by pushing the clutch cage and roller bearings down so the clutch is flush with the ring gear hub **(Figure 9-41, Page 9-14)**.

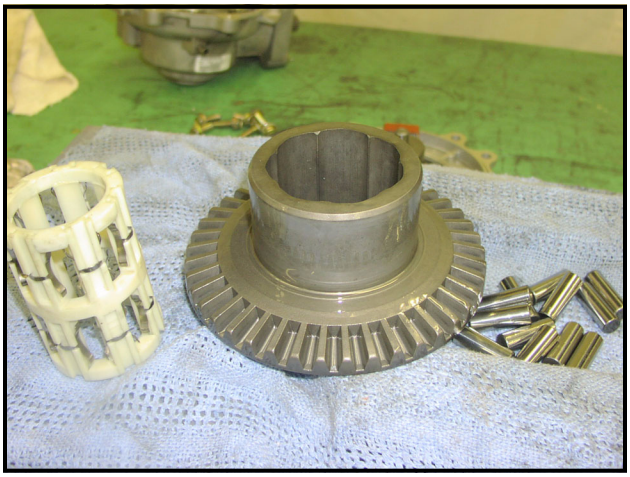


Figure 9-37 Ring Gear Hub, Clutch and Bearings

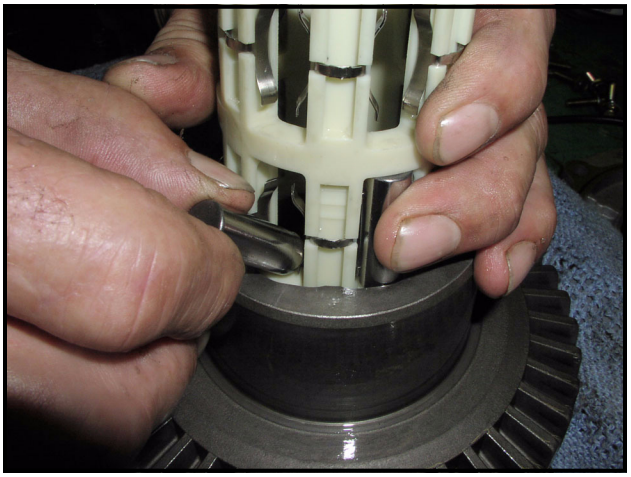


Figure 9-38 Insert Clutch and Bearings

Clutch and Ring Gear Assembly, Continued:

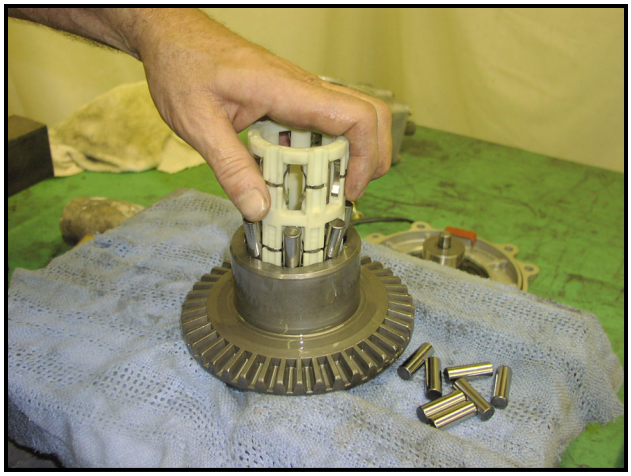


Figure 9-39 Assemble First Level of Bearings

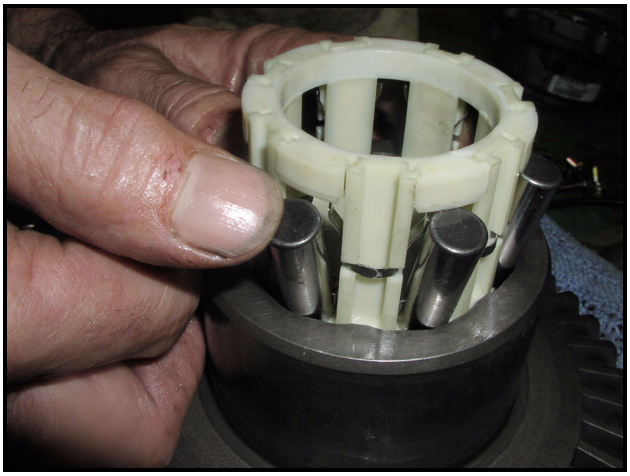


Figure 9-40 Assemble Second Level of Bearings

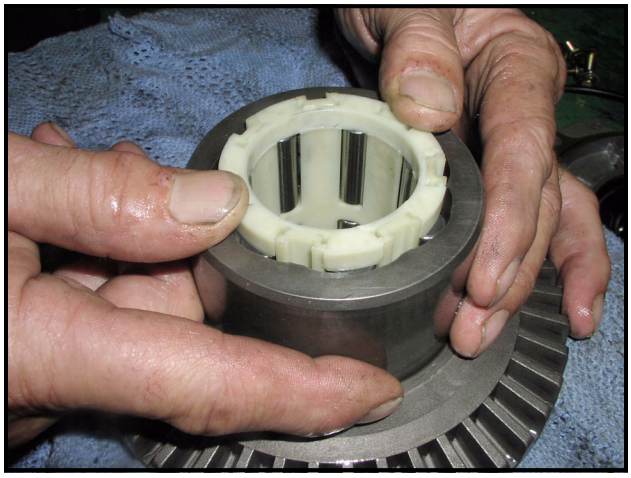


Figure 9-41 Position Clutch Into Ring Gear Hub

FRONT DIFFERENTIAL ASSEMBLY

CAUTION

- **If the inside lining of the gearcase wall is damaged, the gearcase must be replaced. The wall lining, as a component, is not replaceable.**

1. Position the gearcase on a clean solid surface with the output seal cavity up. **See following NOTE.**

NOTE: *Clean and remove all debris and old oil in bearing cavities. Apply a light coat of gear oil to the cavity area to aid in seal installation.*

2. Install a seal into the gearcase cavity using a seal installation tool or large socket, slightly smaller than the seal body diameter **(Figure 9-42, Page 9-15)**.
3. Gently tap the seal body down until the face of the seal is 1/8-inch (3 mm) below the cavity surface.
4. Position the gearcase on a clean solid surface with the output seal down **(Figure 9-43, Page 9-15)**. **See following NOTE.**

NOTE: *Clean and remove all debris and old oil in gearcase cavities and inside surfaces.*

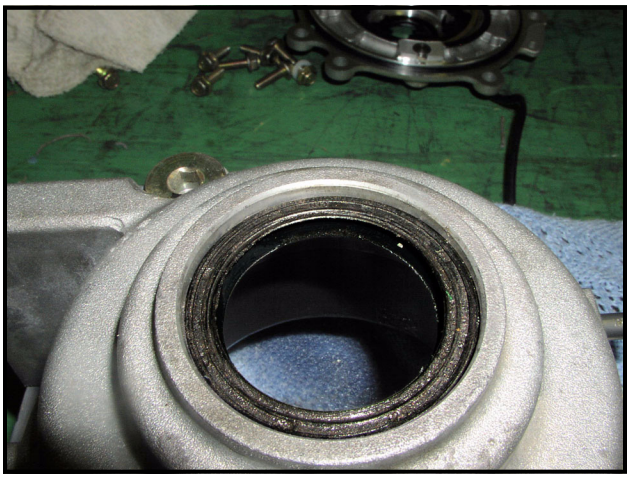


Figure 9-42 Install Output Seal

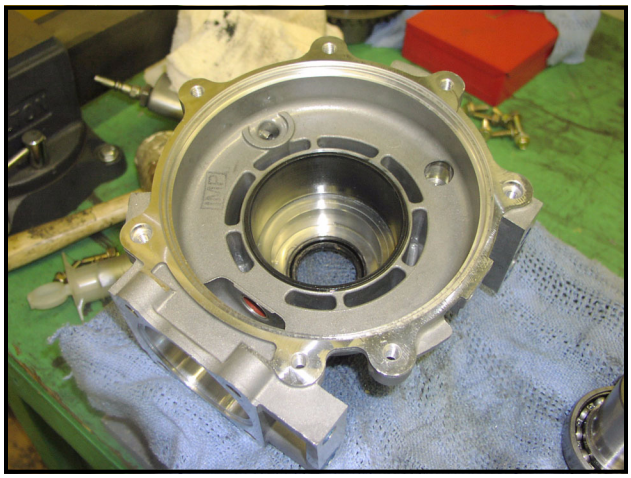


Figure 9-43 Position Gearcase with Seal Down

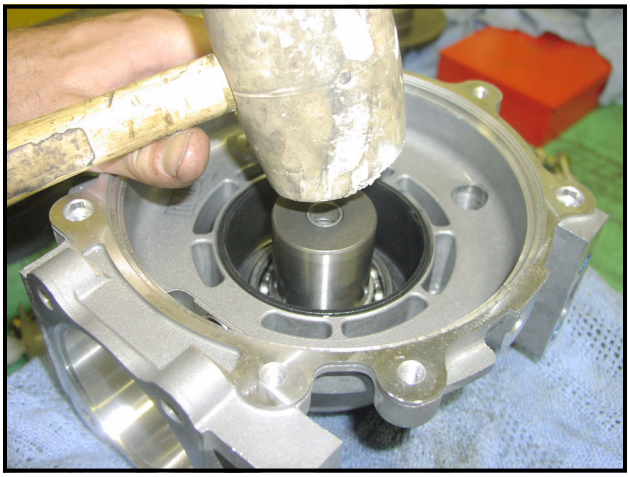


Figure 9-44 Install Output Hub and Bearing

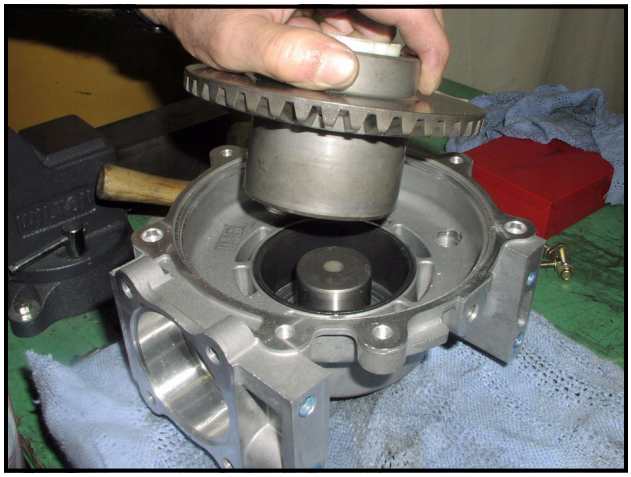


Figure 9-45 Install Ring Gear and Hub

5. Install a female output hub and bearing into the gearcase bearing cavity and gently tap the hub until the bearing seats in the gearcase **(Figure 9-44, Page 9-15)**.
6. Install the ring gear hub with clutch and roller bearing assembly into the gearcase and down around the female output hub **(Figure 9-45, Page 9-15)**.
7. Push the clutch cage and bearing assembly down to be flush with the top surface of the ring gear hub **(Figure 9-46, Page 9-16)**.

Front Differential Assembly, Continued:

8. Use the pinion gear shaft and turn the gear so that one of the tab slots in the ring gear hub and bearing cage assembly is in line with the pinion gear shaft **(Figure 9-17, Page 9-7)**. **See following NOTE.**

NOTE: *The seven tabs on the armature plate fit into these ring gear hub tab slots when assembled. Aligning the ring gear tab slots with the pinion gear shaft helps to establish a match location between the ring gear hub and the armature plate tabs.*

9. Prepare a coil and output cover assembly for installation on the gearcase. **See Coil and Output Cover Assembly on page 9-5.**

10. Position the armature plate on the hub cover so that one of the tabs will align with the pinion shaft and corresponding slot in the ring gear hub bearing and cage assembly. **See following NOTE.**

NOTE: *Make sure that the large rubber O-ring gasket is on the cover flange.*

11. Gently place the cover plate down onto the case, with the seven armature tabs seating down into the tab slots in the ring gear bearing and cage assembly **(Figure 9-47, Page 9-16)**.

NOTE: *Clean and remove all debris and old oil in bearing cavity. Apply a light coat of gear oil to the cavity area to aid in bearing installation.*

12. Install input pinion gear, shaft and bearing. Gently tap on the input shaft with a rubber or wooden mallet to seat the bearing **(Figure 9-48, Page 9-17)**. **See following NOTE.**

NOTE: *Carefully align the input pinion gear with the ring gear before seating the bearing.*

13. Seat the pinion gear bearing into the gearcase cavity **(Figure 9-49, Page 9-17)**. **See following NOTE.**

NOTE: *The bearing outside race should slide into the gearcase cavity without having a press fit.*

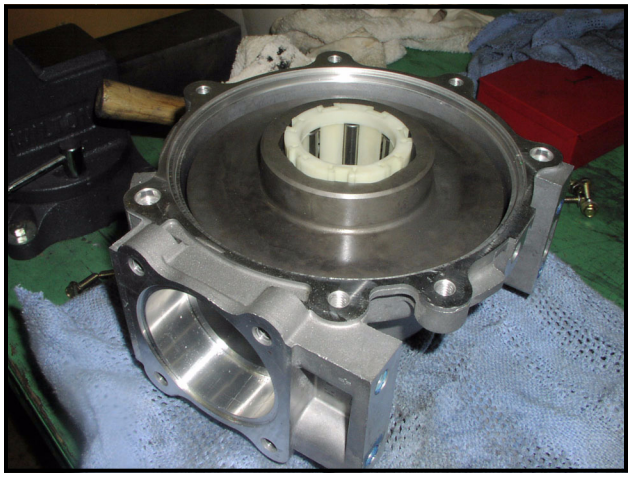


Figure 9-46 Ring Gear Assembled Into Gearcase

Figure 9-47 Coil Side Cover on Gearcase

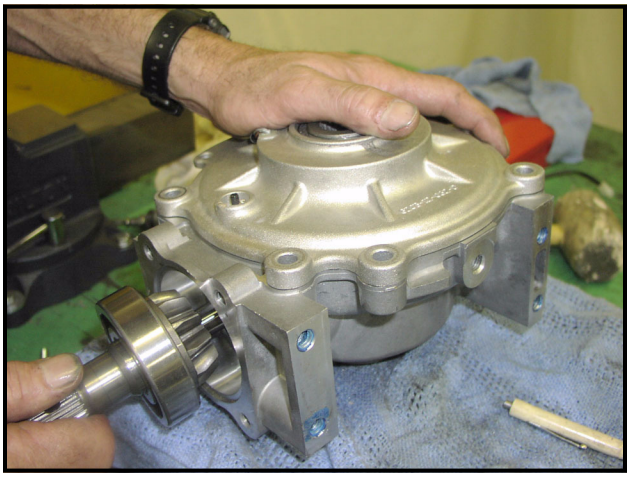


Figure 9-48 Input Pinion Gear, Shaft and Bearing

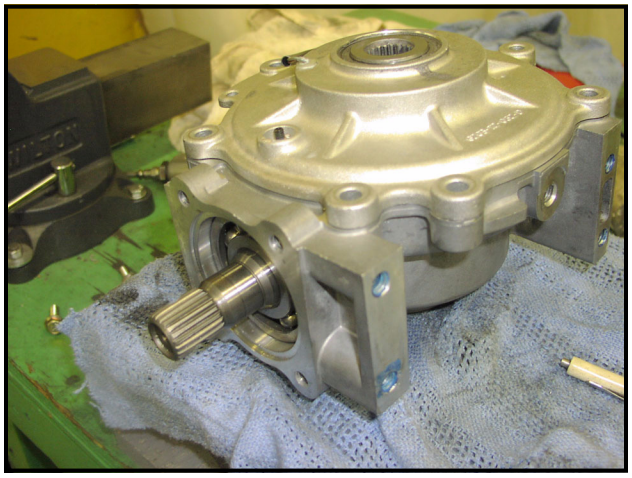


Figure 9-49 Seat Input Bearing

14. Install input cover plate and three-lip seal on input shaft **(Figure 9-50, Page 9-17)**.

NOTE: *Make sure that the O-ring is on the input cover plate* ***(Figure 9-51, Page 9-17)****.*

15. Install the input cover plate bolts and tighten, in a criss-cross pattern, to 17 ft-lb (23 N·m).

16. Adjust the backlash set screw. **See Backlash Adjustment on page 9-7.**

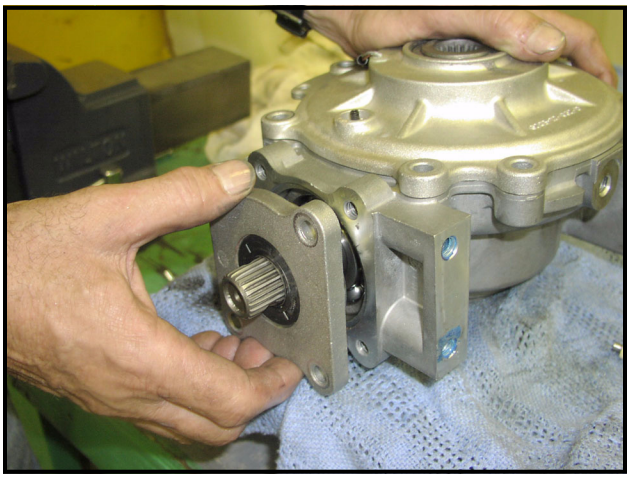


Figure 9-50 Input Cover Plate and Three-Lip Seal

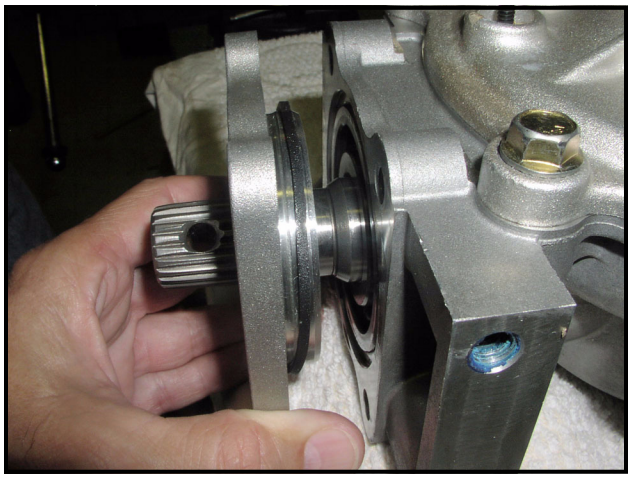


Figure 9-51 O-Ring on Input Cover Plate

17. Remove the oil fill plug and add 5 ounces (150 ml) of Mobil 424, Exxon Hydraul 560, or Esso Hydraul 56 lubricant.

CAUTION

- **Do not use any other brand or type of oil.**

18. Install the oil fill plug and tighten the plug to 10 ft-lb (13 N·m).

FRONT DIFFERENTIAL INSTALLATION

See Front Differential Installation, Section 14, in the appropriate maintenance and service manual.

AXLE HALF SHAFT INSTALLATION

See Half Shaft Installation, Section 14, in the appropriate maintenance and service manual.

SECTION 10 – REAR DIFFERENTIAL MODELS 420366 AND 420851

⚠ DANGER

- **See General Warning on page 1-1.**

⚠ WARNING

- **See General Warning on page 1-1.**

GENERAL INFORMATION

The 420366 and 420851 rear differential models are heavy-duty, fully-synchronized gear-driven differentials. They are self-contained and requires a mixture of 80-90W gear lubricant and TracTech friction modifier lubrication oil to operate properly. The proper mixture of lubrication compounds is 17.8 oz (525 mL) gear lubricant to 2.5 oz. (75 mL) TracTech friction modifier.

Model and Serial Number

The model and serial number are located on the top rear portion of the housing **(Figure 10-1, Page 10-1)**. The procedures in this manual can be used for model 420366 and model 420851.

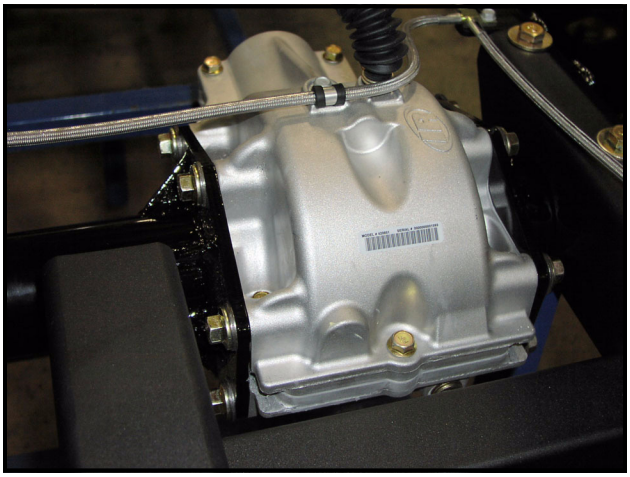


Figure 10-1 Rear Differential

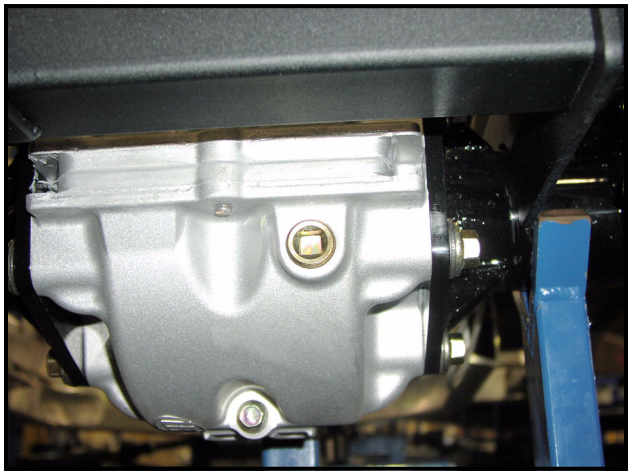


Figure 10-2 Lubricant Level

Tools Required For This Section

Hydraulic press	Plastic or rubber mallet	External snap ring pliers (.047 in. tip), 45°
13 mm combination wrench	Differential Assembly Tool/Fixture (CCI P/N 102723001)	Bearing puller wedge attachment (CCI P/N 1012812)
15 mm combination wrench	ThreeBond® #1215 gasket compound	Medium flat blade screwdriver
16 mm combination wrench	Oil drain pan or tray	

AXLE SHAFTS AND DIFFERENTIAL REMOVAL

See Rear Differential and Axles in the appropriate maintenance and service manual.

REAR DIFFERENTIAL DISASSEMBLY

See General Warning on page 1-1.

1. Remove the bottom drain plug (4) and plug washer (5) and drain the lubrication oil from the differential housing **(Figure 10-4, Page 10-3)**.
2. Clean the outside surfaces of the differential housing.
3. Gently scrape any sealant or gasket material from the housing surfaces where the flanged portion of the axles bolted to the differential.
4. Move the differential assembly to a clean bench area.

NOTE: *It helps to mark **driver side** and **passenger side** on the differential housing. Be sure to correctly identify each side. References will be made to those designations during disassembly and assembly. Use a felt tip marker on the housing where the axle flanges bolt for those markings.*

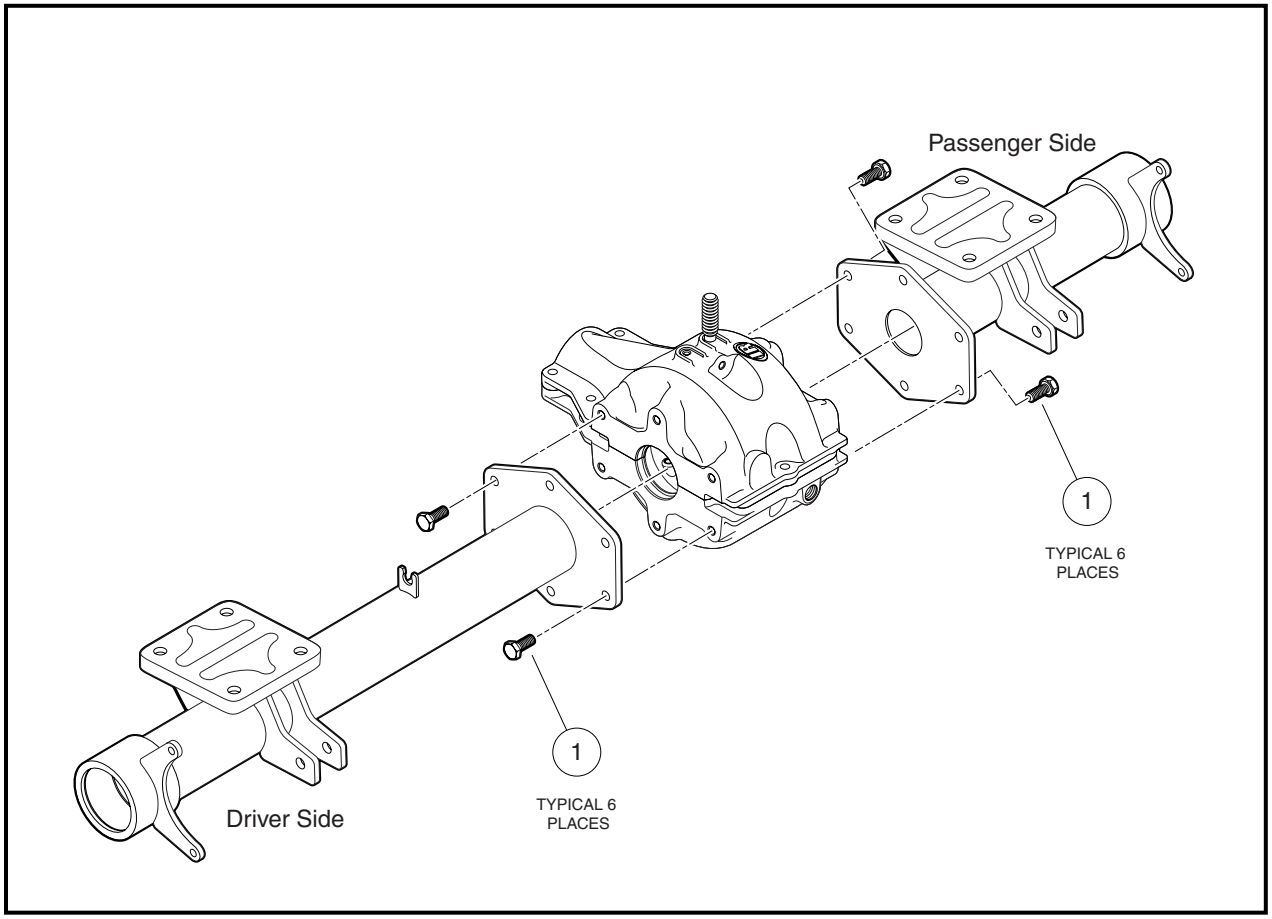


Figure 10-3 Axle Shafts And Differential Assembly

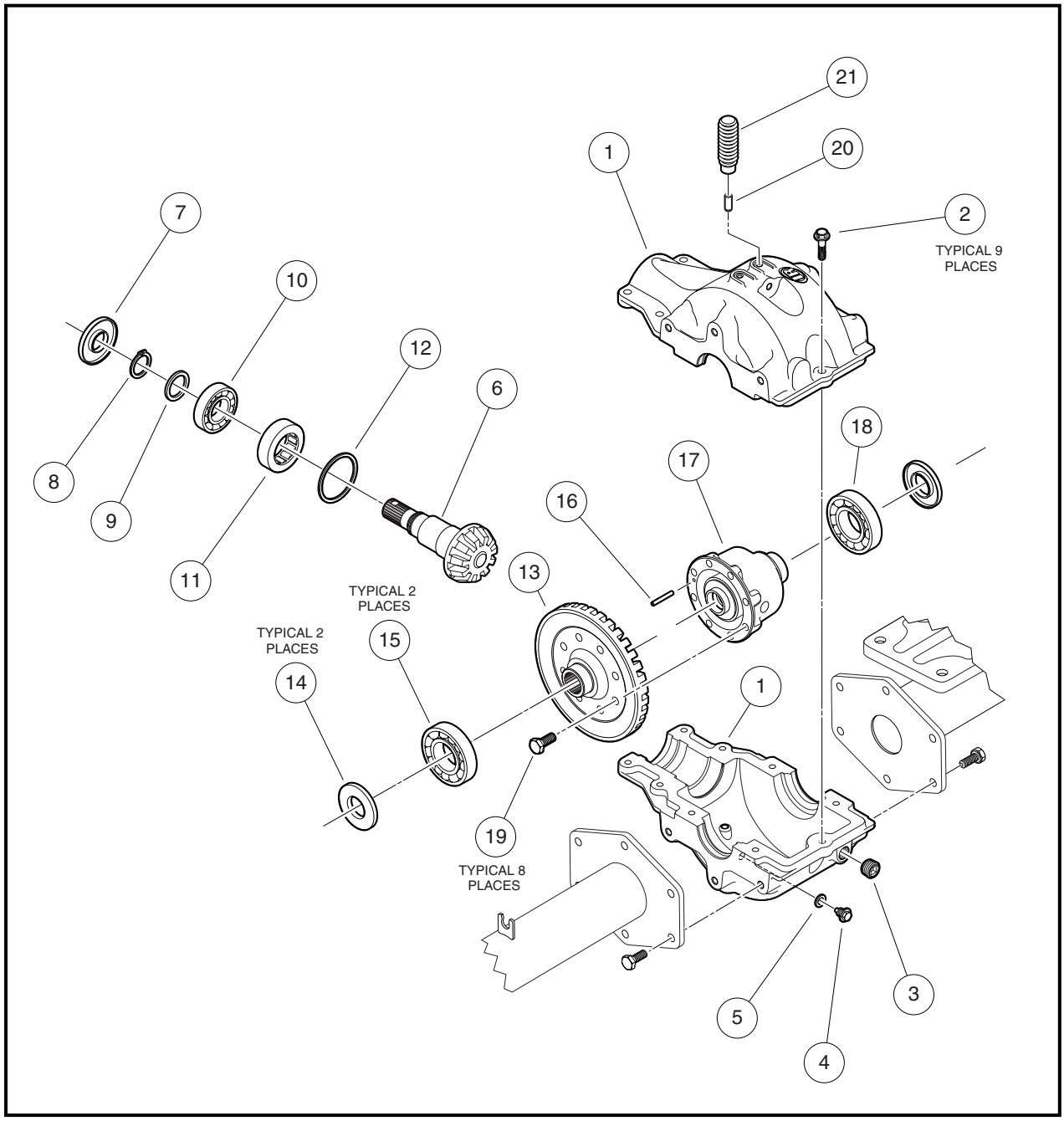


Figure 10-4 Differential Assembly

5. Remove the nine hex flanged-head bolts (2) from the housing **(Figure 10-4, Page 10-3)**.

6. Use two flat wrenches or flat metal bars and gently pry the top portion of the housing away from the bottom portion **(Figure 10-5, Page 10-4)**. **See following CAUTION.**

CAUTION

- **To prevent damage to the mating seal surfaces of the case, use care when separating the halves.**

Rear Differential Disassembly, Continued:

7. Position the bottom half of the housing with the differential pinion and ring gear assemblies so that the ring gear is to the right (driver side) and back **(Figure 10-6, Page 10-4)**. **See following CAUTION.**

CAUTION

- **To prevent damage to the gears, use extreme care when handling them.**

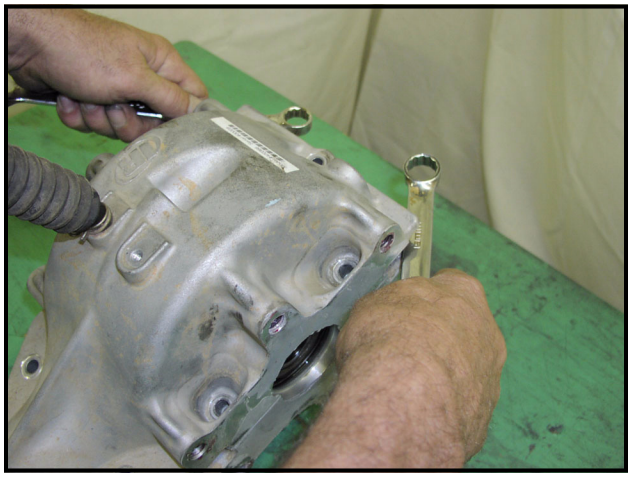


Figure 10-5 Pry Housing Halves Apart

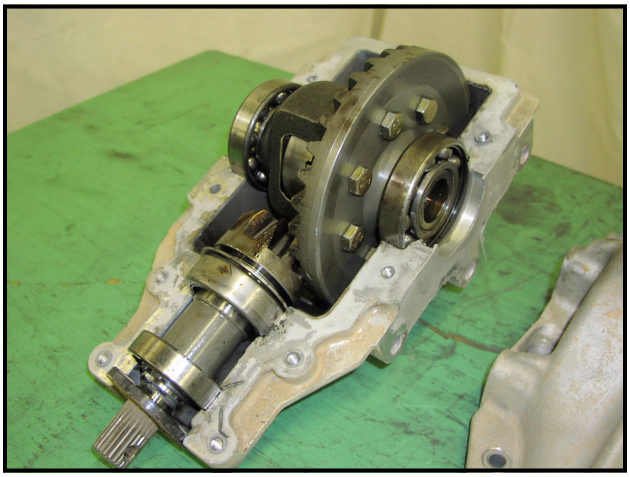


Figure 10-6 Position Housing And Ring Gear

PINION GEAR REMOVAL

1. Remove the pinion shaft oil seal (7) **(Figure 10-4, Page 10-3)**.
2. Remove the pinion gear and shaft (6) with bearings.

Pinion Gear Bearing Removal

1. Place the pinion gear face on a solid flat surface **(Figure 10-7, Page 10-5)**.
2. Remove the snap ring and thin washer adjacent to the splined end of the pinion shaft **(Figure 10-8, Page 10-5)**.
3. Use a bearing puller wedge and press the splined end ball bearing from the pinion shaft **(Figure 10-9, Page 10-5)**.
4. Remove the pinion gear roller bearing and large thin washer **(Figure 10-10, Page 10-5)**.

Pinion Gear Bearing Installation

1. Place the pinion gear face onto a solid flat surface **(Figure 10-7, Page 10-5)**.
2. Slide the thin washer (12) down onto the pinion gear race **(Figure 10-4, Page 10-3)**.
3. Slide a new roller bearing down on the pinion shaft and next to the thin flat washer and pinion gear **(Figure 10-10, Page 10-5)**.
4. Press a new ball bearing onto the pinion shaft.
5. Slide the thin washer (9) down onto ball bearing race **(Figure 10-4, Page 10-3)**.
6. Install the snap ring onto the pinion shaft adjacent to the thin washer and ball bearing race **(Figure 10-8, Page 10-5)**.

Figure 10-7 Pinion Gear Shaft Assembly

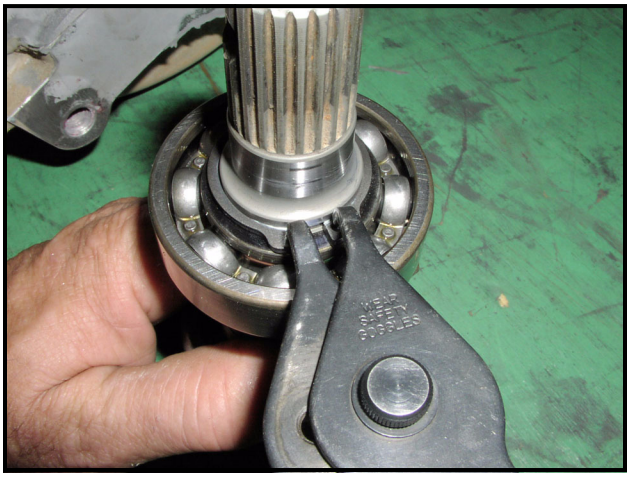


Figure 10-8 Snap Ring On Pinion Gear Shaft

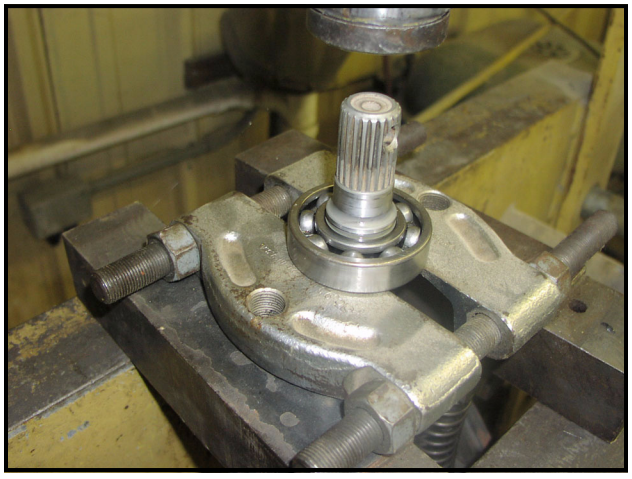


Figure 10-9 Press Off Splined End Roller Bearing

Figure 10-10 Pinion End Roller Bearing

RING GEAR REMOVAL

1. Remove the two axle shaft oil seals (14) from the differential housing **(Figure 10-4, Page 10-3)**.
2. Remove the ring gear, bearings and clutch carrier assembly.
3. Place the assembly with the ring gear and bearing up on a solid flat surface **(Figure 10-11, Page 10-6)**.
4. Remove the ring gear bolts from the ring gear and clutch carrier assembly. **See following CAUTION.**

CAUTION

- **Be careful when separating the ring gear from the clutch carrier to not allow the clutch plates to dislodge from the carrier housing.**

Ring Gear Bearing Removal

1. Use a bearing puller wedge and press the bearing from the ring gear hub **(Figure 10-12, Page 10-6)**.

Ring Gear Bearing Installation

2. Properly support the ring gear surface and press a new bearing onto the ring gear hub **(Figure 10-13, Page 10-6)**.

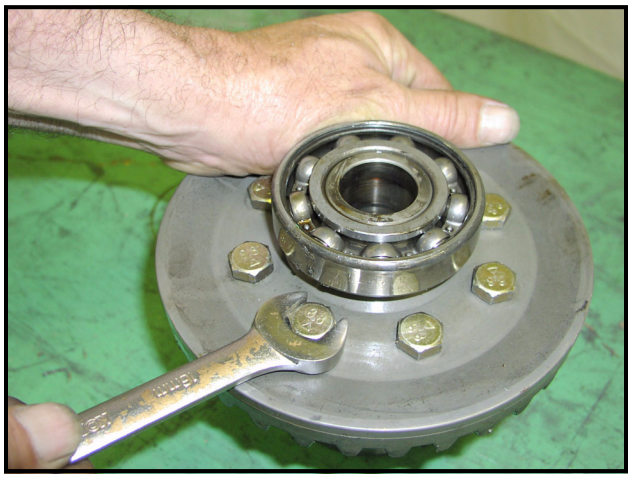


Figure 10-11 Ring Gear Bolts

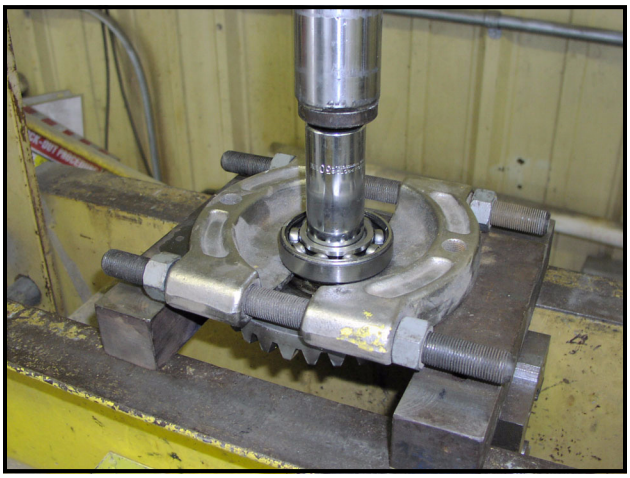


Figure 10-12 Ring Gear Bearing

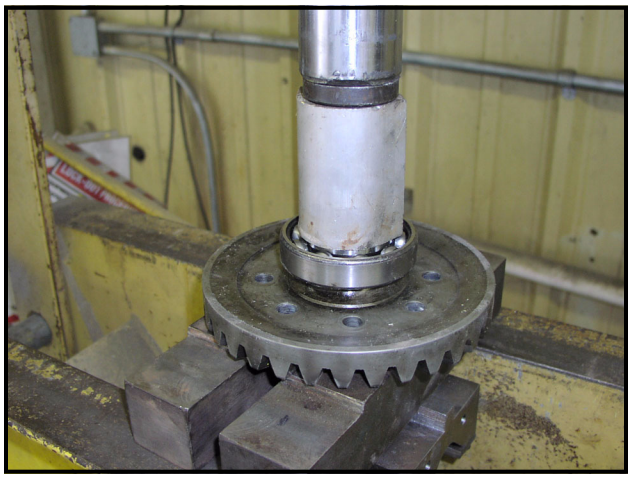


Figure 10-13 Press Bearing onto the Ring Gear

Figure 10-14 Ring Gear And Clutch Carrier Assembly

CLUTCH CARRIER ASSEMBLY

NOTE: *The clutch carrier assembly contains the clutch plates and carrier bearing. They are bolted to the ring gear and ring gear bearing to form a four piece assembly.*

The clutch carrier assembly is provided with a bearing as a sub-assembly replacement item .

The clutch plates are not available as replacement parts. They are included in the carrier sub-assembly.

Clutch Carrier Removal

1. Place the clutch carrier bearing down against a clean flat surface with ring gear and bearing up **(Figure 10-11, Page 10-6)**.
2. Remove the ring gear bolts.
3. Remove the ring gear from the clutch carrier assembly.

Clutch Carrier Installation

1. Position the new clutch carrier assembly with the carrier bearing down and remove the protective plastic plate from the new clutch carrier assembly **(Figure 10-15, Page 10-8)**. **See following CAUTION.**

CAUTION

- **Be careful when separating the protective plastic plate from the clutch carrier to not allow the clutch plates to dislodge from the carrier housing.**

2. Carefully position the ring gear and bearing onto the clutch carrier assembly **(Figure 10-16, Page 10-8)**.
3. Align the bolt holes and install ring gear bolts and finger tighten **(Figure 10-17, Page 10-8)**.
4. Tighten ring gear bolts, in a crisscross pattern, to 33 ft-lb (45 N·m).

Clutch Carrier Bearing Removal

1. Place the ring gear down against a clean flat surface with the clutch carrier hub bearing up **(Figure 10-14, Page 10-6)**.
2. Carefully place a bearing puller wedge between the clutch carrier and the inside bearing surface.
3. Position the clutch carrier assembly and ring gear between press platton bars and press the bearing from the clutch carrier.

Clutch Carrier Bearing Installation

1. Properly support the ring gear surface on press platton bars and press a new bearing on the clutch carrier hub.

Clutch Carrier Bearing Installation, Continued:

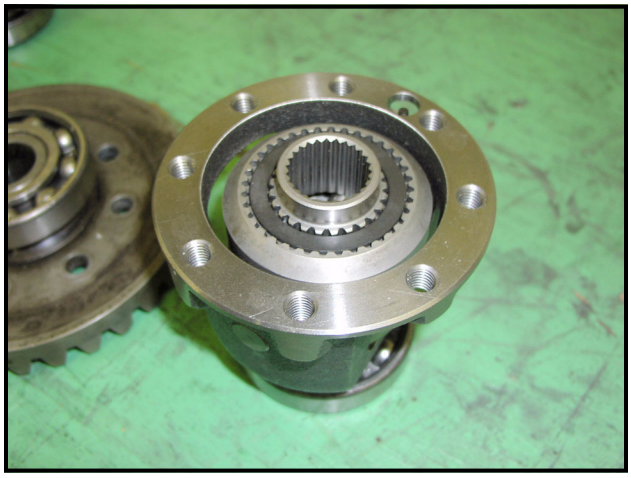


Figure 10-15 New Clutch Carrier And Bearing

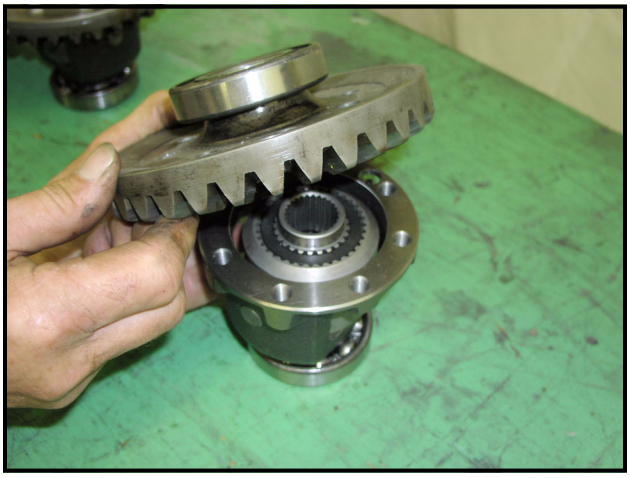


Figure 10-16 Place Ring Gear On Carrier Assembly

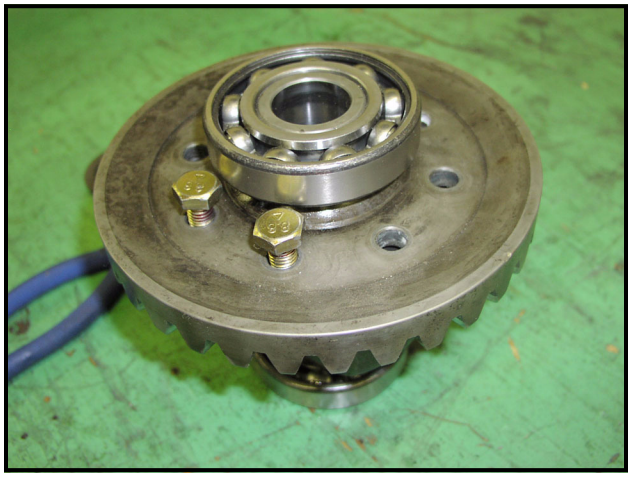


Figure 10-17 Install Ring Gear Bolts

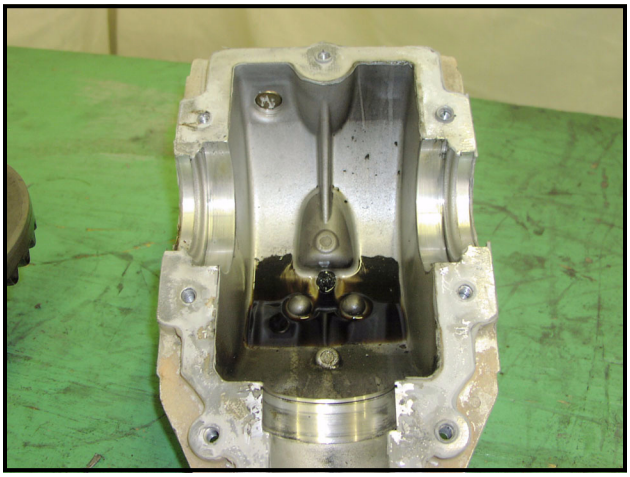


Figure 10-18 Position Differential Housing

RING GEAR INSTALLATION

1. Position the differential housing so that the fill plug is to the back and left **(Figure 10-18, Page 10-8)**.
2. Position the ring gear, bearings and clutch carrier assembly into the differential housing with the ring gear to the right, or driver side of the housing cavity **(Figure 10-20, Page 10-9)**.
3. Seat the ring gear bearing into the driver side housing groove and the clutch carrier bearing into the passenger side housing groove.
4. Install two new oil seals (14), one on each side of the ring gear and carrier assembly, and seat them in housing **(Figure 10-4, Page 10-3)**. **Also see Figure 10-20, Page 10-9**.

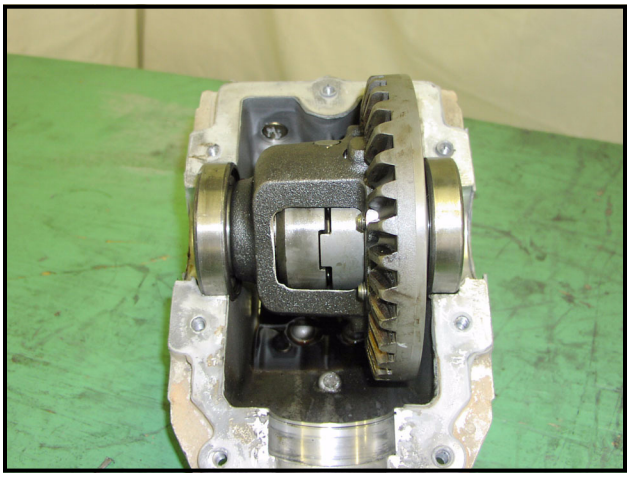


Figure 10-19 Place Ring Gear In Differential Housing

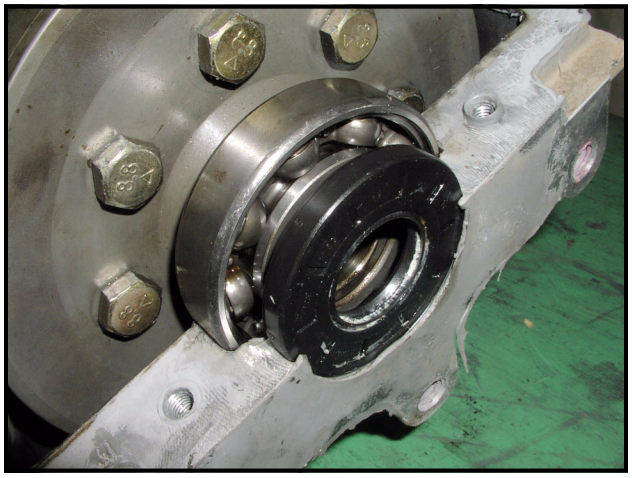


Figure 10-20 Driver Side Ring Gear Seal

PINION GEAR INSTALLATION

1. Position the pinion gear assembly into the differential housing, meshing the pinion gear with the ring gear **(Figure 10-21, Page 10-9)**.
2. Seat bearings and align large thin pinion bearing washer in housing groove **(Figure 10-22, Page 10-9)**.

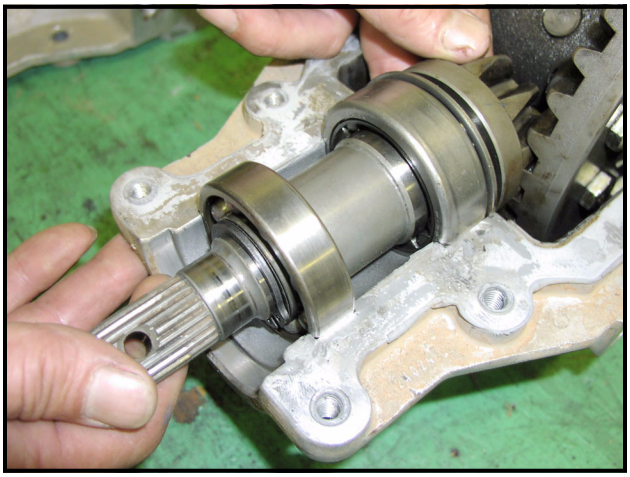


Figure 10-21 Place Pinion Gear In Housing

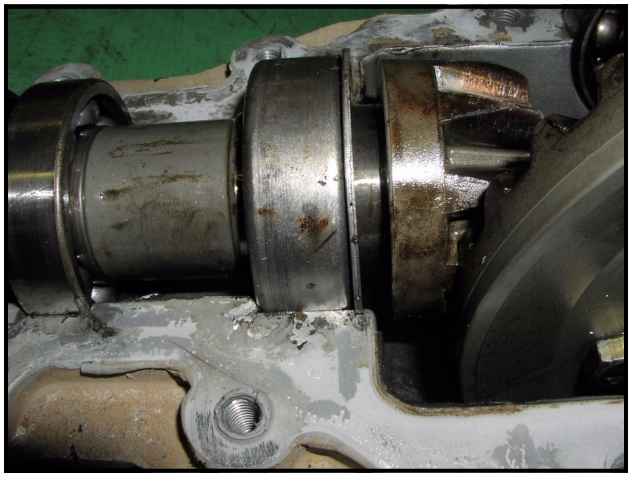


Figure 10-22 Align Pinion Bearing Washer In Groove

REAR DIFFERENTIAL ASSEMBLY

1. Provide a continuous 1/8 inch (3 mm) wide bead of ThreeBond® 1215 gasket compound to the bolt flange on the bottom half of the differential housing **(Figure 10-24, Page 10-10)**. **See following NOTE.**

NOTE: *Make sure that the bolt flanges on both halves of the differential housing are clean of old gasket material and dirt and are dry before applying gasket compound.*

2. Place the top half of the differential housing on the bottom half, making sure that the three oil seals and bearings align in their respective grooves.
3. Install a new oil seal on the splined end of the pinion shaft and seat in housing **(Figure 10-23, Page 10-10)**.

Rear Differential Assembly, Continued:

4. Install the four hex flanged-head bolts in the larger ring gear cavity first, and finger tighten **(Figure 10-25, Page 10-10)**.
5. Install the four hex flanged-head bolts in the pinion cavity last, and finger tighten.
6. Tighten the ring gear cavity bolts first, using a criss cross pattern, with bolt number nine last, to 25 ft-lb (34 N·m) **(Figure 10-26, Page 10-10)**.
7. Tighten the pinion gear cavity bolts last, using a criss cross pattern to 25 ft-lb (34 N·m).

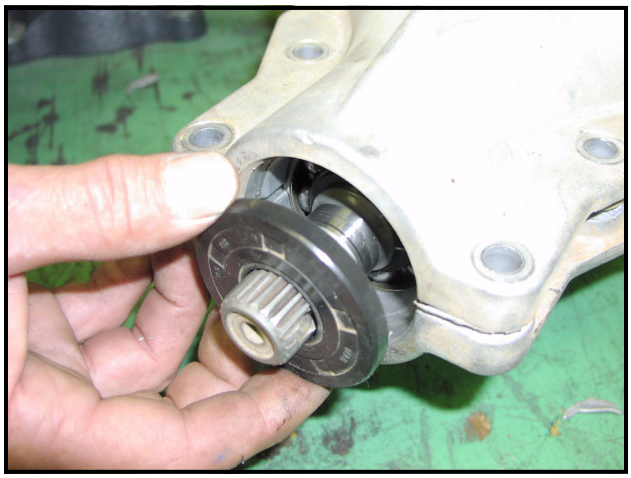


Figure 10-23 Pinion Shaft Oil Seal

Figure 10-24 Apply ThreeBond 1215 Compound

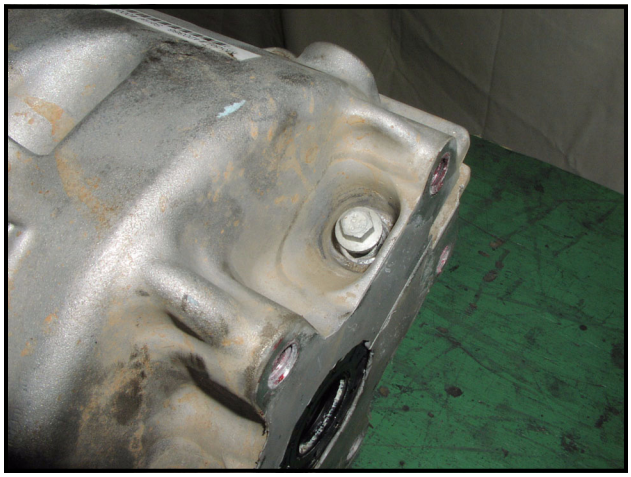


Figure 10-25 Install Housing Bolts

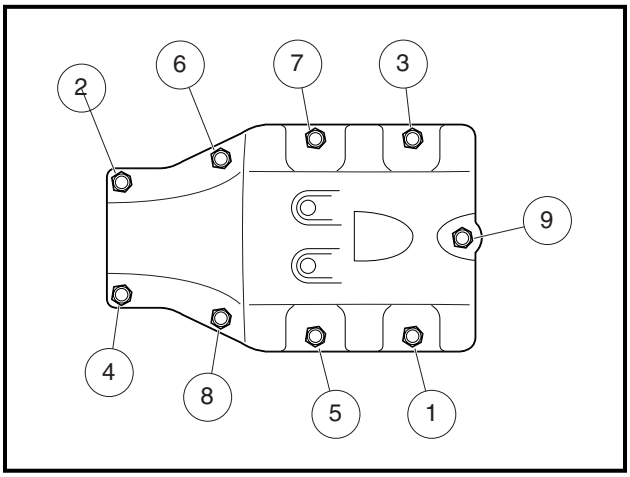


Figure 10-26 Bolt Tightening Sequence

AXLE SHAFTS AND DIFFERENTIAL INSTALLATION

See Rear Differential and Axles in the appropriate maintenance and service manual.

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