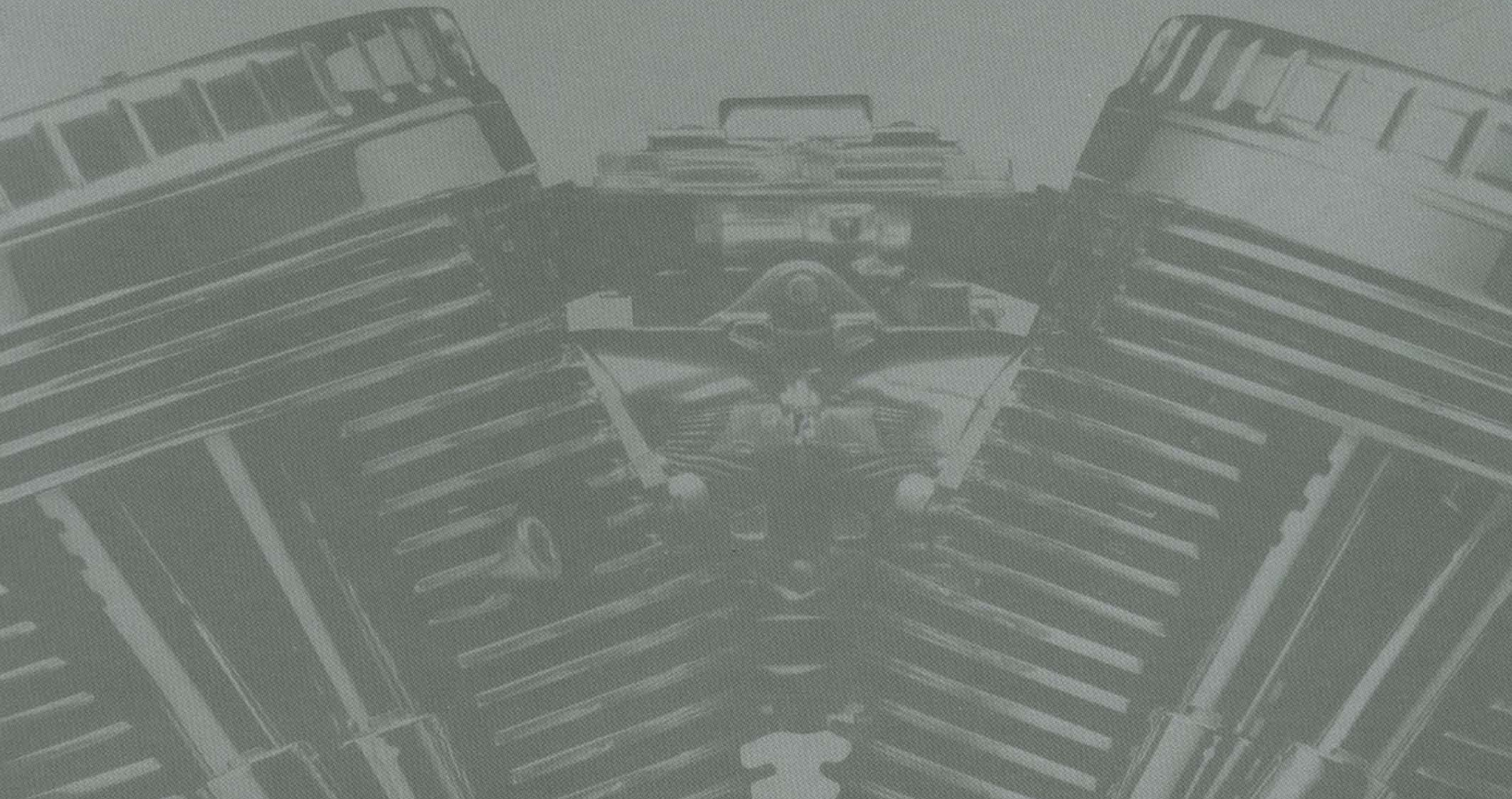
Indian MOTORCYCLE

POWERPLUS™ 100 ENGINE SERVICE MANUAL



OFFICIAL FACTORY MANUAL

INDIAN POWERPLUS™ 100 ENGINE SERVICE PROCEDURES

Introduction

This manual provides service procedures for the Indian POWERPLUS® 100 engine. There are nine sections including sections that cover Troubleshooting and Maintenance in addition to Engine Disassembly and Assembly.

The Engine Removal and Installation section contains sub-sections that concentrate on removing chassis components and engine accessory items in preparation for performing in-chassis repairs from rocker box to cylinder and piston replacement. If a complete rebuild is required, the remaining sub-sections provide procedures for removing the complete engine assembly from the chassis and reinstalling it.

At the back of the manual are sections covering specifications and special tool requirements. The Specifications section provides assembly clearances and wear limits as well as fastener torque values and specified sealants. The Required Tools section identifies special tools that are readily available from JIMS® Machining. In addition, there are drawings for fabricating or modifying tools for use in servicing the engine.

Component and Systems Description

The Indian POWERPLUS® 100 engine is a four-cycle two-cylinder engine with a 45-degree "V" configuration. Its large bore and stroke give it a displacement of 100 cubic inches. The design is also traditional, carrying forward the characteristic "round" cylinders found in early Indian Chief motorcycles.

The engine is standard equipped with a carburetor and electronic ignition system.

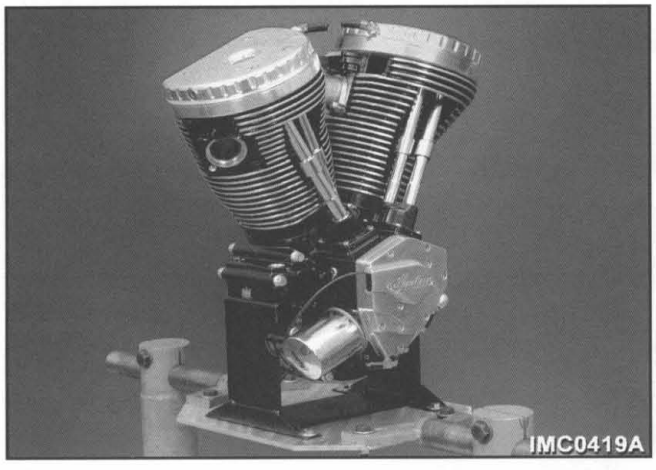


Figure 1— Indian POWERPLUS™ engine

The piston connecting rods are a fork-and-blade style connected to a common crank pin joining two flywheels. The crank pin is set between the pinion shaft flywheel to the right and the sprocket shaft flywheel to the left. The sprocket shaft drives the compensator sprocket in the primary case at the left side of the motorcycle. The sprocket shaft carries the alternator rotor, between the engine crankcase and the compensator. The pinion shaft drives the camshaft, oil pump and breather valve through gearing at the right side of the engine.

The camshaft actuates the intake and exhaust valves through a valve train that includes roller lifters, pushrods and rocker shaft assemblies. The roller lifters, following the cam lobes, raise the pushrods and rocker arms to open the intake and exhaust valves at the appropriate times in the intake and exhaust cycles.

The lubrication system incorporates a gerotor-type oil pump located at the front of the cam housing. The pump, which is driven by a worm gear fitted on the pinion shaft, provides positive lubrication to the engine. At the rear of the cam housing is a full-flow spin-on type filter to screen the lubricating oil as it circulates through the system.

The ignition system with an electronic module and timing sensor controls output to the spark plugs in the cylinders. The ignition rotor, attached to the end of the pinion shaft, in combination with the sensor in the ignition cover, provides the "trigger" signal for the electronic ignition system.

Component Locations

The following views identify the location of major chassis and engine-related parts and accessories referenced in this manual.

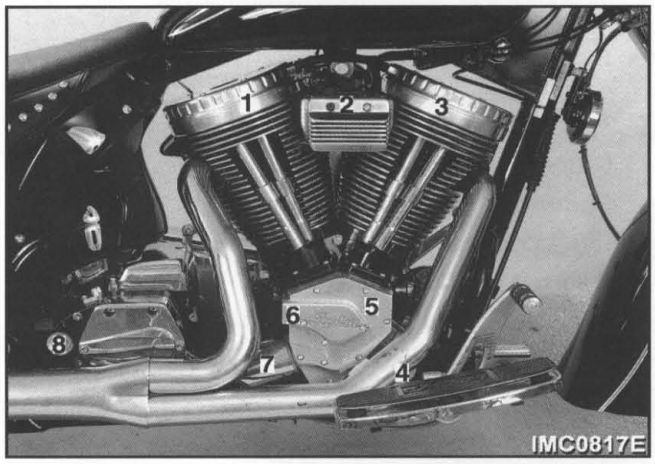


Figure 2 — Indian Chief Motorcycle (right side)

1. Rear cylinder
2. Ignition coil and upper engine support
3. Front cylinder
4. Oil pump
5. Cam cover
6. Ignition cover
7. Oil filter
8. Oil filler and dipstick

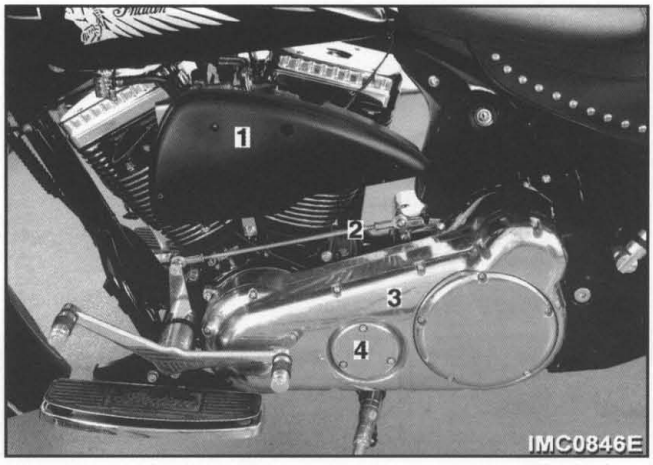


Figure 3 — Indian Chief Motorcycle (left side)

1. Air cleaner housing
2. Transmission shift control
3. Outer primary housing
4. Access cover

Troubleshooting

Symptom-Related Diagnostics

Carburetor

Carburetor floods:

- Excessive pumping of throttle while starting
- Fuel valve (petcock) left open while bike is parked

Electrical system

Alternator charge rate is below normal:

- Low battery voltage
- Loose or corroded connections
- Excessive periods of idling or low-speed riding

Alternator does not charge:

- Engine ground wire loose or broken
- Loose or broken wires in charging circuit
- Voltage regulator not grounded

Engine

Engine knocks or pings:

- Incorrect fuel
- Incorrect spark plugs
- Incorrect ignition timing

Engine overheats:

- Insufficient air reaching the cylinders from slow operation
- Insufficient oil supply
- Oil not circulating due to restricted lines, filter or fittings
- Heavy carbon depositing from lugging the engine
- Incorrect ignition timing

Engine starts but runs irregularly or misses:

- Battery low on charge
- Spark plugs in bad condition, have improper gap or are partially fouled
- Incorrect spark plugs
- Spark plug cables in bad condition and shorting
- Damaged wire or loose connection at battery terminals or at coil
- Damaged wire insulation causing short circuit
- Fuel system clogged by water or dirt
- Fuel vent system plugged

Engine starts hard:

- Battery low on charge
- Spark plugs in bad condition, have improper gap or are partially fouled
- Incorrect spark plugs
- Spark plug cables in bad condition and shorting
- Damaged wire or loose connection(s) at one of the battery terminals or at the coil
- Carburetor not adjusted correctly
- Improper engine oil
- Incorrect ignition timing
- Fuel tank vent plugged or fuel line closed off
- Fuel system clogged by water or dirt

Engine turns over but does not start:

- Fuel tank empty
- Fuel valve (petcock) in OFF position
- Fuel valve or fuel filter clogged
- Discharged battery or loose battery terminal connections
- Fouled spark plugs
- Engine flooded with fuel from overuse of enrichener
- Throttle held open when enrichener was used
- Spark plug cable connections loose or in bad condition
- Loose or corroded wire or cable connection(s) at coil or battery

Engine vibrates excessively or seems to vibrate:

- Swingarm pivot shaft bolts loose
- Front engine mount bolts loose
- Rear engine mount bolts loose
- Broken frame
- Belt badly worn
- Wheels and/or tires damaged
- Vehicle not properly aligned
- Top engine mount loose or broken

Spark plugs foul repeatedly:

- Incorrect spark plugs
- Fuel mixture too rich
- Enrichener used too much

Starter does not operate or does not turn engine over:

- Engine stop switch in OFF position
- Ignition switch not in ON position
- Discharged battery or loose or corroded connections
- Connector to starter loose

Lubrication system

Oil does not return to oil tank:

- Insufficient amount of oil in system
- Oil lines or fittings clogged
- Oil filter clogged
- Inoperative oil pump

Oil leaks from cases, pushrod covers and/or hoses:

- Loose parts
- Imperfect seal at gaskets, pushrod cover, washers, etc.
- Restricted oil return line to tank
- Restricted crankcase vent

Basic Engine Tests

The cylinder leakage and compression checks are basic engine tests that will help determine the overall mechanical condition of the engine and identify problems that can prevent the engine from delivering peak performance.

Cylinder leakage test

With the cylinder leakage test, air pressure is applied to the cylinder. A drop in pressure indicates a leak.

Run the engine to attain normal operating temperature. Stop the engine.

Clean the area around the spark plug and remove the spark plug.

Position the piston, in the cylinder being tested, at top dead center (TDC).

Remove the air filter and set the throttle and choke in the wide-open position.

Place the transmission in 5th gear and engage the rear brake to prevent the engine from turning over.

Using a cylinder leakdown tester, follow the manufacturer's instructions to perform a leak test on the cylinder. Listen for air escaping at the following locations:

- Exhaust pipe — indicates a defective exhaust valve
- Head gasket — indicates defective head gasket, cylinder head surface or cylinder surface
- Carburetor — indicates defective intake valve

Air escaping through the valves may indicate incorrect pushrod length. Check that the correct size pushrods are installed in each location.

Engine compression test

The engine compression test provides a quick method to uncover engine faults.

Run the engine to attain normal operating temperature. Stop the engine.

Clean the areas around the spark plugs and remove the spark plugs.

Remove the air filter and set the throttle and choke in the wide-open position.

Install a compression gauge in the cylinder being tested.

Have an assistant crank the engine at least four complete compression strokes and record the compression readings. Repeat the test on the second cylinder, and compare the readings.

If the highest readings from both cylinders are within specification, 137-183 psi, the engine compression is satisfactory. If the engine compression is not to specification, the cause may be one of the following:

- Worn Piston Rings — If compression is low on the first stroke, increases on successive strokes, but never achieves specification, the piston rings may be worn. Add a tablespoon of heavy oil into the cylinder and crank the engine to distribute the oil. Repeat the compression test. If the compression readings increase considerably, the rings are worn.
- Faulty Valve Seating — If compression is uniformly low on all strokes, the valves may not be seated properly. Add a tablespoon of heavy oil into the cylinder and crank the engine to distribute the oil. Repeat the compression test. If the compression readings remain approximately the same, the valves are not seated properly. Check that the correct size pushrods are installed in each location.
- Head Gasket Leak — If compression is uniformly low on all strokes, the head gasket may be leaking.

Maintenance

Maintenance Schedule

Primary Service (at 500 miles, 5,000 miles and every 10,000 miles thereafter)	Change engine oil and replace oil filter. Clean tappet screen.
Interval Service (at 2,500 miles and every 5,000 miles thereafter)	Change engine oil and replace oil filter.
Renewal Service (at 10,000 miles and every 10,000 miles thereafter)	Replace spark plugs. Change engine oil and replace oil filter.

Engine Maintenance Procedures

It is essential to keep clean, fresh oil in the engine at all times. More frequent oil changes are necessary when:

- The motorcycle is ridden hard.
- The air temperature is very hot or very cold.
- Idling for extended periods of time.
- Two-up riding.
- Mountain riding.
- Dusty conditions.

Indian motorcycles are supplied with 20W-50 V-Twin Motorcycle oil in their engines. This oil is formulated for the rigors of air-cooled motorcycle engines and will provide maximum protection. **Indian Motorcycle does not recommend the addition of mystery oils to the basic 20W-50 Motorcycle product.**

Each oil manufacturer produces products chemically designed which contain detergents, polymers and anti-wear agents to name a few. All these chemicals are balanced to not assault the other. Addition of such oil additives may create an imbalance and the outcome is unknown.

Changing Engine Oil

Tools required:

3/4" wrench

Drain pan

Procedure:

Warm the oil to operating temperature.

The oil drain plug is located in the bottom of the oil tank at the left rear corner.

Place the drain pan under the drain plug. Remove the plug using a 3/4" wrench.

When all the oil has drained from the tank, replace the drain plug.

Remove the oil tank filler cap.

Pour 3 quarts of Indian 20W-50 motorcycle oil into the oil tank.

Return the oil tank filler cap.

Oil Filter Replacement

Tools required:

Drain pan

Oil filter wrench

Procedure:

The oil filter is located at the rear of the crankcase on the right side of the engine.

From the right side of the bike, remove the oil filter using a proper sized oil filter wrench.

Inspect the filter-seating surface of the engine. Make sure the old filter gasket is not attached to the engine crankcase. Clean any dirt or debris from the seating surface and surrounding area.

Replace the filter with an Indian-approved part (#96-021). Apply a thin film of oil to the filter threads and to the gasket of the new filter.

Screw the filter into the filter mount until the gasket contacts the seating surface. Torque another 1/2-3/4 of a revolution.

Engine oil should be checked when warm and the motorcycle is vertical. The oil level should be between the high and low marks on the dipstick. Add oil if necessary.

Cleaning the Tappet Screen

Tools required:

1/4" hex bit

Torque wrench

Procedure:

The tappet screen provides coarse filtering of engine oil before reaching the hydraulic tappets. The tappet screen cap is located on the right side of the engine, at the top front of the crankcase just above the oil pump.

Remove the cap using a 1/4" hex bit.

Then, remove the spring and screen from the bore.

Clean the screen with a suitable oil removal product. Inspect the screen for any metal chips. Chips may be removed with brake clean, carburetor clean, etc. If chips cannot be removed, replace the screen with a new part (#01-185).

Sequence of assembly is as follows:

1. Screen, opening to the bottom
2. Spring
3. O-ring and cap (Inspect the O-ring before assembly.)

Using a torque wrench and 1/4" hex bit, tighten the cap to 8-12 foot-pounds.

Spark Plug Replacement

Tools required:

13/16" hex socket

Pliers

Torque wrench

Procedure:

Gently pull the spark plug caps away from the spark plugs. Be very careful to not separate the caps from the wires while pulling.

Clean the spark plug area of the cylinder heads with compressed air.

Remove the old spark plugs using a 13/16" hex socket.

Gap new NGK BPR5ES spark plugs (#05-002) at 0.038 inch.

Apply a small quantity of anti-seize to the spark plug threads.

Install the new spark plugs in the cylinder heads. Using a torque wrench and 13/16" socket, tighten the plugs to 18 foot-pounds.

Tighten the threaded caps located on the spark plugs with a pair of pliers.

Connect the spark plug wires to the spark plugs.

Engine Removal and Installation

Tools required:

5/32" hex bit

3/16" hex bit

1/4" hex bit

3/8" hex bit

1/2" socket/wrench

9/16" socket/wrench

3/4" socket/wrench

1-1/2" socket

Drain pan

Engine stand, 1006T (available from JIMS®)

Flat-blade screwdriver, medium

Phillips screwdriver

Oil filter wrench

Torque wrench

Removing Chassis Components and Engine Accessories

Using a 3/16" hex bit, remove the two screws attaching the seat to the frame.

Disconnect the battery cables (negative cable first) at the battery terminals.

Remove the screw at the rear of the instrument panel using a 5/32" hex bit. Remove the Phillips head screw in the speedometer housing and remove the instrument panel.

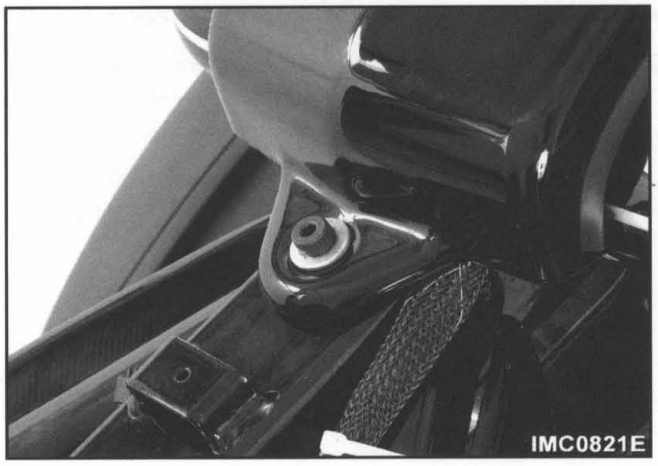


Figure 4 — Instrument panel rear retaining screw

Figure 5 — Speedometer housing retaining screw

Drain the fuel from the fuel tanks into a suitable container and then disconnect and remove the vent and crossover tubes.

Using a 3/16" hex bit, remove the two bright-finish mounting screws at the bottom front of the fuel tanks. Then, using a 1/2" wrench, remove the mounting screws at the top center and front of the tanks. Remove the tanks.

WARNING: Gasoline is flammable and explosive. Work in a well-ventilated area when draining gasoline and drain it into an approved container for gasoline storage. Failure to follow this warning could result in an explosion and/or fire which may cause serious personal injury and/or death and damage to the motorcycle.

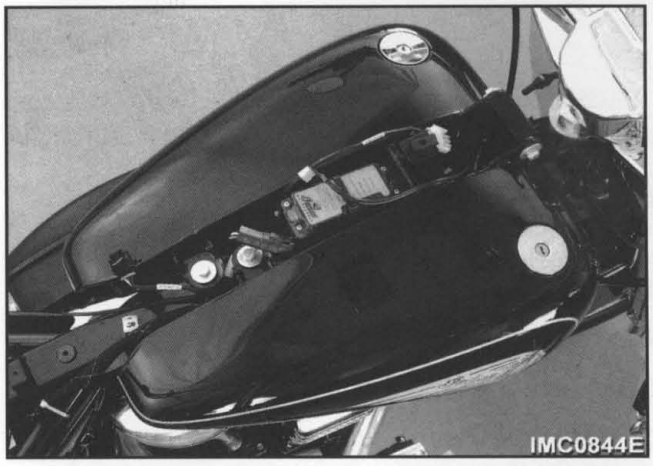


Figure 6 — Fuel tank mounting screws

Remove the fairings at each side of the rear swing arm stanchion.

Figure 7 — Removing fairings

Remove the screws securing the air cleaner housing to the upper engine-mounting bracket and remove the air cleaner as an assembly from the carburetor.

Figure 8 — Air cleaner housing mounting screws

Disconnect the choke- and throttle-control cables, loosen the clamp at the intake manifold and remove the carburetor.

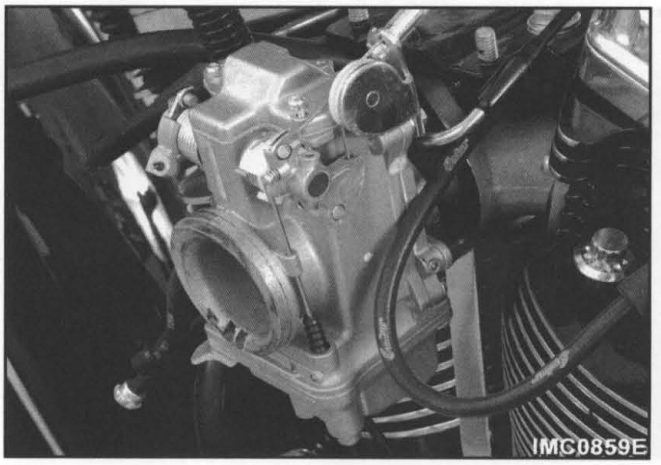


Figure 9 — Carburetor mounting

Disconnect the ignition wires from the spark plugs.

Remove the upper support bracket from the intake manifold and the frame. The ignition coil can remain attached to the bracket.

Figure 10 — Removing upper support bracket

Using a 9/16" wrench, remove the nuts retaining the exhaust pipe at the front and rear cylinder heads. It may be necessary to remove the heat shield(s) to gain access to the mounting nuts.

Figure 11 — Exhaust manifold retaining nuts

Using a 1/2" wrench, remove the two bolts retaining the muffler bracket to the frame. Remove the exhaust pipe assembly.

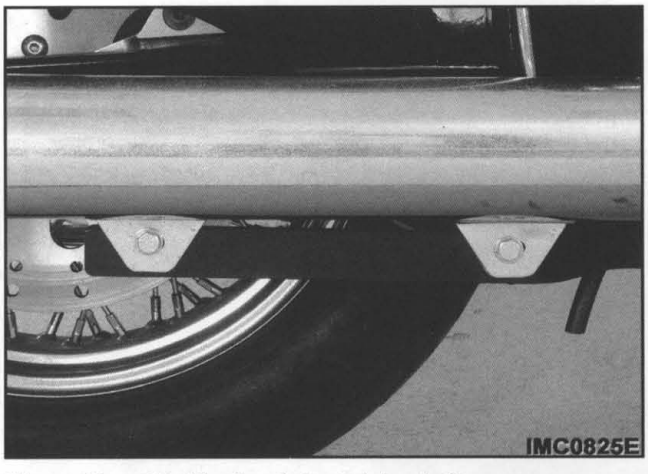


Figure 12 — Muffler bracket retaining bolts

With the above components removed, repairs to the rocker arm/shaft assemblies, cylinder heads, cylinders, pushrods and lifter assemblies, including gasket replacement can be done in chassis as needed. Refer to the following sections for the applicable procedures:

- Rocker Box Procedures
- Pushrod and Tube Removal and Installation
- Cylinder Head Procedures
- Cylinder and Piston Assembly Procedures

Engine Removal

If the engine is to be removed from the chassis, complete all of the steps listed under Removing Chassis Components and Engine Accessories. Then, continue with the steps below.

Place a drain pan under the drain plug at the bottom of the primary chain housing. Remove the plug using a 3/4" wrench and allow the oil to drain from the housing. When completely drained, replace the plug and tighten.

Place a drain pan under the engine drain plug. Remove the plug using a 3/4" wrench and drain the oil from the crankcase. When completely drained, replace the plug and tighten.

Remove the oil filter with an oil filter wrench.

Disconnect the shift rod from the transmission lever using a 3/16" hex bit.

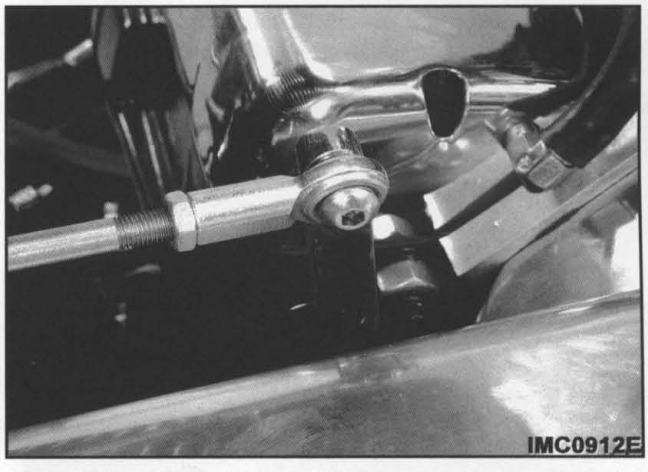


Figure 13 — Transmission shift rod

Using a 5/16" hex, remove the left footrest mounting screws and remove the footrest and clutch pedal assembly from the frame.

Remove the right footrest from the frame using a 5/16" hex bit. Position and secure the footrest with master cylinder attached out-of-way. It is not necessary to remove the brake master cylinder or disconnect the line.

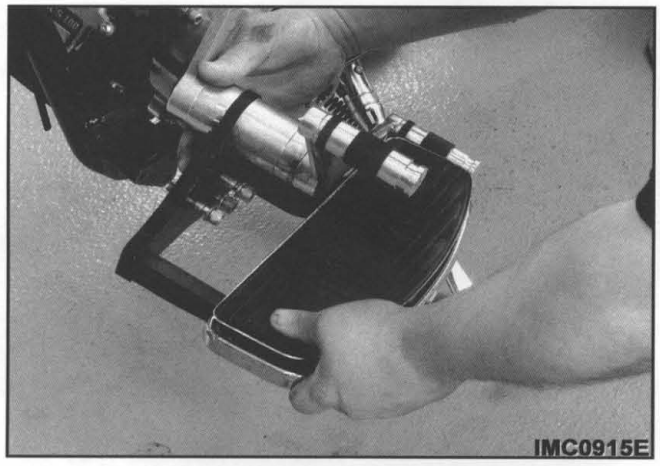


Figure 14 — Removing left footrest assembly

Using a 3/16" hex bit, remove the 15 screws at the perimeter of the outer primary housing. Remove the outer housing. Remove the rubber seal from the housing and inspect it. Discard the seal if it is distorted or damaged.

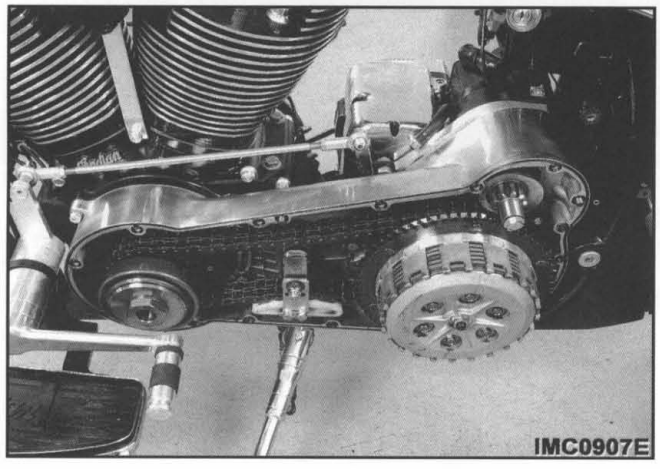


Figure 15 — Outer primary housing removed

Loosen the chain adjuster using a 9/16" socket and slide the adjuster down to provide maximum slack in the chain.

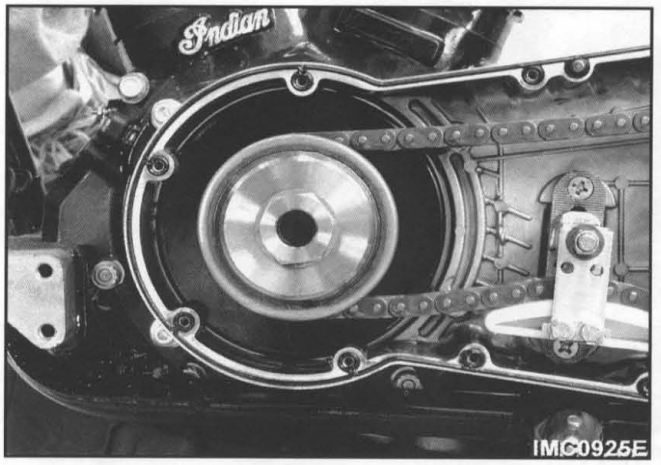


Figure 16 — Compensator sprocket and chain adjuster

Using a 1-1/2" socket, remove the compensator retaining nut and remove the assembly from the sprocket shaft.

Using a 9/16" socket, remove the four primary housing-to-engine mounting screws.

NOTE: The two inner screws are locked by tabbed washers. Bend the tabs back to unlock.

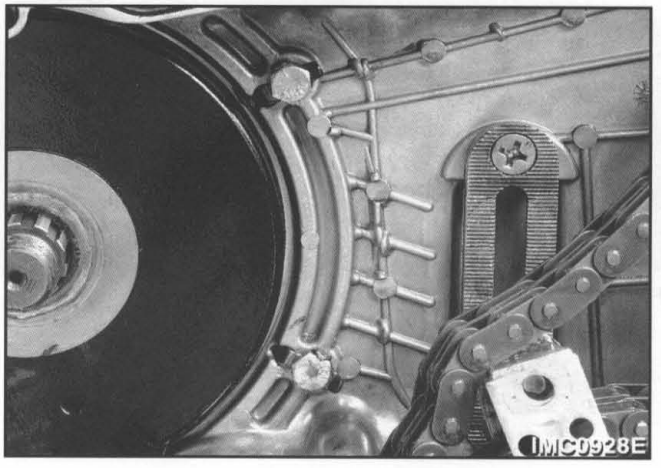


Figure 17 — Primary housing mounting screws

Disconnect the electrical leads from the oil pressure switch, ignition module and the alternator stator and position them out-of-way.

Figure 18 — Electrical leads to oil pressure switch and stator

Remove the breather clamps and hoses from the fittings at the breather valve and the bottom of the cam cover. Disconnect the oil supply line at the oil pump.

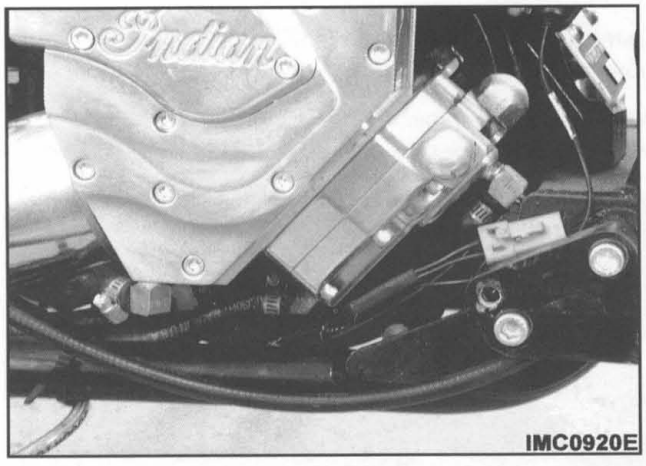


Figure 19 — Breather hoses and oil line

Using a 3/16" hex bit, remove the engine nameplate covering the front engine mounting bolts.

Remove the front and rear engine mounting bolts using a 9/16" socket.

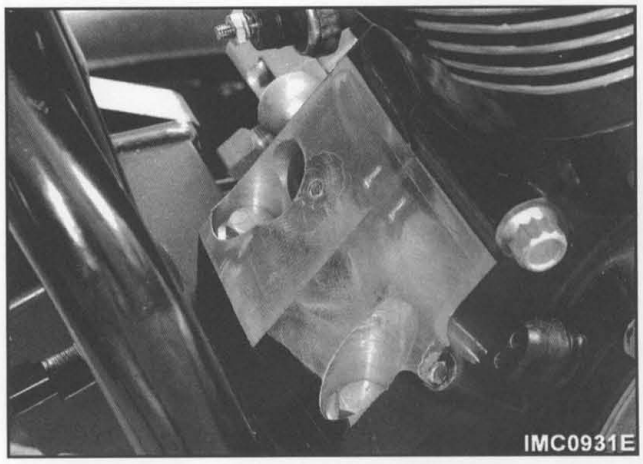


Figure 20 — Front engine mounting bolts

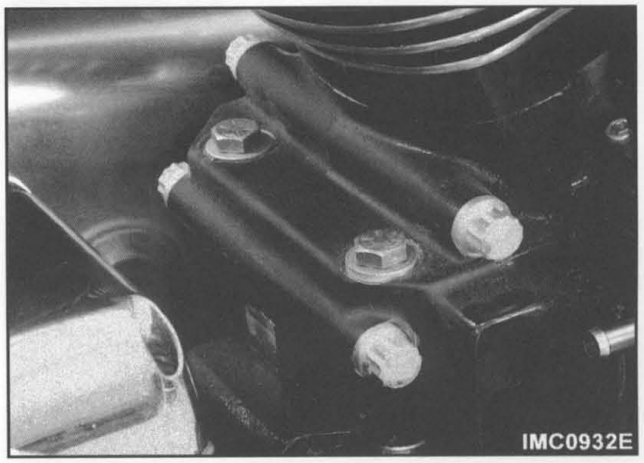


Figure 21 — Rear engine mounting bolts

Lift the engine from the chassis and mount it in an engine stand, JIMS® 1006T, for disassembly and repair.

Engine Installation

Install a new rubber O-ring in the groove on the engine-to-primary housing mounting flange on the crankcase.

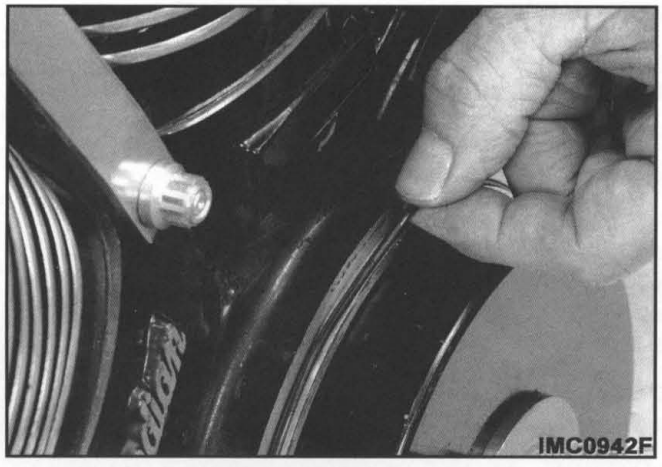


Figure 22 — Installing O-ring on crankcase

Apply black RTV sealant to the inner seal surface on the primary housing.

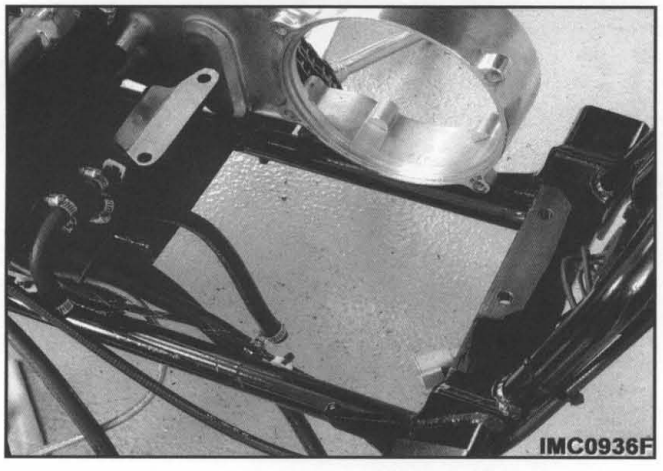


Figure 23 — Inner primary housing seal surface

Place the engine in position over the frame mounting pads making sure the sealing surfaces of the engine and primary housing are properly aligned.

Apply a thin coat of blue threadlock to the threads of the four engine mounting bolts. Then, loosely install the bolts. Do not tighten the bolts at this time.

Apply a thin coat of blue threadlock to the four inner primary housing-to-engine mounting screw threads. Install the screws and tabbed lockwashers, using a 1/4" hex bit. Tighten the screws to 16-18 foot pounds and bend the washer tabs up to lock the screws in place.

Using a 9/16" socket and torque wrench, tighten the four engine mounting bolts to 35-38 foot-pounds.

Adjust the primary chain as follows:

- Move the adjuster up to the top notch and check for slack by pressing down on the chain in the top span.
- If the chain cannot be depressed to the specified 5/16" slack, move the adjuster down to a position where the specified slack is reached. Tighten the adjuster to specification.

Install a new rubber seal and install the outer primary housing and retaining screws using a 3/16" hex bit. Tighten the screws to 8-10 foot-pounds.

Place the right footrest assembly in position on the frame. Install the mounting screws using a 5/16" hex bit and tighten the screws to specification. Install the left footrest and clutch assembly in the same manner.

Apply blue threadlock to the shift rod screw. Connect the shift rod at the transmission using a 3/16" hex bit. Tighten the screw to 13-19 foot-pounds.

Install the breather hoses and clamps on the fittings at the breather valve and the bottom of the cam cover.

Connect the electrical leads to the oil pressure switch, ignition module and the alternator stator.

Remove the access cover in the outer primary housing using a 3/16" hex bit. Fill the housing with 30 ounces of Indian primary oil. Replace the cover and tighten the screws to 8-10 foot-pounds.

Apply a thin coat of engine oil to the gasket and install a new oil filter.

Remove the fill-tube cap and fill the oil tank with 3 quarts of Indian 20W-50 engine oil. Replace the cap.

Installing Chassis Components and Engine Accessories

Place the upper support bracket in position and install the bracket-to-frame bolt using a 3/4" socket and torque wrench. Tighten the bolt to specification.

Install the upper support bracket-to-intake manifold screws, using a 9/16" socket. Tighten the screws to specification.

Connect the ignition wires from the coil to the spark plugs.

Inspect the rubber carburetor-mounting collar, clamp and flange on the intake manifold for damage.

Place the carburetor throttle bore flange in position in the rubber-mounting collar and secure it with the clamp. Connect the choke- and throttle-control cables.

Place the air cleaner in position on the carburetor. Install the two screws attaching the assembly to the upper engine support bracket using a 9/16" socket. Tighten the screws to specification.

Position the fairing at each side of the rear swing arm stanchion and install the retaining screws using a 3/16" hex bit. Tighten the screws to specification.

Place the left fuel tank in position at the side of the upper frame tube and install the two top retaining screws and washers using a 1/2" socket. Tighten the screws to specification. Install the bottom front retaining screw and bright-finish collar using a 3/16" hex bit. Tighten the screw to specification.

Repeat the above step to install the right fuel tank.

Install the fuel crossover, vent lines and clamps. Tighten the clamps securely.

Connect the fuel line from the shutoff valve on the right tank to the carburetor.

Position the instrument panel over the fuel tanks and secure the panel with the Phillips head screw in the speedometer bezel and the socket head screw at the rear of the panel. Using a 5/32" hex bit, tighten the rear screw to specification.

Reconnect the battery positive cable and then the negative cable to the battery terminals.

Position the seat on the frame and using a 3/16" hex bit, install the two screws attaching the seat to the frame. Tighten the screws to specification.

Engine Disassembly and Assembly

The procedures covered under Disassembly and Assembly can be done as separate operations with the engine mounted in-chassis or as a complete rebuild with the engine removed from the chassis.

If a complete rebuild is being done, remove the engine from the chassis and mount it in an engine stand, JIMS® 1006T. If a repair involves a specific operation being done in-chassis, find the appropriate procedure(s) in this section and proceed.

Tools required:

Engine stand, 1006T (available from JIMS®)

Rocker Box Procedures

The following procedures apply for both the front and rear rocker boxes.

Tools required:

3/16" hex bit

1/4" hex bit

Torque wrench

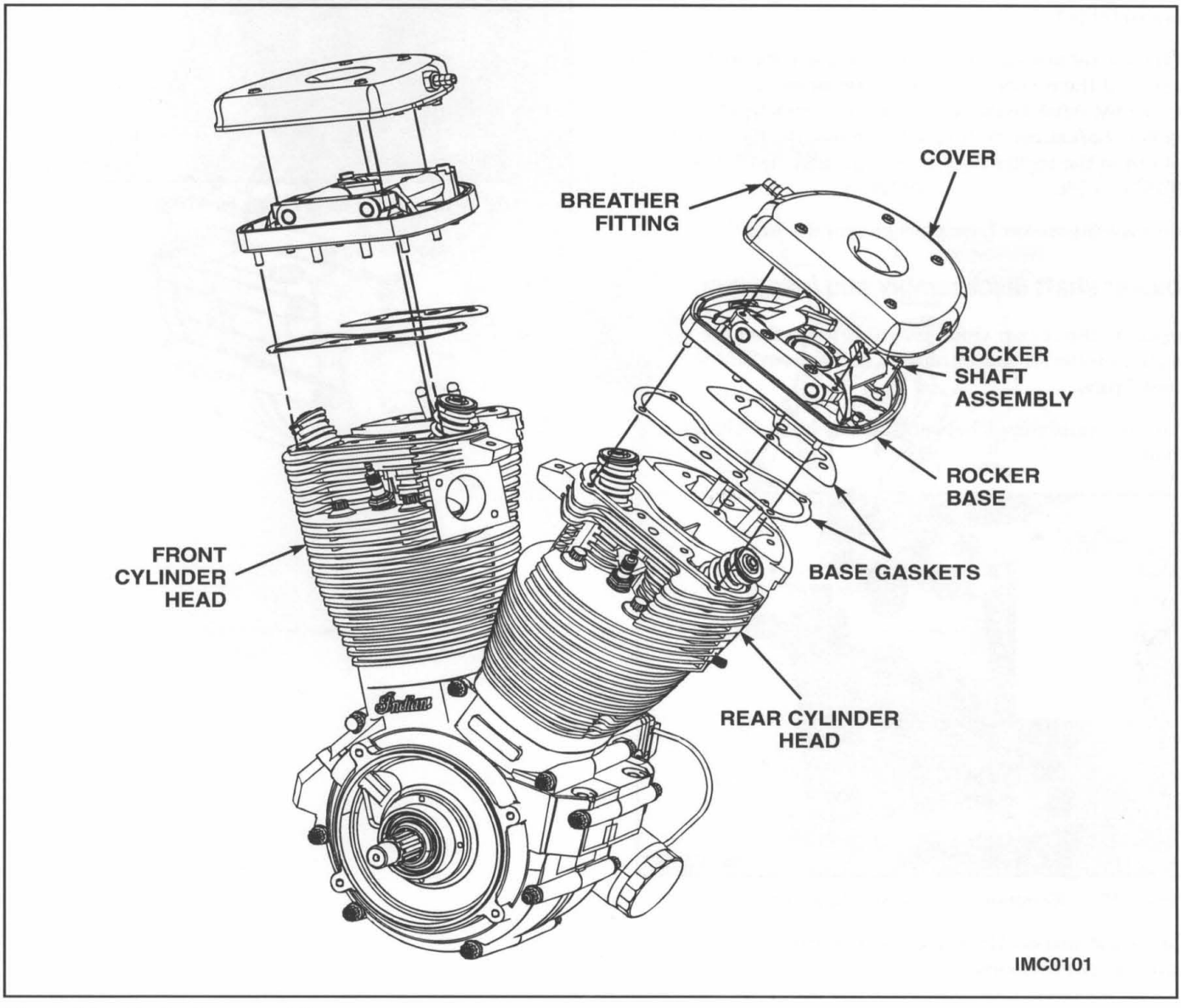


Figure 24 — Rocker box assemblies

Removal

Using a 3/16" hex bit, remove the four screws retaining the rocker cover.

Remove the cover and then remove the two O-ring seals from the rocker base.

Inspect the O-ring seals. Discard any damaged O-rings.

Using a 1/4" hex bit, remove the mounting screws from the left and right rocker-shaft support brackets.

If servicing the rocker arms, turn the sprocket shaft to move the pushrods upwards and loosen the brackets from the rocker base. Then, remove the rocker assembly from the base and inspect the rocker arm shafts and bushings for wear. Replace components as necessary. (Skip this step if the rocker arms are not being serviced and the rocker box is being removed as an assembly.)

If the rocker arms are not being serviced, the rocker box base and the rocker arms can be removed as an assembly. After removing the four screws from the rocker shaft support brackets, remove the five screws retaining the rocker base to the cylinder head using a 3/16" hex bit.

Remove the rocker base gaskets and discard them.

Rocker shaft disassembly and inspection

Separate the rocker shaft assembly from the base by prying on the support brackets to lift them off the dowel pins.

Pull the support brackets and rocker arms from the shafts.

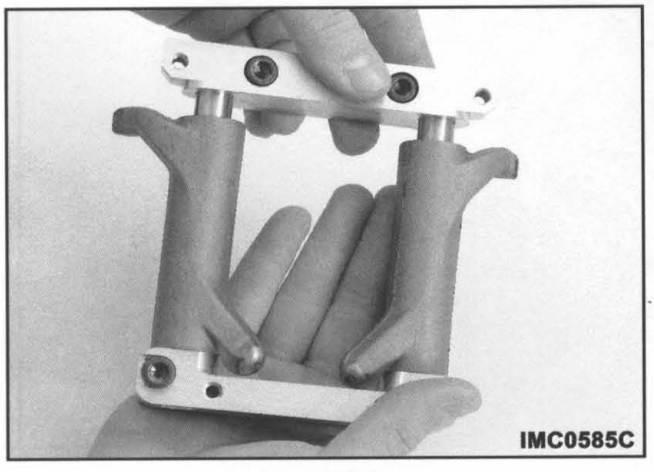


Figure 25 — Removing rocker shaft supports

Clean and inspect the shafts, rocker arms, bushings and support brackets:

- Check the rocker arms, shafts and support brackets for cracks, nicks or other damage. Check the contact pads for wear.
- Check the bushings for unusual wear and pitting. Measure bushing bore diameters (see Specifications). Replace as required.
- Measure the shaft diameters at contact points and the bores of the support brackets. Replace if out of specification.

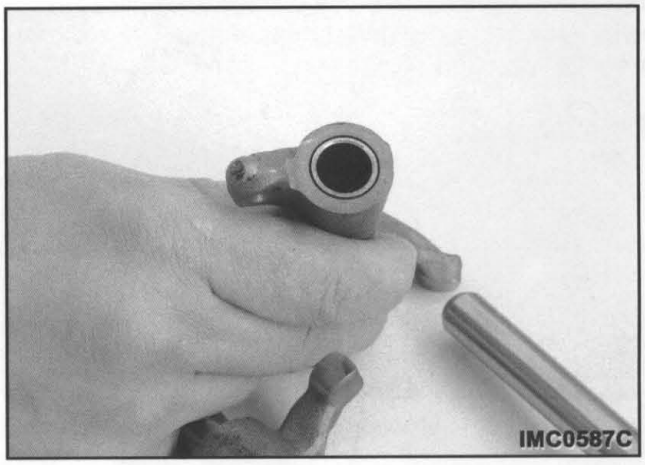


Figure 26 — Inspecting rocker shaft bushings

Rocker shaft assembly

Apply clean engine oil to the rocker shafts and insert them into the rocker arms. The notched end of the shafts must be positioned at the pushrod end of the arms, where they interlock with the mounting screws in the right side support bracket.

Slide the slotted end of the shafts into the right support bracket and align the slots with the mounting screw holes. Slide the left support bracket onto the other end of the shafts.

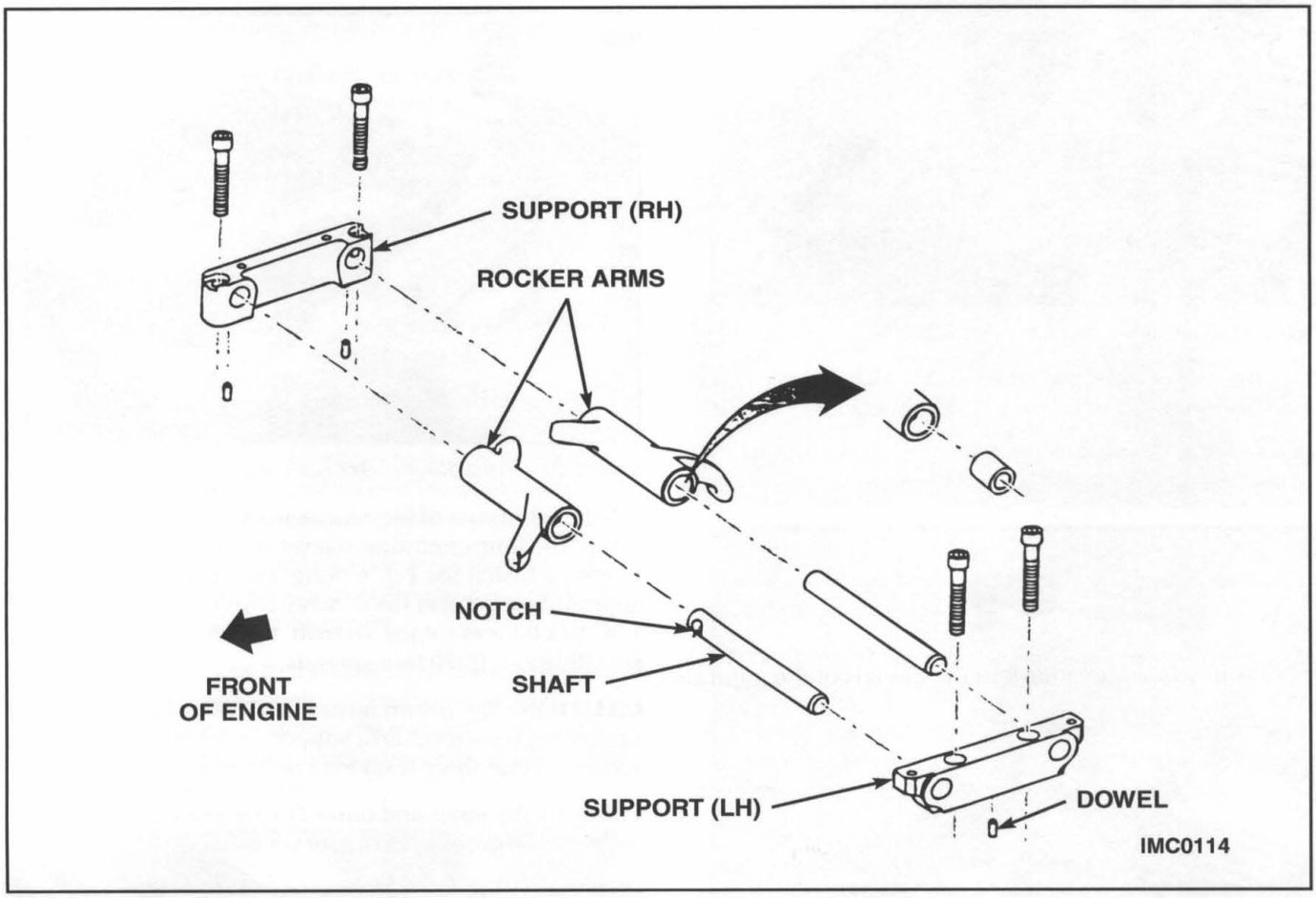


Figure 27 — Rocker shaft assembly

Installation

Install new rocker base gaskets on the cylinder head.

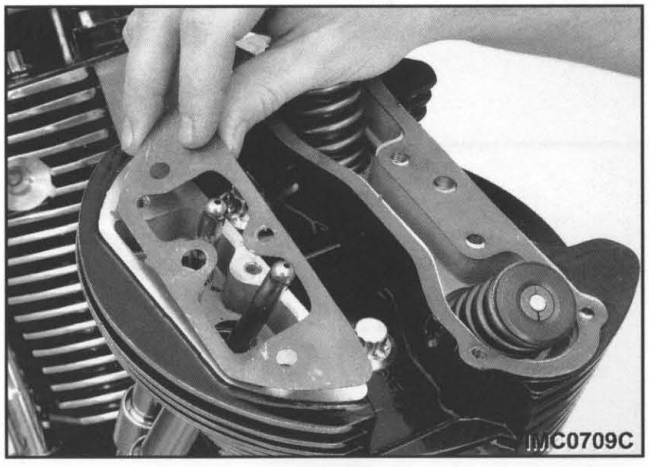


Figure 28 — Installing rocker base gaskets

Place the rocker box base (or base and rocker shaft assembly) in position on the cylinder head.

Apply a thin coat of blue threadlock to the mounting screws and install the five screws in the base.

Figure 29 — Installing rocker base

Using a 3/16" hex bit and torque wrench, tighten the screws to specification, 8-12 foot-pounds.

If removed for service, place the rocker shaft assembly in position on the base. Make sure that the three dowel pins are in place and that the slots in the rocker shafts are properly aligned with the mounting screw holes in the right support bracket.

Figure 30 — Installing rocker shaft assembly

Apply a thin coat of blue threadlock to the screws and install the four mounting screws in the support brackets. Install the 1-3/4" long screws in the left support bracket and the 2" screws in the right. Using a 1/4" hex bit and torque wrench, tighten the screws to specification, 16-20 foot-pounds.

CAUTION: The piston must be at TDC when tightening the rocker arm support bracket mounting screws so that there is no load on the valve springs.

Lubricate the inner and outer O-ring seals and place them on the grooves in the rocker base.

Place the rocker cover in position on the rocker base with the breather fittings facing inward. Apply a thin coat of blue threadlock to the four screws and install them in the cover. Using a 1/4" hex bit and torque wrench, tighten the screws to specification, 8-12 foot-pounds.

Pushrod and Tube Removal and Installation

Tools required:

Small flat-blade screwdriver

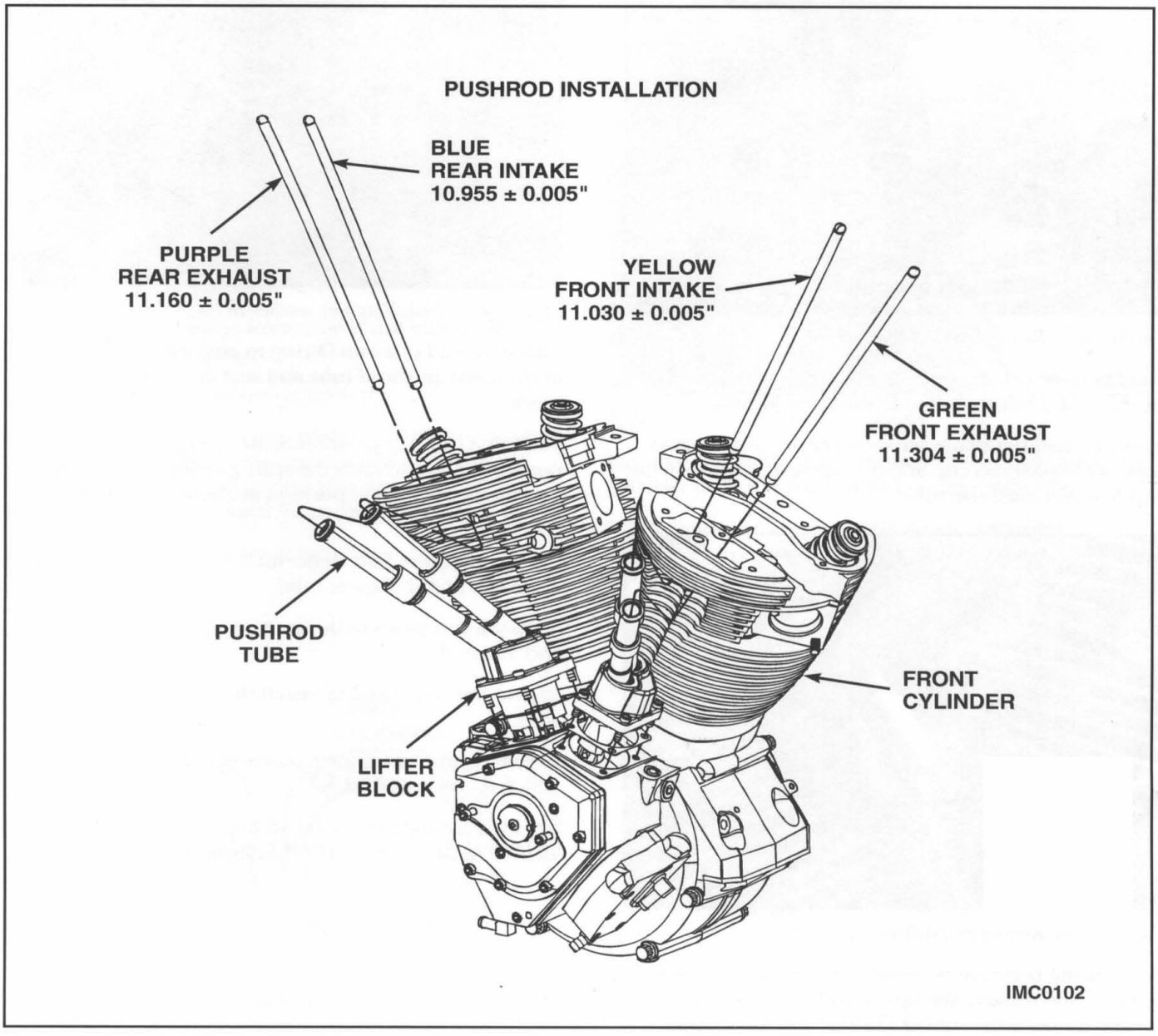


Figure 31 — Pushrod and tube assemblies

Removal

Remove the pushrods from the bores in the cylinder head. Be sure to note the location of each pushrod as it is removed.

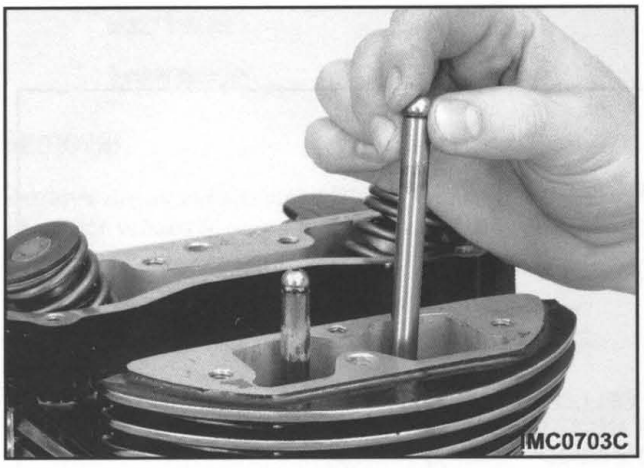


Figure 32 — Removing pushrods

NOTE: If the color codes are not visible, mark the pushrods for reinstallation in the same location.

Insert a small flat-blade screwdriver in the slot at the base of the pushrod clip and pry upward to remove the clip from the pushrod tube.

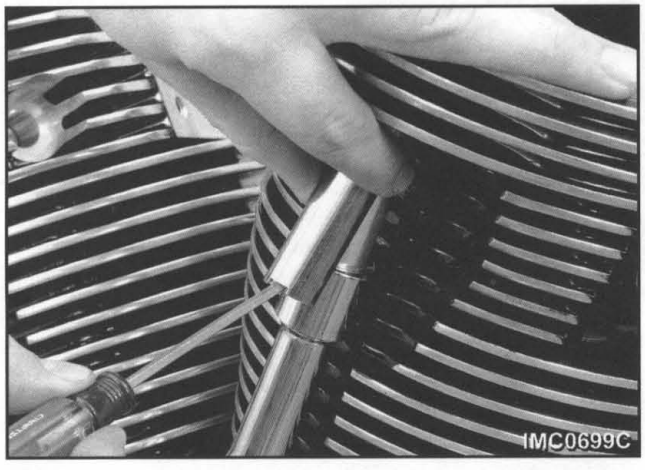


Figure 33 — Removing pushrod tube clip

With spring pressure released, slide the spring cover upward and remove the upper and lower pushrod covers. Remove the rubber O-rings and the washer from the tube seat in the lifter block.

Inspect the O-rings and washer and discard if damaged.

Remove the second pushrod tube repeating the above steps.

Installation

Place the flat washer in position on the tube seat of the lifter block.

Figure 34 — Installing flat washer in lifter block

Lubricate and place an O-ring in position at the bottom of the lower pushrod tube and seat the tube in the lifter block.

Place an O-ring in position at the top of the upper pushrod tube and slide the spring cover, spring, flat washer and O-ring in position at the lower end of the upper tube.

Install the upper tube in position between the cylinder head seat and the lower tube.

Slide the spring cover down to compress the spring and install the clip.

Repeat the procedure to install the second pushrod tube.

Lubricate and install each pushrod into the bore from which it was removed.

NOTE: Pushrods are installed in the order, GREEN, YELLOW, BLUE and PURPLE, from front to rear.

Cylinder Head Procedures

The following procedures apply for both the front and rear cylinder heads.

Tools required:

1/4" hex bit

1/2" wrench

1/2" 12-point socket

Brass hammer

Torque wrench

Valve guide tool, 34731-84 (available from JIMS®)

Valve guide tool handle, 34740-84 (available from JIMS®)

Valve spring compressor tool, 96600-36B (available from JIMS®)

Valve spring tester, 1090 (available from JIMS®)

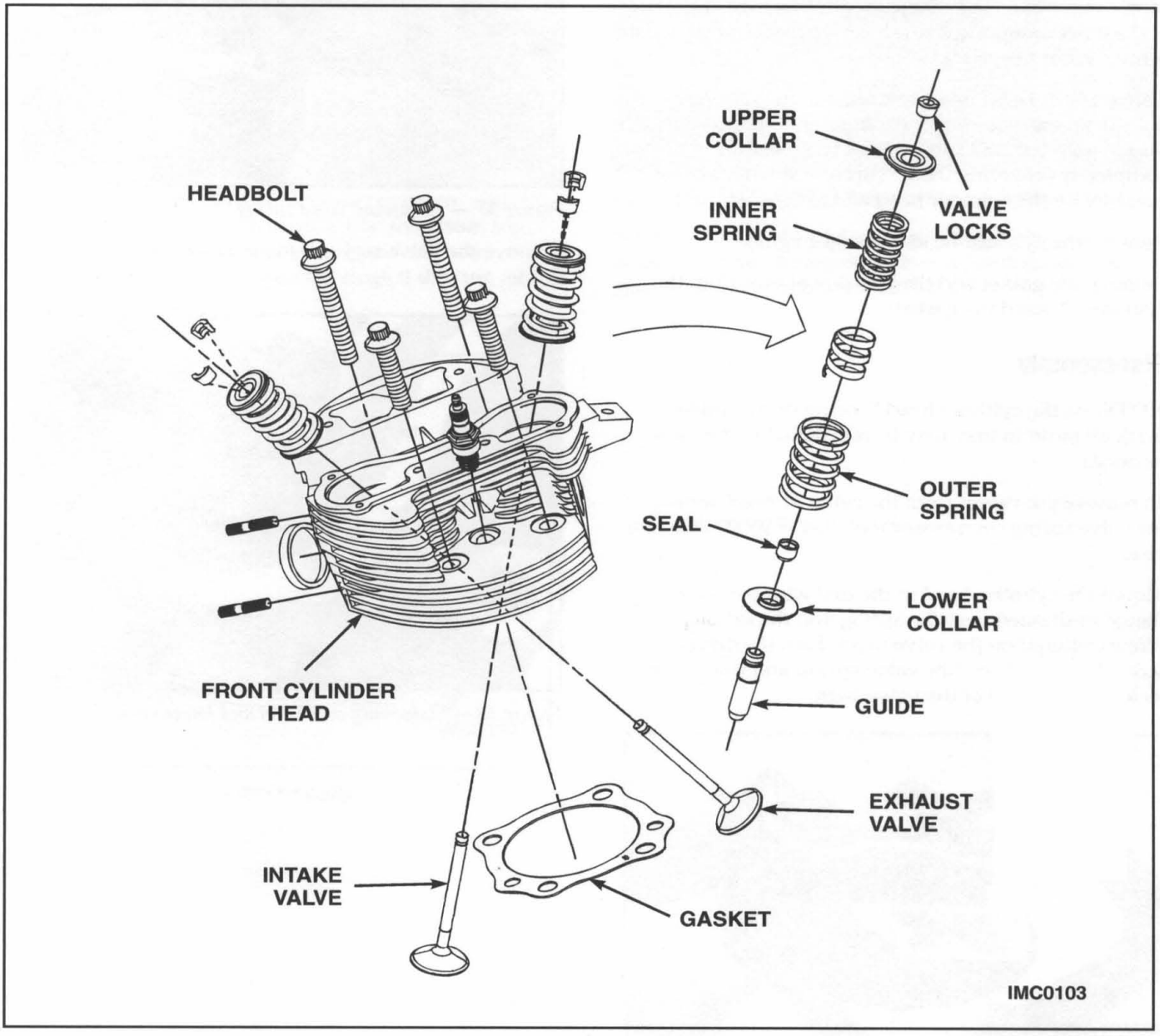


Figure 35 — Cylinder head assembly

Removal

Remove the rocker box assembly (see Rocker Box Procedures).

Using a 1/2" wrench, remove the bolt from the support bracket and carburetor flange at the intake manifold.

Loosen the 12-point nut securing the support bracket to the crankcase and remove the bracket.

Using a 1/4" hex bit, remove the outer intake manifold mounting screws from each cylinder head. Then, loosen the two inner mounting screws and remove the intake manifold. (The intake manifold flange is slotted at the inner mounting screw locations so removal of the screws is not necessary.)

Using a 1/2" 12-point socket, remove the four head bolts from the cylinder studs. In removing the bolts, loosen each bolt 1/4 turn at least twice before completely removing them. This will slowly release pressure on the cylinder head and avoid distortion.

Remove the cylinder head from the engine.

Remove the gasket and the two dowel pins from the cylinder. Discard the gasket.

Disassembly

NOTE: As the cylinder head is being disassembled, mark all parts so they may be reinstalled in the same location.

To remove the valves from the cylinder head, mount the valve spring compressor tool, JIMS® 96600-36B, in a vise.

Mount the cylinder head in the tool with the collar flange positioned over the spring and the driving screw centered on the valve head. Turn the driving screw in to compress the valve spring and remove the locks from the top of the valve stem.

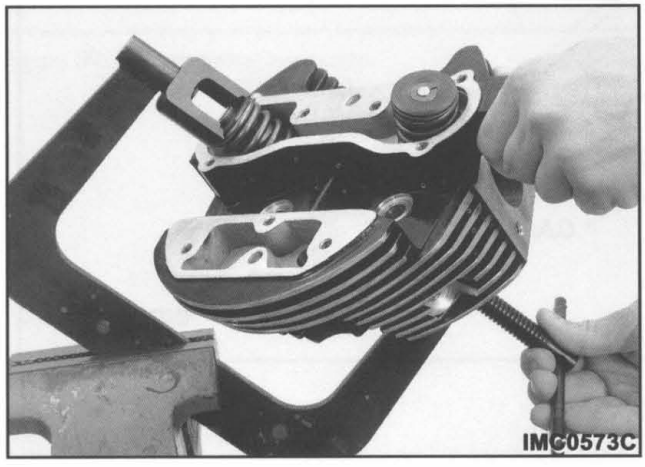


Figure 36 — Removing valves from cylinder head

Turn the driving screw out to release pressure on the spring and remove the cylinder from the tool.

Remove the upper collar and spring set from the top of the head. Pull the valve out from the bottom.

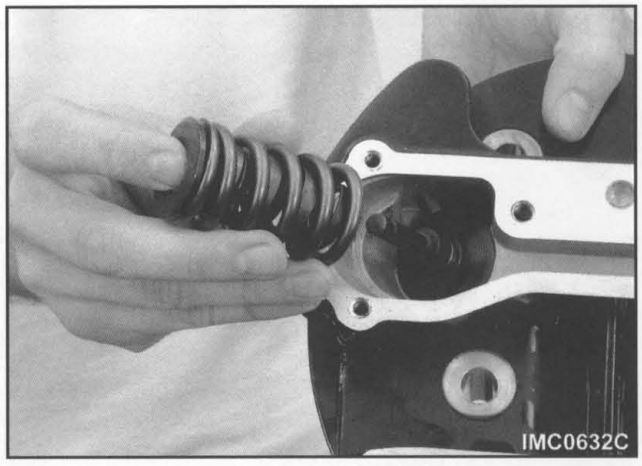


Figure 37 — Removing valve spring

Remove the valve seal and lower collar from the valve guide.

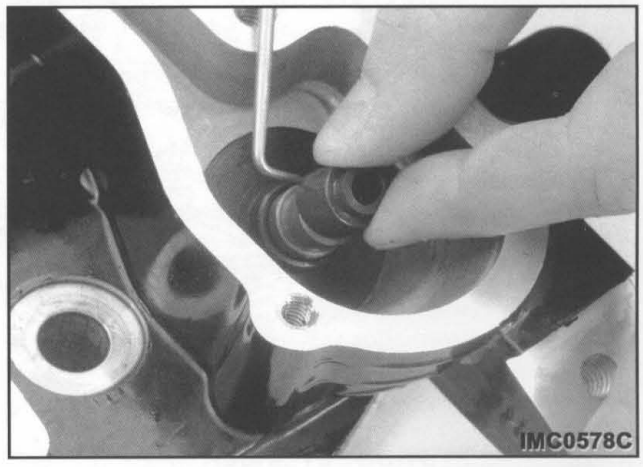


Figure 38 — Removing valve seal and lower spring collar

If the valve guide is to be removed, use valve guide tool, JIMS® 34740-84, and a hammer to drive the guide out from the head.

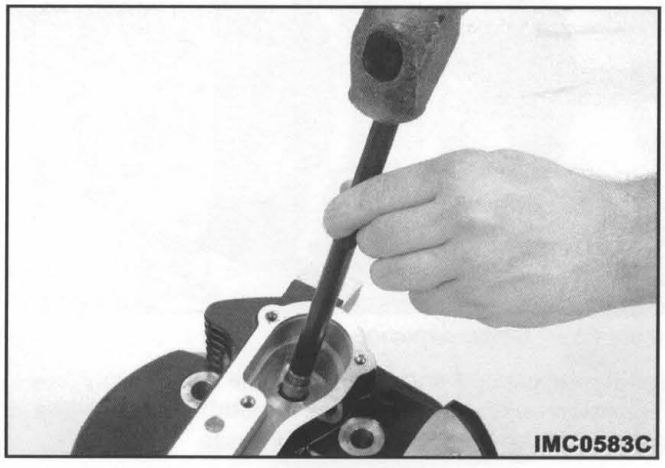


Figure 39 — Removing valve guide

Cleaning and inspection

Clean the cylinder head and all associated parts including valves with a suitable non-flammable solvent. Scrape the carbon buildup from any parts using care to avoid damage. Flush with solvent to remove all traces of dirt and debris, making sure that all ports, passages, bores and threads are thoroughly clean. Dry parts with compressed air.

Inspect the valve stems and faces for wear and damage. Also, inspect the valve guides and valves seats.

Measure the following to ensure that wear limits are not exceeded (see Specifications):

- Cylinder head flatness (gasket surface)
- Valve seat width
- Valve stem protrusion from cylinder head
- Valve-to-guide clearance

If removed from the cylinder head, also measure clearances for valve guides and valve seat inserts. Check against specifications.

Refinish the valves, valve seats and guides. Replace parts if required.

Measure valve spring pressure using a spring tester, JIMS® 1090. Replace springs if not within specification.

Assembly

If removed, start the valve guide into the guide bore in the cylinder head. Using an arbor press and valve guide tools, JIMS® 34731-84 and 34740-84, press the guide into the head until it is properly seated.

Ream the bore of the new guides to the following specified diameters, then finish hone and thoroughly clean the bores.

- Intake guide bore diameter, 0.3108–0.3128"
- Exhaust guide bore diameter, 0.3115–0.3128"

Recut the valve seats, removing only enough material so the seats are concentric with the new finished guides. Both intake and exhaust seats should be cut to 45° with nominal seat widths of 0.052" (intake) and 0.059" (exhaust) respectively. To change the seat width to bring it within specification, or raise or lower the seat, cut the lead or trail angles as specified below. Cutting the lead angle will raise and narrow the seat. Cutting the trail angle will lower and narrow the seat.

- **Intake valve seats**
  Lead angle — 60°
  Seat angle — 45°
  Trail angle — 30°
  Seat width — 0.041-0.063" (0.052" nominal)
- **Exhaust valve seats**
  Lead angle — 52°
  Seat angle — 45°
  Trail angle — 30°
  Seat width — 0.048-0.070" (0.059" nominal)

Insert the valves and check valve stem runout and protrusion. Runout should not exceed 0.002" and protrusion should be within 2.065-2.069" from the cylinder head.

Apply a small amount of lapping compound to the valve faces and finish lapping the seats and faces. Remove the valves and thoroughly clean all parts, using care to ensure that no residue remains.

Install the lower collar and stem seal on the valve guide. Lubricate the valve stem with clean engine oil and insert the appropriate valve into the guide from the bottom of the cylinder head.

NOTE: The intake and exhaust valves are different sizes. The diameter of the intake valve is larger than the exhaust valve. Be sure that each is installed in the correct location.

Place the inner and outer springs and upper collar in position over the valve stem and guide. Then, mount the cylinder head in the valve spring compressor tool, JIMS® 96600-36B.

Turn the driving screw in to compress the spring and install the valve locks in the grooves at the top of the valve stem. Turn the driving screw out slowly to release pressure on the spring, making sure that the locks remain in position.

Remove the cylinder head from the tool and repeat the procedure to install the remaining valve.

Installation

Install the two dowel pins in the cylinder and install a new head gasket, making sure the "fire ring" is facing upward.

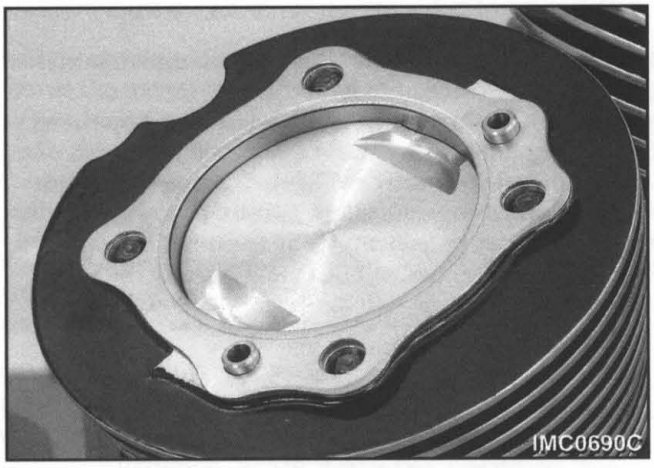


Figure 40 — Installing cylinder head gasket

Place the correct cylinder head in position on the cylinder. Front and rear cylinder heads are different and are marked with an "F" or "R" for identification.

Apply a light coating of oil to the threads of the head bolts and loosely install the two short and two long head bolts at the proper locations.

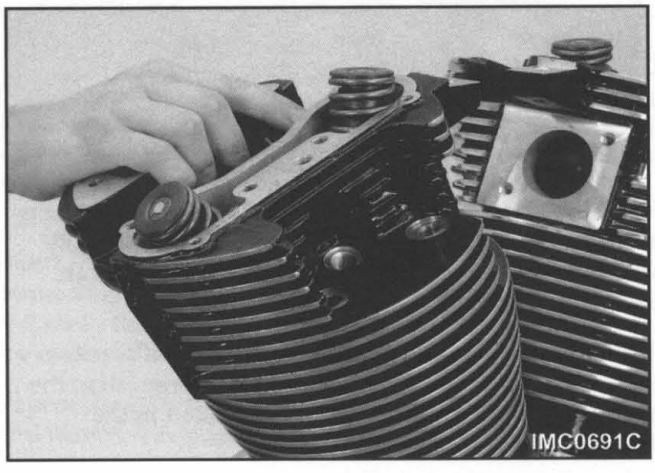


Figure 41 — Installing cylinder head

Using a 1/2" 12-point socket and torque wrench, tighten the head bolts incrementally in three steps following a diagonal cross-head pattern:

Stepped Torque Sequence

1 - Finger tight in sequence
2 - 5 foot pounds in sequence
3- 14 foot pounds in sequence
4 - ¼ turn +/- 2 degrees in sequence

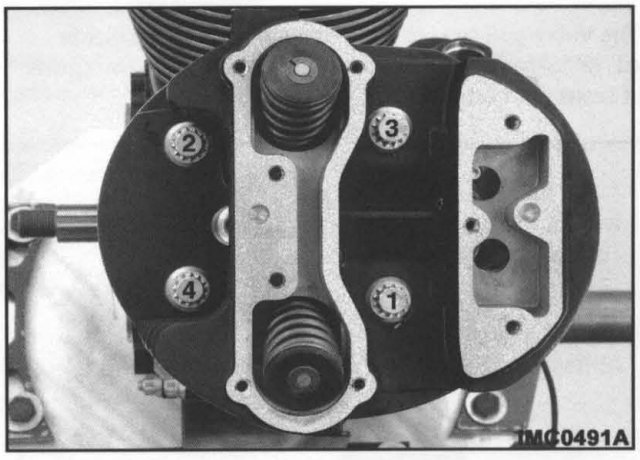


Figure 42 — Torque sequence

Install new gaskets and then place the intake manifold in position on the cylinder heads. Install the mounting screws and tighten to 16-20 foot-pounds.

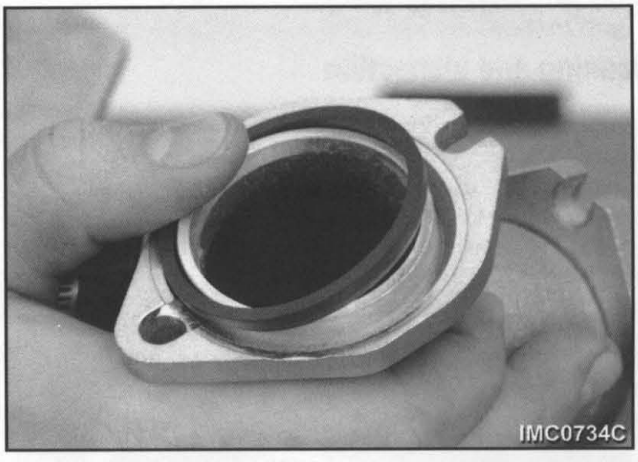


Figure 43 — Installing intake manifold gaskets

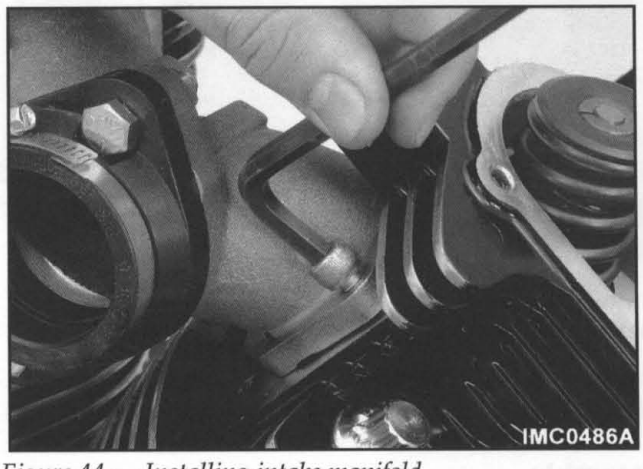


Figure 44 — Installing intake manifold

Install the support bracket between the manifold and the crankcase. Tighten the bolts and nut to 16-20 foot-pounds.

Install the rocker box assembly (see Rocker Box Procedures).