



Buell

AMERICAN MOTORCYCLES

'99/'00 LIGHTNING™ X1

SEWAGE MANAGER

IMPORTANT NOTICE

Buell motorcycles conform to all applicable U.S.A. Federal Motor Vehicle Safety Standards and U.S.A. Environmental Protection Agency regulations effective on the date of manufacture.

To maintain the safety, dependability, and emission and noise control performance, it is essential that the procedures, specifications and service instructions in this manual are followed.

Any substitution, alteration or adjustment of emission system and noise control components outside of factory specifications may be prohibited by law.

Buell Distribution Corporation

1999/2000 BUELL LIGHTNING X1

SERVICE MANUAL

The information in this Service Manual applies
to 1999 and 2000 Buell X1 models.

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1999/2000
Buell X1
Service Manual

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Milwaukee, WI 53201

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FOREWORD

GENERAL

This Service Manual has been prepared with two purposes in mind. First, it will acquaint the user with the construction of the Buell product and assist in the performance of basic maintenance and repair. Secondly, it will introduce to the professional Buell Technician the latest field-tested and factory-approved major repair methods. We sincerely believe that this Service Manual will make your association with Buell products more pleasant and profitable.

HOW TO USE YOUR SERVICE MANUAL

Information is arranged as follows:

- Section 1—Maintenance
- Section 2—Chassis
- Section 3—Engine
- Section 4—Fuel System
- Section 5—Electric Starter
- Section 6—Drive/Transmission
- Section 7—Electrical
- Appendix A—Tools
- Appendix B—Metric Conversions

Use the TABLE OF CONTENTS following this FOREWORD or the INDEX at the back of the book to find the desired subject.

Note that each manual section topic is sequentially numbered in the upper left or right hand corner of the page. The numbering system allows the user to quickly find cross referenced topics by flipping through the pages.

For example, the twelfth topic (CLUTCH) in section one (MAINTENANCE) is listed as:

1.12 CLUTCH

The 1.12 will appear in the upper left or right hand corner of the page.

PREPARATION FOR SERVICE

WARNING

Gasoline is extremely flammable and highly explosive. Always stop the engine when refueling or servicing the fuel system. Do not smoke or allow open flame or sparks near the work site. Inadequate safety precautions may result in personal injury.

Good preparation is very important for efficient service work. A clean work area at the start of each job will allow you to perform the repair as easily and quickly as possible, and will reduce the incidence of misplaced tools and parts. A motorcycle that is excessively dirty should be cleaned before work starts. Cleaning will occasionally uncover sources of trouble. Tools, instruments and any parts needed for the job should be gathered before work is started. Interrupting a job to locate tools or parts is a distraction and causes needless delay. See APPENDIX A—TOOLS for equipment required for special service work.

NOTE

- To avoid unnecessary disassembly, carefully read all relative service information before repair work is started.
- In figure legends, the number which follows the name of a part indicates the quantity necessary for one complete assembly.

SERVICE BULLETINS

In addition to the information presented in this Service Manual, Buell Distribution Corporation will periodically issue Service Bulletins to Buell dealers. Service Bulletins cover interim engineering changes and supplementary information.

USE GENUINE REPLACEMENT PARTS

WARNING

When replacement parts are required, use only genuine Buell parts or parts with equivalent characteristics (which include type, strength and material). Failure to do so may result in product malfunction and possible personal injury.

To ensure satisfactory and lasting repairs, carefully follow the Service Manual instructions and use only genuine Buell replacement parts. This is your assurance that the parts you are using will fit right, operate properly and last longer.

SAFETY DEFINITIONS

Statements in this service manual preceded by the following words are of special significance:

WARNING

WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

CAUTION indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

CAUTION

CAUTION without the safety alert symbol indicates a potentially hazardous situation which, if not avoided, may result in serious property damage.

WARNING

- Proper service and repair is important for the safe, reliable operation of all mechanical products. The service procedures recommended and described in this Service Manual are effective methods for performing service operations. Some of these service operations require the use of tools specially designed for the purpose. These special tools should be used when and as recommended. It is important to note that some warnings against the use of specific service methods, which could damage the motorcycle or render it unsafe, are stated in this Service Manual. However, please remember that these warnings are not all-inclusive.
- Since Buell could not possibly know, evaluate or advise the service trade of all possible ways in which service might be performed, or of the possible hazardous consequences of each method, we have not undertaken any such broad evaluation. Accordingly, anyone who uses a service procedure or tool which is not recommended by Buell must first thoroughly satisfy himself that neither his nor the operator's safety will be jeopardized as a result.
- Wear eye protection when using hammers, arbor or hydraulic presses, gear pullers, spring compressors, slide hammers and similar tools. Be especially cautious when using pulling, pressing or compressing equipment. The forces involved can cause parts to fly outward with considerable force, possibly resulting in personal injury.

Buell products are manufactured under one or more of the following U.S. patents – 4776423, 4951774, 4964484, 4989696, 5209319, 5295702, 5303795, 5332246, 5435584.

PRODUCT REFERENCES

WARNING

Follow the directions listed on all products. Carefully read all labels, warnings and cautions before use. Inadequate safety precautions may result in personal injury.

When reference is made in this Service Manual to a specific brand name product, tool or instrument, an equivalent product, tool or instrument may be substituted.

Kent-Moore Products

All tools mentioned in this manual with an "HD", "J" or "B" preface must be ordered through:

Kent-Moore
SPX Corporation
28635 Mound Road
Warren, Michigan 48092-3499
Telephone: 1-800-345-2233

Sealing and Threadlocking Products

LOCTITE PRODUCTS

Some procedures in this Service Manual call for the use of Loctite® products. If you have any questions regarding Loctite product usage or retailer/wholesaler locations, please call Loctite Corp. at 1-800-323-5106.

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All photographs, illustrations and procedures may not necessarily depict the most current model or component, but are based on the latest production information available at the time of publication.

Since product improvement is our continual goal, Buell Distribution Corporation reserves the right to change specifications, equipment or designs at any time without notice and without incurring obligation.

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SERVICING A NEW MOTORCYCLE

⚠ WARNING

Always follow the listed service and maintenance recommendations, because they affect the safe operation of the motorcycle and the personal welfare of the rider. Failure to follow recommendations could result in death or serious injury.

Service operations to be performed before customer delivery are specified in the applicable model year PREDELIVERY AND SETUP MANUAL.

The performance of new motorcycle initial service is required to keep warranty in force and to ensure proper emissions systems operation.

After a new motorcycle has been driven its first 500 miles (800 km), and at every 2500 mile (4000 km) interval thereafter, have a Buell dealer perform the service operations listed in Table 1-2.

SAFE OPERATING MAINTENANCE

CAUTION

- Do not attempt to retighten engine head bolts. Retightening can cause engine damage.
- During the initial 500 mile (800 km) break-in period, use only Harley-Davidson 20W50 engine oil. Failure to use the recommended oil will result in improper break-in of the engine cylinders and piston rings.

A careful check of certain equipment is necessary after periods of storage, and frequently between regular service intervals, to determine if additional maintenance is required.

Check:

1. Tires for abrasions, cuts and correct pressure.
2. Secondary drive belt for proper tension and condition.
3. Brakes, steering and throttle for responsiveness.
4. Brake fluid level and condition. Hydraulic lines and fittings for leaks. Also, check brake pads and rotors for wear.
5. Cables for fraying, crimping and free operation.
6. Engine oil and transmission fluid levels.
7. Headlamp, passing lamp, tail lamp, brake lamp and turn signal operation.

SHOP PRACTICES

Repair Notes

NOTE

- General maintenance practices are given in this section.
- Repair = Disassembly/Assembly.
- Replace = Removal/Installation.

All special tools and torque values are noted at the point of use.

All required parts or materials can be found in the appropriate PARTS CATALOG.

Safety

Safety is always the most important consideration when performing any job. Be sure you have a complete understanding of the task to be performed. Use common sense. Use the proper tools. Protect yourself and bystanders with approved eye protection. Don't just do the job – do the job safely.

Removing Parts

Always consider the weight of a part when lifting. Use a hoist whenever necessary. Do not lift heavy parts by hand. A hoist and adjustable lifting beam or sling are needed to remove some parts. The lengths of chains or cables from the hoist to the part should be equal and parallel and should be positioned directly over the center of the part. Be sure that no obstructions will interfere with the lifting operation. Never leave a part suspended in mid-air.

Always use blocking or proper stands to support the part that has been hoisted. If a part cannot be removed, verify that all bolts and attaching hardware have been removed. Check to see if any parts are in the way of the part being removed.

When removing hoses, wiring or tubes, always tag each part to ensure proper installation.

Cleaning

If you intend to reuse parts, follow good shop practice and thoroughly clean the parts before assembly. Keep all dirt out of parts; the unit will perform better and last longer. Seals, filters and covers are used in this vehicle to keep out environmental dirt and dust. These items must be kept in good condition to ensure satisfactory operation.

Clean and inspect all parts as they are removed. Be sure all holes and passages are clean and open. After cleaning, cover all parts with clean lint-free cloth, paper or other material. Be sure the part is clean when it is installed.

Always clean around lines or covers before they are removed. Plug, tape or cap holes and openings to keep out dirt, dust and debris.

Disassembly and Assembly

Always assemble or disassemble one part at a time. Do not work on two assemblies simultaneously. Be sure to make all necessary adjustments. Recheck your work when finished. Be sure that everything is done.

Operate the vehicle to perform any final check or adjustments. If all is correct, the vehicle is ready to go back to the customer.

Checking Torques on Fasteners with Lock Patches

To check the torque on a fastener that has a lock patch do the following:

1. Set the torque wrench for the lowest setting in the given torque range for the fastener.
2. Attempt to tighten fastener to set torque. If fastener does not move and lowest setting is satisfied (torque wrench clicks), then the proper torque has been maintained by the fastener.

REPAIR AND REPLACEMENT PROCEDURES

Hardware and Threaded Parts

Install helical thread inserts when inside threads in castings are stripped, damaged or not capable of withstanding specified torque.

Replace bolts, nuts, studs, washers, spacers and small common hardware if missing or in any way damaged. Clean up or repair minor thread damage with a suitable tap or die.

Replace all damaged or missing lubrication fittings.

Use Teflon pipe sealant on pipe fitting threads.

Wiring, Hoses and Lines

Replace hoses, clamps, electrical wiring, electrical switches or fuel lines if they do not meet specifications.

Instruments and Gauges

Replace broken or defective instruments and gauges. Replace dials and glass that are so scratched or discolored that reading is difficult.

Bearings

Anti-friction bearings must be handled in a special way. To keep out dirt and abrasives, cover the bearings as soon as they are removed from the package.

Wash bearings in a non-flammable cleaning solution. Knock out packed lubricant inside by tapping the bearing against a wooden block. Wash bearings again. Cover bearings with clean material after setting them down to dry. Never use compressed air to dry bearings.

Coat bearings with clean oil. Wrap bearings in clean paper.

Be sure that the chamfered side of the bearing always faces the shoulder (when bearings installed against shoulders). Lubricate bearings and all metal contact surfaces before pressing into place. Only apply pressure on the part of the bearing that makes direct contact with the mating part.

Always use the proper tools and fixtures for removing and installing bearings.

Bearings do not usually need to be removed. Only remove bearings if necessary.

Bushings

Do not remove a bushing unless damaged, excessively worn or loose in its bore. Press out bushings that must be replaced.

When pressing or driving bushings, be sure to apply pressure in line with the bushing bore. Use a bearing/bushing driver or a bar with a smooth, flat end. Never use a hammer to drive bushings.

Inspect the bushing and the mated part for oil holes. Be sure all oil holes are properly aligned.

Gaskets

Always discard gaskets after removal. Replace with **new** gaskets. Never use the same gasket twice. Be sure that gasket holes match up with holes in the mating part.

Lip Type Seals

Lip seals are used to seal oil or grease and are usually installed with the sealing lip facing the contained lubricant. Seal orientation, however, may vary under different applications.

Seals should not be removed unless necessary. Only remove seals if required to gain access to other parts or if seal damage or wear dictates replacement.

Leaking oil or grease usually means that a seal is damaged. Replace leaking seals to prevent overheated bearings.

Always discard seals after removal. Do not use the same seal twice.

O-Rings (Preformed Packings)

Always discard O-rings after removal. Replace with **new** O-rings. To prevent leaks, lubricate the O-rings before installation. Apply the same type of lubricant as that being sealed. Be sure that all gasket, O-ring and seal mating surfaces are thoroughly clean before installation.

Gears

Always check gears for damaged or worn teeth.

Lubricate mating surfaces before pressing gears on shafts.

Shafts

If a shaft does not come out easily, check that all nuts, bolts or retaining rings have been removed. Check to see if other parts are in the way before using force.

Shafts fitted to tapered splines should be very tight. If shafts are not tight, disassemble and inspect tapered splines. Discard parts that are worn. Be sure tapered splines are clean, dry and free of burrs before putting them in place. Press mating parts together tightly.

Clean all rust from the machined surfaces of new parts.

Part Replacement

Always replace worn or damaged parts with **new** parts.

CLEANING

Part Protection

Before cleaning, protect rubber parts (such as hoses, boots and electrical insulation) from cleaning solutions. Use a grease-proof barrier material. Remove the rubber part if it cannot be properly protected.

Cleaning Process

Any cleaning method may be used as long as it does not result in parts damage. Thorough cleaning is necessary for proper parts inspection. Strip rusted paint areas to bare metal before repainting.

Rust or Corrosion Removal

Remove rust and corrosion with a wire brush, abrasive cloth, sand blasting, vapor blasting or rust remover. Use buffing crocus cloth on highly polished parts that are rusted.

Bearings

Remove shields and seals from bearings before cleaning. Clean bearings with permanent shields and seals in solution.

Clean open bearings by soaking them in a petroleum cleaning solution. Never use a solution that contains chlorine.

Let bearings stand and dry. Do not dry using compressed air. Do not spin bearings while they are drying.

INSPECTING

Leak Dye

When using leak dye with the black light leak detector, add 1/4 oz. (7.4 ml) of dye for each 1 quart (0.9 l) of fluid in the system being checked.

TOOL SAFETY

Air Tools

- Always use approved eye protection equipment when performing any task using air-operated tools.
- On all power tools, use only recommended accessories with proper capacity ratings.
- Do not exceed air pressure ratings of any power tools.
- Bits should be placed against work surface before air hammers are operated.
- Disconnect the air supply line to an air hammer before attaching a bit.
- Never point an air tool at yourself or another person.
- Protect bystanders with approved eye protection.

Wrenches

- Never use an extension on a wrench handle.

- If possible, always pull on a wrench handle and adjust your stance to prevent a fall if something lets go.
- Never cock a wrench.
- Never use a hammer on any wrench other than a STRIKING FACE wrench.
- Discard any wrench with broken or battered points.
- Never use a pipe wrench to bend, raise or lift a pipe.

Pliers/cutters/prybars

- Plastic- or vinyl-covered pliers handles are not intended to act as insulation; don't use on live electrical circuits.
- Don't use pliers or cutters for cutting hardened wire unless they were designed for that purpose.
- Always cut at right angles.
- Don't use any prybar as a chisel, punch or hammer.

Hammers

- Never strike one hammer against a hardened object, such as another hammer.
- Always grasp a hammer handle firmly, close to the end.
- Strike the object with the full face of the hammer.
- Never work with a hammer which has a loose head.
- Discard hammer if face is chipped or mushroomed.
- Wear approved eye protection when using striking tools.
- Protect bystanders with approved eye protection.

Punches/chisels

- Never use a punch or chisel with a chipped or mushroomed end; dress mushroomed chisels and punches with a file.
- Hold a chisel or a punch with a tool holder if possible.
- When using a chisel on a small piece, clamp the piece firmly in a vise and chip toward the stationary jaw.
- Wear approved eye protection when using these tools.
- Protect bystanders with approved eye protection.

Screwdrivers

- Don't use a screwdriver for prying, punching, chiseling, scoring or scraping.
- Use the right type of screwdriver for the job; match the tip to the fastener.
- Don't interchange POZIDRIV®, PHILLIPS® or REED AND PRINCE screwdrivers.
- Screwdriver handles are not intended to act as insulation; don't use on live electrical circuits.
- Don't use a screwdriver with rounded edges because it will slip – redress with a file.

Ratchets and Handles

- Periodically clean and lubricate ratchet mechanisms with a light grade oil. Do not replace parts individually; ratchets should be rebuilt with the entire contents of service kit.
- Never hammer or put a pipe extension on a ratchet or handle for added leverage.
- Always support the ratchet head when using socket extensions, but do not put your hand on the head or you may interfere with the action of its reversing mechanism.
- When breaking loose a fastener, apply a small amount of pressure as a test to be sure the ratchet's gear wheel is engaged with the pawl.

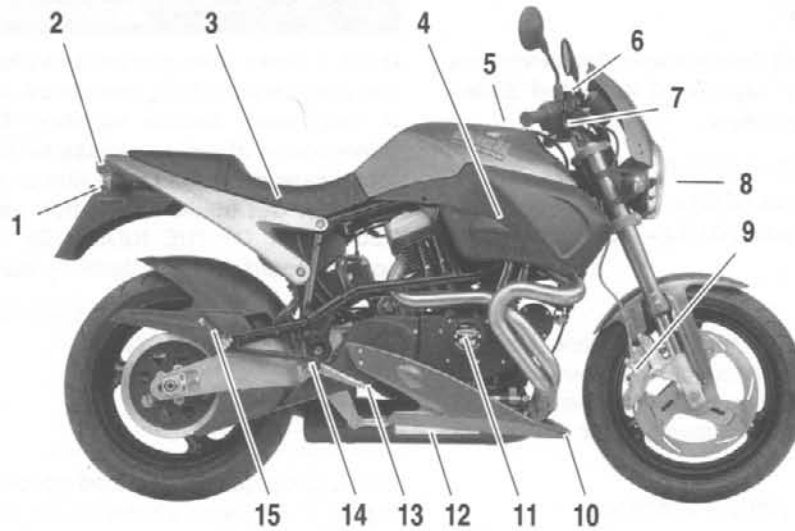
Sockets

- Never use hand sockets on power or impact wrenches.
- Select the right size socket for the job.
- Never cock any wrench or socket.
- Select only impact sockets for use with air or electric impact wrenches.
- Replace sockets showing cracks or wear.
- Keep sockets clean.
- Always use approved eye protection when using power or impact sockets.

Storage Units

- Don't open more than one loaded drawer at a time. Close each drawer before opening up another.
- Close lids and lock drawers and doors before moving storage units.
- Don't pull on a tool cabinet; push it in front of you.
- Set the brakes on the locking casters after the cabinet has been rolled to your work.

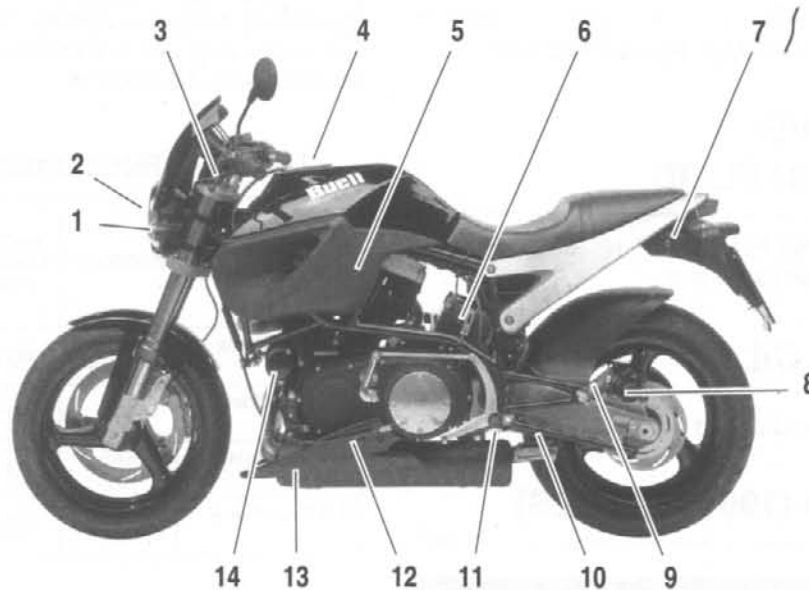
6703



- | | | |
|---------------------------|--------------------------------|-------------------------------|
| 1. Right rear turn signal | 6. Front brake master cylinder | 11. Cam position sensor cover |
| 2. Tail/stop lamp | 7. Front brake hand lever | 12. Rear shock absorber |
| 3. Seat | 8. Headlamp | 13. Rear brake pedal |
| 4. Air cleaner cover | 9. Front brake caliper | 14. Rider footrest |
| 5. Fuel filler cap | 10. Chin fairing | 15. Passenger footrest |

Figure 1-1. 1999 Lightning X1, Right Side View

6702



- | | | |
|---------------------------|------------------------|--------------------|
| 1. Left front turn signal | 6. Battery | 11. Rider footrest |
| 2. Headlamp | 7. Seat lock | 12. Clutch cable |
| 3. Clutch hand lever | 8. Rear brake calliper | 13. Chin fairing |
| 4. Fuel filler cap | 9. Passenger footrest | 14. Oil filter |
| 5. Air scoop | 10. Side stand | |

Figure 1-2. 1999 Lightning X1, Left Side View

GENERAL

United States System

Unless otherwise specified, all fluid volume measurements in this Service Manual are expressed in United States (U.S.) units-of-measure. See below:

- 1 pint (U.S.) = 16 fluid ounces (U.S.)
- 1 quart (U.S.) = 2 pints (U.S.) = 32 fl. oz. (U.S.)
- 1 gallon (U.S.) = 4 quarts (U.S.) = 128 fl. oz. (U.S.)

Metric System

Fluid volume measurements in this Service Manual include the metric system equivalents. In the metric system, 1 liter (L) = 1,000 milliliters (mL). Should you need to convert from U.S. units-of-measure to metric units-of-measure (or vice versa), refer to the following:

- fluid ounces (U.S.) x 29.574 = milliliters
- pints (U.S.) x 0.473 = liters
- quarts (U.S.) x 0.946 = liters
- gallons (U.S.) x 3.785 = liters
- milliliters x 0.0338 = fluid ounces (U.S.)
- liters x 2.114 = pints (U.S.)
- liters x 1.057 = quarts (U.S.)
- liters x 0.264 = gallons (U.S.)

STEERING HEAD BEARING GREASE

Use WHEEL BEARING GREASE (Part No. 99855-89).

PRIMARY DRIVE/ TRANSMISSION FLUID

Use only SPORT-TRANS FLUID (Part No. 98854-96 quart size or Part No. 98855-96 gallon size).

FRONT FORK OIL

Use only TYPE E FORK OIL (Part No. HD-99884-80).

BRAKE FLUID (1999 MODELS)

⚠ CAUTION

D.O.T. 5 SILICONE HYDRAULIC BRAKE FLUID can cause eye irritation and may result in minor or moderate injury. In case of contact with eyes, flush with plenty of water and get medical attention. **KEEP BRAKE FLUID OUT OF THE REACH OF CHILDREN!**

Use only D.O.T. 5 SILICONE HYDRAULIC BRAKE FLUID (Part No. 99902-77) in pre-2000 model Buell motorcycles.

BRAKE FLUID (2000 MODELS)

⚠ WARNING

D.O.T. 4 brake fluid can cause irritation of eyes and skin, and may be harmful if swallowed. If large amount of fluid is swallowed, induce vomiting by administering two tablespoons of salt in a glass of warm water. Call a doctor. In case of contact with skin or eyes, flush with plenty of water. Get medical attention for eyes. **KEEP BRAKE FLUID OUT OF THE REACH OF CHILDREN.** Failure to comply could result in death or serious injury.

Use only D.O.T. 4 BRAKE FLUID (Part No. 99953-99Y) in 2000 model Buell motorcycles.

FUEL

Use a good quality unleaded gasoline (91 pump octane or higher). Pump octane is the octane number usually shown on the gas pump. See 3.2 ENGINE (FUEL) for a detailed explanation of alternative fuels.

ENGINE OIL

Use the proper grade of oil for the lowest temperature expected before the next oil change.

If it is necessary to add oil and Harley-Davidson oil is not available, use an oil certified for diesel engines. Acceptable diesel engine oil designations include CE, CF, CF-4 and CG-4. The preferred viscosities for the diesel engine oils, in descending order, are 20W-50, 15W-40 and 10W-40. At the first opportunity, see a Buell dealer to change back to 100 percent Harley-Davidson oil.

Table 1-1. Recommended Oil Grades

HARLEY-DAVIDSON TYPE	VISCOSITY	HARLEY-DAVIDSON RATING	LOWEST AMBIENT TEMP °F	COLD WEATHER STARTS BELOW 50° F
H.D. Multi-Grade	SAE 10W40	HD 360	Below 40° (4°C)	Excellent
H.D. Multi-Grade	SAE 20W50	HD 360	Above 40° (4°C)	Good
H.D. Regular Heavy	SAE 50	HD 360	Above 60° (16°C)	Poor
H.D. Extra Heavy	SAE 60	HD 360	Above 80° (27°C)	Poor

Table 1-2. Regular Maintenance Intervals

SERVICE OPERATIONS AND SPECIAL TOOLS		SERVICE DATA												Torque 1999 Models: 40 in-lbs (4.5 Nm) 2000 Models: 60-96 in-lbs (6.8-10.9 Nm)			
		A	N	N	U	A	L										
P	R	E	R	I	D	E											
Battery connections (1.4 BATTERY (1999 MODELS), 1.5 BATTERY (2000 MODELS))																	
Engine oil (1.6 ENGINE LUBRICATION SYSTEM) OIL FILTER WRENCH (Part No. HD-41215)		5	0	0	0	0	0	0	0	0	0	0	0	0	0		
Oil filter (1.6 ENGINE LUBRICATION SYSTEM)																	
Brake fluid level and condition (1.7 BRAKES (1999 Models), 1.9 BRAKES (2000 Models))		2	5	0	0	0	0	0	0	0	0	0	0	0	0		
		5	0	0	0	0	0	0	0	0	0	0	0	0	0		

Table Code:
A - Adjust.
I - Inspect, and if necessary, correct, adjust, clean or replace.
L - Lubricate with specified lubricant.

R - Replace or change.
T - Tighten to proper torque.
X - Perform.

**SERVICE OPERATIONS
AND SPECIAL TOOLS**

SERVICE DATA

	P	R	R	E	R	I	D	E	1	1	1	1	2	2	2	2	3	A	N	N	U	A	L
Rear brake pedal height adjustment (1.7 BRAKES (1999 Models), 1.9 BRAKES (2000 Models))	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I					
Brake pads and rotors for wear (1.8 BRAKE PADS AND ROTORS (1999 MODELS), 1.10 BRAKE PADS AND ROTORS (2000 MODELS))	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I					
Front brake rotor fasteners (1999 Models Only) (1.8 BRAKE PADS AND ROTORS (1999 MODELS))	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I					
Condition of rear brake caliper mounting pins and boots													IL	IL	IL	IL	IL						
Tire pressure and inspect tire for wear/damage (1.11 TIRES AND WHEELS)	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I					
Wheel bearings (1.11 TIRES AND WHEELS)																							
Primary drive/transmission fluid (1.12 CLUTCH) REAR WHEEL SUPPORT STAND (Part No. B-41174)	R	I	R	I	R	I	R	I	R	I	R	I	R	I	R	I	R	I					
Clutch adjustment (1.12 CLUTCH)	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A					
Pedal action should be smooth and not binding.																							
Minimum brake pad thickness 0.04 in. (1.0 mm)																							
Minimum brake rotor thickness 0.18 in. (4.5 mm)																							
Check that drive pin assemblies are secure																							
Check pressure when tires are cold.																							
Check for wear and corrosion. Replace in sets only.																							
Fluid type and amount 1.0 quart (0.95 liter) of SPORT-TRANS FLUID (Part No. 98854-96)																							
Fluid level Fluid should reach bottom of clutch spring with motorcycle upright (not on side stand).																							
Drain plug torque 14-21 ft-lbs (19.0-28.5 Nm)																							
Hand lever freeplay 1/16-1/8 in. (1.6-3.2 mm)																							
Clutch inspection cover screw torque 7-9 ft-lbs (9.5-12.2 Nm) in a crosswise pattern																							

Table Code:

- A - Adjust.
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- L - Lubricate with specified lubricant.
- R - Replace or change.
- T - Tighten to proper torque.
- X - Perform.

SERVICE OPERATIONS AND SPECIAL TOOLS	SERVICE DATA																
P R E R I D E	5	0	0	0	0	0	0	1	1	1	2	2	2	2	3	A N N U A L	
MI	MI	MI	MI	MI	MI	MI	MI	MI	MI	MI	MI	MI	MI	MI	MI		
KM	KM	KM	KM	KM	KM	KM	KM	KM	KM	KM	KM	KM	KM	KM	KM		
Rear belt deflection (1.13 REAR BELT DEFLECTION) BELT TENSION GAUGE (Part No. HD-35381)	I	A					I	I	I	I	I	I	I	I	I		Belt deflection with 10 lbs (4.5 kg) of upward force (suspension unloaded) 1.50-1.75 in. (38.1-44.5 mm) Rear axle nut torque 68-73 ft-lbs (89.5-98.9 Nm)
Primary chain (1.15 PRIMARY CHAIN)	I						I	I	I	I	I	I	I	I	I		Chain freeplay with hot engine 1/4-3/8 in. (6.4-9.5 mm) Chain freeplay with cold engine 3/8-1/2 in. (9.5-12.7 mm) Inspection screws torque 40-60 in-lbs (4.5-6.8 Nm)
Rear shock absorber (1.17 SUSPENSION)	I						I	I	I	I	I	I	I	I	I		Check for bushing wear and loose mounting hardware.
Steering head bearing adjustment (1.19 STEERING HEAD BEARINGS)	I						I	IL	IL	IL	IL	IL	IL	IL	IL		Force to pull front wheel to center 4.5-6.5 ft-lbs (2.0-2.9 kg)
Front fork oil (1.18 FRONT FORK OIL) PRO-LEVEL OIL GAUGE (Part No. B-59000A)							I	I	I	I	I	I	R	R	R		Lubricant WHEEL BEARING GREASE (Part No. 99855-89)
Spark plugs (1.20 SPARK PLUGS)							R	R	R	R	R	R	R	R	R		Fork oil HARLEY-DAVIDSON TYPE E Fluid level 3.15 in. (80 mm) from top with fork fully compressed Spark plug type No. 6R12 Spark plug gap 0.038-0.043 in. (0.97-1.09 mm) Lubricant LOCTITE ANTI-SEIZE LUBRICANT Torque 11-18 ft-lbs (14.9-24.4 Nm)

Table Code:

A - Adjust.

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L - Lubricate with specified lubricant.

R - Replace or change.

T - Tighten to proper torque.

X - Perform.

SERVICE OPERATIONS AND SPECIAL TOOLS	SERVICE DATA																									
	P	R	E	R	I	D	E	5	2	7	1	1	1	2	2	2	5	7	3	A	N	N	U	A	L	
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	MI	MI	MI	MI	MI	MI	MI	MI	MI	MI	MI	MI	MI	MI	MI	MI	MI	MI	MI	MI	MI	MI	MI	MI	MI	MI
	KM	KM	KM	KM	KM	KM	KM	KM	KM	KM	KM	KM	KM	KM	KM	KM	KM	KM	KM	KM	KM	KM	KM	KM	KM	KM
Air cleaner filter (1.21 AIR CLEANER FILTER)	I						R																			
Throttle control grip sleeve, cables (2.31 THROTTLE CONTROL)	I						L																			
Front brake hand lever, throttle control cables, clutch control cable and hand lever (Section 2)	L						L																			
Operation of throttle controls (1.22 THROTTLE CABLES)	I						I																			
Engine idle speed (1.23 IGNITION TIMING)	I						I																			
Ignition timing (1.23 IGNITION TIMING)							I																			
HARNES CONNECTOR TEST KIT (Part No. HD-41404)																										
Fuel supply hoses and fittings for leaks							I																			
Fuel Filter (4.36 INLINE FUEL FILTER)							I																			
Rezero Throttle Position Sensor (TPS) (4.33 THROTTLE POSITION SENSOR)																										
Swingarm pivot bolt (2.27 SWINGARM)																										
Swingarm bearings (2.27 SWINGARM)																										
Oil and brake lines (Section 2 and 3)	I						I																			
Side stand (2.50 SIDE STAND)																										
Engine mounts (Section 3)																										
Interlock system (Section 7)																										
Operation of all electrical equipment and switches (Section 7)	I						I																			
All fasteners except engine head bolts																										
Road test																										

Check more often in dusty conditions.
Check for damage and freeplay.
Check for damage and freeplay.
Controls must be smooth and not binding.
Regular idle- 850-1050 RPM
See Section 4.
See Section 4, THROTTLE POSITION SENSOR, Calibration
Lubricant LOCTITE THREADLOCKER 222 (purple)
Lubricant WHEEL BEARING GREASE (Part No. HD 99855-89)
Check for leaks and loose connections.
It is recommended to inspect front and rear brake lines on D.O.T. 4 Brake systems every 4 years and replace as required
It is recommended to inspect front and rear master cylinder and caliper seals on D.O.T. 4 Brake systems every 2 years and replace as required.

Table Code:
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L - Lubricate with specified lubricant.
R - Replace or change.
T - Tighten to proper torque.
X - Perform.

GENERAL

⚠ WARNING

- Batteries contain sulfuric acid which can cause severe burns. Avoid contact with skin, eyes or clothing. Failure to do so could result in death or serious injury.
- Batteries produce explosive hydrogen gas at all times, especially when being charged. Keep cigarettes, open flame and sparks away from the battery at all times. Ventilate area when charging battery. Always protect hands and protect eyes with shield or goggles when working near a battery or acid. **KEEP BATTERIES AND ACID OUT OF THE REACH OF CHILDREN!**

The permanently sealed, maintenance-free battery is below the seat in the center of the vehicle. Remove the battery from the right side of the motorcycle.

The battery requires no additional fluid at any time.

Check the battery:

- At every scheduled service interval.
- When storing or removing the motorcycle from storage for the season.

INSPECTION

⚠ WARNING

Batteries contain sulfuric acid which can cause severe burns. Avoid contact with skin, eyes or clothing. Always wear approved hand and eye protection when working around batteries. Battery electrolyte is poisonous. Keep children away from battery. Failure to do so could result in death or serious injury.

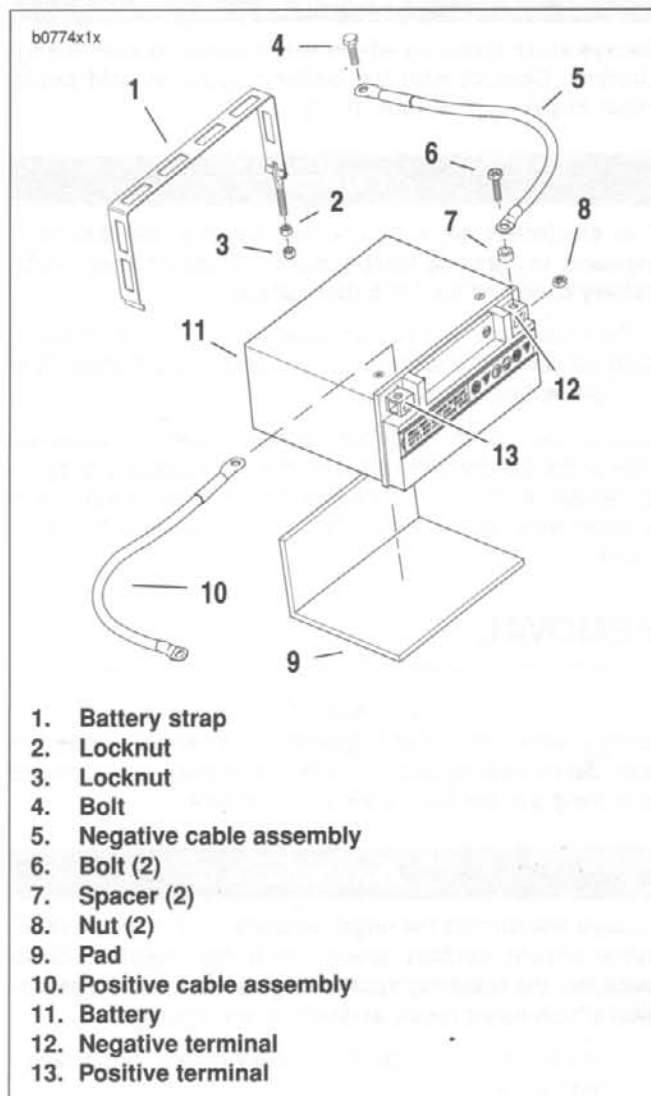
ANTIDOTE

External – Flush with water.

Internal – Drink large quantities of milk or water, followed by Milk of Magnesia, vegetable oil or beaten eggs. Call doctor immediately.

Eyes – Flush with water, get immediate medical attention.

1. Battery top must be clean and dry. Dirt on the top of battery may cause the battery to self-discharge at a faster than normal rate.
2. See Figure 1-3. Inspect battery terminal nuts (8) and cables (5, 10) for breakage, loose connections and corrosion. Clean clamps. Apply light coat of petroleum jelly or corrosion-retardant material to both battery terminals.
3. Inspect battery for discoloration, raised top or warped case which may indicate battery has been overheated or overcharged.
4. Inspect the battery case for cracks or leaks.



1. Battery strap
2. Locknut
3. Locknut
4. Bolt
5. Negative cable assembly
6. Bolt (2)
7. Spacer (2)
8. Nut (2)
9. Pad
10. Positive cable assembly
11. Battery
12. Negative terminal
13. Positive terminal

Figure 1-3. Battery (1999 Models)

⚠ WARNING - EXPLOSIVE GASES

Cigarettes, flames or sparks could cause battery to explode which could result in death or serious injury. Always shield eyes and face from battery. Do not charge without proper instruction and training. Securely connect cables to the proper terminals.

POISON - CAUSES SEVERE BURNS

Contains sulfuric acid. Avoid contact with skin, eyes, and clothing. In event of accident, flush with water and call a physician immediately.

KEEP OUT OF REACH OF CHILDREN

Figure 1-4. Battery Warnings

STORAGE

⚠ WARNING

Always store batteries where they cannot be reached by children. Contact with the battery's sulfuric acid could result in death or serious injury.

CAUTION

The electrolyte in a discharged battery will freeze if exposed to freezing temperatures. Freezing may crack battery case and buckle battery plates.

If the motorcycle will not be operated for several months, such as during the winter season, remove the battery from the vehicle. See REMOVAL.

Charge the battery until the correct voltage is obtained. Charge the battery every other month if it is stored at temperatures below 60°F (16°C). Charge more frequently if stored in a warm area, above 60°F (16°C). See CHARGING BATTERY.

REMOVAL

NOTE

Battery cable routing will depend upon vehicle production date. Some motorcycles may have the battery cables routed over the top of the battery and below oil tank.

⚠ WARNING

Always disconnect the negative cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion which could result in death or serious injury.

1. See Figure 1-5. Disconnect battery cables, negative terminal (4) first.
 - a. Remove bolt (2) (metric) holding negative cable (4) to negative terminal (5). Do not misplace spacer (3) or terminal nut (7).
 - b. Remove bolt (2) (metric) holding positive cable (1) to positive terminal (6). Do not misplace spacer (3) or terminal nut (7).
2. See Figure 1-6. Remove battery strap locknut (3) (metric). Unhook battery strap (2) from frame near negative terminal.
3. Cut any cable straps holding oxygen sensor connector to battery.
4. Remove battery from right side.

NOTE

See 7.9 BATTERY (1999 MODELS) for testing and charging information.

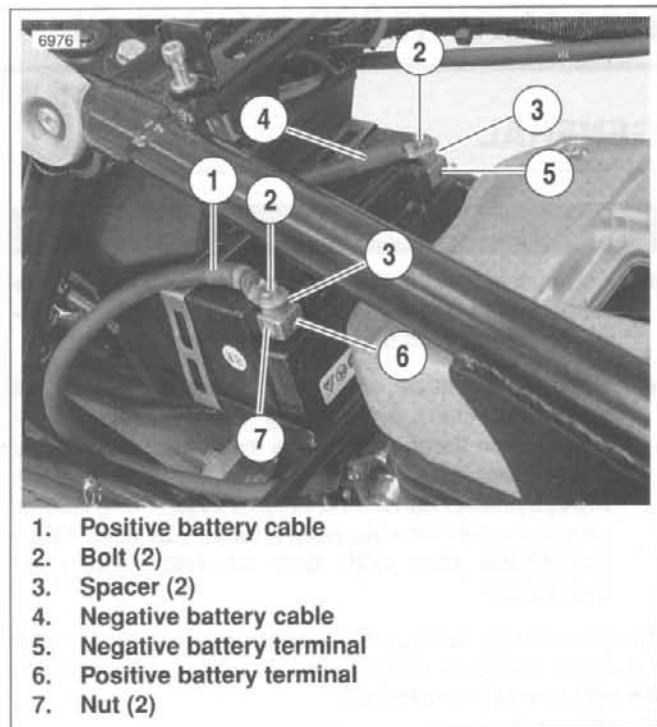


Figure 1-5. Battery Cables

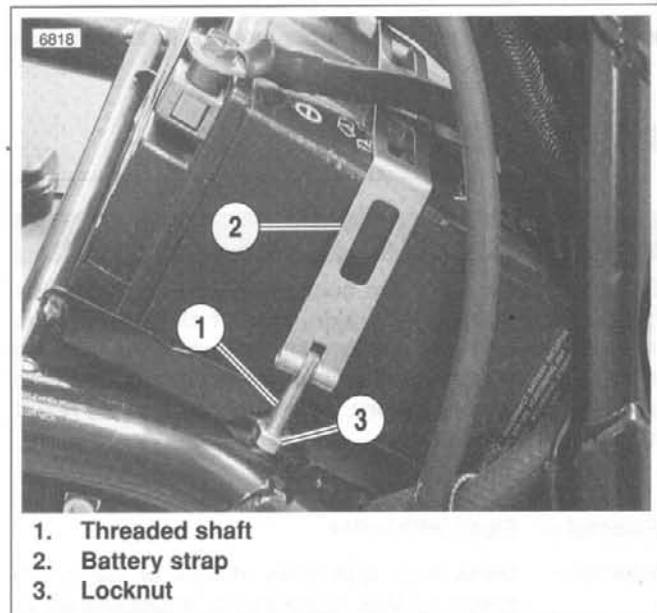


Figure 1-6. Battery Strap, Left Side

INSTALLATION

1. Clean cable connectors and battery terminals using a wire brush or sandpaper to remove any oxidation.
2. See Figure 1-7. Place battery on battery tray pad. Insert battery from right side of motorcycle.

⚠ WARNING

Always connect positive battery cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion which could result in death or serious injury.

CAUTION

Connect cables to correct terminals of battery or serious damage to motorcycle electrical system will occur.

3. See Figure 1-5. Connect battery cables.
 - a. Connect positive cable (1) to positive (+) battery terminal (6) using bolt (2) (metric), spacer (3) and nut (7).
 - b. Connect negative cable (4) to negative (-) battery terminal (5) using bolt (2) (metric), spacer (3) and nut (7).
 - c. Tighten bolts to 40 **in-lbs** (4.5 Nm).
4. Install battery strap.
 - a. See Figure 1-8. Insert tab on right side of battery tray. Place battery strap around top side of battery.
 - b. See Figure 1-6. Hook edge of strap into frame tab.
 - c. Insert threaded shaft (1) on strap through frame tab.
 - d. Install battery strap locknut on threaded shaft. Tighten to 40 **in-lbs** (4.5 Nm).
5. Apply light coat of petroleum jelly or corrosion-retardant material to both battery terminals.
6. Secure oxygen sensor connector with **new** cable straps.

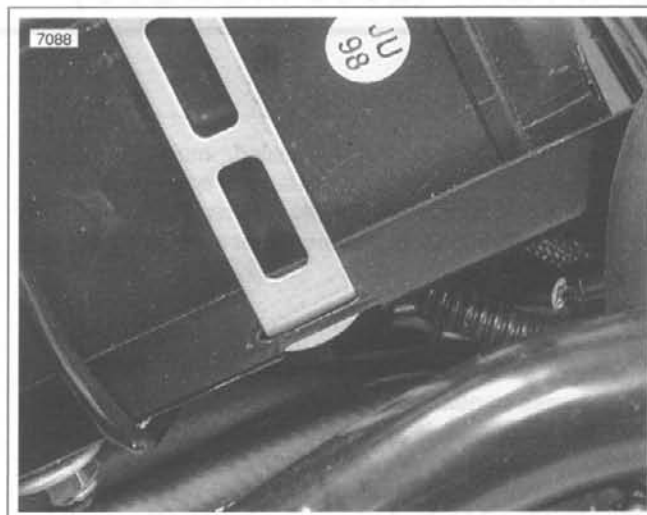


Figure 1-8. Battery Strap, Right Side

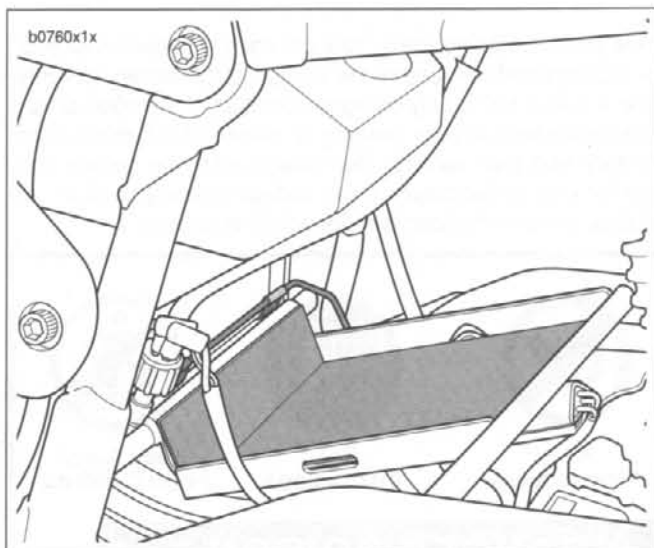


Figure 1-7. Battery Pad

GENERAL

All batteries are permanently sealed, maintenance-free, valve-regulated, lead/calcium and sulfuric acid batteries. The batteries are shipped pre-charged and ready to be put into service. Do not attempt to open these batteries for any reason.

⚠ WARNING

All batteries contain electrolyte. Electrolyte is a sulfuric acid solution that is highly corrosive and can cause severe chemical burns. Avoid contact with skin, eyes, and clothing. Avoid spillage. Always wear protective face shield, rubberized gloves and protective clothing when working with batteries. A warning label is attached to the top of the battery. See Figures 1-9 and 1-10. Never remove warning label from battery. Failure to read and understand all precautions contained in warning label before performing any service on batteries could result in death or serious injury.

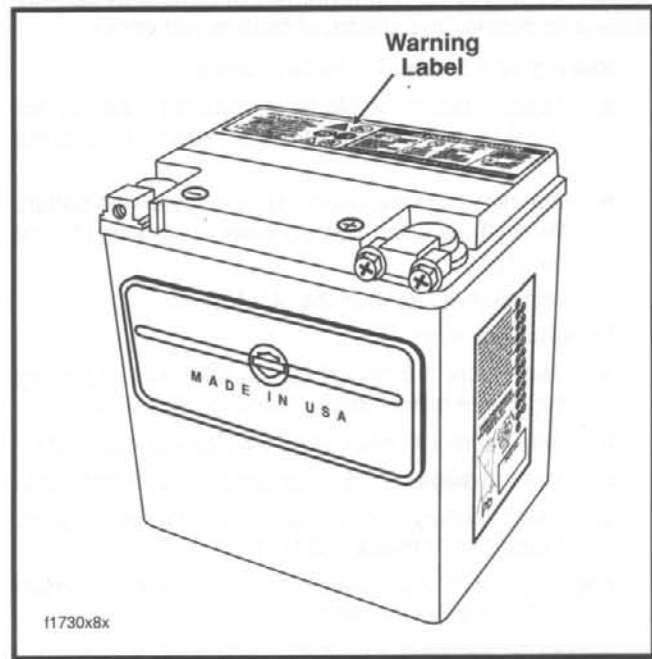


Figure 1-9. Maintenance-Free Battery (Typical)

ANTIDOTE

- External – Flush with water.
- Internal – Drink large quantities of milk or water, followed by milk of magnesia, vegetable oil or beaten eggs. Call doctor immediately.
- Eyes – Flush with water, get immediate medical attention.

BATTERY TESTING

Voltmeter Test

See Table 1. The voltmeter test provides a general indicator of battery condition. Check the voltage of the battery to verify that it is in a 100% fully charged condition. If the open circuit (disconnected) voltage reading is below 12.6V, charge the battery and then recheck the voltage after the battery has set for one to two hours. If the voltage reading is 12.8V or above, perform the load test described in Section 7



Contents are Corrosive.



Wear Safety Glasses.



Contents are Explosive.



Keep Flames Away.



Read Instructions.



Keep Away From Children.

NON-SPILLABLE

This is a ready filled, activated, SEALED BATTERY. NEVER remove strip. Refer to owner's manual for charging instructions.

If battery is put into service after date shown, charge for minimum of 1 hour at 6-10 amps. (See side of battery for date.)

⚠ DANGER/POISON 3-4425



SHIELD EYES.

EXPLOSIVE GASES CAN CAUSE BLINDNESS OR INJURY.



NO SPARKS
FLAMES
SMOKING



SULFURIC ACID CAN CAUSE BLINDNESS OR SEVERE BURNS.



FLUSH EYES IMMEDIATELY WITH WATER. GET MEDICAL HELP FAST.

KEEP OUT OF REACH OF CHILDREN. DO NOT OPEN BATTERY.

f1733x8x

Figure 1-10. Battery Warning Label

Table 1. Voltmeter Test

BATTERY CHARGE CONDITIONS	
Voltage (OCV)	State of Charge
12.8	100%
12.6	75%
12.3	50%
12.0	25%
11.8	0%

DISCONNECTION AND REMOVAL

1. Remove seat. See SEAT, REMOVAL, Section 2.

WARNING

Always disconnect the negative battery cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion that could result in death or serious injury.

2. Unthread bolt and remove battery negative cable (black) from battery negative (-) terminal.
3. Unthread bolt and remove battery positive cable (red) from battery positive (+) terminal.
4. Remove battery strap locknut (metric). Unhook battery strap from frame near negative terminal.
5. Cut any cable straps holding oxygen sensor connector to battery.
6. Remove battery from right side.

CLEANING AND INSPECTION

1. Battery top must be clean and dry. Dirt and electrolyte on top of the battery can cause battery to self-discharge. Clean battery top with a solution of baking soda (sodium bicarbonate) and water (5 teaspoons baking soda per quart or liter of water). When the solution stops bubbling, rinse off the battery with clean water.
2. Clean cable connectors and battery terminals using a wire brush or sandpaper. Remove any oxidation.
3. Inspect the battery screws, clamps and cables for breakage, loose connections and corrosion. Clean clamps.
4. Check the battery posts for melting or damage caused by overtightening.
5. Inspect the battery for discoloration, raised top or a warped or distorted case, which might indicate that the battery has been frozen, overheated or overcharged.
6. Inspect the battery case for cracks or leaks.

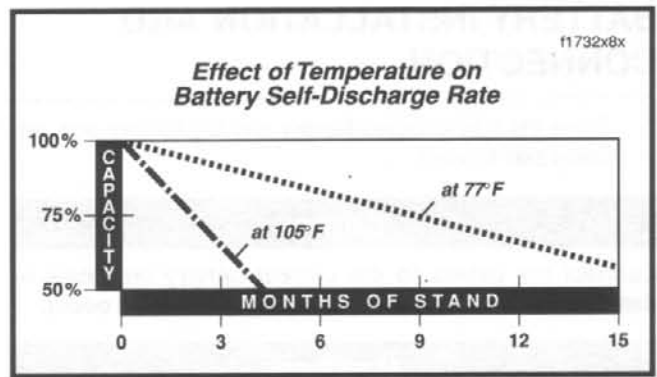


Figure 1-11. Battery Self-Discharge Rate

STORAGE

WARNING

Always store batteries where they cannot be reached by children. Contact with the battery's sulfuric acid could result in death or serious injury.

CAUTION

The electrolyte in a discharged battery will freeze if exposed to freezing temperatures. Freezing may crack the battery case and buckle battery plates.

If the motorcycle will not be operated for several months, such as during the winter season, remove the battery from the motorcycle and fully charge. See CHARGING BATTERY, Section 7.

Self-discharge is a normal condition and occurs continuously at a rate that depends on the ambient temperature and the battery's state of charge. Batteries discharge at a faster rate at higher ambient temperatures. To reduce the self-discharge rate, store battery in a cool (not freezing), dry place. See Figure 1-11.

Charge the battery every month if stored at temperatures below 60° F. (16° C). Charge the battery more frequently if stored in a warm area above 60° F. (16° C).

NOTE

The H-D Battery Tender Automatic Battery Charger (P/N 99863-93TA) may be used to maintain battery charge for extended periods of time without risk of overcharging or boiling.

When returning a battery to service after storage, refer to the instructions under CHARGING BATTERY, Section 7.

BATTERY INSTALLATION AND CONNECTION

1. Place the fully charged battery into the battery box, terminal side forward.

CAUTION

Connect the cables to the correct battery terminals or damage to the motorcycle electrical system will occur.

⚠ WARNING

Always connect the positive battery cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion that could result in death or serious injury.

CAUTION

Overtightening bolts can damage battery terminals.

2. Insert bolt through battery positive cable (red) into threaded hole of battery positive (+) terminal. Tighten bolt to 60-96 **in-lbs** (6.8-10.9 Nm).
3. Insert bolt through battery negative cable (black) into threaded hole of battery negative (-) terminal. Tighten bolt to 60-96 **in-lbs** (6.8-10.9 Nm).
4. Apply a light coat of petroleum jelly or corrosion retardant material to both battery terminals.
5. Install battery strap.
 - a. Insert tab on right side of battery tray. Place battery strap around top side of battery.
 - b. Hook edge of strap into frame tab.
 - c. Insert threaded shaft on strap through frame tab.
 - d. Install battery strap locknut on threaded shaft. Tighten to 40 **in-lbs** (4.5 Nm).
8. Apply light coat of petroleum jelly or corrosion-retardant material to both battery terminals.
9. Secure oxygen sensor connector with **new** cable straps.
6. Install seat. See SEAT, INSTALLATION, Section 2.

CHECKING ENGINE OIL LEVEL

Check engine oil level:

- At least once every 500 miles (800 km).
- At every scheduled service interval.

NOTE

If engine uses more oil than normal or if vehicle is operated under harsh conditions, check oil more frequently.

When checking or changing engine oil:

- Warm vehicle to normal operating temperature.
 - Turn engine off.
 - Hold motorcycle upright (not leaning on side stand) on a level surface.
1. Remove seat.
 2. See Figure 1-13. Remove filler cap/dipstick from oil tank. Wipe dipstick clean.
 3. Install filler cap onto oil tank. Make sure cap is fully seated on tank.

CAUTION

Do not switch oil brands indiscriminately because some oils interact chemically when mixed. Use of inferior oils or non-detergent oils can damage the engine.

4. Remove filler cap again and check oil level on dipstick.
 - a. Oil level should be between upper (1) and lower (2) dipstick level marks.
 - b. If oil level in tank is below lower mark of dipstick, add oil to tank. Recommended viscosity depends upon ambient temperature. See Table 1-3. If it is necessary to add oil and Harley-Davidson oil is not available, use an oil certified for diesel engines. Acceptable diesel engine oil designations include CE, CF, CF-4 and CG-4. The preferred viscosities for the diesel engine oils, in descending order, are 20W-50, 15W-40 and 10W-40. At the first opportunity, see a Buell dealer to change back to 100 percent Harley-Davidson oil.
 - c. Install filler cap/dipstick.

WARNING

After installing seat, pull upward on front of seat to be sure it is locked in position. If seat is loose, it could shift during vehicle operation and startle the rider, causing loss of control which could result in death or serious injury.

5. Install seat.

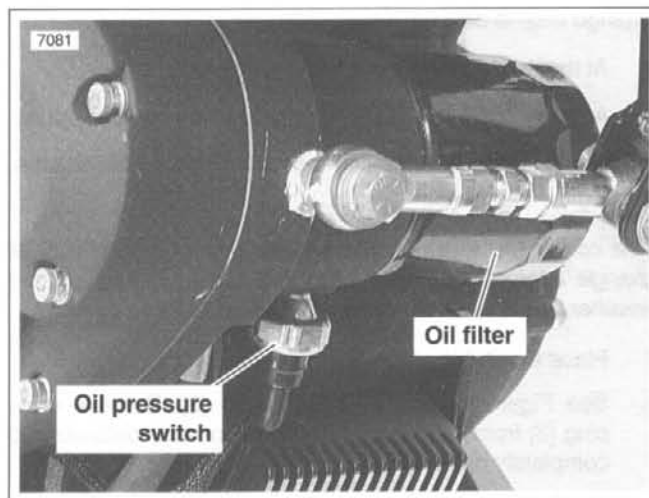


Figure 1-12. Oil Filter and Mount

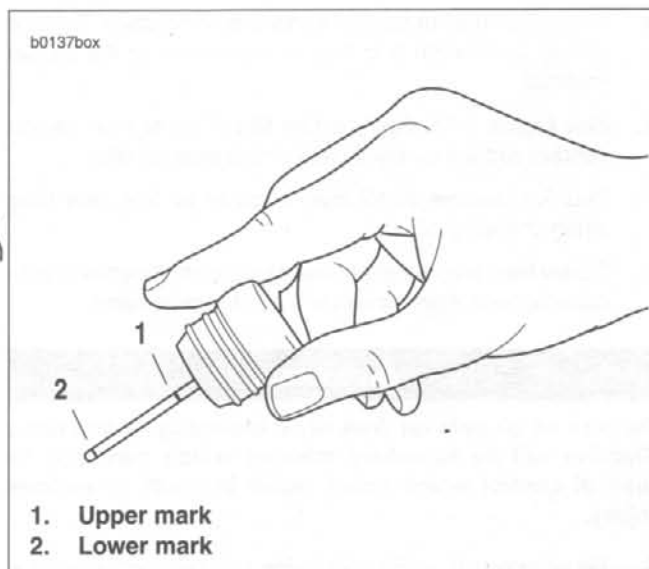


Figure 1-13. Checking Oil Tank Level

Table 1-3. Recommended Oil Grades

HARLEY-DAVIDSON TYPE	VISCOSITY	HARLEY-DAVIDSON RATING	LOWEST AMBIENT TEMP °F	COLD WEATHER STARTS BELOW 50° F
H.D. Multi-Grade	SAE 10W40	HD 360	Below 40° (4°C)	Excellent
H.D. Multi-Grade	SAE 20W50	HD 360	Above 40° (4°C)	Good
H.D. Regular Heavy	SAE 50	HD 360	Above 60° (16°C)	Poor
H.D. Extra Heavy	SAE 60	HD 360	Above 80° (27°C)	Poor

CHANGING ENGINE OIL AND FILTER

Change engine oil:

- At the 500 mile (800 km) service interval.
- At every 5000 mile (8000 km) service interval thereafter.
- When storing or removing the motorcycle for the season.

NOTE

The colder the weather, the shorter the recommended oil change interval. A vehicle used only for short runs in cold weather must have the engine oil drained more frequently.

1. Place a suitable container under the motorcycle.
2. See Figure 1-14. Compress clamp (2). Remove drain plug (3) from drain hose (1). Direct hose to container and completely drain oil tank.
3. Install drain plug (3) on drain hose (1). Tighten clamp (2).
4. Remove oil filter using OIL FILTER WRENCH (Part No. HD-42311).
5. Clean filter gasket contact surface on crankcase. Surface should be smooth and free of any debris or old gasket material.
6. See Figure 1-15. Apply a thin film of oil to filter gasket contact surface on crankcase and to **new** oil filter.
7. Pour 4.0 ounces (0.12 liter) of clean oil into **new** filter when changing oil.
8. Screw filter onto adapter until filter gasket touches crankcase surface. Apply another 1/2-3/4 turn by hand.

⚠ WARNING

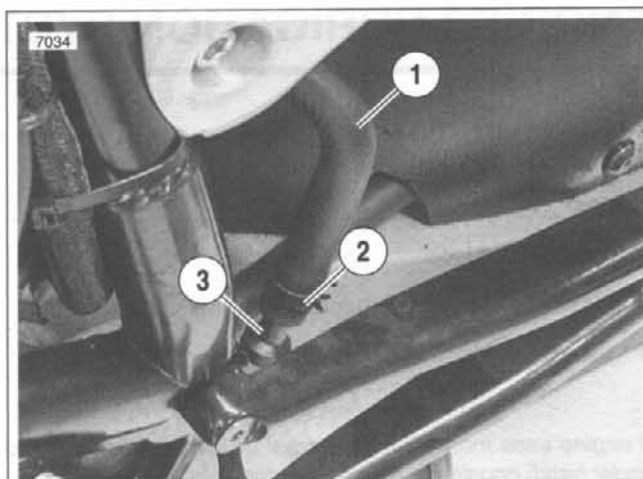
Be sure no oil gets on tires when changing oil and filter. Traction will be adversely affected which may lead to loss of control which could result in death or serious injury.

9. Fill oil tank with an oil from Table 1-3. Oil tank capacity is 2.5 quarts (2.37 liters) including the 4.0 ounces (0.12 liter) added in Step 7.
10. Install filler cap onto oil tank. Make sure filler cap is fully seated.

⚠ WARNING

After installing seat, pull upward on front of seat to be sure it is locked in position. If seat is loose, it could shift during vehicle operation and startle the rider, causing loss of control which could result in death or serious injury.

11. Install seat.
12. See Figure 1-16. Start engine. Verify that oil pressure signal light on instrument support turns off when engine speed is 1000 RPM or above.
13. Check for oil leaks at oil filter and drain hose.
14. Check oil level. See CHECKING ENGINE OIL LEVEL.



1. Drain hose
2. Clamp
3. Drain plug

Figure 1-14. Oil Tank Drain Line

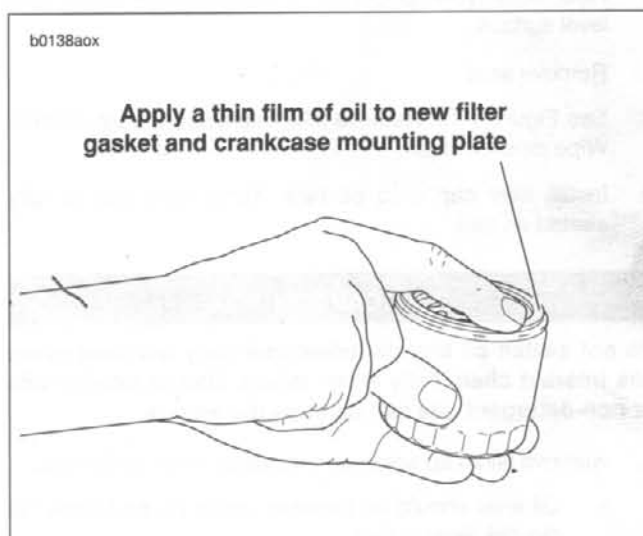


Figure 1-15. Oil Filter

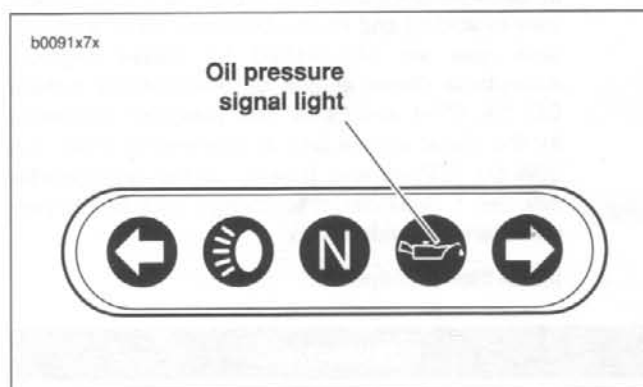


Figure 1-16. Oil Pressure Signal Light

GENERAL

WARNING

D.O.T. 5 brake fluid can cause irritation of eyes and skin. These events could result in death or serious injury. In case of contact with skin or eyes, flush with plenty of water. Get medical attention for eyes. **KEEP BRAKE FLUID OUT OF THE REACH OF CHILDREN.** Failure to comply may result in mild or moderate injury.

Check brake fluid level and condition:

- At the 500 mile (800 km) service interval.
- At every 5000 mile (8000 km) service interval thereafter.
- When storing or removing the motorcycle for the season.

Front brake hand lever and rear brake foot pedal must have a firm feel when brakes are applied. If not, bleed system as described.

BLEEDING BRAKES

NOTE

Hydraulic brake fluid bladder-type pressure equipment can be used to fill brake master cylinder through the bleeder valve. Remove master cylinder reservoir cover so that system cannot pressurize. Do not use pressure bleeding equipment when the hydraulic system is sealed with master cylinder reservoir cover and gasket in place.

1. Install end of a length of plastic tubing over caliper bleeder valve; place other end in a clean container. Stand motorcycle upright.
 - a. Front brake bleeder valve-see Figure 1-17.
 - b. Rear brake bleeder valve-see Figure 1-18.
2. Add D.O.T. 5 SILICONE HYDRAULIC BRAKE FLUID to master cylinder reservoir. Do not reuse brake fluid.
 - a. Bring fluid level to within 1/8 in. (3.2 mm) of molded boss for front master cylinder reservoir.
 - b. Remove seat to locate master cylinder reservoir. Bring fluid level between upper and lower marks for rear master cylinder reservoir.
3. Depress and hold brake lever/pedal to build up hydraulic pressure.
4. Open bleeder valve (metric) about 1/2-turn counterclockwise; brake fluid will flow from bleeder valve and through tubing. When brake lever/pedal has moved 1/2-3/4 of its full range of travel, close bleeder valve (clockwise). Allow brake lever/pedal to return slowly to its released position.
 5. Repeat Steps 2-4 until all air bubbles are purged.
 6. Tighten bleeder valve (metric) to 3-5 ft-lbs (4.1-6.8 Nm).
 7. Verify master cylinder fluid level as described in Step 2.
8. Attach covers to master cylinder reservoirs.
 - a. Tighten screws on master cylinder reservoir cover to 9-13 in-lbs (1.0-1.5 Nm).
 - b. Tighten cap on rear master cylinder securely.

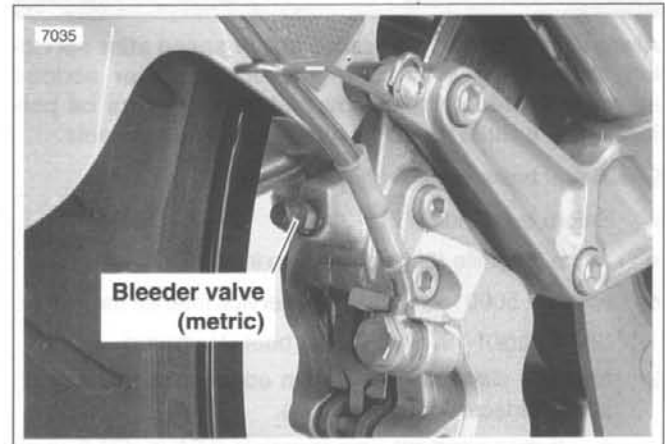


Figure 1-17. Front Brake Bleeder Valve

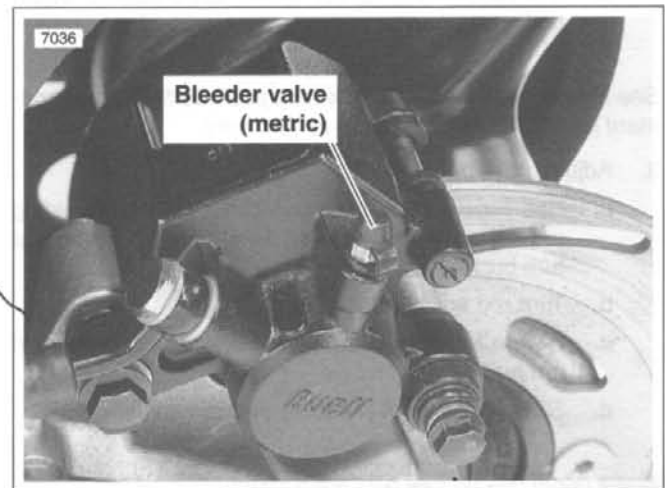


Figure 1-18. Rear Brake Bleeder Valve

WARNING

Always test motorcycle brakes at low speed after servicing or bleeding system. To prevent death or serious injury, Buell recommends that all brake repairs be performed by a Buell dealer or other qualified mechanic.

REAR BRAKE PEDAL

⚠ WARNING

Always test motorcycle brakes at low speed after servicing or bleeding system. To prevent death or serious injury, Buell recommends that all brake repairs be performed by a Buell dealer or other qualified mechanic.

Check rear brake pedal height.

- Before every ride.
 - At the 500 mile (800 km) service interval.
 - At every 5000 mile (8000 km) service interval thereafter.
1. See Figure 1-19. Slide rubber boot (1) upward.
 2. Measure distance from bottom edge of rod adjuster (2) to top surface of turn buckle (4).
 - a. If measurement approximately 0.84 in. (21.3 mm), slide rubber boot (1) down over assembly. Brake pedal adjustment is not needed.
 - b. If measurement is not within specification, adjust brake pedal.

NOTE

See Figure 1-20. Minimum allowable pushrod thread engagement inside turn buckle is 0.24 in. (6.0 mm).

3. Adjust brake pedal.
 - a. See Figure 1-19. Loosen locknut (3) while holding rod adjuster. Move locknut away from top surface of turn buckle.
 - b. Turn rod adjuster to set pedal height.
 - c. Return locknut (3) to fit flush against top surface of turnbuckle (4).
 - d. Slide rubber boot (1) down over rod adjuster (2).

NOTE

Brake pedal has no free play adjustment.

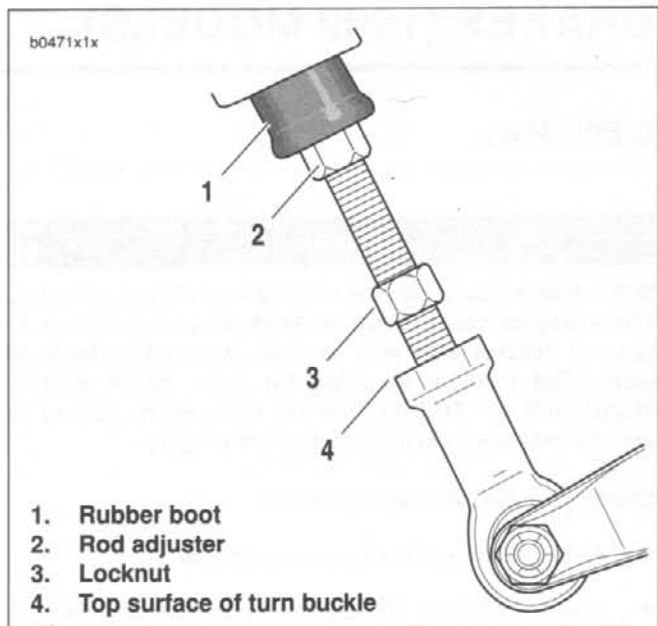


Figure 1-19. Pushrod Adjustment

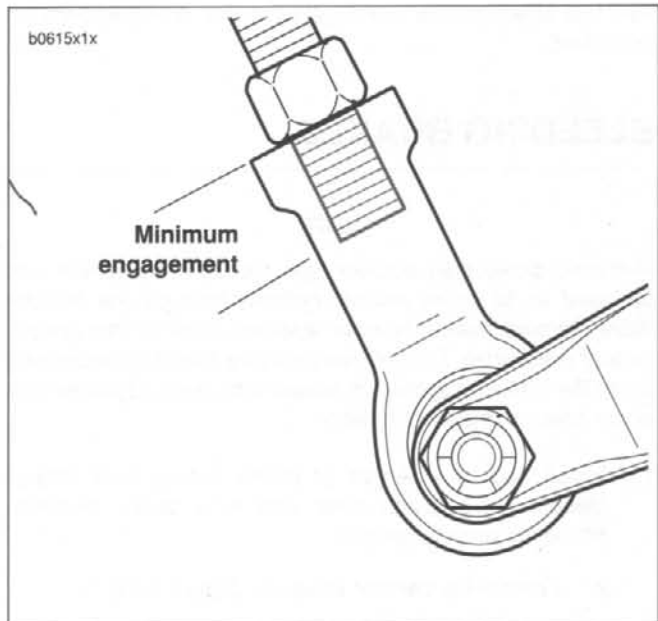


Figure 1-20. Minimum Thread Engagement

BRAKE PADS

⚠ WARNING

Always replace brake pads in complete sets for correct brake operation. Never replace just one brake pad. Failure to install brake pads as a set could result in death or serious injury.

Check brake pads for minimum thickness:

- At the 500 mile (800 km) service interval.
- At every scheduled service interval thereafter.

See Figure 1-21. Inspect brake pads for damage or excessive wear. Replace both pads as a set if friction material (1) of either pad is worn to 0.04 in. (1.0 mm) or less. If this amount of wear occurs, wear grooves (2) will disappear from friction material surface.

- Replace front brake pads using procedure under 2.12 FRONT BRAKE CALIPER (1999 Models).
- Replace rear brake pads using procedure under 2.15 REAR BRAKE CALIPER (1999 models).

BRAKE ROTORS

Brake Rotor Drive Pins

⚠ WARNING

Always test motorcycle brakes at low speed after servicing or bleeding system. To prevent death or serious injury, Buell recommends that all brake repairs be performed by a Buell dealer or other qualified mechanic.

Check fasteners for tightness:

- At the 500 mile (800 km) service interval.
- At every service interval thereafter.

See Figure 1-22. Inspect each drive pin assembly. There must be a minimum clearance of 0.050 in. (1.27 mm) between drive pin assembly and caliper mount bolts.

Brake Rotor Thickness

⚠ WARNING

Do not allow brake fluid, bearing grease, lubricants, etc. to contact brake rotor or reduced braking ability will occur, which could result in death or serious injury.

Check brake rotors for minimum thickness:

- At the 500 mile (800 km) service interval.
 - At every scheduled service interval thereafter.
1. Measure rotor thickness. Replace if minimum thickness is less than 0.18 in. (4.5 mm).
 2. Check rotor surface. Replace if warped or badly scored.

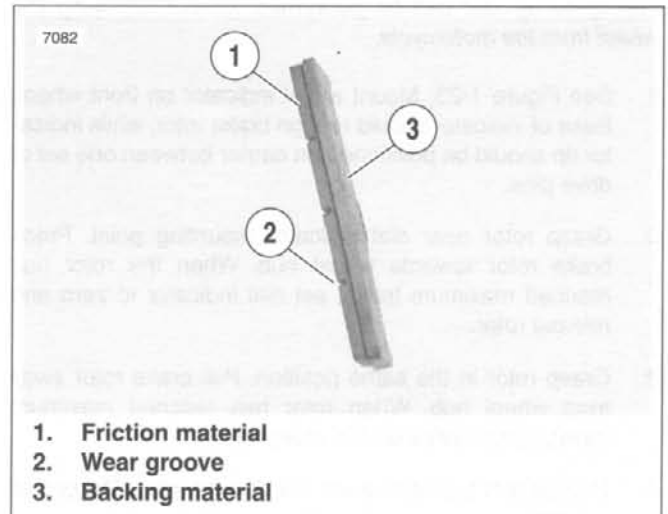


Figure 1-21. Brake Pad Thickness

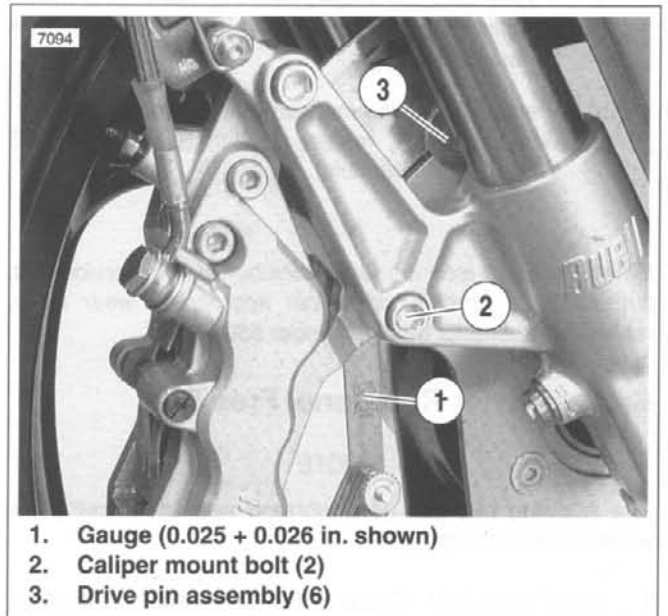


Figure 1-22. Drive Pin Clearance

Brake Carrier Lateral Free Play

NOTE

The following test can be performed without removing the wheel from the motorcycle.

1. See Figure 1-23. Mount a dial indicator on front wheel. Base of indicator should rest on brake rotor, while indicator tip should be positioned on carrier between one set of drive pins.
2. Grasp rotor near dial indicator mounting point. Press brake rotor towards wheel hub. When the rotor has reached maximum travel, set dial indicator to zero and release rotor.
3. Grasp rotor in the same position. Pull brake rotor away from wheel hub. When rotor has reached maximum travel, record value on dial indicator.
4. Repeat test between each set of drive pins. Record all values.
5. Compare test results to service specifications.
 - a. If each recorded measurement is less than 0.100 in. (2.54 mm), brake carrier is within service wear limits for lateral free play.
 - b. If any of the three measurements exceeds the service wear limit, replace carrier. See 2.5 FRONT WHEEL (1999 Models).

NOTE

If the front brake rotor carrier is worn beyond the service limit, but the rotor itself is still within appropriate wear limits, replace components with kit number 53050-96Y.

Brake Carrier Rotational Free Play

NOTE

The following test can be performed without removing the wheel from the motorcycle.

1. See Figure 1-24. Grasp brake rotor and turn it as far counterclockwise as possible. While holding rotor in this manner, place a piece of tape between carrier and brake rotor.
2. Cut the tape and release rotor.
3. See Figure 1-25. Grasp brake rotor and turn it as far as possible in the opposite direction. While holding rotor in this manner, measure the distance the tape has traveled relative to the piece of tape remaining on carrier.
4. Compare test results to service specifications.
 - a. If measurement is less than 0.050 in. (1.27 mm), brake carrier is within service wear limits for rotational free play.
 - b. If measurement exceeds service wear limit, replace carrier. See 2.5 FRONT WHEEL (1999 Models) and note under Brake Carrier Lateral Free Play.

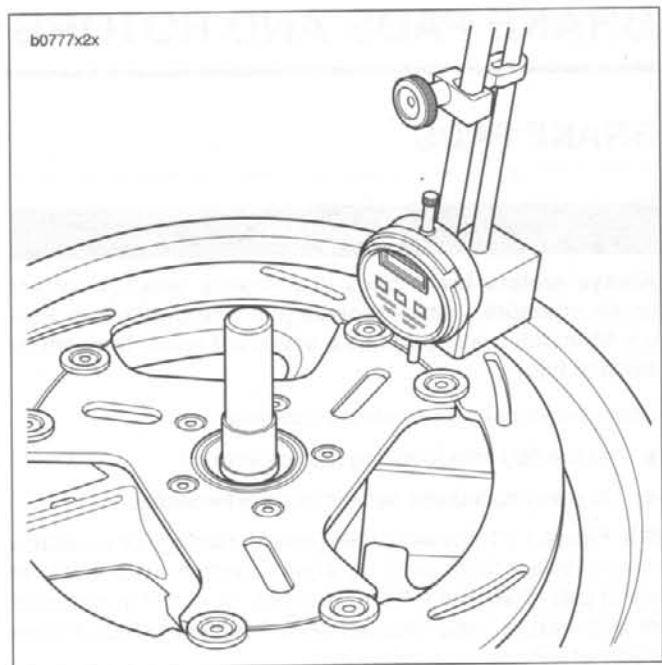


Figure 1-23. Dial Indicator

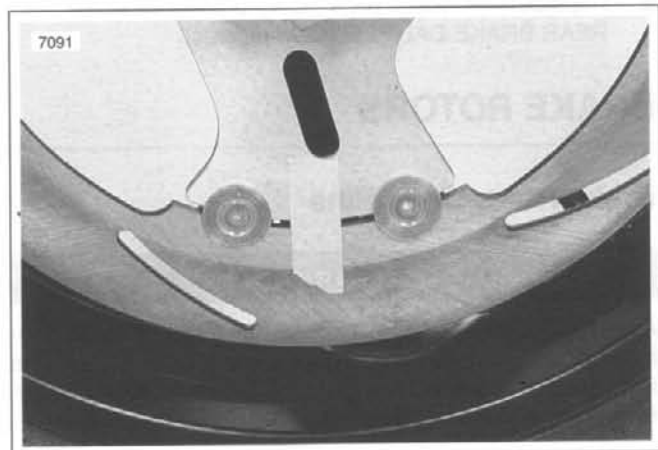


Figure 1-24. Initial Mark

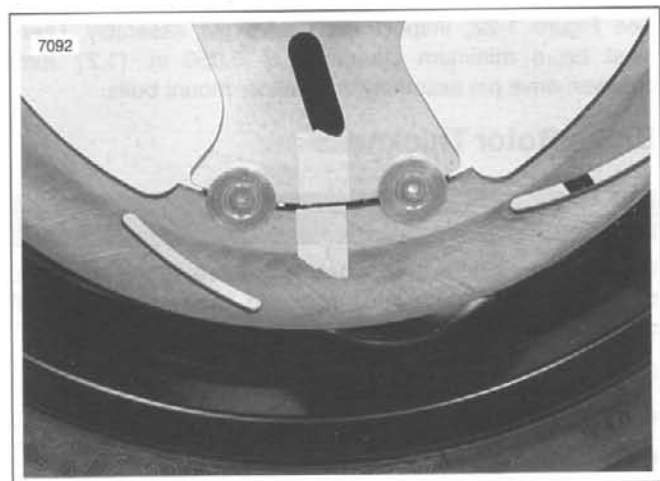


Figure 1-25. Rotation

GENERAL

WARNING

D.O.T. 4 brake fluid can cause irritation of eyes and skin, and may be harmful if swallowed. If large amount of fluid is swallowed, induce vomiting by administering two tablespoons of salt in a glass of warm water. Call a doctor. In case of contact with skin or eyes, flush with plenty of water. Get medical attention for eyes. **KEEP BRAKE FLUID OUT OF THE REACH OF CHILDREN.** Failure to comply could result in death or serious injury.

CAUTION

D.O.T. 4 brake fluid will damage painted surfaces it comes in contact with. Always use caution and protect painted surfaces from spills whenever brake work is performed. Failure to comply may result in cosmetic damage.

Check brake fluid level and condition:

- At the 500 mile (800 km) service interval.
- At every 5000 mile (8000 km) service interval thereafter.
- When storing or removing the motorcycle for the season.

Replace D.O.T. 4 BRAKE FLUID:

- Every 2 years.

Front brake hand lever and rear brake foot pedal must have a firm feel when brakes are applied. If not, bleed system as described.

Inspect front and rear brake lines and replace as required:

- Every 4 years.

Inspect caliper and master cylinder seals and replace as required:

- Every 2 years.

BLEEDING BRAKES

WARNING

D.O.T. 4 brake fluid can cause irritation of eyes and skin, and may be harmful if swallowed. If large amount of fluid is swallowed, induce vomiting by administering two tablespoons of salt in a glass of warm water. Call a doctor. In case of contact with skin or eyes, flush with plenty of water. Get medical attention for eyes. **KEEP BRAKE FLUID OUT OF THE REACH OF CHILDREN.** Failure to comply could result in death or serious injury.

WARNING

Never mix D.O.T. 4 with other brake fluids (such as D.O.T. 5). Use only D.O.T. 4 brake fluid in motorcycles that specify D.O.T. 4 fluid on the reservoir cap. Mixing different types of fluid may adversely affect braking ability and lead to brake failure which could result in death or serious injury.

WARNING

Use only fresh, uncontaminated D.O.T. 4 Fluid. Cans of fluid that have been opened may have been contaminated by moisture in the air or dirt. Use of contaminated brake fluid may adversely affect braking ability and lead to brake failure which could result in death or serious injury.

WARNING

Use only new black banjo washers (See Parts Catalog for Part No.) with D.O.T. 4 brake fluid. Earlier silver banjo washers are not compatible with D.O.T. 4 fluid and will not seal properly over time. Failure to comply may adversely affect braking ability and lead to brake failure which could result in death or serious injury.

CAUTION

D.O.T. 4 brake fluid will damage painted surfaces it comes in contact with. Always use caution and protect painted surfaces from spills whenever brake work is performed. Failure to comply may result in cosmetic damage.

NOTE

Hydraulic brake fluid bladder-type pressure equipment can be used to fill the brake master cylinder through the bleeder valve if master cylinder reservoir cover is removed to prevent pressurization.

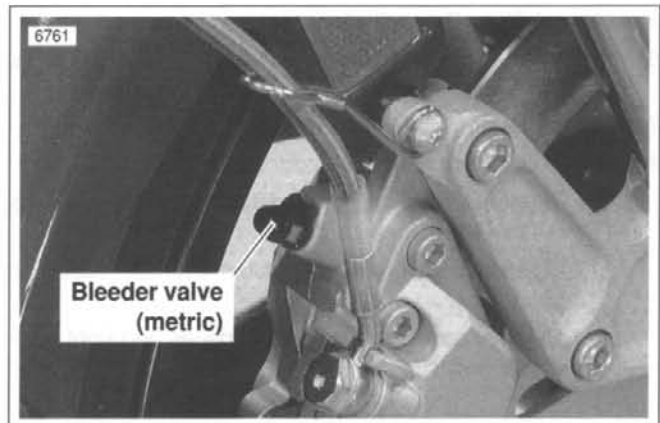


Figure 1-26. Front Brake Caliper Bleeder Valve

1. Install end of a length of plastic tubing over caliper bleeder valve; place other end in a clean container. Stand motorcycle upright.
 - a. Front brake caliper bleeder valve-Figure 1-26.
 - b. Rear brake caliper bleeder valve-Figure 1-27.

CAUTION

Cover painted surfaces and right handlebar switches and use care when removing brake reservoir cover and adding D.O.T. 4 brake fluid. Spilling D.O.T. 4 brake fluid on painted surfaces will result in cosmetic damage. Spilling brake fluid on switches may render them inoperative.

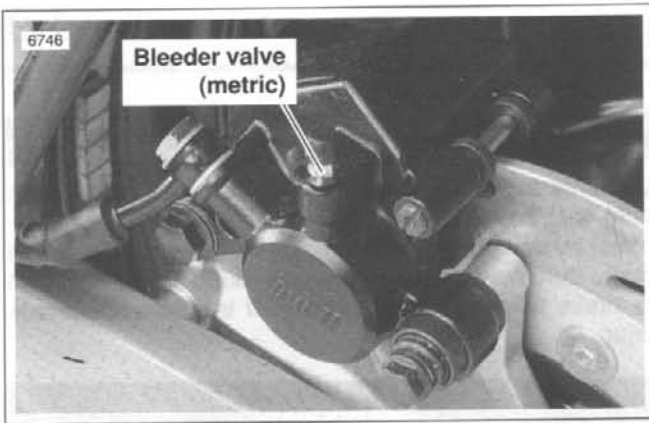


Figure 1-27. Rear Brake Caliper Bleeder Valve

2. Add **D.O.T. 4 BRAKE FLUID** to master cylinder reservoir. Do not reuse brake fluid.
 - a. Cover painted surfaces and right handlebar switches.
 - b. Remove two screws from front master cylinder cover. Bring fluid level to within 1/8 in. (3.2 mm) of molded boss inside front master cylinder. See Figure 1-28.
 - c. Remove cap and gasket from rear master cylinder reservoir. Bring fluid level to between upper and lower marks on reservoir. See Figure 1-29.
3. Depress, release and then hold brake lever/pedal to build up hydraulic pressure.
4. Open bleeder valve about 1/2-turn counterclockwise; brake fluid will flow from bleeder valve and through tubing. When brake lever/pedal has moved 1/2 to 3/4 of its full range of travel, close bleeder valve (clockwise). Allow brake lever/pedal to return slowly to its released position.
5. Repeat Steps 2-4 until all air bubbles are purged.
6. Tighten brake caliper bleeder valves (metric) to 3-5 ft-lbs (4.1-6.8 Nm).
7. Verify master cylinder fluid level as described in Step 2.
8. Attach covers to master cylinder reservoirs.
 - a. Tighten screws on front master cylinder reservoir to 9-13 **in-lbs** (1.0-1.5 Nm).
 - b. Tighten cap on rear master cylinder reservoir securely.
 - c. Remove cover from painted surfaces and right handlebar switches.

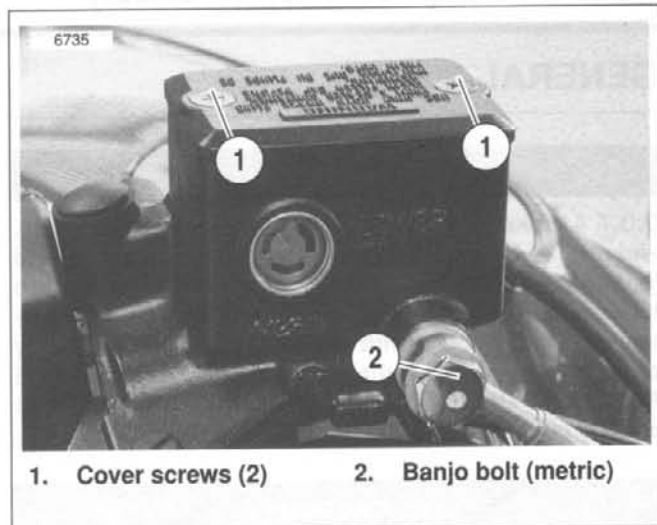


Figure 1-28. Front Master Cylinder

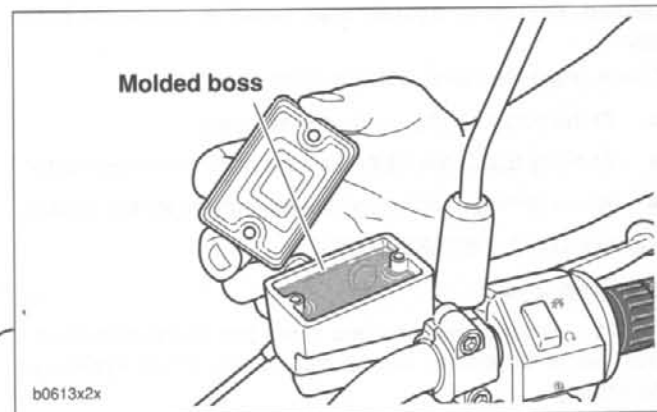


Figure 1-29. Checking Brake Fluid (Switch shown uncovered for clarity)

REAR BRAKE PEDAL

WARNING

Always test motorcycle brakes at low speed after servicing or bleeding system. To prevent death or serious injury, Buell recommends that all brake repairs be performed by a Buell dealer or other qualified mechanic.

Check rear brake pedal height.

- Before every ride.
 - At the 500 mile (800 km) service interval.
 - At every 5000 mile (8000 km) service interval thereafter.
1. See Figure 1-30. Slide rubber boot (1) upward.
 2. Measure distance from bottom edge of rod adjuster (2) to top surface of turn buckle (4).
 - a. If measurement approximately 0.84 in. (21.3 mm), slide rubber boot (1) down over assembly. Brake pedal adjustment is not needed.
 - b. If measurement is not within specification, adjust brake pedal.

NOTE

See Figure 1-31. Minimum allowable pushrod thread engagement inside turn buckle is 0.24 in. (6.0 mm).

3. Adjust brake pedal.
 - a. See Figure 1-30. Loosen locknut (3) while holding rod adjuster. Move locknut away from top surface of turn buckle.
 - b. Turn rod adjuster to set pedal height.
 - c. Return locknut (3) to fit flush against top surface of turnbuckle (4).
 - d. Slide rubber boot (1) down over rod adjuster (2).

NOTE

Brake pedal has no free play adjustment.

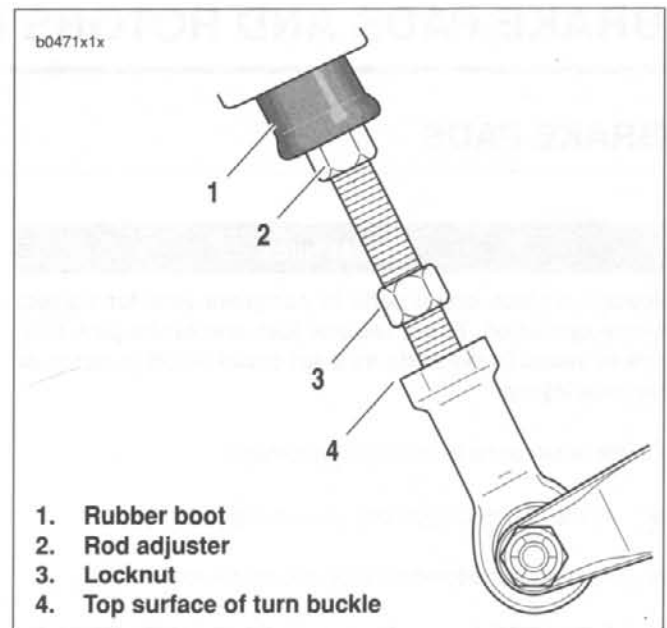


Figure 1-30. Pushrod Adjustment

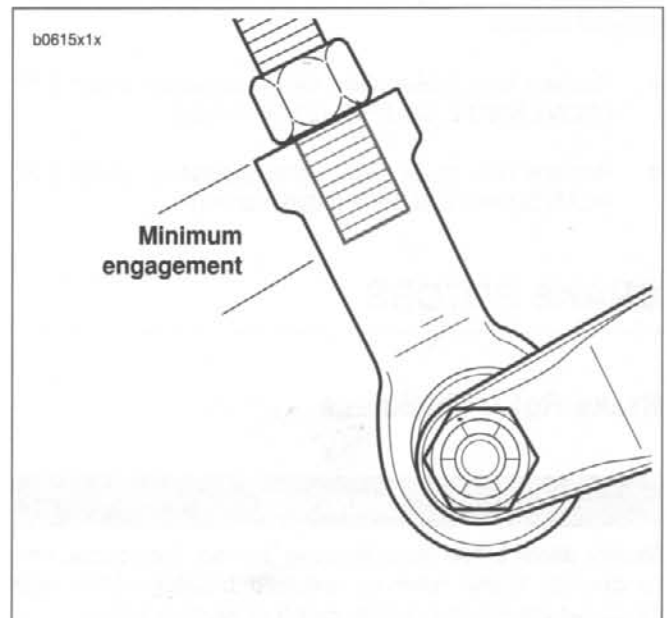


Figure 1-31. Minimum Thread Engagement

BRAKE PADS

⚠ WARNING

Always replace brake pads in complete sets for correct brake operation. Never replace just one brake pad. Failure to install brake pads as a set could result in death or serious injury.

Check brake pads for minimum thickness:

- At the 500 mile (800 km) service interval.
- At every scheduled service interval thereafter.

See Figure 1-32. Inspect brake pads for damage or excessive wear. Replace both pads as a set if friction material (1) of either pad is worn to 0.04 in. (1.0 mm) or less. If this amount of wear occurs, wear grooves (2) will disappear from friction material surface.

- Replace front brake pads using procedure under 2.19 FRONT BRAKE CALIPER (2000 Models).
- Replace rear brake pads using procedure under 2.22 REAR BRAKE CALIPER (2000 models).

BRAKE ROTORS

Brake Rotor Thickness

⚠ WARNING

Do not allow brake fluid, bearing grease, lubricants, etc. to contact brake rotor or reduced braking ability will occur, which could result in death or serious injury.

Check brake rotors for minimum thickness:

- At the 500 mile (800 km) service interval.
 - At every scheduled service interval thereafter.
1. Measure rotor thickness. Replace if minimum thickness is less than 0.18 in. (4.5 mm).
 2. Check rotor surface. Replace if warped or badly scored.
 3. The brake rotor must be within the following specifications. If the brake rotor is suspected of being damaged, inspect rotor using the following measurements:
 - Lateral Movement: 0.3-0.5 mm
 - Radial Movement: 0.45 mm
 - Rotational Movement: 0.39 mm

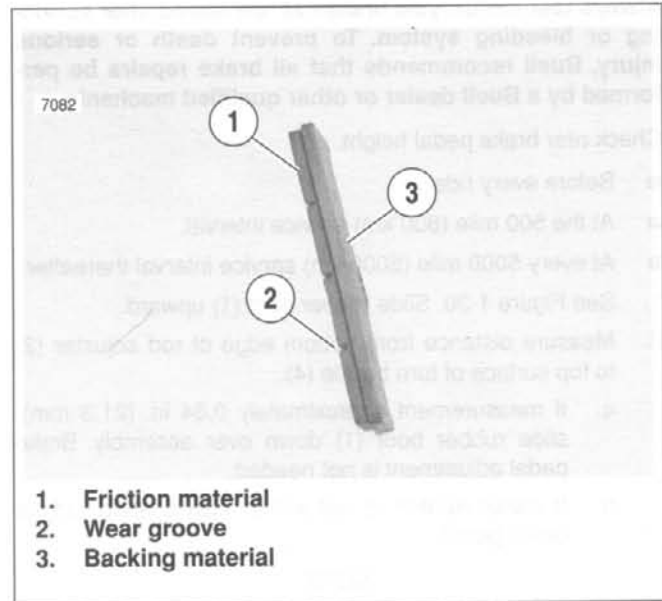


Figure 1-32. Brake Pad Thickness

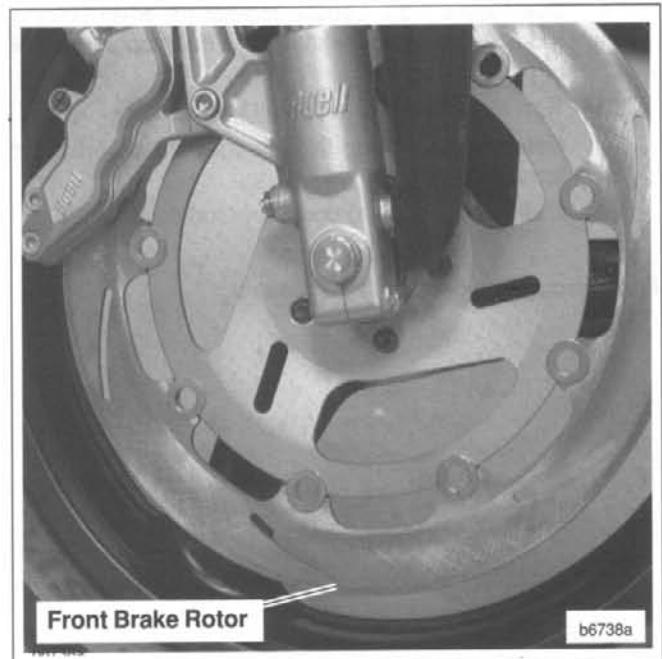


Figure 1-33. Front Brake Rotor

TIRE INFLATION

⚠ WARNING

Do not inflate any tire beyond its maximum inflation pressure as specified on tire sidewall. Overinflation may cause tire to suddenly deflate which could result in death or serious injury.

Check tire pressure and tread:

- Before every ride.
- At the 500 mile (800 km) service interval.
- At every scheduled service interval.

Check for proper front and rear tire pressures when tires are cold. Compare pressure against Table 1-4.

Table 1-4. Tire Pressures

TIRE	PRESSURE FOR SOLO RIDING		PRESSURE AT GVWR	
	PSI	kPa	PSI	kPa
Front	32	220	36	248
Rear	36	248	38	262

WHEEL BEARINGS

⚠ WARNING

Never use compressed air to "spin-dry" bearings. Very high bearing speeds can damage unlubricated bearings. Spinning bearings with compressed air can also cause a bearing to fly apart, which could result in death or serious injury.

Check wheel bearings:

- Every time the wheel is removed.
- At every 10,000 mile (16,000 km) service interval.
- When storing or removing the motorcycle for the season.

Check wheel bearings and axle spacers for wear and corrosion. Excessive play or roughness indicates worn bearings. Replace bearings in sets only.

TRANSMISSION FLUID

Check transmission fluid:

- Replace at the 500 mile (800 km) service interval.
- Inspect level at every 2500 mile (4000 km) service interval.
- Replace at every 5000 mile (8000 km) service interval.

Transmission fluid capacity is approximately 1.0 quart (0.95 liter). For best results, drain fluid while hot.

1. Raise rear wheel off floor using REAR WHEEL SUPPORT STAND (Part No. B-41174). This prevents transmission fluid from spilling out of the clutch inspection cover opening.
2. Remove muffler to access drain plug. See 2.35 EXHAUST SYSTEM.
3. See Figure 1-34. Position a suitable container under drain plug (3). Remove plug and drain fluid.
4. Wipe any foreign material from the magnetic drain plug. Reinstall plug. Tighten to 14-21 ft-lbs (19.0-28.5 Nm).
5. Remove four TORX screws with washers (1) from clutch inspection cover (2). Remove clutch inspection cover from primary cover. Do not damage or dislodge Quad ring from primary cover.

CAUTION

Do not overfill the transmission with fluid. Overfilling may cause rough clutch engagement and incomplete disengagement, clutch drag and/or difficulty finding neutral at engine idle.

6. See Figure 1-35. Add SPORT-TRANS FLUID (Part No. 98854-96 quart size; Part No. 98855-96 gallon size) as required until fluid level (4) is even with bottom of clutch diaphragm spring (3).
7. See Figure 1-34. Install clutch inspection cover (2) using four TORX screws with washers (1). Tighten in a cross-wise pattern to 7-9 ft-lbs (9.5-12.2 Nm).
8. Install muffler. See 2.35 EXHAUST SYSTEM.

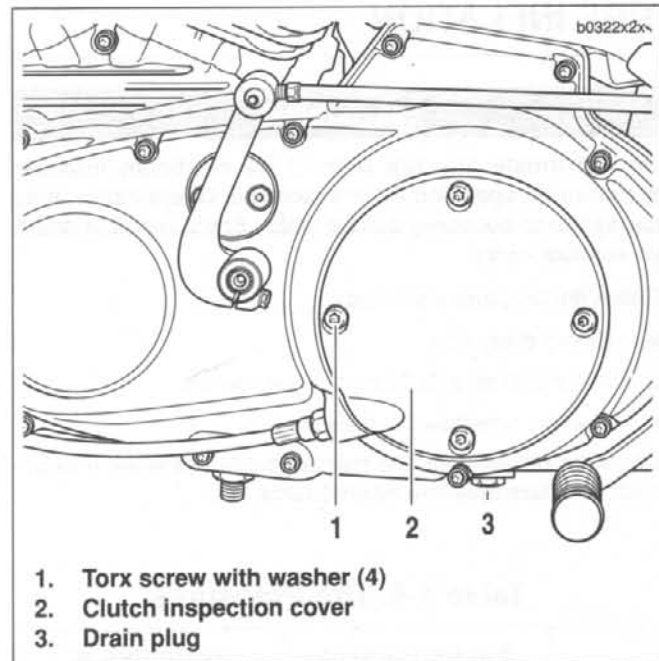


Figure 1-34. Primary Cover

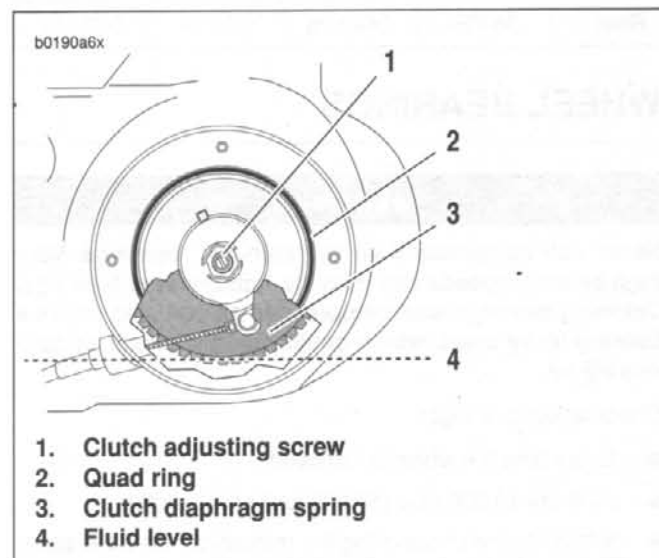


Figure 1-35. Fluid Level

ADJUSTMENT

Check clutch adjustment:

- At the 500 mile (800 km) service interval.
- At every 5000 mile (8000 km) service interval thereafter.

If clutch slips under load or drags when released, first check control cable adjustment. If cable adjustment is within specifications, adjust clutch mechanism as described below.

When necessary, lubricate cable with LUBIT-8 TUFOIL® CHAIN AND CABLE LUBE (Part No. HD-94968-85TV).

1. Raise rear wheel off floor using REAR WHEEL SUPPORT STAND (Part No. B-41174).
2. See Figure 1-36. Slide rubber boot (1) upward to expose adjuster mechanism. Loosen jam nut (3) from adjuster (4). Turn adjuster to shorten cable housing until there is a large amount of free play at clutch hand lever.
3. See Figure 1-37. Remove four TORX screws with washers (1) from clutch inspection cover (2). Remove clutch inspection cover from primary cover. Do not damage or dislodge Quad ring (3) from primary cover.

NOTE

Quad ring removed from primary cover for illustrative purposes only in Figure 1-37.

4. Remove spring (4) and lockplate (5). Turn adjusting screw (6) counterclockwise until it lightly bottoms.
5. Turn adjusting screw (6) clockwise 1/4 turn. Install lockplate (5) and spring (4) on adjusting screw flats. If hex on lockplate does not align with recess in outer ramp, rotate adjusting screw clockwise until it aligns.
6. Squeeze clutch hand lever to maximum limit three times. This sets the ball and ramp mechanism. Pull outer cable conduit and at the same time adjust cable adjuster to provide 1/16-1/8 in. (1.6-3.2 mm) free play at clutch hand lever. Adjust as follows.
 - a. See Figure 1-38. Pull ferrule (1) (end of cable housing) away from bracket (2). Gap between ferrule and bracket should be 1/16-1/8 in. (1.6-3.2 mm).
 - b. See Figure 1-36. Set free play by turning adjuster (4).
 - c. Tighten jam nut (3) against adjuster (4).
 - d. Slide boot (1) over cable adjuster mechanism.
7. Change or add transmission fluid if necessary.
8. See Figure 1-37. Install clutch inspection cover (2) using four TORX screws with washers (1). Tighten in a cross-wise pattern to 7-9 ft-lbs (9.5-12.2 Nm).
9. Check clutch cable free play. See Step 6 above.

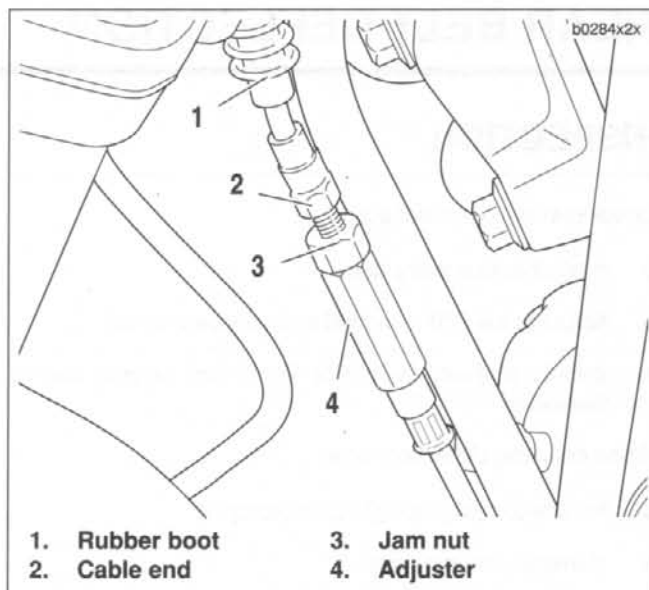


Figure 1-36. Clutch Cable Adjuster Mechanism

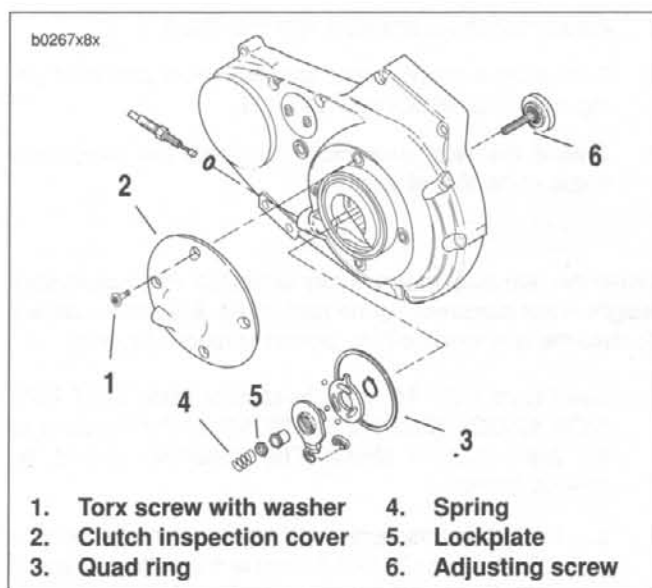


Figure 1-37. Clutch Release Mechanism

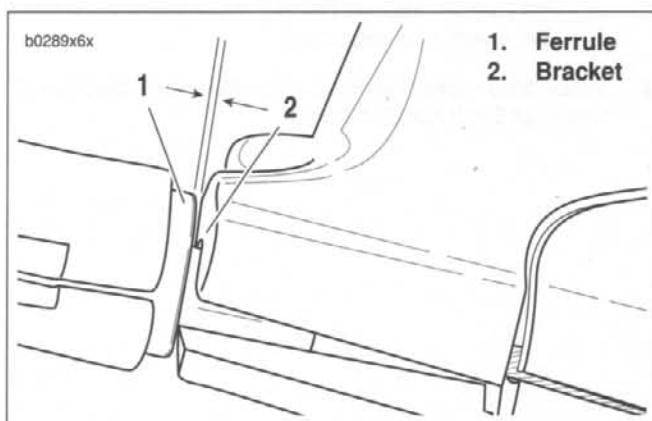


Figure 1-38. Adjusting Clutch Free Play

INSPECTION

Check rear drive belt deflection:

- Inspect before every ride.
- Adjust at the 500 mile (800 km) service interval.
- Inspect at every 5000 mile (8000 km) service interval thereafter.

When checking deflection, have:

- No rider or cargo weight on motorcycle.
 - Transmission in neutral.
 - Belt and sprockets at room temperature.
 - Motorcycle upright (not on side stand).
1. Adjust rear shock absorber spring preload.
 2. Detach drive support arm, sprocket cover and chin fairing. See 2.38 SPROCKET COVER.
 3. Unload the rear suspension by lifting the motorcycle frame under the tail section.

NOTE

When the rear suspension is fully unloaded, the motorcycle's weight is not compressing the rear shock. It is not necessary to raise the rear wheel off the ground to reach this point.

4. See Figure 1-39. Apply 10 lbs of force using BELT TENSION GAUGE (Part No. HD-35381) at the midpoint of the belt's bottom strand. The deflection should be upward as shown.
 - a. Deflection (measured with 10 lbs of force) should be 1.50-1.75 in. (38.1-44.5 mm) at the bottom strand. If deflection is within limits, see Axle Alignment under ADJUSTMENT.
 - b. If belt requires adjustment, see Deflection Adjustment under ADJUSTMENT. After adjusting deflection, check axle alignment.
5. Install drive support arm, sprocket cover and chin fairing. See 2.38 SPROCKET COVER.

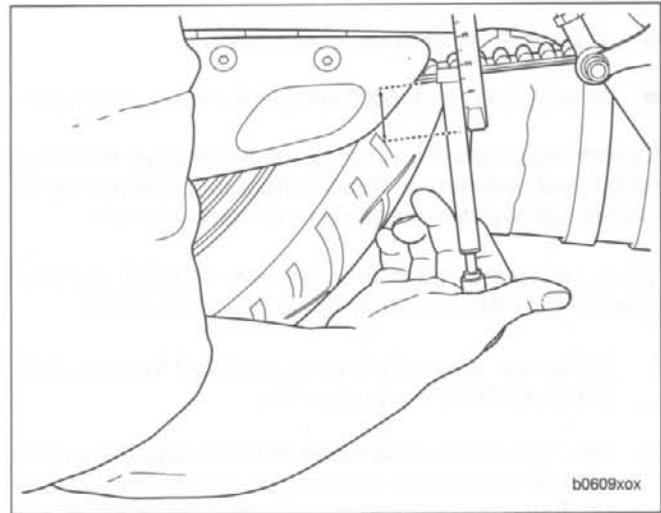


Figure 1-39. Belt Deflection

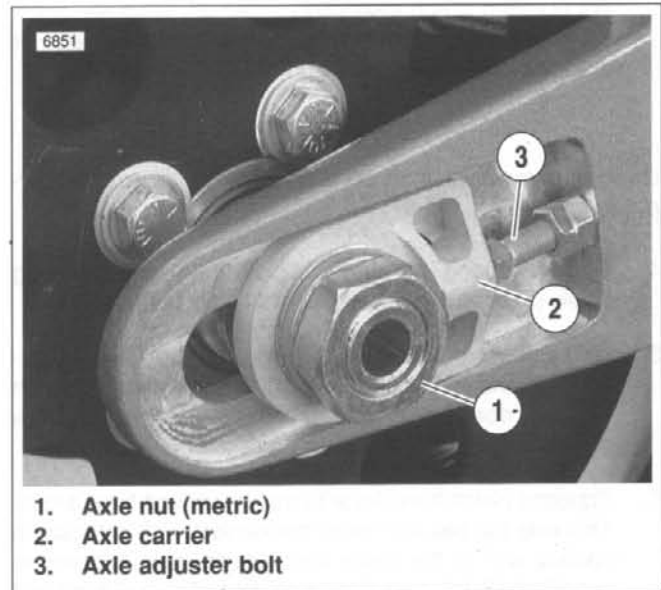


Figure 1-40. Rear Axle Adjuster

ADJUSTMENT

Axle Alignment

Check to be sure rear wheel axle is parallel with swingarm pivot shaft.

1. See Figure 1-41. Measure each side from the flat of the axle carrier to the flat of the swingarm.
 - a. If the measurements are equal ± 0.015 in. (0.381 mm) the rear axle is correctly aligned.
 - b. If the two measurements are not equal, adjustment is required. Follow Deflection Adjustment below.

Deflection Adjustment

2. See Figure 1-40. Loosen rear axle nut (1) (metric), if not already loose.

NOTE

See Figure 1-42. Use an automotive-style ignition wrench to hold axle adjuster bolt (1) in place during Step 2.

3. To adjust belt deflection/rear wheel alignment, loosen locknut (2), hold axle adjuster bolt (1) and turn adjusting nut (3).
 - a. If belt is too loose, tighten adjusting nut (3) to decrease deflection and therefore increase drive belt tension.
 - b. If belt is too tight, loosen adjusting nut (3) to increase belt deflection and therefore decrease drive belt tension.
 - c. See Figure 1-41. Repeat this step until the distance between the flat on the axle carrier and the flat of the swingarm is the same on both sides of the rear wheel and belt deflection is correct.
4. See Figure 1-42. Tighten locknut (2) flush against adjusting nut (3).
5. Tighten axle nut (metric) to 66-73 ft-lbs (89.5-98.9 Nm).
6. Verify that belt deflection is correct.

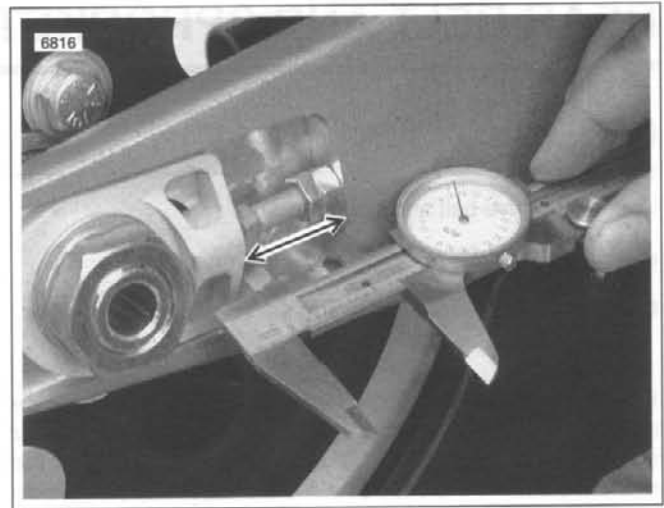


Figure 1-41. Checking Rear Wheel Alignment, Right Side Shown

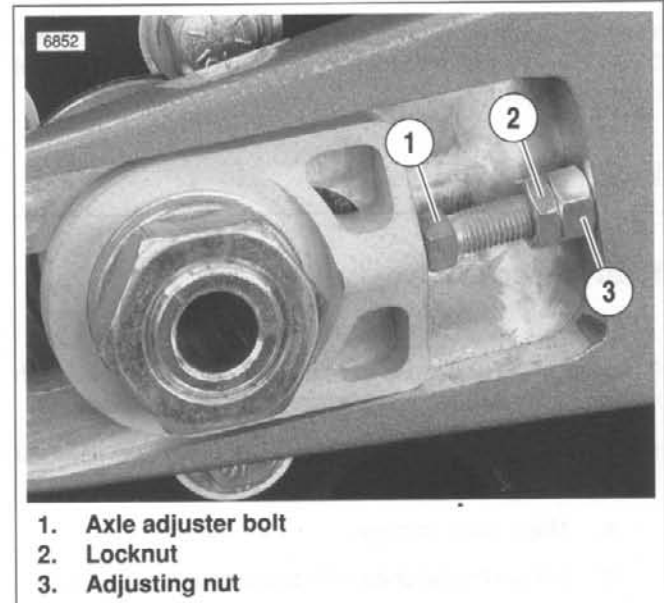


Figure 1-42. Axle Adjuster Bolt, Right Side Shown

GENERAL

Inspect the drive belt and rear sprocket:

- At the 500 mile (800 km) service interval.
- At every 5000 mile (8000 km) service interval thereafter.

NOTE

When a drive belt is replaced for any reason other than stone damage, it is recommended that the transmission and rear sprockets also be replaced to increase the longevity of the new drive belt. In the case of stone damage, inspect sprockets for damage and replace as required.

CLEANING

Keep dirt, grease, oil, and debris off the belt and sprockets. Clean the belt with a rag which is slightly damp with a light cleaning agent.

INSPECTION

Rear Sprocket

NOTE

If chrome chips or gouges to rear sprocket are large enough to be harmful, they will leave a pattern on the belt face.

1. See Figure 1-43. Inspect each tooth (1) of rear sprocket for:
 - a. Major tooth damage.
 - b. Large chrome chips with sharp edges.
 - c. Gouges caused by hard objects.
 - d. Excessive loss of chrome plating (see Step 2).
2. To check if chrome plating has worn off, drag a scribe or sharp knife point across the bottom of a groove (2) (between two teeth) with medium pressure.
 - a. If scribe or knife point slides across groove without digging in or leaving a visible mark, chrome plating is still good.
 - b. If scribe or knife points digs in and leaves a visible mark, it is cutting the bare aluminum. A knife point will not penetrate the chrome plating.
3. Replace rear sprocket if major tooth damage or loss of chrome exists.

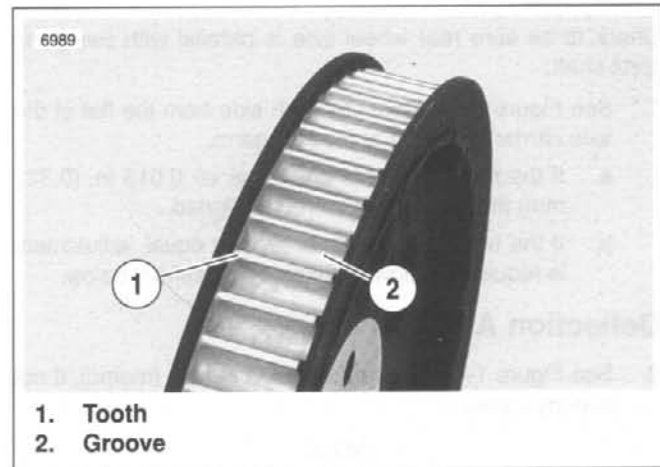


Figure 1-43. Rear Sprocket

Drive Belt

See Figure 1-44. Inspect drive belt for:

- Cuts or unusual wear patterns.
- Outside edge bevelling (8). Some bevelling is common, but it indicates that sprockets are misaligned.
- Outside ribbed surface for signs of stone puncture (7). If cracks/damage exists near edge of belt, replace belt immediately. Damage to center of belt will require belt replacement eventually, but when cracks extend to edge of belt, belt failure is imminent.
- Inside (toothed portion) of belt for exposed tensile cords (normally covered by nylon layer and polyethylene layer). This condition will result in belt failure and indicates worn transmission sprocket teeth. Replace belt and transmission sprocket.
- Signs of puncture or cracking at the base of the belt teeth. Replace belt if either condition exists.
- Replace belt if conditions 2, 3, 6 or 7 (on edge of belt) exist.

NOTE

Condition 1 may develop into 2 or 3 over time. Condition 1 is not grounds for replacing the belt, but it should be watched closely before condition 2 develops which will require belt replacement.

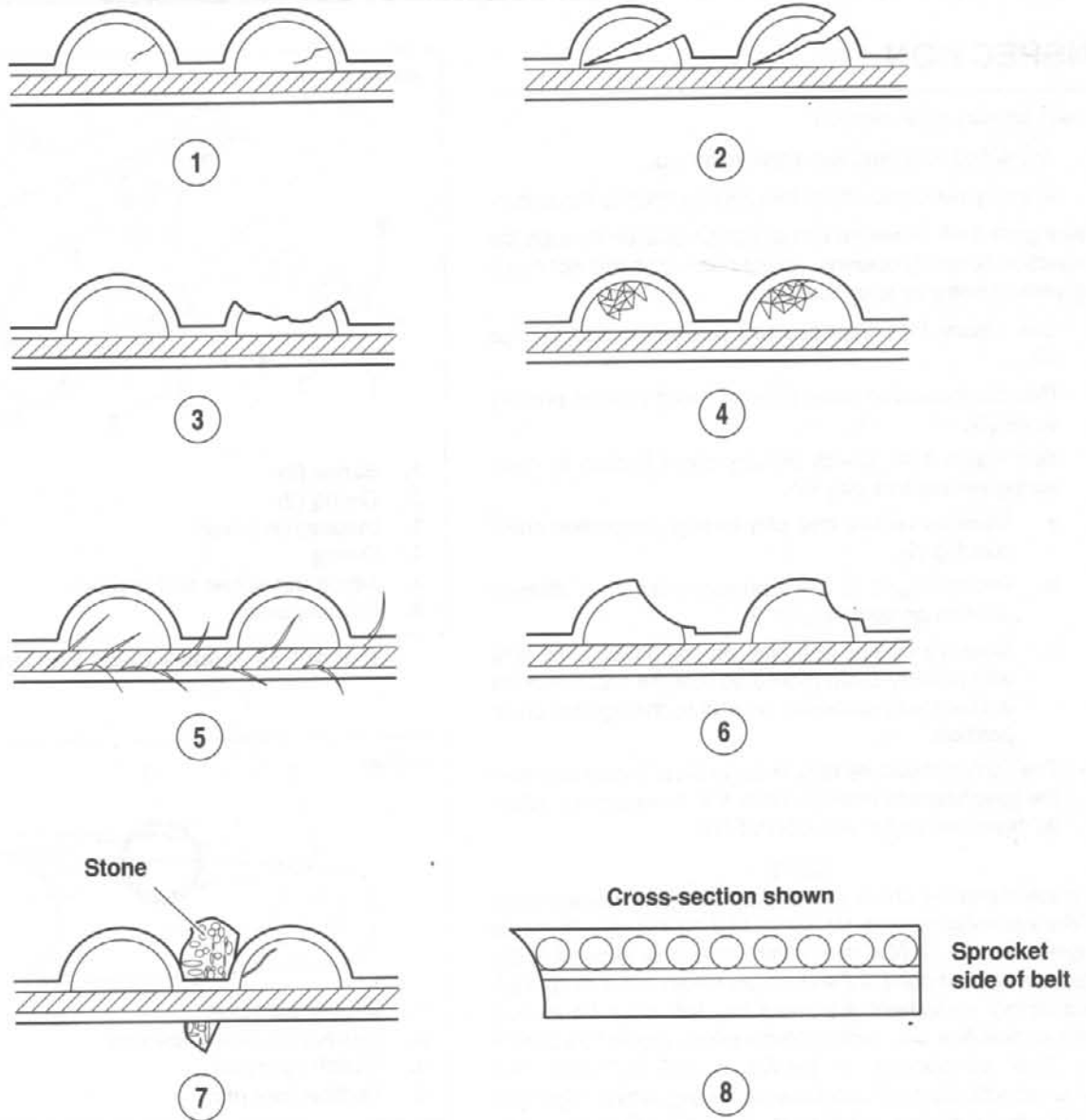


Figure 1-44. Drive Belt Wear Patterns

Table 1-5. Drive Belt Wear Analysis in Figure 1-44.

PATTERN	CONDITION	REQUIRED ACTION
1	Internal tooth cracks (hairline)	OK to run, but monitor condition
2	External tooth cracks	Replace belt
3	Missing teeth	Replace belt
4	Chipping (not serious)	OK to run, but monitor condition
5	Fuzzy edge cord	OK to run, but monitor condition
6	Hook wear	Replace belt
7	Stone damage	Replace belt if damage is on the edge
8	Bevel wear (outboard edge only)	OK to run, but monitor condition

INSPECTION

Check primary chain tension:

- At the 500 mile (800 km) service interval.
- At every 5000 mile (8000 km) service interval thereafter.

See Figure 1-45. Measure primary chain tension through the inspection cover (3) opening. Adjust primary chains not meeting vertical free play specifications.

1. See Figure 1-45. Remove two screws (1) and O-rings (2).
2. Remove inspection cover (3) and O-ring (4) from primary cover (6).
3. See Figure 1-46. Check primary chain tension by measuring vertical free play (4).
 - a. Measure vertical free play through inspection cover opening (2).
 - b. Rotate engine to move primary chain to a different position on sprockets (1, 3).
 - c. Measure vertical free play several times, each time with primary chain moved so that the measurement is taken with sprockets rotated to the tightest chain position.
4. The tightest measurement taken in Step 3 must be within the specifications listed in Table 1-6. If necessary, adjust as described under ADJUSTMENT.

NOTE

The initial primary chain vertical free play specification used at the assembly plant is 1/4-1/2 in. (6.4-12.7 mm) with a cold engine. The 1/4 in. (6.4 mm) minimum is only allowed at the absolute tightest point in the drive, as measured with specialized factory equipment. If a chain has less than 1/4 in. (6.4 mm) vertical free play (with a cold engine), adjust free play to the "field" specification of 3/8-1/2 in. (9.5-12.7 mm). The looser specification will avoid overtightening, which might otherwise occur during adjustment using "non-factory" equipment and methods.

5. See Figure 1-45. Install O-ring (4).
6. Fasten inspection cover (3) to primary cover (6) using two screws (1) with O-rings (2). Tighten to 40-60 in-lbs (4.5-6.8 Nm).

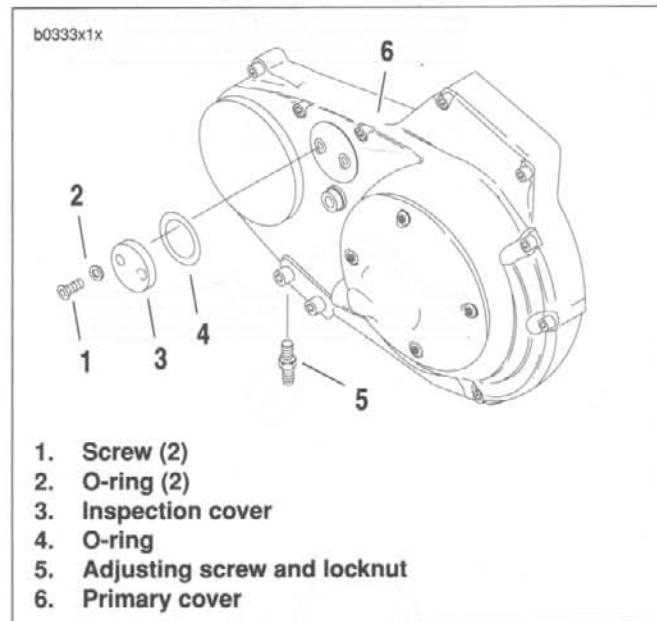


Figure 1-45. Primary Chain Inspection Cover

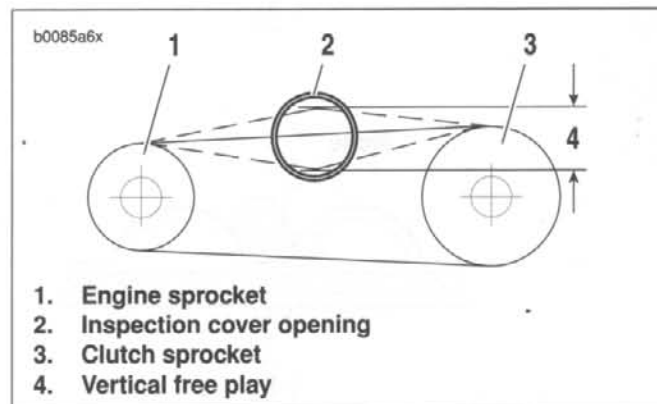


Figure 1-46. Measuring Primary Chain Tension

Table 1-6. Primary Chain Tension

ENGINE TEMPERATURE	FREE PLAY	
	Cold	3/8-1/2 in.
Hot (normal running temperature)	1/4-3/8 in.	6.4-9.5 mm

ADJUSTMENT

NOTE

If vertical free play cannot be set within the limits specified, then primary chain and/or chain adjuster are worn beyond adjustment limits. Replace parts as necessary. See Section 6.

1. See Figure 1-47. Loosen locknut (1).
2. Turn adjusting screw (2):
 - a. Clockwise (inward) to reduce free play.
 - b. Counterclockwise (outward) to increase free play.
3. Tighten locknut (1) to 20-25 ft-lbs (27.1-33.9 Nm).

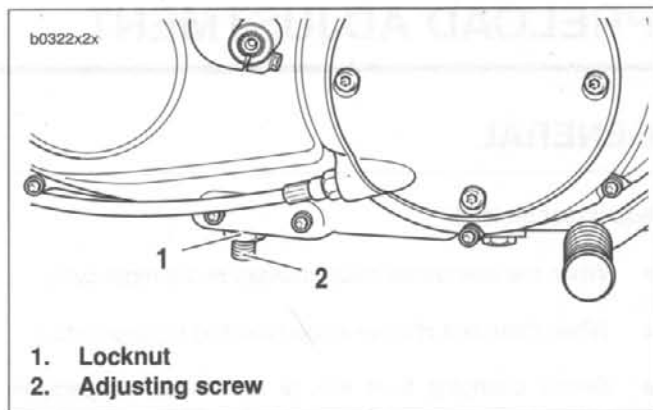


Figure 1-47. Primary Chain Adjustment

GENERAL

Adjust rear preload:

- When the new owner takes delivery of the motorcycle.
- When there is a change in load (adding luggage, etc.).
- Before changing front fork or rear shock suspension settings.

Rear suspension spring preload assures that the rear suspension has the proper amount of travel.

Spring preload is the most important suspension adjustment. Improper preload will adversely affect both the handling and motorcycle ride. Correct preload setting will result in motorcycle handling that suits the rider's size and weight.

NOTE

The preload measuring technique listed in this procedure yields the same preload setting as what is listed in the owner's manual, but by a different method. The measuring technique listed in this procedure is more accurate than the previous technique using the welding rod and O-rings.

ADJUSTMENT

1. See Figure 1-48. Check and adjust rear shock preload.
 - a. With rider seated on motorcycle, the preload is determined by measuring the distance between the centers of the front and rear shock eye and adjusting until the measurement is within specification.
 - b. See below for optimum preload measurement:
 - **X1 Models:** 17-17.4 in. (434-442 mm)

NOTE:

- All measurements must be taken with rider seated on motorcycle.
 - Riders with passenger at or near GVWR may exceed optimum preload adjustment.
2. See Figure 1-49. To adjust shock preload, loosen the locknut and turn the preload adjuster at the end of the shock to move the canister towards the front or rear of the motorcycle.
 - a. Move canister towards **rear** of motorcycle to increase preload.
 - b. Move canister towards **front** of motorcycle to decrease preload.
 - c. When finished, tighten locknut flush against rear shock canister. Tighten locknut to 22-29 ft-lbs (30-40 Nm).

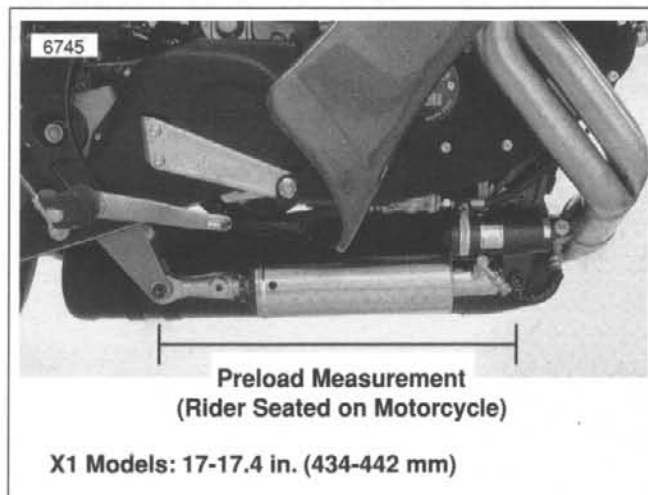


Figure 1-48. Measuring Preload (Typical)

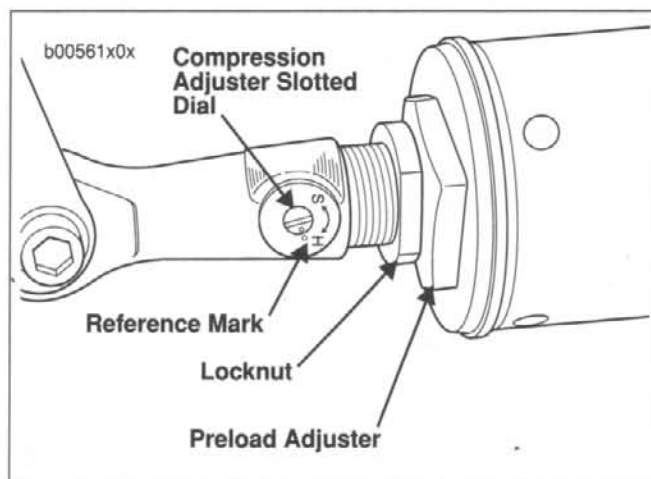


Figure 1-49. Preload Adjustment

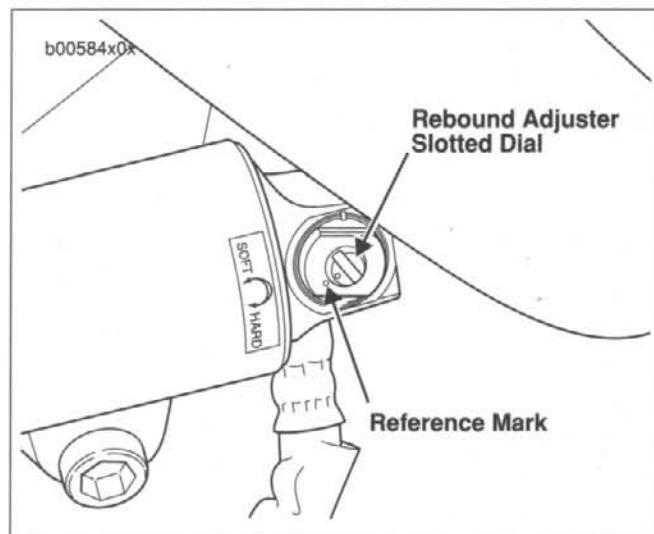


Figure 1-50. Rebound Adjustment

NOTE

- See Figure 1-51. Use REAR SHOCK PRELOAD SPANNER (Part No. B-43895) to simplify adjustment. This specialty tool loosens locknut and rotates shock canister to change the preload setting.
 - See Figures 1-49 and 1-50. To adjust rear shock to maximum damping setting, use screwdriver to turn slotted dial on appropriate adjuster clockwise until it stops. This is the maximum damping setting.
 - See Figures 1-49 and 1-50. To adjust rear shock to factory recommended settings, turn dial counterclockwise from maximum damping the amounts shown in Steps 3 and 4 to align the reference marks.
3. See Figure 1-49. Set compression damping using the slotted dial on the shaft at the end of the shock. Factory setting is as listed below:
 - **X1 Models:** full damping minus 1 turn.
 4. See Figure 1-50. Set rebound damping using the slotted dial on the remote reservoir at the front of the shock. The factory setting is as listed below:
 - **X1 Models:** full damping minus 1/2 turn.

NOTE

- When preload is increased, both compression and rebound damping should be increased. If preload is decreased, both compression and rebound damping should be decreased.
 - Compression adjustment has an effect on the low speed rebound damping as well.
5. Adjust drive belt deflection. See 1.13 REAR BELT DEFLECTION.



Figure 1-51. Rear Shock Preload Spanner
(Some parts removed for clarity.)

ADJUSTMENT

⚠ WARNING

Always adjust each fork leg to the same settings. Uneven adjustment between left and right forks may lead to a loss of control, which could result in death or serious injury.

Verify that all suspension settings are adjusted to the factory recommended standards.

1. Using a screwdriver, turn the slotted dial on the appropriate adjuster clockwise until it stops. This is the maximum damping setting for that adjustment.
2. Then turn the dial counterclockwise the recommended amount to align the reference marks. This is the factory recommended setting.

NOTE

See 2.29 *SUSPENSION THEORY* and 2.30 *SUSPENSION ADJUSTMENTS* for information on suspension tuning.

Front Fork Rebound

- See Figure 1-52. Factory setting-maximum damping minus 0.5 turn.

Front Fork Compression

- See Figure 1-52. Factory setting-maximum damping minus 1.25 turns.

Rear Shock Rebound

- See Figure 1-53. Factory setting-maximum damping minus 0.5 turn.

Rear Shock Compression

- See Figure 1-53. Factory setting-maximum damping minus 1.0 turn.

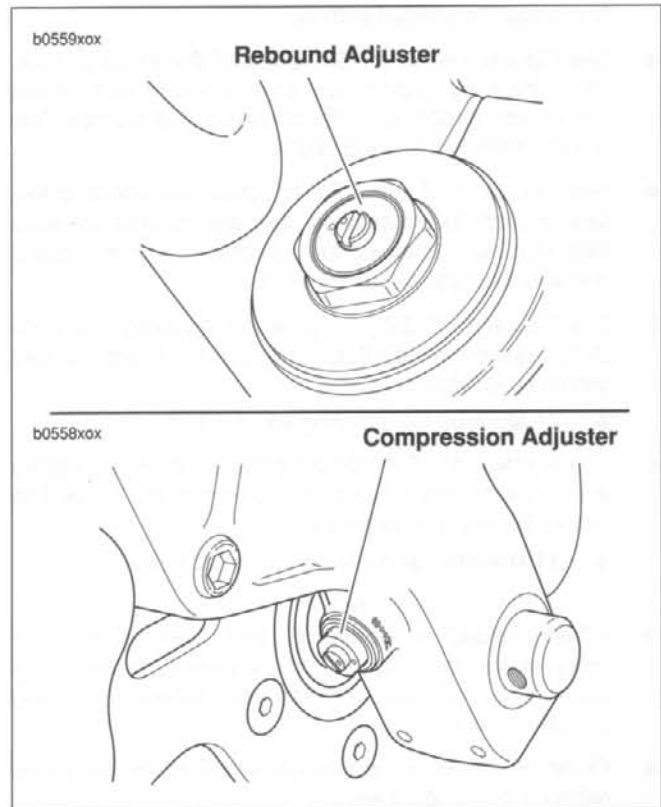


Figure 1-52. Front Forks

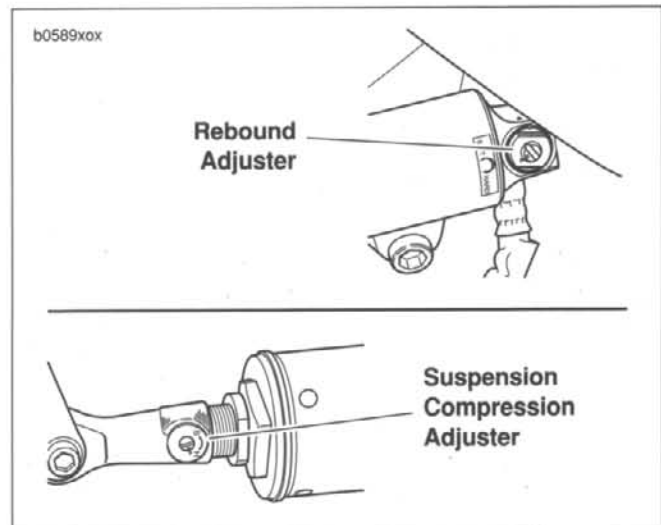


Figure 1-53. Rear Shock

FORK OIL CHANGE

Replace fork oil:

- At every 20,000 mile (32,000 km) service interval.
- If fork should be submerged in water.

NOTE

If fork oil is emulsified, aerated or light brown in color, then it has been contaminated by water. If this happens, replace the fork oil seals.

1. Remove, drain and disassemble front forks. Inspect and assemble parts as described under 2.24 FRONT FORK.

NOTE

Use only **TYPE E FORK OIL** (Part No. HD-99884-80).

2. See Table 1-7. While supporting fork, pour one-half of the recommended amount of fork oil into fork pipe.
3. See Figure 1-54. Pump damper assembly (3) and leg slowly about 10 times, using 6.0 in. (150 mm) strokes.
4. Place damper assembly and outer tube in full bottomed position.
5. Pour remaining amount of recommended fork oil into fork pipe.
6. Check fork oil level. Maximum and minimum oil levels are listed in Table 1-7.
 - a. With front fork fully compressed, clamp vertically in FRONT FORK HOLDING TOOL (Part No. B-41177).
 - b. Measure distance from fork oil (4) surface to top of outer tube (1) using PRO-LEVEL OIL GAUGE (Part No. B-59000A). See Figure 1-55.
 - c. Add or drain fork oil as needed until distance from top of fork tube to oil surface measures 3.15 in. (80.0 mm).

NOTE

Left and right forks must contain equal amounts of fork oil.

7. Finish fork assembly and install. See 2.24 FRONT FORK.

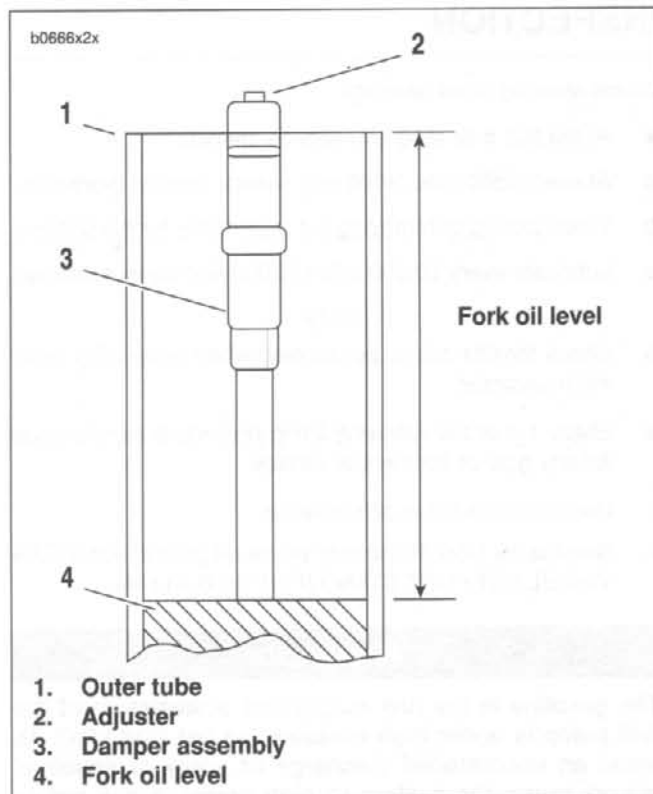


Figure 1-54. Correct Fork Oil Level

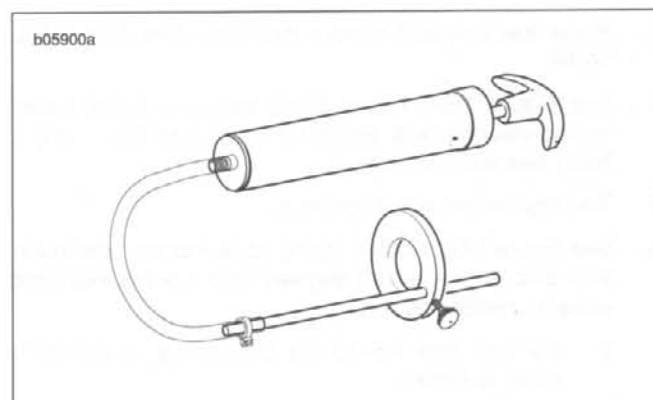


Figure 1-55. Pro Level Oil Gauge

Table 1-7. Fork Oil

PROPERTY	SPECIFICATION	
Fork oil	TYPE E FORK OIL (Part No. HD-99884-80)	
Standard capacity	15.36 ounces	450 cc
Standard oil level	3.15 in.	80 mm
Maximum oil level	4.333 in.	110 mm
Minimum oil level	2.36 in.	60 mm

INSPECTION

Check steering head bearings:

- At the 500 mile (800 km) service interval.
- At every 2500 mile (4000 km) service interval thereafter.
- When storing or removing the motorcycle for the season.
- Lubricate every 10,000 mile (16,000 km) service interval.

NOTE

- Check throttle cables do not bind when measuring bearing resistance.
- Steps 1-4 of the following lifting procedure can be used for any type of front wheel service.

1. Detach clutch cable at handlebar.
2. See Figure 1-56. Raise rear wheel off ground with REAR WHEEL SUPPORT STAND (Part No. B-41174).

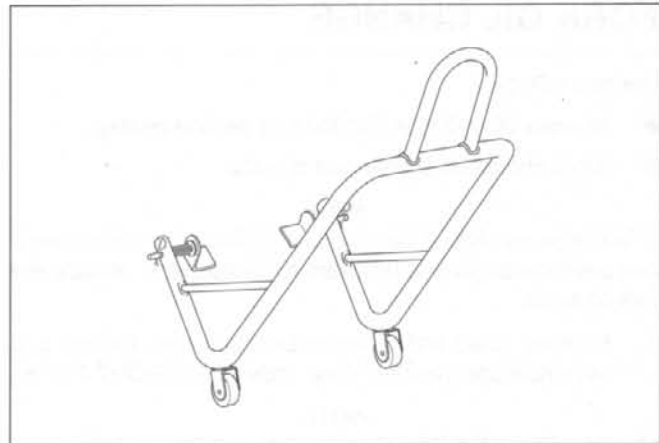


Figure 1-56. Rear Wheel Stand

WARNING

The gasoline in the fuel supply line downstream of the fuel pump is under high pressure (49 psi [338 kPa]). To avoid an uncontrolled discharge or spray of gasoline, always purge the system of high pressure gas before attaching fuel pressure gauge. Gasoline is extremely flammable and highly explosive. Inadequate safety precautions could result in death or serious injury.

3. Purge fuel line and remove fuel tank. See 4.34 FUEL TANK.
4. See Figure 1-57. Attach lifting straps to frame tubes behind steering neck. Raise front wheel off floor using a floor hoist and lifting straps.
5. Turn front wheel to full right lock.
6. See Figure 1-58. Hook a spring scale into the hole in the front axle. With scale 90 degrees from fork leg, pull front wheel to center position.
 - a. It should take 4.5-6.5 lbs (2.0-2.9 kg) to pull front wheel to center.
 - b. If steering head bearings need adjustment, see ADJUSTMENT.
7. Attach clutch cable and adjust. See 1.12 CLUTCH.

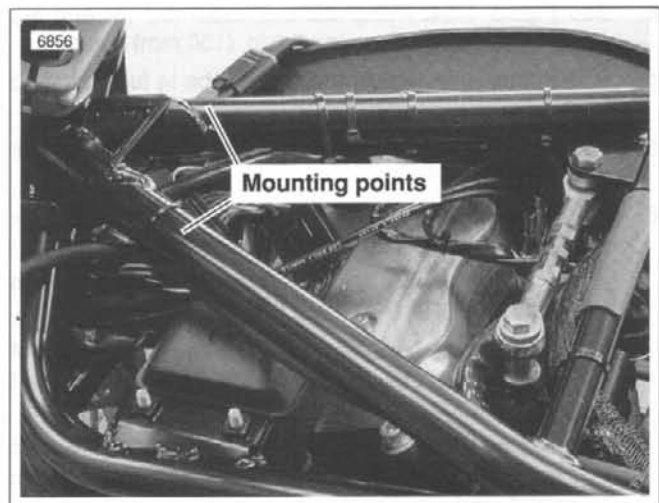


Figure 1-57. Attaching Straps

Lubrication

At 10,000 miles (16,000 km) and every 10,000 miles (16,000 km) thereafter, lubricate the steering head bearings with WHEEL BEARING GREASE (Part No. 99855-89).

See 2.25 FORK STEM AND BRACKET ASSEMBLY for lubrication procedure.

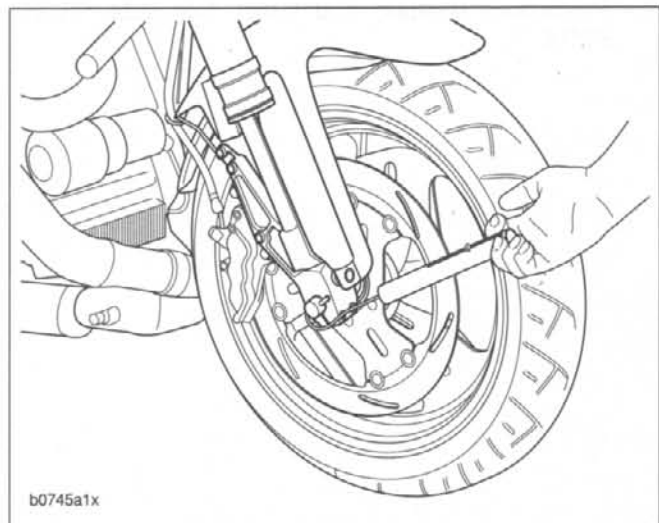
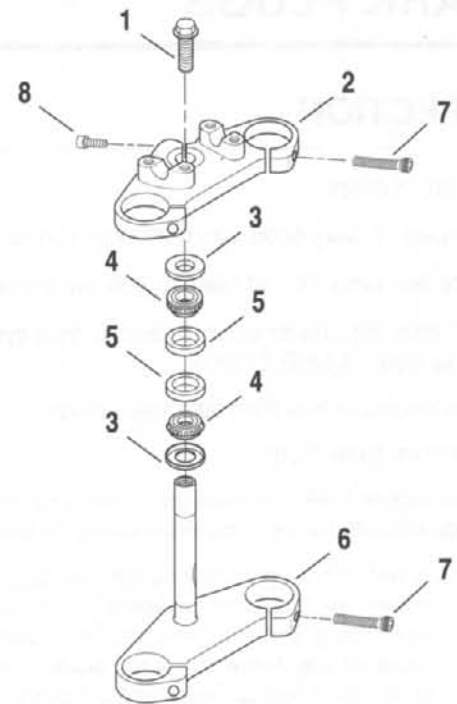


Figure 1-58. Checking Steering Head Bearings

ADJUSTMENT

1. Test motorcycle according to procedure listed under 1.19 STEERING HEAD BEARINGS. If adjustment is needed, follow the instructions below.
2. See Figure 1-59. Loosen both pinch screws (7) on lower triple clamp.
3. Loosen small pinch screw (8) on upper triple clamp.
4. Tighten or loosen fork stem bolt (1) to set proper tension.
5. Recheck tension using spring scale.
6. Tighten both lower triple clamp pinch screws (7) to 18-20 ft-lbs (24.4-27.1 Nm).
7. Tighten small pinch screw (8) on upper triple clamp to 10-12 ft-lbs (13.6-16.2 Nm).

b0373x2x



1. Fork stem bolt
2. Upper triple clamp
3. Dust shield (2)
4. Roller bearing (2)
5. Bearing cup (2)
6. Lower triple clamp
7. Screw (4)
8. Screw

Figure 1-59. Steering Head Assembly

INSPECTION

Check spark plugs:

- Inspect at every 5000 mile (8000 km) service interval.
 - Replace every 10,000 mile (16,000 km) service interval.
1. Remove left side air scoop to access front cylinder spark plug. See 2.44 AIR SCOOP.
 2. Disconnect cables from both spark plugs.
 3. Remove spark plugs.
 4. See Figure 1-60. Compare your observations of the plug deposits with the descriptions provided below.
 - a. A wet, black and shiny deposit on plug base, electrodes and ceramic insulator tip indicates an oil fouled plug. The condition may be caused by one or more of the following: worn pistons, worn piston rings, worn valves, worn valve guides, worn valve seals, a weak battery or a faulty ignition system.
 - b. A dry, fluffy or sooty black deposit indicates an air-fuel mixture that is too rich and/or engine idling for excessive periods.
 - c. A light brown, glassy deposit indicates an over-heated plug. This condition may be accompanied by cracks in the insulator or by erosion of the electrodes and is caused by an air-fuel mixture that is too lean, a hot-running engine, valves not seating or improper ignition timing. The glassy deposit on the spark plug is a conductor when hot and may cause high-speed misfiring. A plug with eroded electrodes, heavy deposits or a cracked insulator must be replaced.
 - d. A plug with a white, yellow, tan or rusty brown powdery deposit indicates balanced combustion. Clean off spark plug deposits at regular intervals.
 5. If the plugs require cleaning between tune-ups, proceed as follows:
 - a. Degrease firing end of spark plug using ELECTRICAL CONTACT CLEANER. Dry plug with compressed air.
 - b. Use a thin file to flatten spark plug electrodes. A spark plug with sharp edges on its electrodes requires 25-40% less firing voltage than one with rounded edges.
 6. If the plugs cannot be cleaned, replace with No. 6R12 spark plugs.
 7. Check electrode gap with a wire-type feeler gauge. Gap should be 0.038-0.043 in. (0.97-1.09 mm).

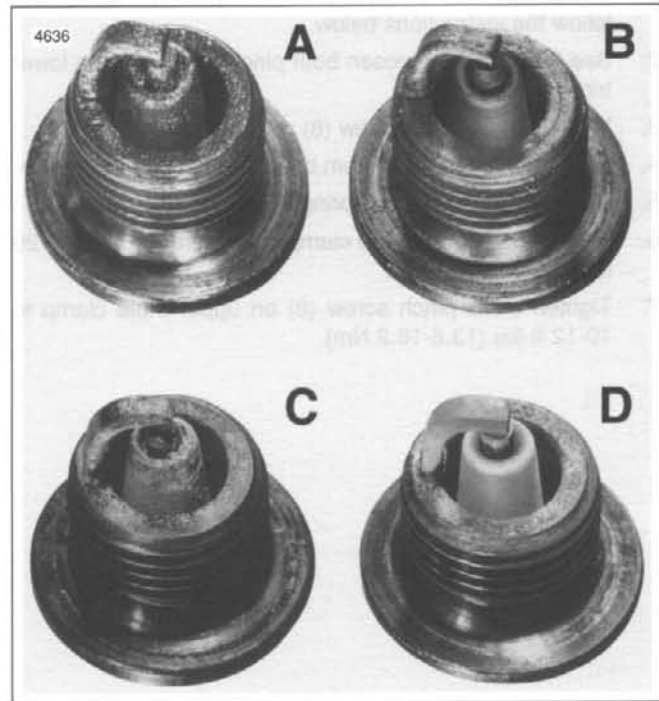


Figure 1-60. Typical Spark Plug Deposits

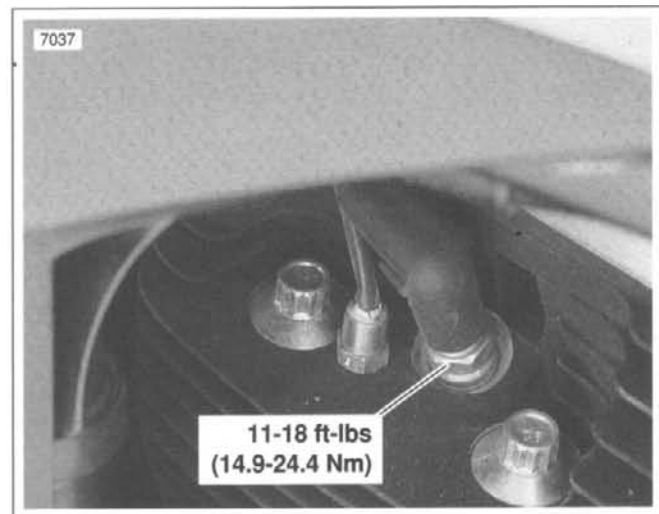


Figure 1-61. Spark Plugs

8. See Figure 1-61. Apply LOCTITE ANTI-SEIZE to plugs. Install and tighten to 11-18 ft-lbs (14.9-24.4 Nm).
9. Connect spark plug cables. Longer cable attaches to rear cylinder spark plug. Verify that cables are securely connected to coil and spark plugs.
10. Install left side air scoop. See 2.44 AIR SCOOP.

REMOVAL

CAUTION

Do not run engine without filter element in place. Debris could be drawn into the engine causing damage.

Check air cleaner filter element:

- Inspect at the 500 mile (800 km) service interval.
- Replace at every 5000 mile (8000 km) service interval thereafter.

NOTE

Service air cleaner filter element more often if the motorcycle is run in a dusty environment.

1. See Figure 1-62. Remove two small screws and nylon washers (1).
2. Remove large screw and nylon washer (2). Lift cover (4) away from backplate (3).
3. See Figure 1-63. Remove the filter element (1) from backplate (2). Inspect and replace if necessary.

INSTALLATION

WARNING

Do not use gasoline or solvents to clean the filter element. Volatile/flammable cleaning agents may cause an intake system fire which could result in death or serious injury.

1. Check filter element. Hold filter element up to strong light source. The element can be considered sufficiently clean if light is uniformly visible through the element.
2. Thoroughly clean backplate, filter box and inside of cover.
3. See Figure 1-63. Place filter element (1) inside backplate. Align tabs (4) on element with tabs on backplate. Two small strips of tape may be used to align element with backplate opening.
4. See Figure 1-62. Position air cleaner cover (4) over backplate (3). Make sure air filter and trim are correctly positioned.
5. Install long screw and nylon washer (2). Tighten to 27-29 **in-lbs** (3.1-3.3 Nm).
6. Install two screws and nylon washers (1) to secure air cleaner cover. Tighten to 27-29 **in-lbs** (3.1-3.3 Nm).

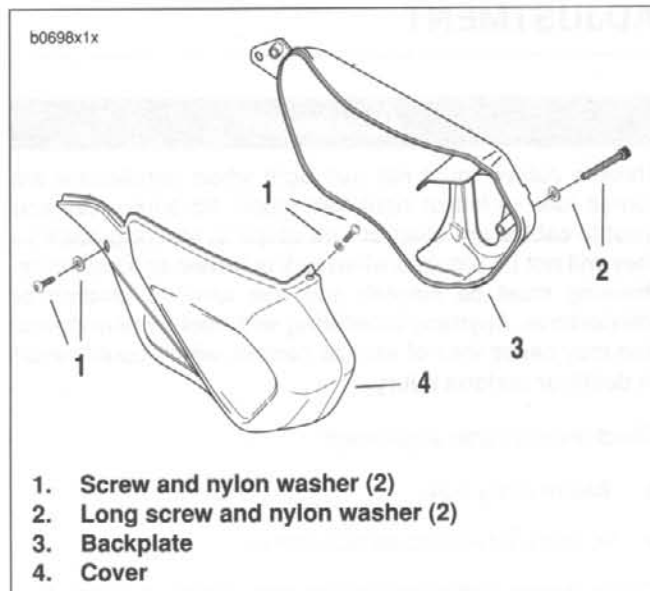


Figure 1-62. Air Cleaner Cover



Figure 1-63. Installed Air Cleaner Filter

ADJUSTMENT

WARNING

Throttle cables must not pull tight when handlebars are turned fully to left or right fork stops. Be sure wires and throttle cables are clear of fork stops at steering head so they will not be pinched when fork is turned against stops. Steering must be smooth and free with no binding or interference. Anything interfering with fuel system operation may cause loss of vehicle control, which could result in death or serious injury.

Check throttle cable adjustment:

- Before every ride.
- At every scheduled service interval.

Check throttle cable adjustment with engine running. Turn handlebars through full range of travel. If engine speed changes during this maneuver, adjust throttle cables as follows:

1. Remove air cleaner cover and backplate. See 4.39 AIR CLEANER.
2. See Figure 1-64. Slide rubber boot (5) off each cable adjuster (4).
3. Loosen cable adjuster lock (3) on each cable (1, 2).
4. Turn adjusters in direction which will shorten cable housings to minimum length.
5. Point front wheel straight ahead. Twist throttle control grip to fully open position; hold in position.

NOTE

All 2000 Model motorcycles have throttle cable clamps (not shown) secured by a screw that positively locate the cables. The throttle cable clamps are located over the guides (items 1 and 2 in Figure 1-64).

6. See Figure 1-65. Turn adjuster on throttle control cable until throttle cam stop (5) touches stop plate. Tighten jam nut on throttle control cable adjuster; release throttle control grip.
7. Turn handlebars fully to right. Turn adjuster on idle control cable (3) until end of cable housing just touches the cable guide (2).
8. See Figure 1-64. Twist and release throttle control grip a few times. Throttle plate must return to idle position each time throttle grip is released. If this is not the case, turn adjuster (4) on idle control cable (2) (shortening cable housing) until throttle control functions properly.
9. Tighten cable adjuster lock (3) on idle control cable (2). Recheck operation of throttle control.
10. Slide rubber boot (5) over each cable adjuster (4). Recheck engine slow idle speed; adjust if required.
11. Install air cleaner assembly. See 4.39 AIR CLEANER.

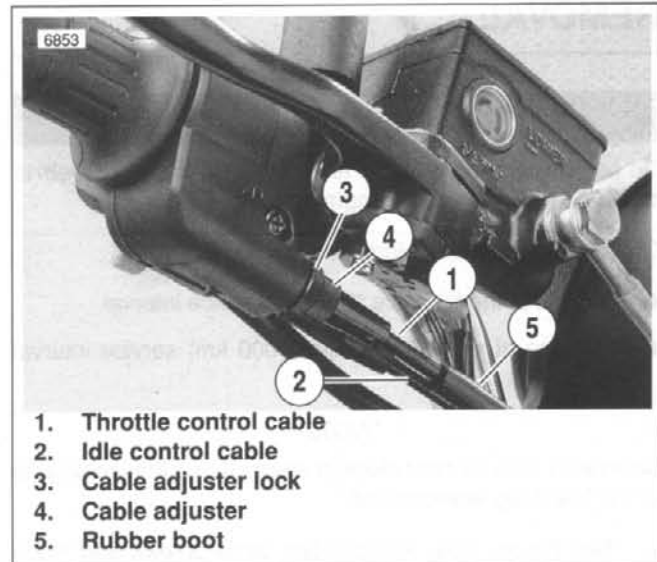


Figure 1-64. Throttle Cables

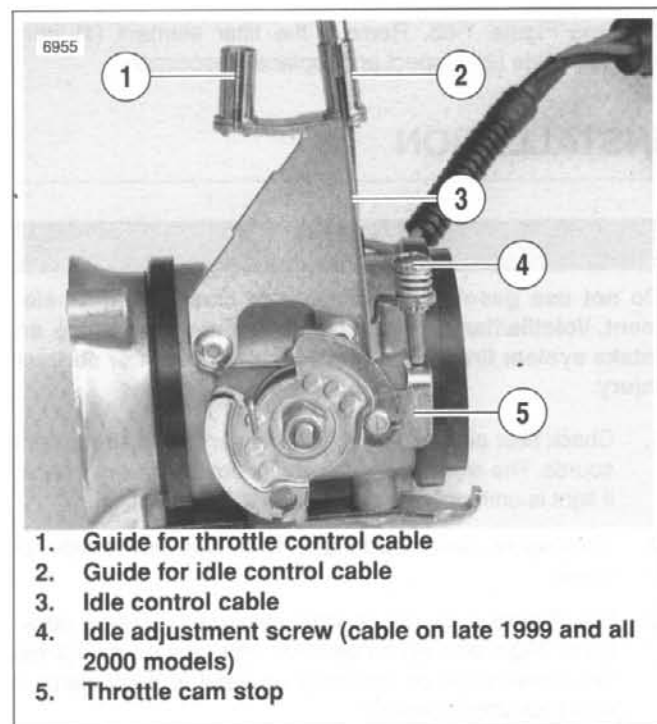


Figure 1-65. Throttle Body Manifold

IDLE ADJUSTMENT

Check idle adjustment:

- Before every ride.
- At every scheduled service interval.

Regular idle speed is 850-1050 RPM. Set idle speed using idle adjustment screw (4) shown in Figure 1-65.

NOTE.

Some 1999 and all 2000 model year vehicles have an idle adjustment cable instead of the idle adjustment screw.

INSPECTION

Check ignition timing:

- After each removal of the cam position sensor, use the **STATIC TIMING** method.

STATIC TIMING

⚠ CAUTION

Always wear proper eye protection when drilling. Flying debris may result in minor or moderate injury.

1. See Figure 1-66. Locate outer timer cover (2) at bottom of gearcase cover on right side of vehicle.
 - a. Drill off heads of outer timer cover rivets (1) using a 1/8 inch drill bit. Use a punch to tap rivet shafts inboard through holes in outer timer cover. Remove outer timer cover (2).
 - b. Remove two Phillips screws (3) to free inner timer cover (4). If necessary, tap remaining rivet shafts through holes in inner timer cover.
 - c. Carefully check the gearcase cover timer bore for any rivet fragments.
2. Remove seat.
3. Prepare vehicle for testing.
 - a. Remove the timing plug from the timing inspection hole centered below the cylinders on the right side of the crankcase.
 - b. Remove the spark plugs.
 - c. Jack up vehicle to allow rotation of the rear wheel.
 - d. Shift transmission into fifth gear.
4. Bring engine to top dead center (TDC).
 - a. Standing on left side of vehicle, slowly rotate rear wheel in a counter-clockwise direction until front intake valve opens and closes (as viewed through spark plug holes).
 - b. See Figure 1-67. Rotate rear wheel until TDC mark (2) is centered in timing inspection hole (1).
5. See Figure 1-68. Attach test components.
 - a. Remove electronic control module. See 4.28 ELECTRONIC CONTROL MODULE. Unplug gray connector [11].
 - b. Attach female gray connector on BREAKOUT BOX (Part No. HD-42682) to electronic control module.
 - c. Attach male gray connector on BREAKOUT BOX to wiring harness.
 - d. Connect red (+) lead on voltmeter to Pin 3 on gray side of BREAKOUT BOX.
 - e. Connect black (-) lead on voltmeter to Pin 8 on gray side of BREAKOUT BOX.

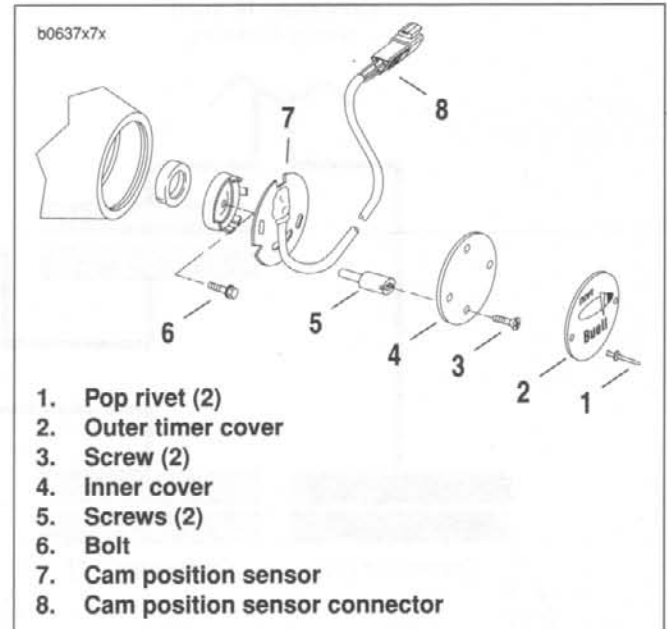


Figure 1-66. Timing Cover

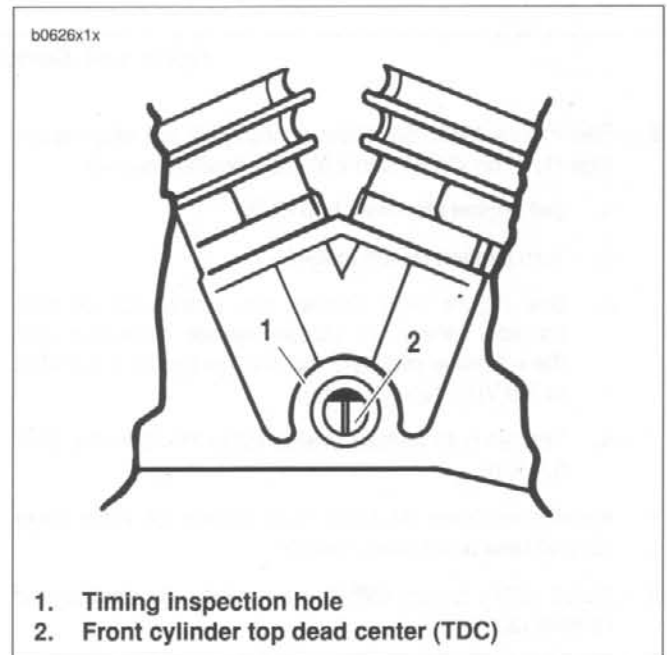


Figure 1-67. Timing Marks

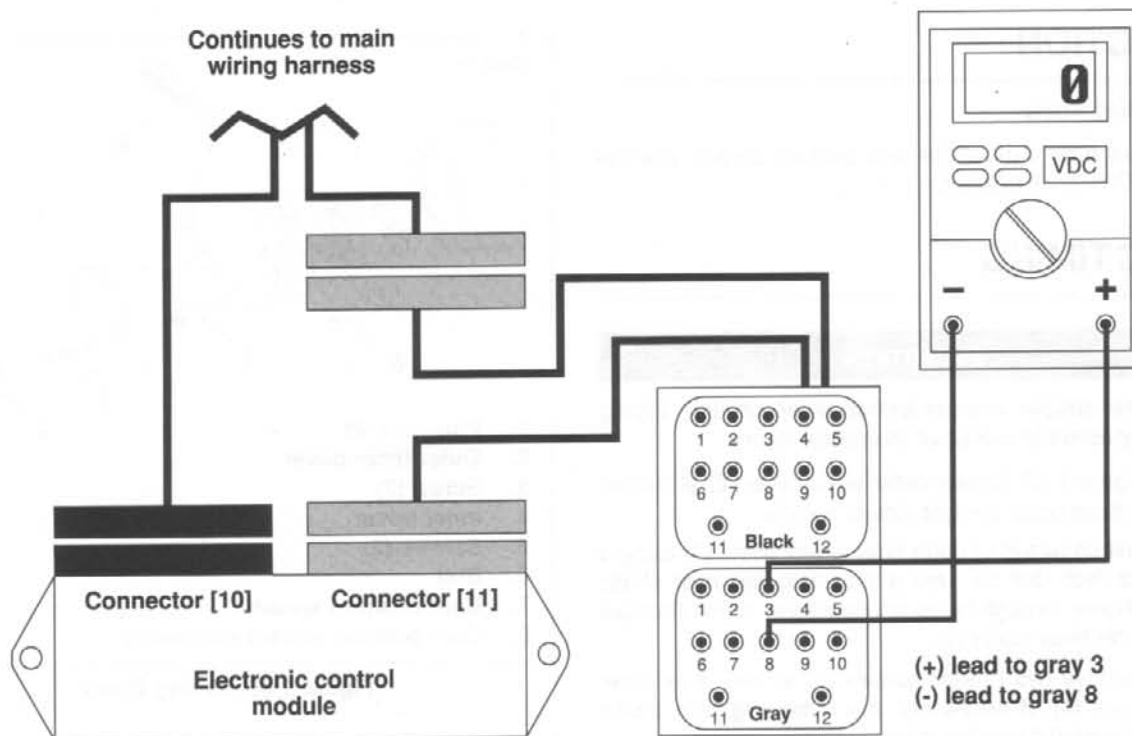


Figure 1-68. Static Timing Connections

6. See Figure 1-69. Set static timing. This will align openings (1, 2) on trigger cup with cam position sensor.
 - a. Set engine stop switch to RUN.
 - b. Turn ignition switch to IGN.
 - c. See Figure 1-66. Loosen two screws (5) on cam position sensor (7). Rotate sensor clockwise until the voltmeter registers the change from 0.0-1.0 VDC to 5.0 VDC (+/- 0.5 volts).
 - d. Tighten both sensor screws (5) to 15-30 **in-lbs** (1.7-3.4 Nm).
7. Install inner cover (4), inner cover screws (3), outer cover (2) and **new** outer cover rivets (1).
8. Install spark plugs, shift transmission into neutral and remove jack.
9. Remove BREAKOUT BOX harness and connect electronic control module connector [11].

⚠ WARNING

After installing seat, pull upward on front of seat to be sure it is locked in position. If seat is loose, it could shift during vehicle operation and startle the rider, causing loss of control which could result in death or serious injury.

10. Install seat.

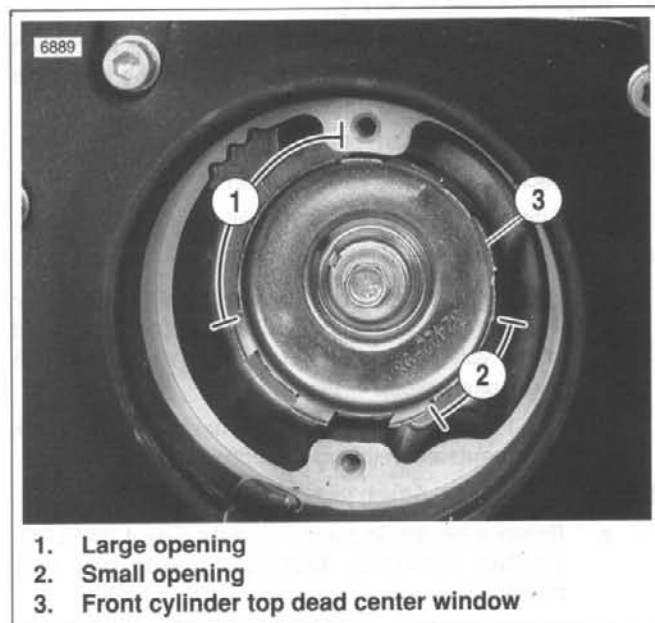


Figure 1-69. Trigger Cup Openings
(Cam Position Sensor Removed For Illustration)

INSPECTION

Check handlebar adjustment:

- Before every ride.
1. Check steering motion range to both fork stops. Handlebars should not make contact with the front forks or fuel tank cover.
 2. Handlebars should be equally spaced between outside edge of handlebar clamp and inside edge of mirror mounts.

If necessary, adjust handlebars as described below.

ADJUSTMENT

WARNING

Handlebars must not touch front forks or gas tank. Improperly adjusted handlebars may cause loss of control which could result in death or serious injury.

CAUTION

Never adjust handlebars using excessive force or damage to handlebars might result.

1. Detach windscreen by removing four screws and rubber washers.
2. See Figure 1-70. Detach instrument support by removing both instrument support screws (3).
3. Loosen clamp screws (1, 2).
4. Move handlebar to desired position.
5. Tighten clamp screws to 10-12 ft-lbs (13.6-16.2 Nm).

NOTE

First tighten the front clamp screws (1) to 10-12 ft-lbs (13.6-16.2 Nm). Once the front clamp screws are tight, tighten the rear clamp screws to 10-12 ft-lbs (13.6-16.2 Nm).

6. Install instrument support and windscreen.
 - a. Apply LOCTITE THREADLOCKER 243 (blue) to instrument support screws (3). Tighten to 4-5 ft-lbs (5.4-6.8 Nm).
 - b. Attach windscreen with four screws and rubber washers.
7. Check steering motion range to both fork stops. Handlebars should not make contact with the front forks or fuel tank cover. If handlebar needs further adjustment, repeat adjustment beginning with Step 1.

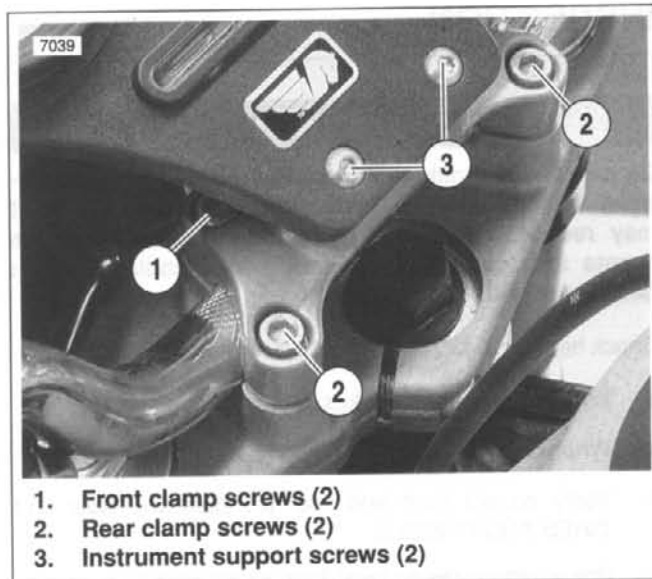


Figure 1-70. Adjusting Handlebars

INSPECTION

⚠ WARNING

Do not modify ignition wiring to permit motorcycle operation with headlamp off. Operating with headlamp off may reduce your visibility to other motorists. These events may cause an accident, which could result in death or serious injury.

Check headlamp for proper height and lateral alignment:

- When the new owner takes delivery of the motorcycle.
 - When there is a change in load (adding luggage, etc.)
1. Verify correct front and rear tire pressure. See 1.11 TIRES AND WHEELS.
 2. Place motorcycle on level floor (or pavement) in an area with minimum light.
 3. See Figure 1-71. Position motorcycle 25 ft (7.62 M) away from a screen or wall. Measure the distance from directly below the front axle to the base of the screen/wall.
 4. Draw a horizontal line 26 in. (66 cm) above floor on screen/wall.
 5. Load vehicle with rider/passenger/cargo/accessories. Weight will compress vehicle suspension slightly.
 6. Stand motorcycle upright with both tires resting on floor and with front wheel held in straight alignment (directly forward).
 7. See Figure 1-72. Turn ignition switch to IGN. Set handlebar headlamp switch to HIGH beam position (1).
 8. Check light beam for alignment.
 - a. The main beam, which is a broad, flat pattern of light, should be centered equally above and below the horizontal line.
 - b. The main beam of light should also be directed straight ahead. Properly adjusted headlamps project an equal area of light to right and left of center.
 - c. Adjust headlamp alignment if necessary. See 1.25 HEADLAMP.

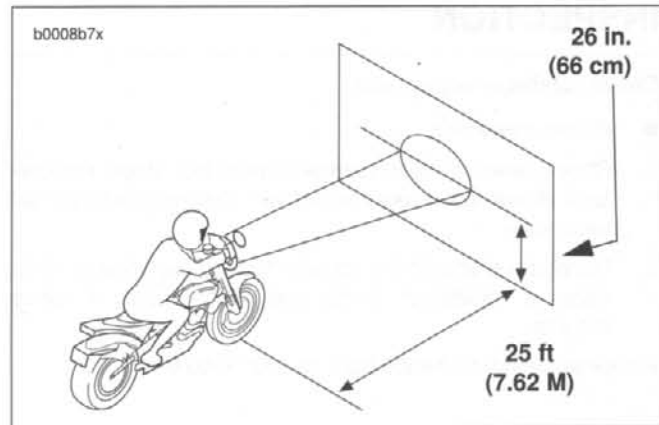


Figure 1-71. Checking Headlamp Alignment

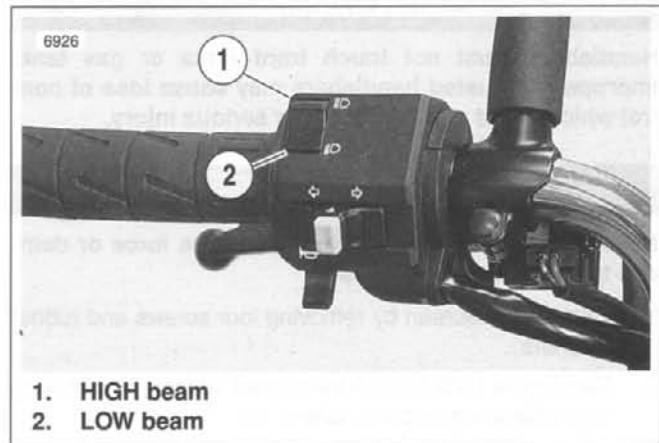


Figure 1-72. Headlamp Switch

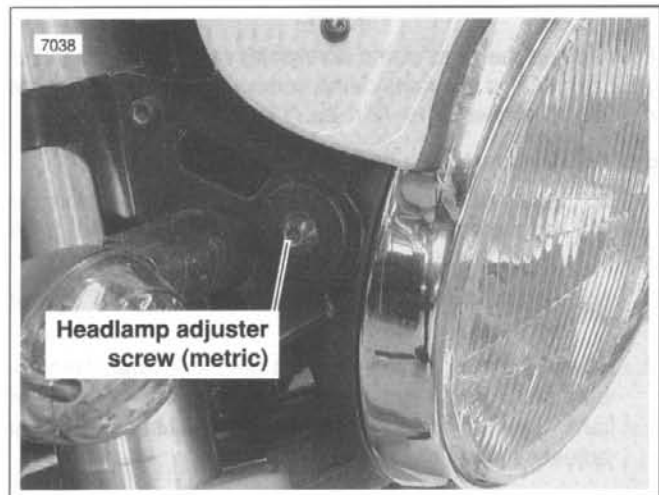


Figure 1-73. Headlamp Height Adjustment

ADJUSTMENT

If headlamp requires adjustment, perform the following:

1. See Figure 1-73. Loosen both adjuster screws (metric).
2. See Figure 1-71. Tilt headlamp up or down to aim it in relation to the horizontal line. At the same time, turn headlamp right or left to direct light beam straight ahead.
3. Tighten both adjuster screws (metric) to 5-7 ft-lbs (6.8-9.5 Nm).

GENERAL

⚠ WARNING

Gasoline is flammable. Do not store motorcycle having gasoline in tank within the home or garage where open flames, pilot lights, sparks or electric motors are present. Inadequate safety precautions may cause an accident which could result in death or serious injury.

If the motorcycle will not be operated for several months, such as during the winter season, there are several things which should be done to protect parts against corrosion, to preserve the battery and to prevent the buildup of gum and varnish in the fuel system.

This work should be performed by your local Buell dealer following Service Manual procedures.

1. Fill fuel tank and add a gasoline stabilizer. Use one of the commercially available gasoline stabilizers following the manufacturer's instructions. Run engine until gasoline has had a chance to reach throttle body manifold.
2. Fill the oil tank. See 1.6 ENGINE LUBRICATION SYSTEM. Pinch off (or remove and plug) the line leading from the oil tank bottom to the oil pump feed fitting. This prevents oil from seeping past the check ball into the oil pump and filling the engine flywheel compartment.
3. Remove battery and charge as needed to maintain the correct voltage. See 1.4 BATTERY (1999 MODELS) or 1.5 BATTERY (2000 MODELS).
4. Remove the spark plugs, inject a few squirts of engine oil into each cylinder and crank the engine 5-6 revolutions. Reinstall spark plugs. See 1.20 SPARK PLUGS.
5. Adjust rear drive belt deflection. See 1.13 REAR BELT DEFLECTION.
6. Adjust primary chain. See 1.15 PRIMARY CHAIN.
7. Check tire inflation. See 1.11 TIRES AND WHEELS. If the motorcycle will be stored for an extended period of time, securely support the motorcycle under the frame so that all weight is off the tires.

⚠ WARNING

Do not apply any oil to brake rotors or brake pads. Oil on brake pads degrades braking efficiency and can result in an accident which could result in death or serious injury.

8. Wash painted and chrome-plated surfaces. Apply a light film of oil to exposed unpainted surfaces.
9. If motorcycle is to be covered, use a material that will breathe, such as light canvas. Plastic materials that do not breathe promote the formation of condensation.

REMOVAL FROM STORAGE

⚠ WARNING

After extended periods of storage and prior to starting vehicle, place transmission in gear, disengage clutch and push vehicle back and forth a few times to ensure proper clutch disengagement. Improper clutch disengagement could result in death or serious injury.

1. Charge and install battery. See 1.4 BATTERY (1999 MODELS) or 1.5 BATTERY (2000 MODELS).
2. Remove and inspect spark plugs. Replace if necessary. See 1.20 SPARK PLUGS.
3. Inspect air filter element. Replace if necessary. See 1.21 AIR CLEANER FILTER.
4. If fuel tank was drained, fill fuel tank with fresh gasoline.
5. If oil feed line was pinched off or plugged, unplug it and reconnect.
6. Start the engine and run until it reaches normal operating temperature. Check fluids and refill to proper levels if required.
 - a. Check engine oil level. See 1.6 ENGINE LUBRICATION SYSTEM.
 - b. Check transmission fluid level. See 1.12 CLUTCH.
7. Perform all of the checks in the PRE-RIDING CHECK LIST in the Owner's Manual.

GENERAL

The following check list can be helpful in locating most operating troubles. Refer to the appropriate sections in this Service Manual for detailed procedures.

ENGINE

Starter Motor Does Not Operate or Does Not Turn Engine Over

1. Engine stop switch in OFF position.
2. Ignition key switch not ON.
3. Discharged battery or loose or corroded connections. (Solenoid chatters.)
4. Starter control relay or solenoid not functioning.
5. Electric starter shaft pinion gear not engaging or over-running clutch slipping.
6. Clutch lever pulled in. Vehicle in neutral.
7. Starter interlock circuit malfunction.

Engine Turns Over But Does Not Start

NOTE

See 4.11 ENGINE CRANKS BUT WILL NOT START for specific tests.

1. Fuel tank empty.
2. Fuel filter clogged.
3. Discharged battery, loose or broken battery terminal connections.
4. Fouled spark plugs.
5. Loose or shorting spark plug cables or connections.
6. Ignition timing badly out of adjustment.
7. Loose wire connection at coil or battery connection or plug between ignition sensor and module. See Section 4.
8. Ignition coil not functioning.
9. Ignition module not functioning.
10. Ignition sensor not functioning.
11. Sticking or damaged valve or valves.
12. Engine flooded with gasoline as a result of overchoking.
13. Engine oil too heavy (winter operation).
14. Ignition circuit interlock malfunction.
15. No output from the ECM. See dealer.
16. Inadequate fuel pressure in fuel lines (possible leak). See dealer.
17. Clogged fuel filter (on pump or in-line).
18. Clogged fuel injectors. See dealer.
19. Tripped bank angle sensor. Turn key to OFF and then back to IGN again to start bike.
20. TPS/fast idle screw not set properly. See dealer.
21. No output from CMP sensor. See dealer.
22. Inoperative fuel pump. See dealer.

Starts Hard

1. Spark plugs in bad condition, have improper gap or are partially fouled.
2. Spark plug cables in bad condition and shorting.
3. Battery nearly discharged.
4. Loose wire connection at one of the battery terminals, at coil or at plug between ignition sensor and module.
5. Throttle controls not adjusted correctly.
6. Ignition coil not functioning.
7. Engine oil too heavy (winter operation).
8. Ignition not timed properly. See dealer.
9. Vapor vent valve plugged or fuel line closed off restricting fuel flow.
10. Water or dirt in fuel system.
11. Enrichener valve inoperative.
12. Air leak at intake manifold.
13. Valves sticking.
14. TPS and/or fast idle screw not set properly. See dealer.
15. O₂, IAT or ET sensors damaged or malfunctioning. See dealer.

Starts But Runs Irregularly or Misses

NOTE

See 4.15 MISFIRE for specific tests.

1. Spark plugs in bad condition or partially fouled.
2. Spark plug cables in bad condition and shorting.
3. Spark plug gap too close or too wide.
4. Ignition coil not functioning.
5. Ignition module not functioning.
6. Ignition sensor not functioning.
7. Battery nearly discharged.
8. Damaged wire or loose connection at battery terminals or coil.
9. Intermittent short circuit due to damaged wire insulation.
10. Water or dirt in fuel system and throttle body or filter.
11. Vapor vent valve plugged.
12. Throttle controls improperly adjusted.
13. Air leak at intake manifold or air filter.
14. Damaged intake or exhaust valve.
15. Weak or broken valve springs.
16. Incorrect valve timing.
17. O₂, IAT or ET sensors damaged or malfunctioning. See dealer.
18. TPS and/or fast idle screw not set properly. See dealer.
19. Fuel level too low. Add gasoline.
20. Inoperative fuel injector. See dealer.
21. Obstructed fuel tank vent valve or pinched vent tube. See dealer.

Spark Plug Fouls Repeatedly

1. Incorrect spark plug.
2. Piston rings badly worn or broken.
3. Fuel mixture too rich for conditions.
4. Valve stem seals worn or damaged.
5. Valve guides badly worn.

Pre-Ignition or Detonation (Knocks or Pings)

1. Excessive carbon deposit on piston head or combustion chamber.
2. Incorrect heat range spark plug.
3. Spark plugs not firing.
4. Ignition timing advanced.
5. Fuel octane rating too low.
6. Intake manifold vacuum leak.

Overheating

1. Insufficient oil supply or oil not circulating.
2. Leaking valves.
3. Heavy carbon deposit.
4. Ignition timing retarded.

Valve Train Noise

1. Hydraulic lifter not functioning properly.
2. Bent push rod.
3. Cam, cam gears or cam bushings worn.
4. Rocker arm binding on shaft.
5. Valve sticking in guide.

Excessive Vibration

1. Engine tie-bars loose, broken or improperly spaced.
2. Lower mounting bolts loose.
3. Broken frame.
4. Primary chain badly worn or links tight as a result of insufficient lubrication.
5. Wheels not aligned and/or tires worn.
6. Internal engine problem.

ENGINE LUBRICATION SYSTEM

Oil Does Not Return To Oil Tank

1. Oil tank empty.
2. Return pump gears damaged.
3. Oil feed pump not functioning.
4. Restricted oil lines or fittings.

Engine Uses Too Much Oil or Smokes Excessively

1. Piston rings badly worn or broken.
2. Valve stem seals worn or damaged.
3. Valve guides worn.

Engine Leaks Oil From Cases, Push Rods, Hoses, Etc.

1. Loose parts.
2. Imperfect seal at gaskets, push rod cover, washers, etc. To aid locating leaks, use BLACK LIGHT LEAK DETECTOR (Part No. HD-35457).
3. Restricted oil return line to tank.
4. Restricted breather passage(s) to air cleaner.

ELECTRICAL SYSTEM

Alternator Does Not Charge

1. Regulator-rectifier module not functioning.
2. Rectifier not grounded.
3. Engine ground wire loose or broken.
4. Loose or broken wires in charging circuit.
5. Stator not functioning.
6. Rotor not functioning.

Alternator Charge Rate Is Below Normal

1. Regulator-rectifier module not functioning.
2. Stator not functioning.
3. Rotor not functioning.
4. Weak battery.
5. Loose connections.

FUEL

Fuel System Floods

1. Excessive "pumping" of throttle control grip.
2. Inlet valve sticking.
3. Inlet valve and/or valve seat worn or damaged.
4. Dirt or other foreign matter between valve and its seat.

Poor Fuel Economy

1. O2 sensor damaged or malfunctioning (bike running rich). See dealer.

TRANSMISSION

Shifts Hard

1. Clutch dragging slightly.
2. Shifter forks (inside transmission) damaged.
3. Corners worn off shifter clutch dogs (inside transmission).

Jumps Out of Gear

1. Shifter pawl improperly adjusted.
2. Shifter engaging parts (inside transmission) badly worn and rounded.
3. Shifter forks bent.
4. Damaged gears.

CLUTCH

Slips

1. Clutch controls improperly adjusted.
2. Worn friction plates.

Drags or Does Not Release

1. Clutch controls improperly adjusted.
2. Clutch plates excessively warped.

Chatters

1. Friction or steel plates worn, warped or dragging.

CHASSIS

Irregular/Inadequate Brake Action

1. Master cylinder low on fluid.
2. Brake line contains air bubbles.
3. Master or wheel cylinder piston worn.
4. Brake pads covered with grease or oil.
5. Brake pads badly worn to minimum lining thickness.
6. Brake rotor badly worn or warped.
7. Brake pads dragging or excessive braking (brake fades due to heat buildup).
8. Insufficient brake pedal or hand lever free play (brake drags).

Handling Irregularities

1. Tires improperly inflated. See 1.11 TIRES AND WHEELS. Do not overinflate.
2. Loose wheel axle nuts (metric). Tighten front nut to 48-53 ft-lbs (65.1-71.9 Nm). Tighten rear nut to 66-73 ft-lbs (89.5-98.9 Nm).
3. Excessive wheel hub bearing play.
4. Rear wheel out of alignment with frame and front wheel.
5. Rims and tires out-of-true sideways (tire runout should not be more than 0.080 in. (2.03 mm)).
6. Rims and tires out-of-round or eccentric with hub (tire runout should not be more than 0.090 in. (2.29 mm)).
7. Irregular or peaked front tire tread wear.
8. Tire and wheel unbalanced.
9. Steering head bearings improperly adjusted. See 1.19 STEERING HEAD BEARINGS. Correct adjustment and replace pitted or worn bearings and races. See 2.25 FORK STEM AND BRACKET ASSEMBLY.
10. Shock absorber not functioning normally.
11. Heavy front end loading. Non-standard equipment on the front end (such as heavy radio receivers, extra lighting equipment or luggage) tends to cause unstable handling.

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DIMENSIONS	IN.	MM
Wheel base	55.0	1397
Seat height	29.5	749
Road clearance	4.9	124.5
Trail	3.5	88.9
Rake	23 degrees	

CAPACITIES	U.S.	LITERS
Fuel tank (including reserve)	4.6 gallons	17.41
Reserve/Low Fuel Indicator at	0.4 gallons	1.51
Oil tank	2.5 quarts	2.37
Transmission	1.0 quart	0.95

WEIGHT-U.S. MODELS	LBS.	KG
Dry weight	440	199.58
GVWR	820	371.95
Load capacity	380	197.17

NOTE

Gross Vehicle Weight Rating (GVWR) (maximum allowable loaded vehicle weight) and corresponding Gross Axle Weight Ratings (GAWR) are given on an information decal located on the steering head.

TIRE AND POSITION	SOLO RIDING	GVWR
1999 Models: Front-Dunlop Sportmax Radial II 120/70 ZR 17 D204F	32 PSI (220 kPa)	36 PSI (248 kPa)
1999 Models: Rear-Dunlop Sportmax Radial II 170/60 ZR 17 D204	36 PSI (248 kPa)	38 PSI (262 kPa)
2000 Models: Front-Dunlop Sportmax Radial II 120/70 ZR 17 D207F	32 PSI (220 kPa)	36 PSI (248 kPa)
2000 Models: Rear-Dunlop Sportmax Radial II 170/60 ZR 17 D207	36 PSI (248 kPa)	38 PSI (262 kPa)

⚠ WARNING

Do not inflate any tire beyond its maximum inflation pressure as specified on tire sidewall. Overinflation may cause tire to suddenly deflate which could result in death or serious injury.

TORQUE VALUES

ITEM	TORQUE		NOTES
Brake hand lever nut	44-62 in-lbs	5.0-7.0 Nm	metric, page 2-23
Brake hand lever pivot bolt	4-13 in-lbs	0.5-1.5 Nm	LOCTITE ANTI-SEIZE, page 2-23
Brake rotor drive pin nut (1999 Models Only)	7.5-10 ft-lbs	10.2-13.6 Nm	page 2-10
Chin fairing bolts	9-10 ft-lbs	12.2-13.6 Nm	LOCTITE THREADLOCKER 243 (blue), page 2-94
Clutch cable, primary cover fitting	3-5 ft-lbs	4-6.87 Nm	turn clockwise to install, page 2-81
Clutch clamp screw	30-33 in-lbs	3.4-4.0 Nm	metric, page 2-81
Drive support nut	30-35 ft-lbs	40.7-47.4 Nm	page 2-90
Exhaust header nuts	6-8 ft-lbs	8.1-10.8 Nm	page 2-87
Fender mounting screw, lower	10-15 in-lbs	1.1-1.7 Nm	page 2-91

ITEM	TORQUE		NOTES
Fender mounting screw, upper	20-25 in-lbs	2.3-2.8 Nm	metric, page 2-91
Footrest frame nuts	13-16 ft-lbs	17.6-21.7 Nm	LOCTITE THREADLOCKER 272 (red), page 2-88, page 2-89
Footrest mounting bolt	10-15 ft-lbs	13.6 -20.3 Nm	LOCTITE THREADLOCKER 243 (blue), page 2-88, page 2-89
Front axle nut	48-53 ft-lbs	65.1-71.9 Nm	LOCTITE THREADLOCKER 243 (blue), metric, page 2-10
Front axle pinch screw	13-15 ft-lbs	17.6-20.3 Nm	metric, page 2-10
Front brake caliper banjo bolt	16-20 ft-lbs	21.7-27.1 Nm	metric, page 2-27
Front brake caliper bleeder valve	3-5 ft-lbs	4.1-6.8 Nm	metric, page 2-26
Front brake caliper mounting screws	22-25 ft-lbs	29.8-33.9 Nm	LOCTITE THREADLOCKER 272 (red), page 2-27
Front brake caliper pad hanger pin	11-14.5 ft-lbs	14.7-19.6 Nm	metric, page 2-27
Front brake caliper pin plug	1.5-2.1 ft-lbs	2.0-2.9 Nm	page 2-27
Front brake caliper screw	14.5-18 ft-lbs	19.6-24.4 Nm	metric, page 2-26
Front brake line clamp screw	30-35 in-lbs	3.4-4.0 Nm	page 2-30
Front brake master cylinder clamp screw	80-90 in-lbs	9.0-10.2 Nm	metric, page 2-24
Front brake rotor carrier screw (1999 Models Only)	20-22 ft-lbs	27.1-29.8 Nm	LOCTITE THREADLOCKER 272 (red), page 2-9
Front brake switch screw	7-13 in-lbs	0.8-1.5 Nm	page 2-23
Front caliper banjo bolt	16-20 ft-lbs	21.7-27.1 Nm	metric, page 2-27
Front caliper bleeder valve	3-5 ft-lbs	4.1-6.8 Nm	metric, page 2-26
Front fork bolt	22-29 ft-lbs	29.8-39.3 Nm	page 2-61
Front fork center bolt	22-29 ft-lbs	29.8-39.3 Nm	metric, page 2-61
Front fork triple clamp screw, large	18-20 ft-lbs	24.4-27.1 Nm	LOCTITE ANTI-SEIZE, page 2-62
Front fork triple clamp screw, small	10-12 ft-lbs	13.6-16.3 Nm	LOCTITE ANTI-SEIZE, page 2-62
Front master cylinder banjo bolt	16-20 ft-lbs	21.7-27.1 Nm	metric, page 2-24, page 2-30
Front master cylinder cover screws	9-13 in-lbs	1.0-1.5 Nm	page 2-24, page 2-28
Fuel tank bracket screw	9-11 ft-lbs	12.2-14.9 Nm	page 2-95
Handlebar clamp screw	10-12 ft-lbs	13.6-16.2 Nm	tighten front screws first, page 2-83
Instrument support screws	4-5 ft-lbs	5.4-6.8 Nm	LOCTITE THREADLOCKER 243 (blue), page 2-82
Muffler clamp	40-45 ft-lbs	54.2-61.0 Nm	discard after use, page 2-86, page 2-87
Muffler front mounting support	17-19 ft-lbs	23-25.8 Nm	page 2-86
Muffler rear mounting support	17-19 ft-lbs	23-25.8 Nm	page 2-86
Muffler support mounting bolt, front	30-33 ft-lbs	40.7-44.7 Nm	page 2-86
Muffler Z bracket nuts	8-10 ft-lbs	10.8-13.6 Nm	page 2-86

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ITEM	TORQUE		NOTES
Oxygen sensor	42-45 ft-lbs	56.9-61 Nm	LOCTITE ANTI-SEIZE, page 2-87
Rear axle nut	66-73 ft-lbs	89.5-98.9 Nm	metric, page 2-15, page 2-70
Rear brake caliper banjo bolt	16-20 ft-lbs	21.7-27.1 Nm	metric, page 2-35
Rear brake caliper bleeder valve	3-5 ft-lbs	4.1-6.8 Nm	metric, page 2-30, page 2-35
Rear brake caliper mounting screw, large	18-22 ft-lbs	24.4-29.8 Nm	metric, page 2-35
Rear brake caliper mounting screw, small	14.5-18 ft-lbs	19.6-24.4 Nm	metric, page 2-35
Rear brake caliper pad hanger pin	11-14.5 ft-lbs	14.7-19.6 Nm	metric, page 2-35
Rear brake caliper pin plug	1.5-2.1 ft-lbs	2.0-2.9 Nm	page 2-35
Rear brake lamp switch	7-8 ft-lbs	9.5-10.8 Nm	LOCTITE SEALANT WITH TEFLON, page 2-38
Rear brake reservoir mounting screw	12-15 in-lbs	1.4-1.7 Nm	page 2-32
Rear brake rotor screw	35-40 ft-lbs	47.5-54.2 Nm	LOCTITE THREADLOCKER 272 (red), metric, page 2-15
Rear caliper banjo bolt	16-20 ft-lbs	21.7-27.1 Nm	metric, page 2-36
Rear master cylinder banjo bolt	16-20 ft-lbs	21.7-27.1 Nm	metric, page 2-32, page 2-37
Rear master cylinder mounting screws	8-10 ft-lbs	10.8-13.6 Nm	LOCTITE THREADLOCKER 243 (blue), metric, page 2-32
Rear shock, front bolt	49-53 ft-lbs	66.4-71.9 Nm	tighten from bolt side only, page 2-72
Rear shock, rear bolt	30-33 ft-lbs	40.7-44.7 Nm	metric, page 2-70, page 2-72
Rear tiebar	30-33 ft-lbs	40.7-44.7 Nm	page 2-70
Seat lock nuts	20-25 in-lbs	2.3-2.8 Nm	page 2-100
Sprocket bolt	55-65 ft-lbs	74.6-88.1 Nm	LOCTITE THREADLOCKER 272 (red), page 2-15
Sprocket cover mounting screw	12-17 in-lbs	1.4-1.9 Nm	LOCTITE THREADLOCKER 222 (purple), page 2-90
Sprocket cover screw	4-6 ft-lbs	5.4-8.6 Nm	LOCTITE THREADLOCKER 243 (blue), page 2-90
Swingarm isolator bolts	100-110 ft-lbs	135.6-149.1 Nm	LOCTITE THREADLOCKER 272 (red), page 2-70
Swingarm pinch screw	18-20 ft-lbs	24.4-27.1 Nm	LOCTITE THREADLOCKER 243 (blue), page 2-69, page 2-70
Swingarm threaded rod	10-13 ft-lbs	13.6-17.6 Nm	LOCTITE THREADLOCKER 222 (purple), initial torque only, page 2-69
Swingarm/drive support bolt	4-6 ft-lbs	5.4-8.6 Nm	LOCTITE THREADLOCKER 243 (blue), page 2-90
Switchgear housing screws, left side	25-33 in-lbs	2.8-3.7 Nm	metric, page 2-81
Switchgear housing screws, right side	12-17 in-lbs	1.4-1.9 Nm	metric, page 2-78
Tail section bolts	9-11 ft-lbs	12.2-14.9 Nm	page 2-100
Turn signal nuts	96-120 in-lbs	10.8-13.6 Nm	metric, page 2-100
Valve stem nut	42-44 in-lbs	4.7-5.0 Nm	page 2-19

GENERAL

⚠ WARNING

Tires must be correctly matched to wheel rims. Only the tires listed in the fitment tables below can be used for replacement. Mismatching tires and rims can cause damage to the tire bead during mounting. Using tires other than those specified can adversely affect motorcycle handling and could result in death or serious injury.

Tire sizes are molded on the sidewall. Rim size and contour are marked on the rim's exterior surface. See Figure 2-1.

Example: **MT 3.5 x 17.0 DOT**

- **MT** designates the rim contour.
- **3.5** is the width of the bead seat measured in inches.
- **17.0** is the normal diameter of the rim in inches, measured at the bead seat diameter.
- **DOT** means that the rim meets Department of Transportation Federal Motor Vehicle Safety Standards.

See the tables below.

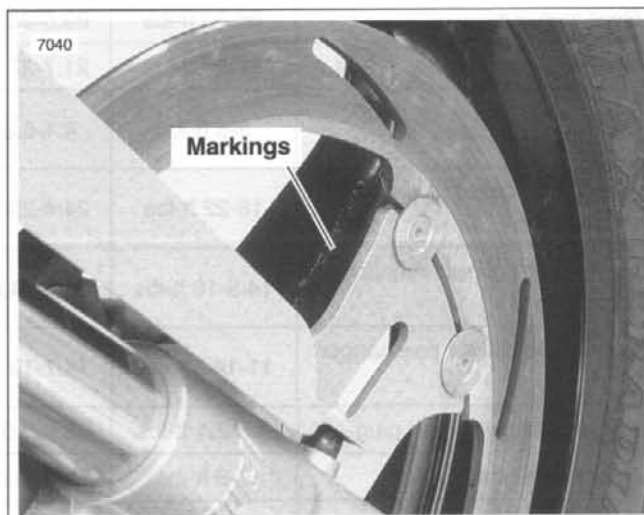


Figure 2-1. Rim Markings

Table 2-1. Tire Fitment-Tubeless Cast Wheels

WHEEL SIZE & POSITION	CONTOUR & RIM SIZE	RIM VALVE HOLE DIAMETER	DUNLOP SPORTMAX RADIAL II TIRE SIZE
17 in. – Front	MT 3.5 x 17.0 DOT	0.33 in.	1999 Models: 120/70 ZR17 D204F 2000 Models: 120/70 ZR17 D207F
17 in. – Rear	MT 5.0 x 17.0 DOT	0.33 in.	1999 Models: 170/60 ZR17 D204 2000 Models: 170/60 ZR17 D207

Table 2-2. Tire Fitment-Tubeless Aluminum P/M Wheels

WHEEL SIZE & POSITION	CONTOUR & RIM SIZE	RIM VALVE HOLE DIAMETER	DUNLOP SPORTMAX RADIAL II TIRE SIZE
17 in. – Front	MT 3.5 x 17.0 DOT	0.33 in.	1999 Models: 120/70 ZR17 D204F 2000 Models: 120/70 ZR17 D207F
17 in. – Rear	MT 5.5 x 17.0 DOT	0.33 in.	1999 Models: 170/60 ZR17 D204 2000 Models: 170/60 ZR17 D207

GENERAL

The full 17 digit serial or Vehicle Identification Number (V.I.N.) is stamped on the steering head and on an information decal at the same location.

See Figure 2-2. An abbreviated V.I.N. is stamped on the front left side of the crankcase.

NOTE

See Figure 2-3. Always give the V.I.N. or abbreviated V.I.N. when ordering parts or making inquiries about your Buell motorcycle.

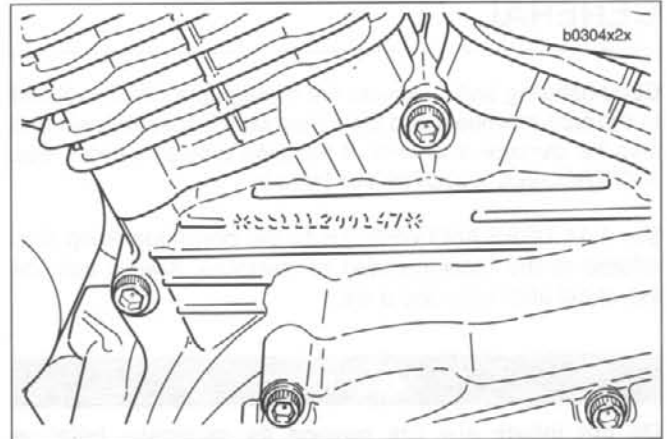


Figure 2-2. Abbreviated V.I.N. Location

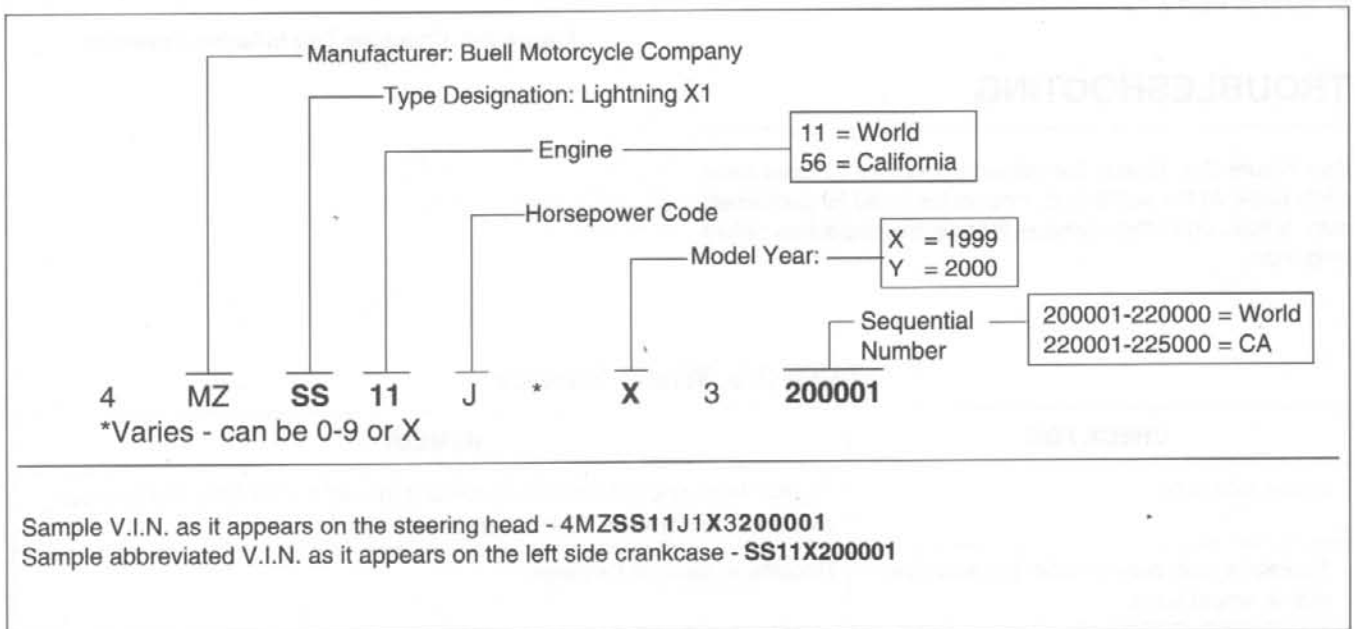


Figure 2-3. Vehicle Identification Number (V.I.N.)

GENERAL

Good handling and maximum tire mileage are directly related to the care of wheels and tires. Regularly inspect wheels and tires for damage and wear. If handling problems occur, see 1.27 TROUBLESHOOTING or Table 2-3.

See 1.11 TIRES AND WHEELS for tire pressures. Keep tires inflated to the recommended air pressure. Always balance the wheel after replacing a tire.

WARNING

Do not inflate any tire beyond its maximum inflation pressure as specified on tire sidewall. Overinflation may cause tire to suddenly deflate which could result in death or serious injury.

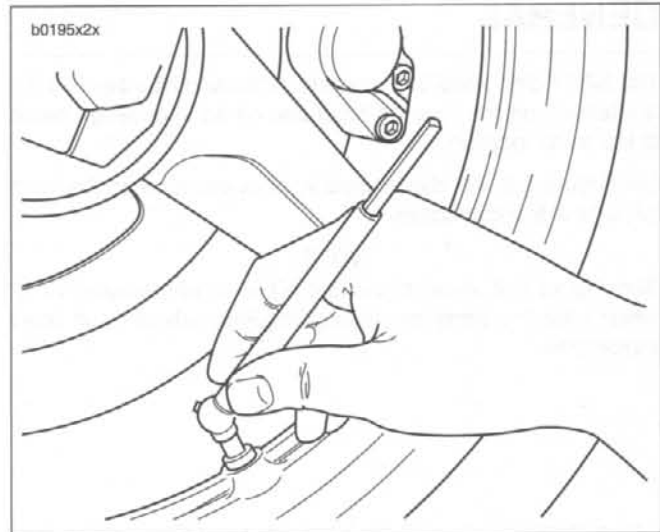


Figure 2-4. Checking Tire Inflation Pressure

TROUBLESHOOTING

See Figure 2-4. Check tire inflation pressure at least once each week. At the same time, inspect tire tread for punctures, cuts, breaks and other damage. Repeat the inspection before long trips.

Table 2-3. Wheel Service

CHECK FOR	REMEDY
Loose axle nuts.	Tighten front axle nut (metric) to 48-53 ft-lbs (65.1-71.9 Nm). Tighten rear axle nut (metric) to 66-73 ft-lbs (89.5-98.9 Nm).
Excessive side-play or radial (up-and-down) play in wheel hubs.	Replace wheel hub bearings.
Alignment of rear wheel in frame or with front wheel.	Check Axle Alignment under 1.13 REAR BELT DEFLECTION or repair swingarm as described under 2.27 SWINGARM.
Rims and tires out-of-true sideways; should not be more than 0.080 in. (2.03 mm).	Replace rims. See 2.9 TIRES.
Rims and tires out-of-round or eccentric with hub; should not be more than 0.090 in. (2.29 mm).	Replace rims. See 2.9 TIRES.
Irregular or peaked front tire wear.	Replace as described under 2.5 FRONT WHEEL (1999 Models) or 2.6 FRONT WHEEL (2000 Models), 2.7 REAR WHEEL and 2.9 TIRES.
Correct tire inflation.	Inflate tires to correct pressure. See 1.11 TIRES AND WHEELS.
Correct tire and wheel balance.	Static balance may be satisfactory if dynamic balancing facilities are not available. However, dynamic balancing is strongly recommended.
Steering head bearings.	Correct adjustment and replace pitted or worn bearings. See 1.19 STEERING HEAD BEARINGS.
Damper tubes.	Check for leaks. See 2.24 FRONT FORK.
Shock absorbers.	Check damping action and mounts. See 1.17 SUSPENSION.
Swingarm bearings.	Check for looseness. See 2.27 SWINGARM.

⚠ WARNING

To prevent death or serious injury, use the following guidelines when installing a new tire or repairing a flat:

1. Always locate and eliminate the cause of the original tire failure.
2. Do not patch or vulcanize a tire casing. These procedures weaken the casing and increase the risk of a blowout.
3. The use of tires other than those specified can adversely affect handling which could result in death or serious injury.
4. Tires and wheels are critical items. Since the servicing of these components requires special tools and skills, Buell recommends that you see your dealer for these services.

⚠ WARNING

Buell recommends replacement of any tire punctured or damaged. In some cases small punctures in the tread area may be repaired from within the demounted tire by your Buell dealer. Speed should not exceed 50 mph (80 km/h) for the first 24 hours after repair and the repaired tire should NEVER be used over 80 mph (1340 km/h). In emergency situations, if a temporary repair is made, ride slowly with as light of a load as possible until the tire is permanently repaired or replaced. Failure to follow this warning could result in death or serious injury.

⚠ WARNING

Excessively worn tires adversely affect motorcycle traction, steering and handling and could result in death or serious injury.

At regular intervals of 5000 miles (8000 km) or whenever handling irregularities are noted, perform the recommended service checks. See Table 2-3.

If tires must be replaced, same as original equipment tires must be used. Other tires may not fit correctly and may be hazardous to use.

REMOVAL

1. Raise front wheel off floor using procedure under 1.19 STEERING HEAD BEARINGS.
2. Detach front brake caliper from rotor. See 2.12 FRONT BRAKE CALIPER (1999 Models).

NOTE

Do not operate front brake lever with front wheel removed or caliper pistons may be forced out. Reseating pistons requires caliper disassembly.

3. See Figure 2-5. Insert screwdriver/rod through hole in axle (1). Loosen front axle nut (4) (metric).
4. Loosen all four pinch screws (2) (metric).
5. Remove front axle nut (4) and washer (3). Pull front axle out of wheel hub while supporting front wheel.
6. See Figure 2-7. Remove spacer (3) from left side of wheel hub. Remove front wheel.

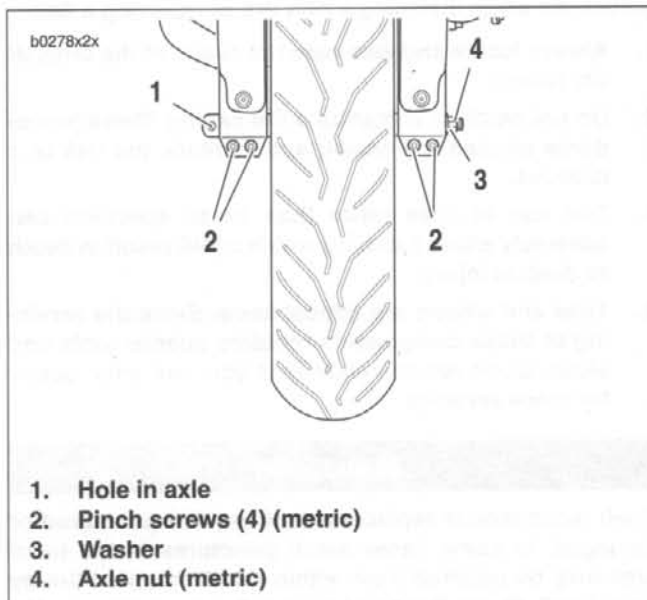


Figure 2-5. Front Wheel Mounting

DISASSEMBLY

1. See Figure 2-7. Move wheel to bench area. On brake rotor side of wheel, remove right axle spacer (10).
2. Remove wheel bearings (4, 9) using BUSHING AND BEARING PULLER (Part No. HD-95760-69A) and 3/4 in. COLLET (Part No. HD-95767-69A).
3. To detach brake rotor (18) from front brake carrier (16), disassemble the six brake drive pins (20).
 - a. See Figure 2-6. Remove nut (1) and drive pin flat washer (2).
 - b. Remove flat washer (3) and wave washer (4). Discard wave washer. Inspect flat washer for damage and discard if necessary.
4. See Figure 2-7. Remove five screws (17) to detach front brake carrier (16) from wheel hub.
5. Remove tire. See 2.9 TIRES.

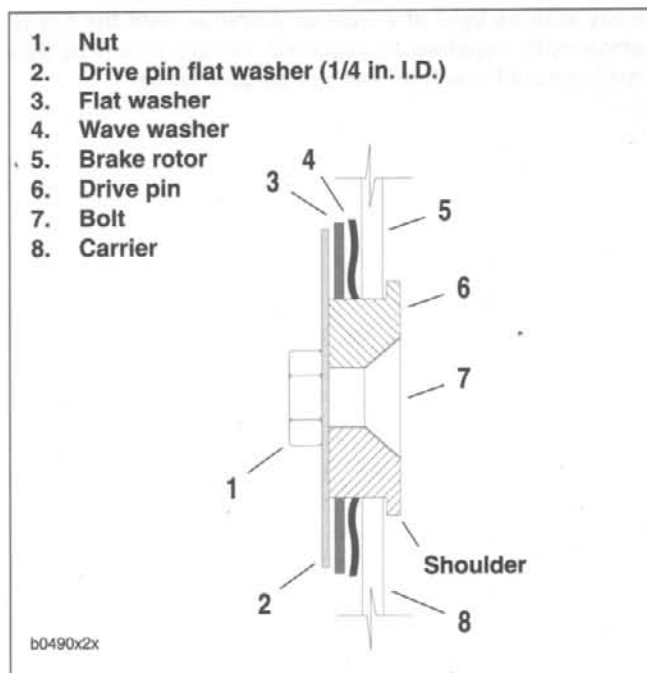


Figure 2-6. Rotor to Carrier Fastener

2. Inspect all parts for damage or excessive wear.

CLEANING, INSPECTION AND REPAIR

⚠ WARNING

Never use compressed air to "spin-dry" bearings. Very high bearing speeds can damage unlubricated bearings. Spinning bearings with compressed air can also cause a bearing to fly apart, which could result in death or serious injury.

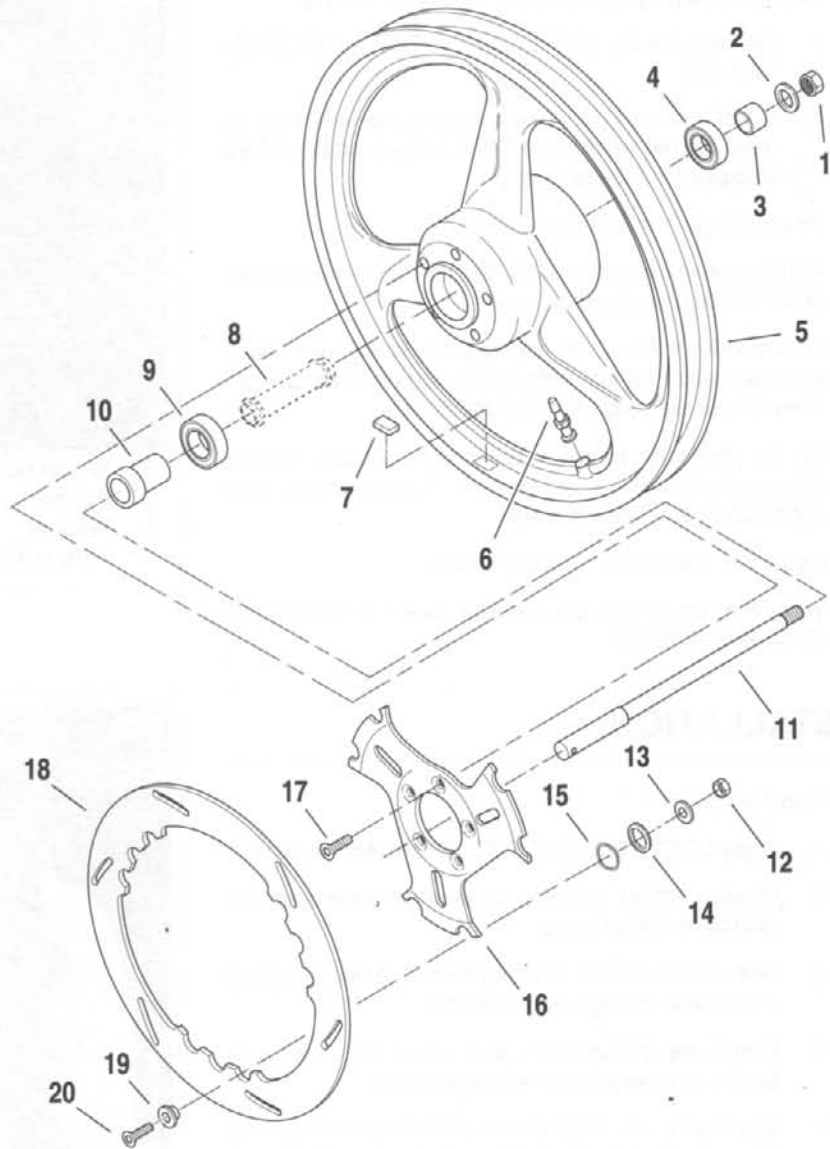
1. Thoroughly clean all parts in solvent.

⚠ WARNING

Always replace brake pads in complete sets for correct brake operation. Never replace just one brake pad. Failure to install brake pads as a set could result in death or serious injury.

3. Inspect brake rotor and pads. See 1.8 BRAKE PADS AND ROTORS (1999 MODELS).

1. Nut (metric)
2. Washer
3. Left axle spacer
4. Wheel bearing
5. Wheel
6. Valve stem
7. Wheel weight
8. Spacer
9. Wheel bearing
10. Right axle spacer
11. Front axle
12. Locknut (6)
13. Flat washer (6)
14. Washer (6)
15. Wave washer (6)
16. Front brake carrier
17. Screw (5)
18. Front brake rotor
19. Brake drive pin (6)
20. Screw (6)



b0701x2x

Figure 2-7. Front Wheel

ASSEMBLY

WARNING

Do not allow brake fluid, bearing grease, lubricants, etc. to contact brake rotor or reduced braking ability will occur, which could result in death or serious injury.

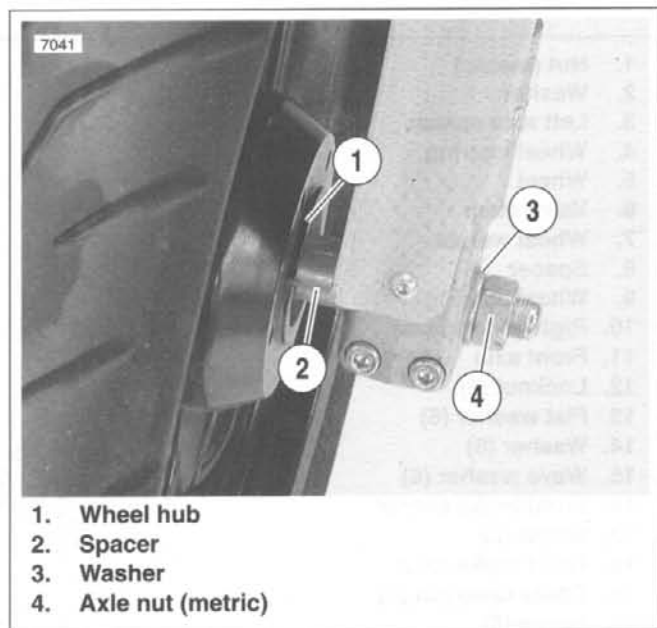
1. See Figure 2-7. Install front brake carrier (16) on right side of wheel. Slots in carrier must line up with wheel spokes.
 - a. Verify that the front brake carrier is thoroughly clean.
 - b. Apply LOCTITE THREADLOCKER 272 (red) to each of the five screws (17).
 - c. Install carrier (16) on wheel hub using screws. Tighten to 20-22 ft-lbs (27.1-29.8 Nm).

2. Attach front brake rotor (18) to carrier. Sweep of slots in rotor must be in the same direction as slots in carrier.
 - a. See Figure 2-6. Place drive pin (6) between rotor and carrier. Shoulder on drive pin faces away from wheel hub.
 - b. Insert bolt (7) through drive pin (6).
 - c. Install **new** wave washer (4) on back side of rotor.
 - d. Install flat washer (3).
 - e. Install drive pin flat washer (2).

NOTE

Updated drive pins were introduced midway through the 1999 model year. Measure outside diameter of drive pin before installation. If diameter is 1.0 in. (25.4 mm), replace with part number 45164-96YA.

3. Check that flat washer (3) has not fallen between drive pin (6) and drive pin flat washer (2). Install nut (1).
 - a. On cast wheels, torque nut (1) to 7.5-10 ft-lbs (10.2-13.6 Nm).
 - b. On aluminum P/M wheels, tighten nut until flush to drive pin flat washer (2). Then turn an additional 60 degrees (one flat on nut).
4. See Figure 2-7. Install spacer (8).
5. Install **new** wheel bearings (4, 9) into hub using suitable driver. Press on outer race only.
6. On the side of the wheel opposite the brake rotor insert left axle spacer (3) into hub until it seats in bore. Spacer sleeve must not be cocked or tilted in bore.
7. On the right side of the wheel insert right axle spacer (10) into hub until it seats in bore. Spacer sleeve must not be cocked or tilted in bore.
8. Install tire, if removed. See 2.9 TIRES.
9. Verify that wheel and tire are true. See 2.8 CHECKING CAST RIM RUNOUT.

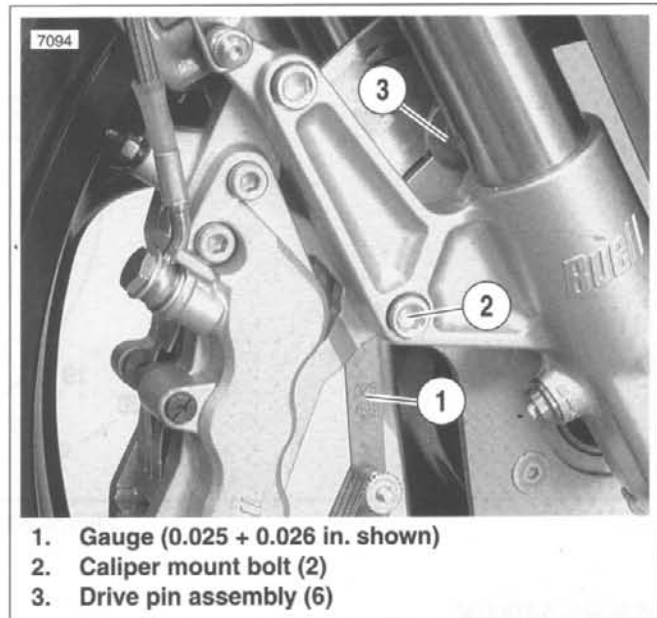


1. Wheel hub
2. Spacer
3. Washer
4. Axle nut (metric)

Figure 2-8. Spacer

INSTALLATION

1. Install front axle.
 - a. Apply LOCTITE ANTI-SEIZE LUBRICANT to axle.
 - b. Position wheel between forks with brake rotor on gearcase side of motor.
 - c. With pinch screws (metric) loose, insert threaded end of axle through right side fork.
 - d. Push axle through fork and wheel hub until axle begins to emerge from left side of hub.
 - e. See Figure 2-8. Align spacer (2) between wheel hub and fork. Push axle through spacer and left fork leg.
2. Compress the front suspension to make sure it is free and not binding.
3. Install axle nut (4).
 - a. Apply LOCTITE THREADLOCKER 243 (blue) to axle threads.
 - b. Install washer (3) and axle nut (4) (metric) over threaded end of axle.
 - c. See Figure 2-5. Insert screwdriver or steel rod through hole (1) in axle.
 - d. While holding axle stationary, tighten axle nut (4) (metric) to 48-53 ft-lbs (65.1-71.9 Nm).



1. Gauge (0.025 + 0.026 in. shown)
2. Caliper mount bolt (2)
3. Drive pin assembly (6)

Figure 2-9. Checking Drive Pins

4. Tighten the four front axle pinch screws (2) (metric) to 13-15 ft-lbs (17.6-20.3 Nm).
5. Install front brake caliper. See 2.12 FRONT BRAKE CALIPER (1999 Models).
6. See Figure 2-9. Inspect each drive pin assembly. There must be a minimum clearance of 0.050 in. (1.27 mm) between drive pin assembly and caliper mount bolts.

MODEL YEAR CHANGE

All 2000 Model Year Buell motorcycles have a new one-piece riveted brake disc/carrier assembly.

REMOVAL

1. Raise front wheel off floor using procedure under 1.19 STEERING HEAD BEARINGS.
2. Detach front brake caliper from rotor. See 2.19 FRONT BRAKE CALIPER (2000 Models).

NOTE

Do not operate front brake lever with front wheel removed or caliper pistons may be forced out. Reseating pistons requires caliper disassembly.

3. See Figure 2-10. Insert screwdriver/rod through hole in axle (1). Loosen front axle nut (4) (metric).
4. Loosen all four pinch screws (2) (metric).
5. Remove front axle nut (4) and washer (3). Pull front axle out of wheel hub while supporting front wheel.
6. See Figure 2-11. Remove spacer (3) from left side of wheel hub. Remove front wheel.

DISASSEMBLY

1. See Figure 2-11. Move wheel to bench area. On brake rotor side of wheel, remove right axle spacer (10).
2. Remove wheel bearings (4, 9) using BUSHING AND BEARING PULLER (Part No. HD-95760-69A) and 3/4 in. COLLET (Part No. HD-95767-69A).
3. See Figure 2-10. Remove five T-40 TORX screws (12) to detach front brake rotor (13) from wheel hub. Discard T-40 TORX screws.
4. Remove tire. See 2.9 TIRES.

CLEANING AND INSPECTION

WARNING

Never use compressed air to "spin-dry" bearings. Very high bearing speeds can damage unlubricated bearings. Spinning bearings with compressed air can also cause a bearing to fly apart, which could result in death or serious injury.

1. Thoroughly clean all parts in solvent.
2. Inspect all parts for damage or excessive wear.

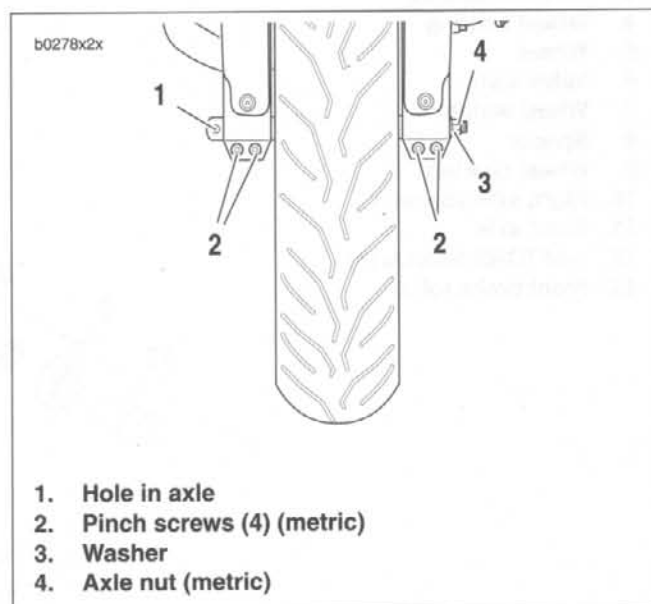


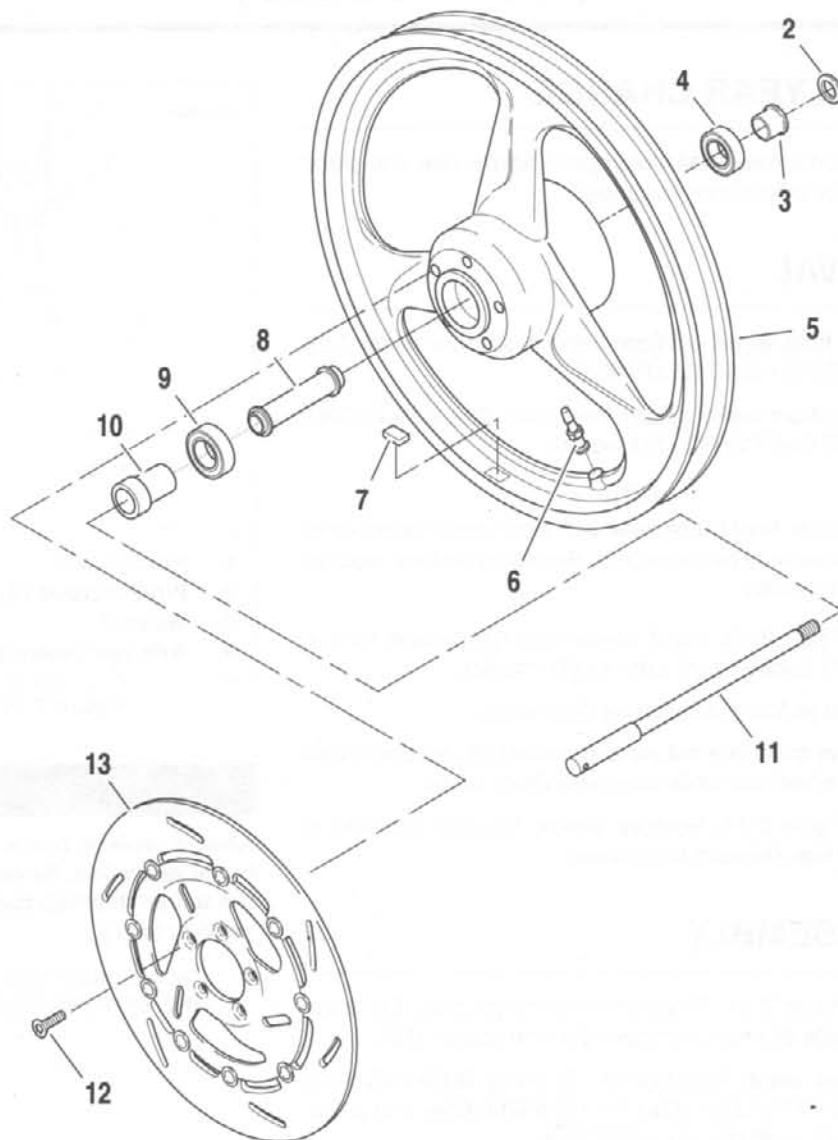
Figure 2-10. Front Wheel Mounting

WARNING

Always replace brake pads in complete sets for correct brake operation. Never replace just one brake pad. Failure to install brake pads as a set could result in death or serious injury.

3. Inspect brake rotor and pads. See 1.10 BRAKE PADS AND ROTORS (2000 MODELS).

1. Nut (metric)
2. Washer
3. Left axle spacer
4. Wheel bearing
5. Wheel
6. Valve stem
7. Wheel weight
8. Spacer
9. Wheel bearing
10. Right axle spacer
11. Front axle
12. T-40 TORX Screws (5)
13. Front brake rotor



b0701a2x

Figure 2-11. Front Wheel

ASSEMBLY

1. See Figure 2-11. Install spacer (8).
2. Install **new** wheel bearings (4, 9) into hub using suitable driver. Press on outer race only.
3. On the side of the wheel opposite the brake rotor insert left axle spacer (3) into hub until it seats in bore. Spacer sleeve must not be cocked or tilted in bore.
4. On the right side of the wheel insert right axle spacer (10) into hub until it seats in bore. Spacer sleeve must not be cocked or tilted in bore.
5. Install tire, if removed. See 2.9 TIRES.
6. Verify that wheel and tire are true. See 2.8 CHECKING CAST RIM RUNOUT.
7. Balance tire. See 2.9 TIRES, Adjustment.

WARNING

Do not allow brake fluid, bearing grease, lubricants, etc. to contact brake rotor or reduced braking ability will occur, which could result in death or serious injury.

8. See Figure 2-11. Install front brake rotor (13) on right side of wheel. Slots in carrier must line up with wheel spokes.
 - a. Verify that the front brake carrier is thoroughly clean.
 - b. Apply LOCTITE THREADLOCKER 243 (blue) to threads of **new** T-40 TORX screws (12).
 - c. Install rotor (13) on wheel hub using five **new** T-40 TORX screws (12). Tighten TORX screws in criss-cross pattern to 20-22 ft-lbs (27.1-29.8 Nm).

INSTALLATION

1. Install front axle.
 - a. Apply LOCTITE ANTI-SEIZE LUBRICANT to axle.
 - b. Position wheel between forks with brake rotor on gearcase side of motor.
 - c. With pinch screws (metric) loose, insert threaded end of axle through right side fork.
 - d. Push axle through fork and wheel hub until axle begins to emerge from left side of hub.
 - e. See Figure 2-12. Align spacer (2) between wheel hub and fork. Push axle through spacer and left fork leg.
2. Compress the front suspension to make sure it is free and not binding.
3. Install axle nut (4).
 - a. Apply LOCTITE THREADLOCKER 243 (blue) to axle threads.
 - b. Install washer (3) and axle nut (4) (metric) over threaded end of axle.
 - c. See Figure 2-10. Insert screwdriver or steel rod through hole (1) in axle.
 - d. While holding axle stationary, tighten axle nut (4) (metric) to 48-53 ft-lbs (65.1-71.9 Nm).
4. Tighten the four front axle pinch screws (2) (metric) to 13-15 ft-lbs (17.6-20.3 Nm).
5. Install front brake caliper. See 2.19 FRONT BRAKE CALIPER (2000 Models).

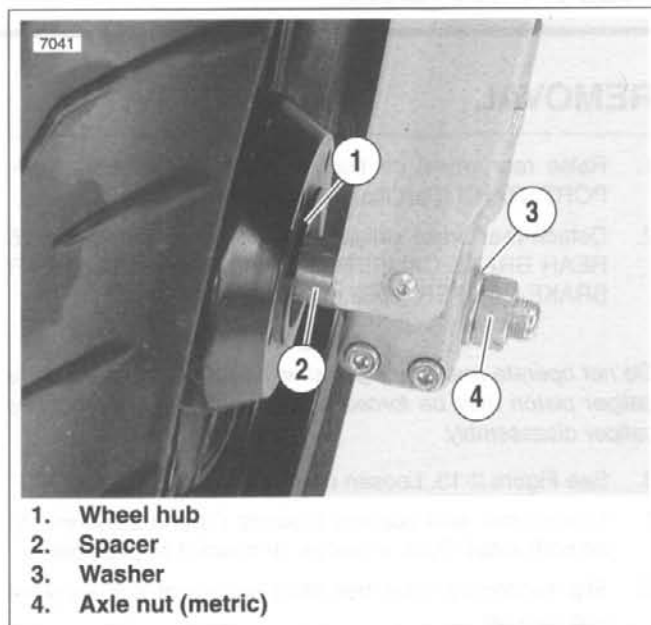


Figure 2-12. Spacer

REMOVAL

1. Raise rear wheel off floor using REAR WHEEL SUPPORT STAND (Part No. B-41174).
2. Detach rear brake caliper from caliper mount. See 2.15 REAR BRAKE CALIPER (1999 models) or 2.22 REAR BRAKE CALIPER (2000 models).

NOTE

Do not operate rear brake pedal with rear wheel removed or caliper piston may be forced out. Reseating piston requires caliper disassembly.

3. See Figure 2-13. Loosen rear axle nut (1) (metric).
4. Loosen rear axle adjuster locknuts (7) and adjusters (5) on both sides. Push wheel as far forward as possible.
5. Slip secondary drive belt from bottom of belt sprocket and remove.
6. Remove rear axle nut (1) (metric), lockwasher (2), washer (3) and axle carrier (4).
7. See Figure 2-14. Pull axle (3) and washer (4) out from left side and remove wheel. Support caliper mount from frame.

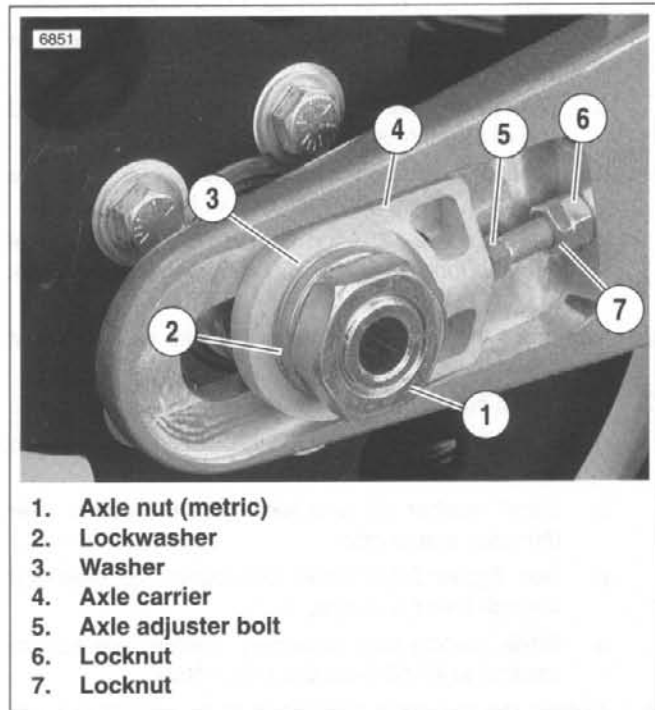


Figure 2-13. Rear Wheel Mounting, Right Side

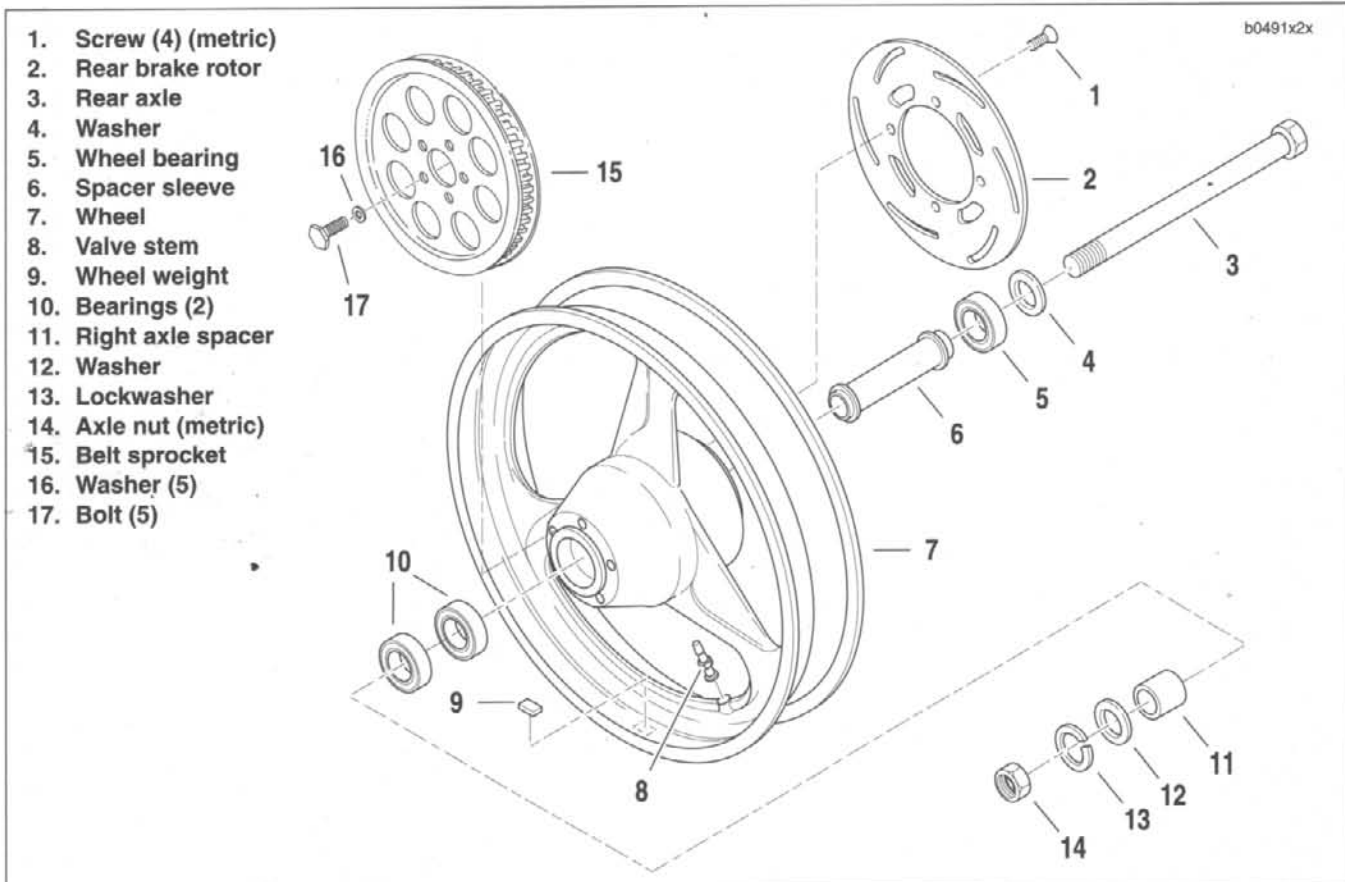


Figure 2-14. Rear Wheel

DISASSEMBLY

1. See Figure 2-15. Move wheel to bench area. On the brake rotor side of the wheel, remove bearing using BUSHING AND BEARING PULLER (Part No. HD-95760-69A) and 1 1/8 in. COLLET (Part No. HD-95769-69).
2. See Figure 2-14. Remove two bearings (10) from sprocket side of wheel.
3. Remove four screws (1) (metric) to detach rear brake rotor (2) from wheel hub. On vehicles with P/M wheels, remove nut from each screw.
4. Remove five bolts (17) and washers (16) to detach belt sprocket (15) from wheel hub.

CLEANING, INSPECTION AND REPAIR

WARNING

Never use compressed air to "spin-dry" bearings. Very high bearing speeds can damage unlubricated bearings. Spinning bearings with compressed air can also cause a bearing to fly apart, which could result in death or serious injury.

1. Thoroughly clean all parts in solvent.
2. Inspect all parts for damage or excessive wear.

WARNING

Always replace brake pads in complete sets for correct brake operation. Never replace just one brake pad. Failure to install brake pads as a set could result in death or serious injury.

3. Inspect brake rotor. See 1.8 BRAKE PADS AND ROTORS (1999 MODELS) or 1.10 BRAKE PADS AND ROTORS (2000 MODELS).

ASSEMBLY

WARNING

Do not allow brake fluid, bearing grease, lubricants, etc. to contact brake rotor or reduced braking ability will occur. These events could result in death or serious injury.

1. See Figure 2-14. Install rear brake rotor (2) on side of wheel hub with room for a single wheel bearing. Place rotor surface listing minimum thickness specification away from wheel hub.
 - a. Verify that rear brake rotor is thoroughly clean.
 - b. Apply LOCTITE THREADLOCKER 272 (red) to each of the four screws (1) (metric).
 - c. Fasten rotor to wheel hub using screws. Tighten to 35-40 ft-lbs (47.5-54.2 Nm).



Figure 2-15. Removing Wheel Bearing

2. Install belt sprocket (15) on side of wheel hub with room for two wheel bearings. Place sprocket machined surface away from wheel hub.
 - a. Check sprocket for unusual wear, broken teeth or a damaged flange. Replace if necessary.
 - b. Apply LOCTITE THREADLOCKER 272 (red) to each of the five sprocket bolts (17).
 - c. Install belt sprocket (15) using bolts (17) and washers (16). Tighten to 55-65 ft-lbs (74.6-88.1 Nm).
3. Install bearings (5, 10) and spacer (6) into wheel hub.
 - a. On the belt sprocket side of the wheel, install two bearings (10). Insert bearings separately, pressing on outer race only. Fully seated bearings will touch shoulder for spacer sleeve.
 - b. Insert spacer sleeve (6) into wheel hub.
 - c. On the brake rotor side of the wheel, insert bearing (5) into wheel hub until it contacts end of spacer sleeve. Press on outer race only.
4. Verify that wheel is true. See 2.8 CHECKING CAST RIM RUNOUT.
5. Install tire if removed. Under all circumstances, check that wheel and tire are true. See 2.9 TIRES.

INSTALLATION

1. Place wheel centrally in the swingarm with the brake rotor in the caliper. Slide wheel far enough forward to slip belt over sprocket and then slide wheel back.
2. Install rear axle.
 - a. Apply LOCTITE ANTI-SEIZE LUBRICANT to axle.

- b. See Figure 2-16. Insert axle (1) through washer (2) so that rounded side of washer will face swingarm. Continue through axle carrier (3), left side of swingarm (4), rear brake caliper mount (5) and wheel assembly.
 - c. See Figure 2-17. Place spacer (7) between wheel hub and right side of swingarm (6). Slide axle (1) through spacer, swingarm and axle carrier (5).
 - d. Place washer (4) on axle with rounded side facing swingarm. Install lockwasher (3) and axle nut (2) (metric). Do not fully tighten rear axle nut at this time.
3. Attach rear brake caliper to caliper mount. See 2.15 REAR BRAKE CALIPER (1999 models).
 4. Check for proper belt tension and wheel alignment. See 1.13 REAR BELT DEFLECTION.
 5. Tighten rear axle nut (14) (metric) to 66-73 ft-lbs (89.5-98.9 Nm).

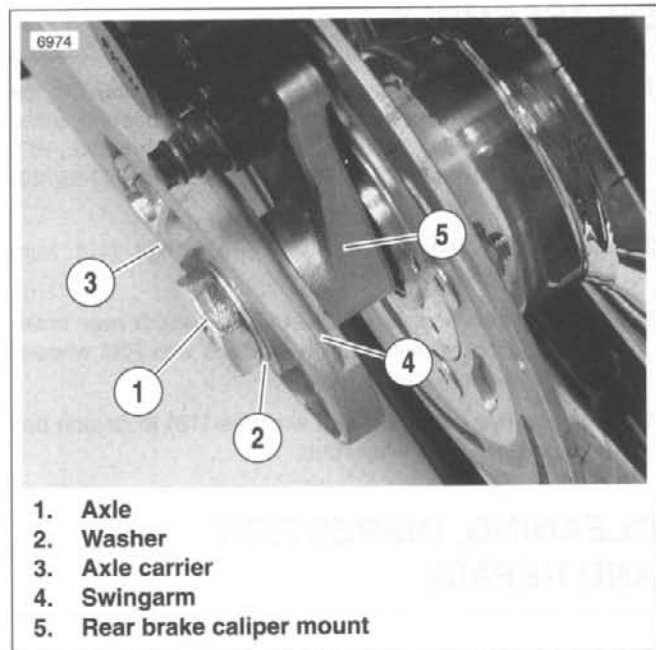


Figure 2-16. Axle, Left Side

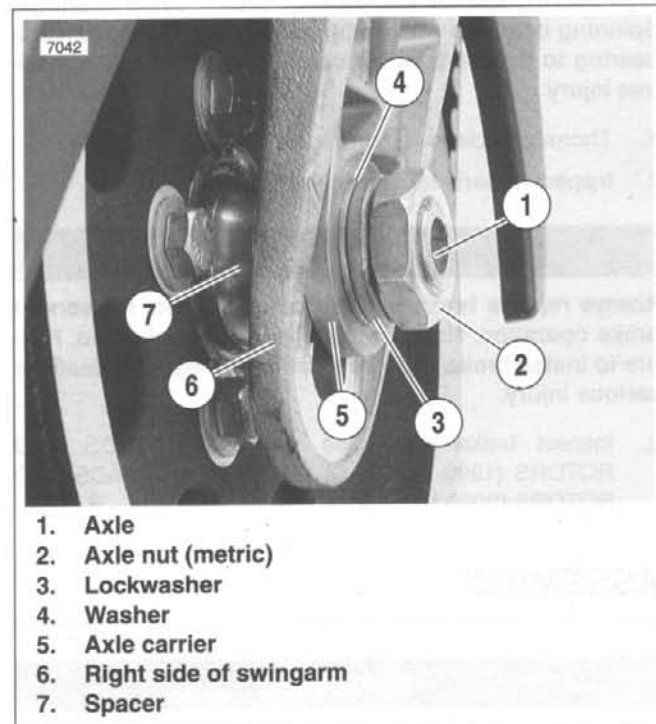


Figure 2-17. Axle, Right Side

GENERAL

Check wheels for lateral and radial runout before installing a new tire.

Rim Lateral Runout

1. See Figure 2-18. Install truing arbor in wheel hub and place wheel in WHEEL TRUING AND BALANCING STAND (Part No. HD-99500-80).
2. Tighten arbor nuts so hub will turn on its bearings.
3. Check rim lateral runout by placing a gauge rod or dial indicator near the rim bead. Replace wheel if lateral runout exceeds specification shown in Table 2-4.

Rim Radial Runout

1. See Figure 2-19. Install truing arbor in wheel hub and place wheel in WHEEL TRUING AND BALANCING STAND (Part No. HD-99500-80).
2. Tighten arbor nuts so hub will turn on its bearings.
3. Check radial runout as shown. Replace wheel if runout exceeds specification shown in Table 2-4.

Table 2-4. Wheel Runout

WHEEL TYPE	MAXIMUM LATERAL RUNOUT	MAXIMUM RADIAL RUNOUT
Cast	0.040 in. (1.02 mm)	0.030 in. (0.76 mm)
Aluminum P/M	0.020 in. (0.51 mm)	0.020 in. (0.51 mm)

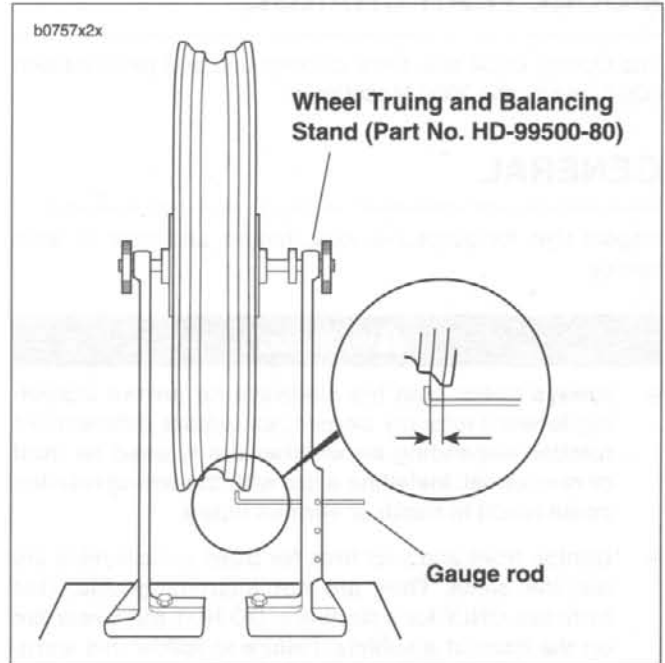


Figure 2-18. Checking Cast Rim Lateral Runout

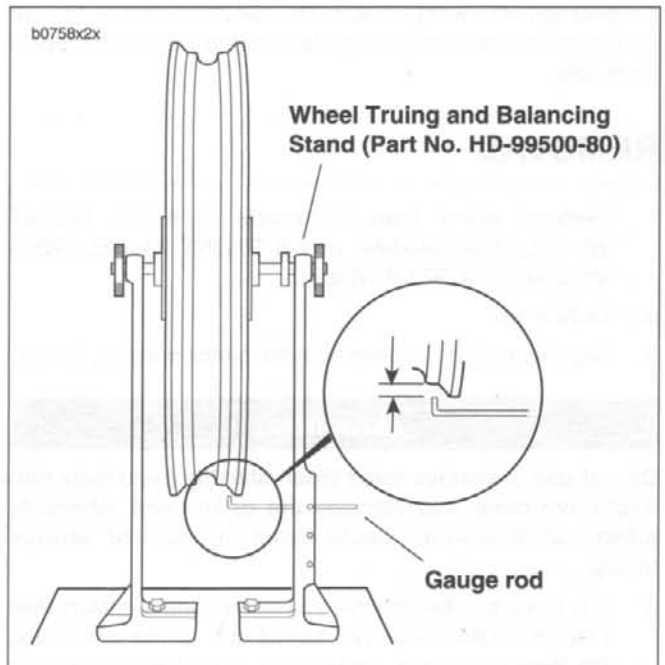


Figure 2-19. Checking Cast Rim Radial Runout

MODEL YEAR CHANGE

The Dunlop D204 tires were discontinued and replaced with D207 tires for the 2000 Model Year.

GENERAL

Inspect tires for punctures, cuts, breaks and wear at least weekly.

WARNING

- Always check both tire sidewalls for arrows indicating forward rotation. Some tires require different tire rotation depending on whether tire is used on front or rear wheel. Installing a tire with the wrong rotation could result in death or serious injury.
- Dunlop front and rear tires for Buell motorcycles are not the same. They are not interchangeable. Use front tire ONLY for a front tire. DO NOT put a rear tire on the front of a vehicle. Failure to follow this warning could result in death or serious injury.

Some tires have arrows molded into the tire sidewall. These tires should be mounted on the rim with the arrow pointing in the direction of forward rotation. The red circle on the sidewall is a balance mark and should be located next to the valve stem hole.

REMOVAL

1. Remove wheel from motorcycle. See 2.5 FRONT WHEEL (1999 Models) or 2.6 FRONT WHEEL (2000 Models) or 2.7 REAR WHEEL.
2. Deflate tire.
3. See Figure 2-20. Loosen both tire beads from rim flange.

WARNING

Do not use excessive force when starting bead over rim. Excessive force may damage tire or rim and adversely affect handling which could result in death or serious injury.

4. If a bead breaker machine is not available, attach RIM PROTECTORS (Part No. HD-01289) to the rim. Using tire tools (not sharp instruments), start upper bead over edge of rim at valve. Repeat all around rim until first bead is over rim.
5. See Figure 2-21. Push lower bead into rim well on one side and insert tire tool underneath bead from opposite side. Pry bead over rim edge. Remove tire from rim.
6. Remove valve stem if it is damaged or leaks.
7. Mount tire on TIRE SPREADER (Part No. HD-21000) for inspection and repair procedures.

CLEANING AND INSPECTION

1. Clean inside of tire.

2. If rim is dirty or corroded, clean with a stiff wire brush.
3. Inspect tire for wear and damage. Replace worn or damaged tires.

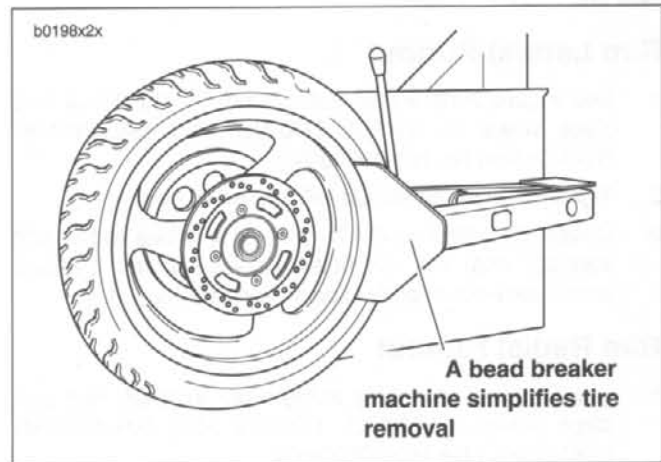


Figure 2-20. Loosening Beads from Rim Flange

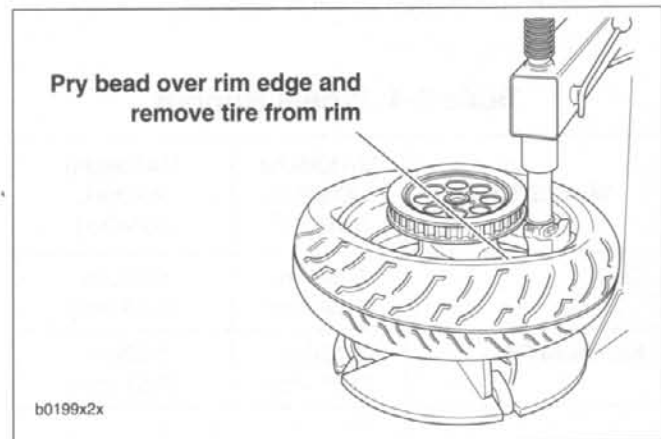


Figure 2-21. Starting Tire Off Rim

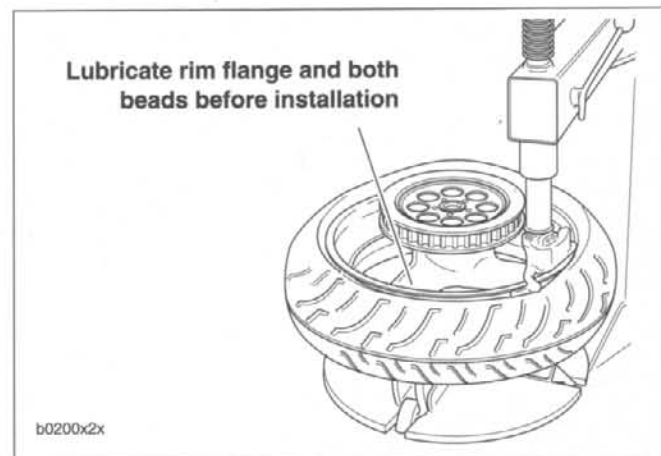


Figure 2-22. Starting Bead on Rim

INSTALLATION

WARNING

- Only install original equipment (stock) tire valves and valve caps. A valve or valve and cap combination that is too long may interfere with (strike) adjacent components, damage the valve and cause rapid tire deflation. Rapid tire deflation could cause loss of control. These events could result in death or serious injury.
- Also, aftermarket valve caps that are heavier than the stock cap may have clearance at slow speeds; but, at high speed the valve/cap will be moved outward by centrifugal force. This outward movement could cause the valve/cap to strike the adjacent components, damage the valve and cause rapid tire deflation. Rapid tire deflation could cause loss of control. These events could result in death or serious injury.

1. Damaged or leaking valve stems must be replaced. Place rubber grommet on valve stem with shoulder in recess of the valve stem head.
2. Install and tighten nut to 42-44 **in-lbs** (4.7-5.0 Nm).
3. Thoroughly lubricate rim flanges and both beads of tire with tire lubricant.
4. See Figure 2-22. Starting at the valve stem, start first bead into the rim well using a bead breaker machine. If no machine is available, work bead on as far as possible by hand. Use a tire tool to pry the remaining bead over rim flange.
5. Start 180° from valve stem hole and place second bead on rim. Work bead onto rim with tire tools, working toward valve in both directions.

WARNING

Do not inflate over 40 psi (275 kPa) to seat the beads. Inflating the tire beyond 40 psi (275 kPa) to seat the beads can cause the tire rim assembly to burst with force sufficient to cause death or serious injury. If the beads fail to seat to 40 psi (275 kPa), deflate and relubricate the bead and rim and reinflate to seat the beads, but do not exceed 40 psi (275 kPa).

6. Apply air to stem to seat beads on rim. It may be necessary to use a TIRE BEAD EXPANDER (Part No. HD-28700) on the tire until beads seal on rim.

Checking Tire Lateral Runout

1. See Figure 2-23. Turn wheel on axle and measure amount of displacement from a fixed point to tire sidewall.
2. Tire tread lateral runout should be no more than 0.080 in. (2.03 mm). If runout is more than 0.080 in. (2.03 mm), remove tire from rim.
3. Check rim bead side runout. See 2.8 CHECKING CAST RIM RUNOUT. Replace rims not meeting specifications.
4. Install tire and check again for tire tread lateral runout.

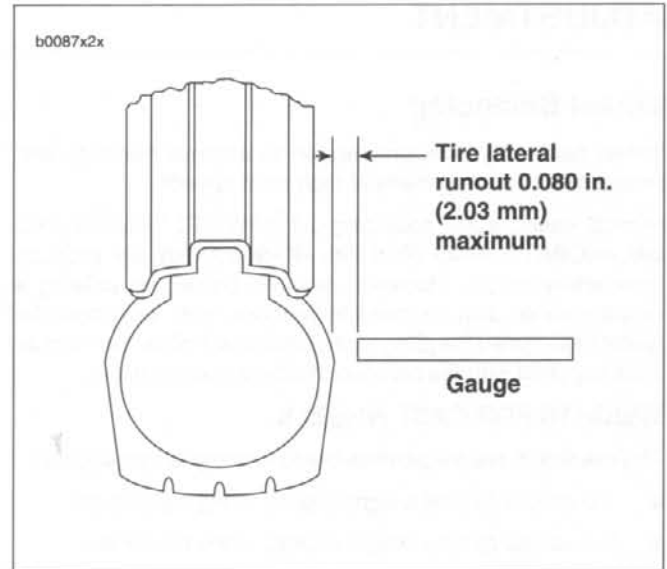


Figure 2-23. Checking Tire Lateral Runout

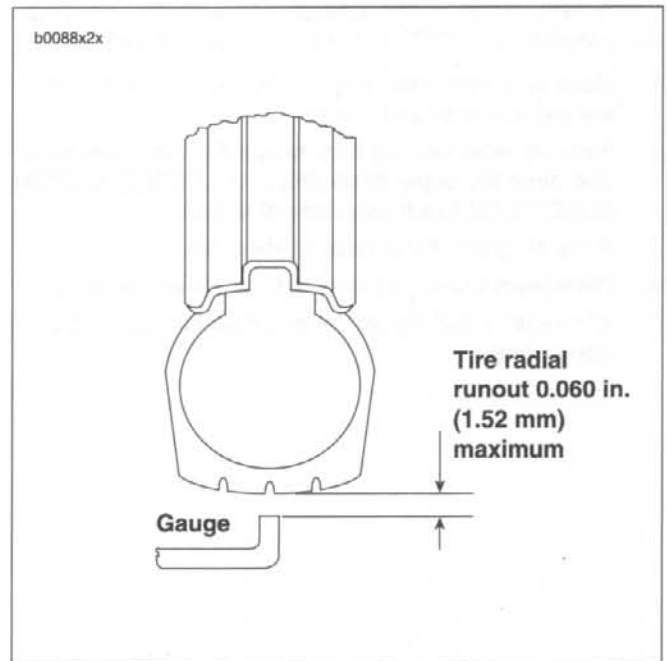


Figure 2-24. Checking Tire Radial Runout

Checking Tire Radial Runout

1. See Figure 2-24. Turn wheel on axle and measure tread radial runout.
2. Tire tread radial runout should not be greater than 0.060 in. (1.52 mm). If runout exceeds specification, remove tire from rim.
3. Check rim bead runout. See 2.8 CHECKING CAST RIM RUNOUT. Replace rims not meeting specifications.
4. Install tire and check tire tread radial runout again.

ADJUSTMENT

Wheel Balancing

Wheel balancing is recommended to improve handling and reduce vibration, especially at high road speeds.

In most cases, static balancing using WHEEL TRUING AND BALANCING STAND (Part No. HD-99500-80) will produce satisfactory results. However, dynamic balancing, utilizing a wheel spinner, can be used to produce finer tolerances for better high-speed handling characteristics. Follow the instructions supplied with the balance machine you are using.

WEIGHTS FOR CAST WHEELS

The maximum weight permissible to accomplish balance is:

- 1.0 oz. (28 g) total weight applied to the front wheel.
- 2.0 oz. (56 g) total weight applied to the rear wheel.

Wheels should be balanced to within 1/4 oz. (7 g) at 60 MPH (97 KM/H).

See Figure 2-25. Use only WHEEL WEIGHTS (Part No. 43692-94Y) which have special self-adhesive backings. Apply WHEEL WEIGHTS to the flat surface of the wheel rim.

1. Make sure that area of application is completely clean, dry and free of oil and grease.
2. Remove paper backing from weight. For additional adhesive strength, apply three drops of LOCTITE SUPER-BONDER 420 to adhesive side of weight.
3. Place weight on flat surface of wheel rim.
4. Press weight firmly in place and hold for ten seconds.
5. Allow eight hours for adhesive to cure completely before using wheel.

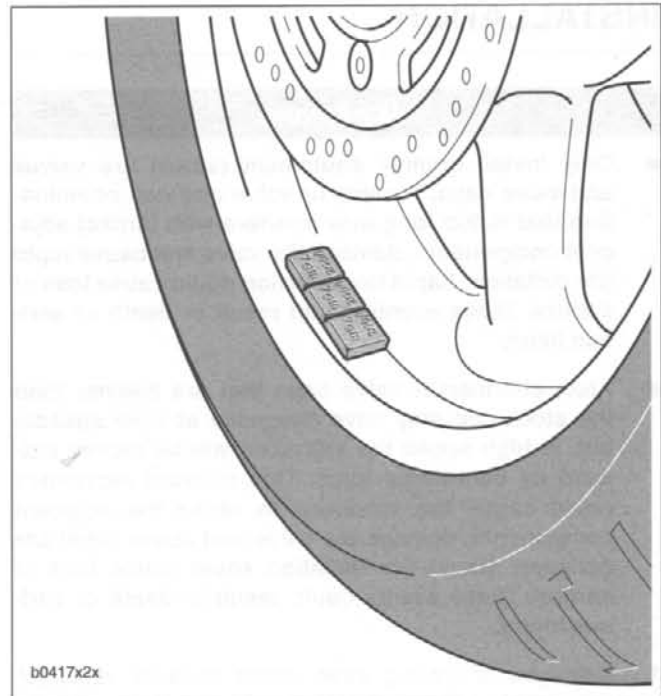


Figure 2-25. Wheel Weights

GENERAL

The front and rear brakes are fully hydraulic disc brake systems that require little maintenance. The front brake master cylinder is an integral part of the brake hand lever assembly. The rear brake master cylinder is located on the right side of the motorcycle near the brake pedal.

Check the master cylinder reservoirs for proper fluid levels after the first 500 miles (800 km) and every 5000 miles (8000 km) thereafter. Also inspect fluid levels at the end of every riding season. See 1.7 BRAKES (1999 Models).

Check brake pads and rotors for wear at every service interval. See 1.8 BRAKE PADS AND ROTORS (1999 MODELS).

If determining probable causes of poor brake operation, see Table 2-5.

WARNING

- Clean brake system components using denatured alcohol. Do not use mineral-base cleaning solvents, such as gasoline or paint thinner. Use of mineral-base solvents causes deterioration of rubber parts that continues after assembly. This may result in improper brake operation which could result in death or serious injury.
- Always test motorcycle brakes at low speed after servicing or bleeding system. To prevent death or serious injury, Buell recommends that all brake repairs be performed by a Buell dealer or other qualified mechanic.

CAUTION

D.O.T. 5 brake fluid can cause irritation of eyes and skin. In case of contact with skin or eyes, flush with plenty of water. Get medical attention for eyes. **KEEP BRAKE FLUID OUT OF THE REACH OF CHILDREN.** Failure to comply may result in mild or moderate injury.

Table 2-5. Brake Troubleshooting

CONDITION	CHECK FOR	REMEDY
Excessive lever/pedal travel or spongy feel.	Air in system. Master cylinder low on fluid.	Bleed brake(s). Fill master cylinder with approved brake fluid.
Chattering sound when brake is applied.	Worn pads. Loose mounting bolts. Warped rotor.	Replace brake pads. Tighten bolts. Replace rotor.
Ineffective brake – lever/pedal travels to limit.	Low fluid level. Piston cup not functioning.	Fill master cylinder with approved brake fluid, and bleed system. Rebuild cylinder.
Ineffective brake – lever/pedal travel normal.	Distorted or glazed rotor. Distorted, glazed or contaminated brake pads.	Replace rotor. Replace pads.
Brake pads drag on rotor – will not retract.	Cup in master cylinder not uncovering relief port. Rear brake pedal linkage out of adjustment.	Inspect master cylinder. Adjust linkage.

FRONT BRAKE MASTER CYLINDER (1999 MODELS) 2.11

REMOVAL

NOTE

Do not remove the master cylinder unless problems are being experienced.

1. See Figure 2-26. Drain brake fluid into a suitable container. Discard of used fluid according to local laws.
 - a. Open bleeder valve (metric) about 1/2-turn.
 - b. Install a length of plastic tubing over caliper bleeder valve. Place free end in a suitable container.
 - c. Pump brake hand lever to drain brake fluid.
 - d. Tighten bleeder valve to 3-5 ft-lbs (4.1-6.8 Nm)
2. Remove mirror from right handlebar.

CAUTION

Damaged banjo bolt seating surfaces will leak when reassembled. Prevent damage to seating surfaces by carefully removing brake line components.

3. See Figure 2-27. Remove banjo bolt (6) (metric) and two gaskets (4) to disconnect brake line (5) from master cylinder. Discard gaskets.
4. Remove screw (8) or unplug both terminals to detach brake lamp switch (7).

NOTE

The individual parts of the brake lamp switch are not serviceable. Replace switch upon failure.

5. Remove two screws (1) (metric) and clamp (2) to detach master cylinder assembly from handlebar.

DISASSEMBLY

1. See Figure 2-28. Detach front brake hand lever.
 - a. Remove nut (1) (metric) from lever pivot.
 - b. Remove pivot bolt (2) from lever pivot.
 - c. Detach front brake hand lever (3) from master cylinder assembly.
2. If present, detach front brake lamp switch by removing screw.
3. See Figure 2-29. Compress piston (2) and remove rubber boot (1).
4. Depress piston assembly and remove internal snap ring (3). Discard snap ring.
5. See Figure 2-30. Remove piston assembly (1-4) from front master cylinder.

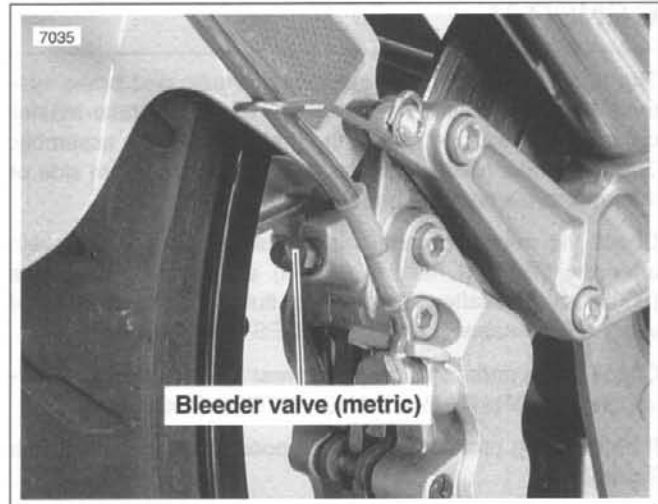


Figure 2-26. Draining Front Brake System

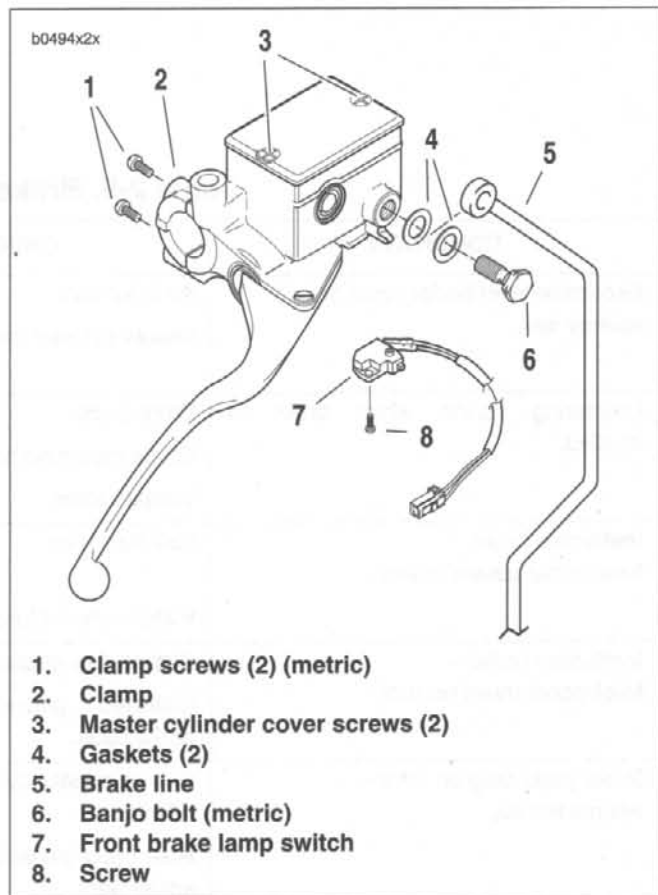


Figure 2-27. Front Master Cylinder

CLEANING, INSPECTION AND REPAIR

WARNING

Clean brake system components using denatured alcohol. Do not use mineral-base cleaning solvents, such as gasoline or paint thinner. Use of mineral-base solvents causes deterioration of rubber parts that continues after assembly. This could result in improper brake operation which could result in death or serious injury.

1. Clean all parts with denatured alcohol or D.O.T. 5 BRAKE FLUID. Do not contaminate with mineral oil or other solvents. Wipe dry with a clean, lint free cloth. Blow out drilled passages and bore with a clean air supply. Do not use a wire or similar instrument to clean drilled passages in bottom of reservoir.
2. Carefully inspect all parts for wear or damage and replace as necessary.
3. Inspect piston bore in master cylinder housing for scoring, pitting or corrosion. Replace housing if any of these conditions are found.
4. Inspect outlet port that mates with brake line fitting. As a critical sealing surface, replace housing if any scratches, dents or other damage is noted.
5. Inspect boot for cuts, tears or general deterioration. Replace as necessary.

ASSEMBLY

1. See Figure 2-30. Check piston assembly components.
 - a. Small end of spring (1) sits behind primary cup (2). Large side of primary cup faces spring.
 - b. Secondary cup (3) sits within ridge at middle of piston (4).
2. Insert piston assembly, spring first, into master cylinder. Secure with a **new** snap ring (6).
3. Install ridge on boot (5) into groove on piston (4).
4. See Figure 2-28. Install front brake hand lever.
 - a. Align hole in lever (3) with hole in master cylinder assembly.
 - b. Lubricate pivot bolt (2) with LOCTITE ANTI-SEIZE.
 - c. Install pivot bolt through top of assembly. Tighten to 4-13 **in-lbs** (0.5-1.5 Nm).
 - d. Install nut (1) (metric). Tighten to 44-62 **in-lbs** (5.0-7.0 Nm).
5. See Figure 2-27. Install front brake lamp switch (7).
 - a. Attach front brake lamp switch with screw (8). Tighten to 7-13 **in-lbs** (0.8-1.5 Nm).
 - b. Test switch action. Tang on switch must release when hand lever is moved.

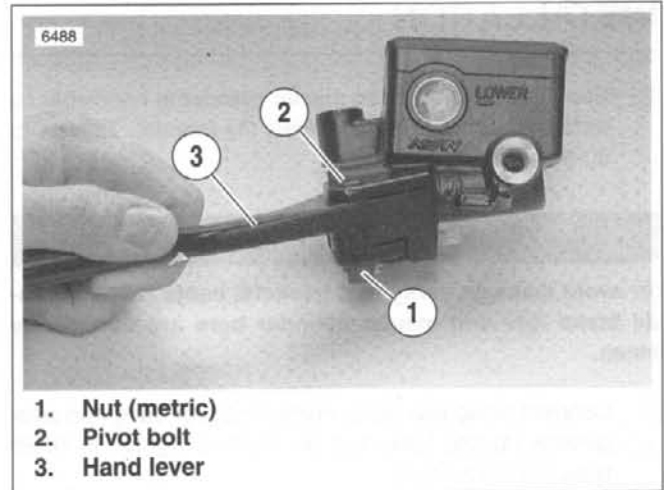


Figure 2-28. Hand Lever

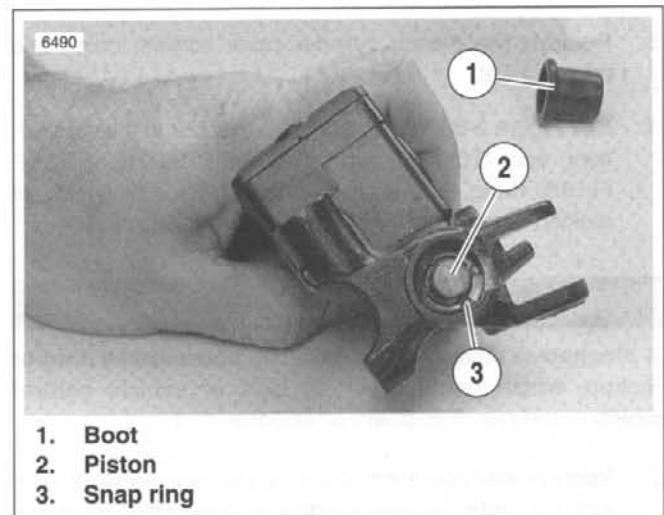


Figure 2-29. Snap Ring

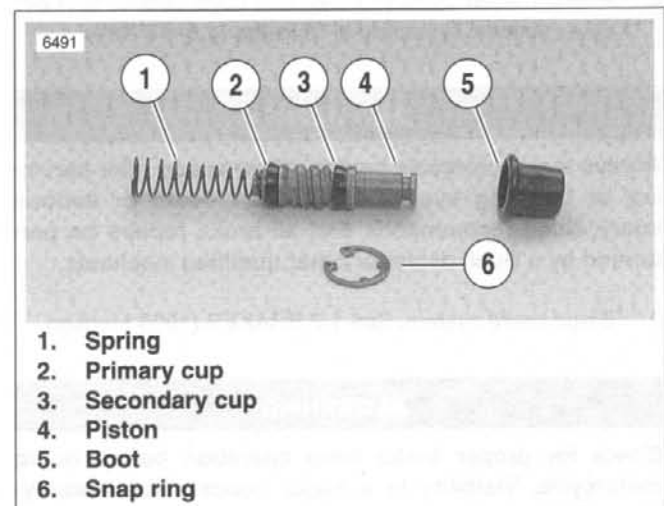


Figure 2-30. Piston Assembly

INSTALLATION

1. See Figure 2-27. Fasten master cylinder to handlebar by installing clamp (2) and screws (1) (metric). Tighten to 80-90 **in-lbs** (9.0-10.2 Nm).

CAUTION

To avoid leakage, verify that gaskets, banjo bolt, hydraulic brake line and master cylinder bore are completely clean.

2. Connect brake line (5) to master cylinder using two **new** gaskets (4) and banjo bolt (6) (metric). Tighten to 16-20 ft-lbs (21.7-27.1 Nm).
3. See Figure 2-31. Verify brake lamp switch wires are tight.
4. See Figure 2-32. Install mirror parallel to handlebars.
5. Remove two master cylinder cover screws, cover and cover gasket.
6. See Figure 2-33. With the master cylinder in a level position, add D.O.T. 5 SILICONE HYDRAULIC BRAKE FLUID. Bring fluid level to within 1/8 in. (3.2 mm) of molded boss inside front master cylinder reservoir.

WARNING

A plugged or covered relief port can cause brake drag or lockup, which could result in loss of vehicle control which could result in death or serious injury.

7. Verify proper operation of the master cylinder relief port. Actuate the brake lever with the reservoir cover removed. A slight spurt of fluid will break the surface if all internal components are working properly.
8. Attach master cylinder cover and cover gasket with two cover screws. Tighten to 9-13 **in-lbs** (1.0-1.5 Nm).

WARNING

Always test motorcycle brakes at low speed after servicing or bleeding system. To prevent death or serious injury, Buell recommends that all brake repairs be performed by a Buell dealer or other qualified mechanic.

9. Bleed brake system. See 1.7 BRAKES (1999 Models).

WARNING

Check for proper brake lamp operation before riding motorcycle. Visibility is a major concern for motorcyclists. Failure to have proper brake lamp operation could result in death or serious injury.

10. Turn ignition key switch to IGN. Apply brake hand lever to test brake lamp operation. Turn ignition key switch to LOCK.

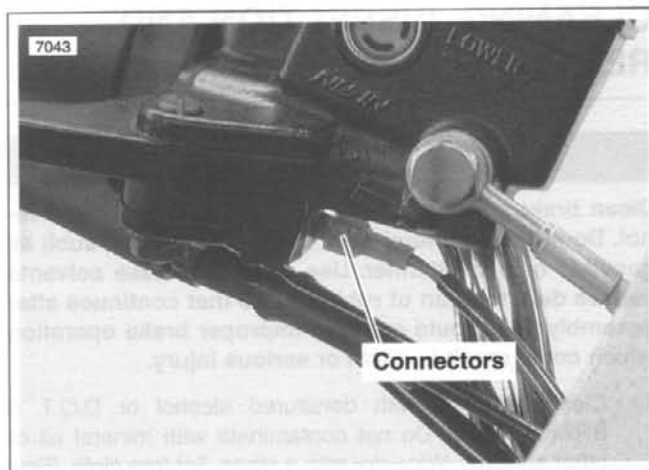


Figure 2-31. Brake Lamp Switch Connectors

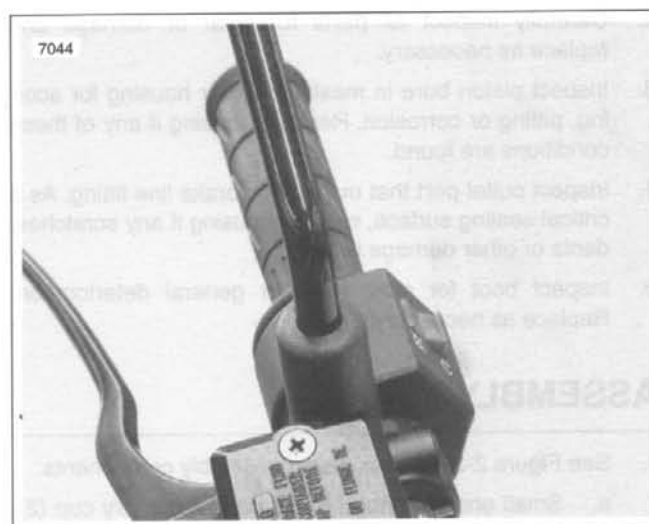


Figure 2-32. Mirror Installation

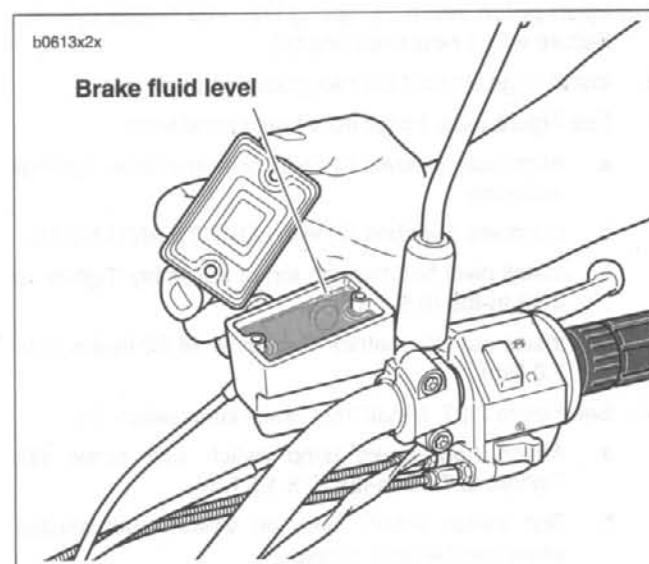


Figure 2-33. Brake Fluid Level

REMOVAL

NOTE

Steps 1 and 2 are not required for detaching caliper from rotor. Drain fluid only when disassembling caliper.

1. Drain and discard brake fluid.

CAUTION

Damaged banjo bolt seating surfaces will leak when reassembled. Prevent damage to seating surfaces by carefully removing brake line components.

2. See Figure 2-34. Remove banjo bolt (2) (metric) and two gaskets (3) to disconnect brake line (1) from caliper. Discard gaskets.
3. Remove brake pads.
 - a. Remove pin plug (4).
 - b. See Figure 2-35. Remove pad hanger pin (1) (metric).
 - c. Remove pad spring (2).
 - d. Remove brake pads from caliper.
4. See Figure 2-34. Detach caliper from mounts.
 - a. Remove both mounting screws (5) while supporting caliper above brake rotor.
 - b. Slowly remove caliper by tilting away from wheel and then pulling away from rotor.

DISASSEMBLY

1. See Figure 2-35. Remove four screws (3) (metric) to separate caliper halves.
2. Remove two O-rings from between caliper halves and discard.
3. See Figure 2-36. Use BRAKE CALIPER PISTON REMOVER (Part No. B-42887) without adaptor to pull the six pistons from caliper bores.
4. See Figure 2-37. Pry O-rings (6) out of their respective grooves on each side of caliper. Discard O-rings.
5. Check bleeder valve (4) (metric). Remove and replace if damaged.

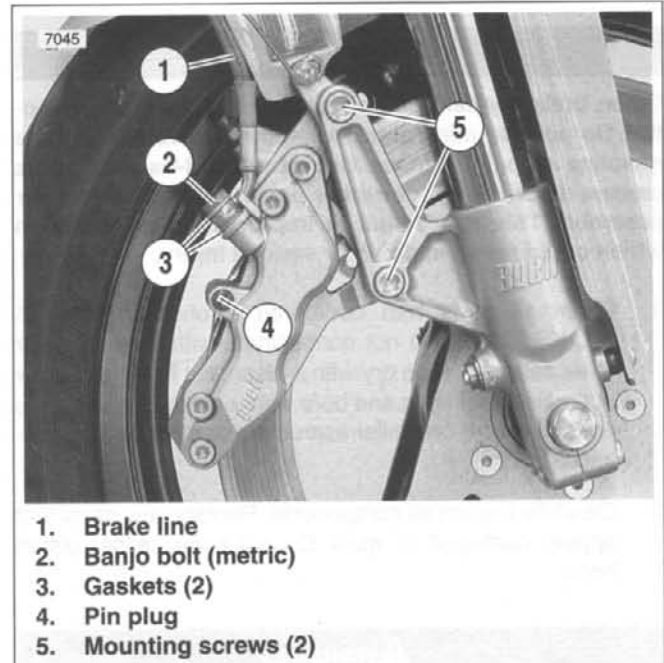


Figure 2-34. Front Brake Caliper Mounts

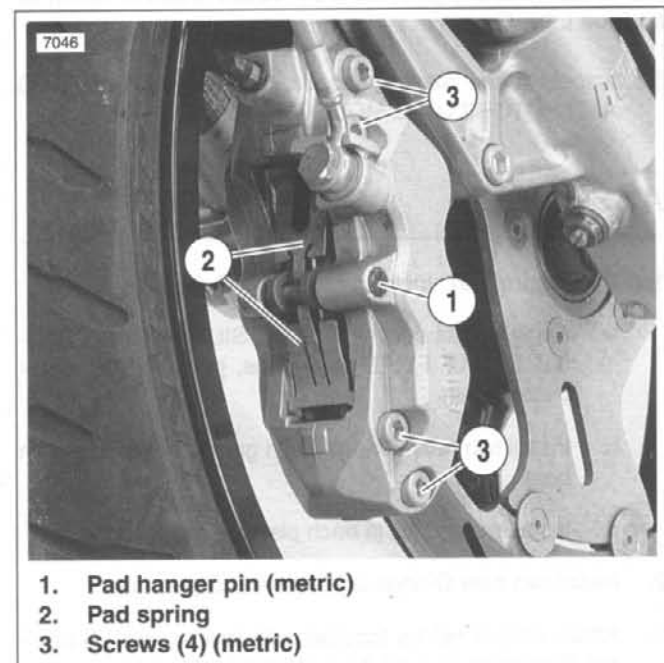


Figure 2-35. Pad Spring

CLEANING, INSPECTION AND REPAIR

⚠ WARNING

Clean brake system components using denatured alcohol. Do not use mineral-base cleaning solvents, such as gasoline or paint thinner. Use of mineral-base solvents causes deterioration of rubber parts that continues after assembly. This may result in improper brake operation which could result in death or serious injury.

1. Clean all parts with denatured alcohol or D.O.T. 5 BRAKE FLUID. Do not contaminate with mineral oil or other solvents. Wipe dry with a clean, lint free cloth. Blow out drilled passages and bore with a clean air supply. Do not use a wire or similar instrument to clean drilled passages.
2. Carefully inspect all components. Replace any parts that appear damaged or worn. Do not hone caliper piston bore.

⚠ WARNING

Always replace brake pads in complete sets for correct brake operation. Never replace just one brake pad. Failure to install brake pads as a set could result in death or serious injury.

3. Inspect brake rotor and pads. See 1.8 BRAKE PADS AND ROTORS (1999 MODELS).

ASSEMBLY

1. See Figure 2-37. Install pistons and O-rings.
 - a. Apply a light coat of D.O.T. 5 SILICONE HYDRAULIC BRAKE FLUID to O-rings, pistons and caliper piston bores.
 - b. Install two **new** O-rings (6) in grooves of each piston bore.
 - c. Install pistons (5) in each piston bore.
2. Install two **new** O-rings (3) between caliper halves.
3. Attach caliper halves together with four screws (7) (metric). Tighten to 14.5-18 ft-lbs (19.6-24.4 Nm).
4. Install a **new** bleeder valve (4) (metric) if necessary. Tighten to 3-5 ft-lbs (4.1-6.8 Nm).

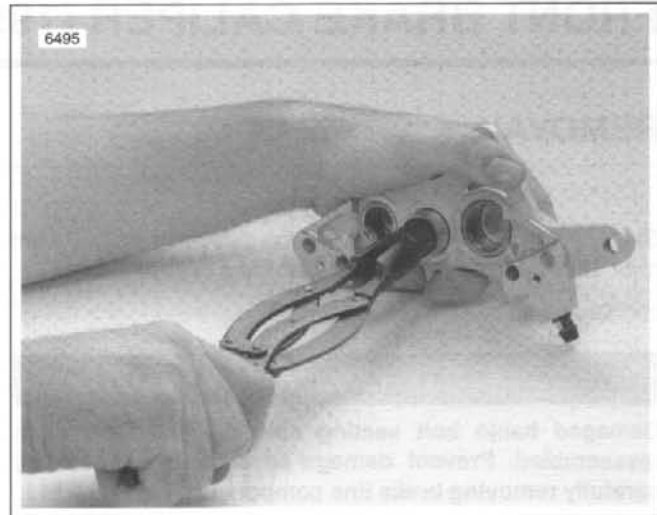


Figure 2-36. Removing Pistons

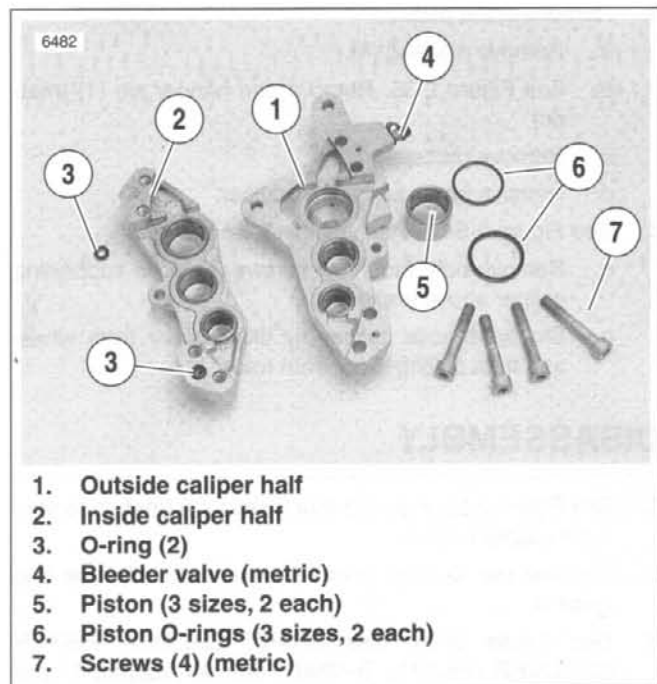


Figure 2-37. Caliper O-rings and Pistons

INSTALLATION

1. Fit front brake caliper on rotor.
 - a. Check rotor attachment to carrier. Inspect all six brake drive pins for missing hardware.
 - b. Make sure rotor is centered on carrier. Use two clamps on rotor and carrier to reduce free play and center rotor.
 - c. Slide caliper over front brake rotor without brake pads installed.
2. See Figure 2-34. Apply LOCTITE THREADLOCKER 272 (red) to both caliper mounting screws (5). Install and tighten to 22-25 ft-lbs (29.8-33.9 Nm).
3. Install brake pads.
 - a. See Figure 2-38. Insert brake pads from behind.
 - b. See Figure 2-35. Install pad spring (2) with opening at top as shown.
 - c. Install pad hanger pin (1) (metric). Tighten to 11-14.5 ft-lbs (14.7-19.6 Nm).
 - d. See Figure 2-34. Install pin plug (4). Tighten to 1.5-2.1 ft-lbs (2.0-2.9 Nm).

CAUTION

To avoid leakage, verify that gaskets, banjo bolt, hydraulic brake line and caliper bore are completely clean.

4. Connect brake line (1) to caliper using two **new** gaskets (3) and banjo bolt (2) (metric). Tighten to 16-20 ft-lbs (21.7-27.1 Nm).
5. See Figure 2-39. Remove both master cylinder cover screws (2). Remove master cylinder cover (1) and gasket.
6. With the master cylinder in a level position, verify that the brake fluid level is 1/8 in. (3.2 mm) from molded boss inside reservoir. Add D.O.T. 5 SILICONE HYDRAULIC BRAKE FLUID if necessary.

WARNING

A plugged or covered relief port can cause brake drag or lockup, which could result in loss of vehicle control which could result in death or serious injury.

7. Verify proper operation of the master cylinder relief port. Actuate the brake lever with the reservoir cover removed. A slight spurt of fluid will break the surface if all internal components are working properly.

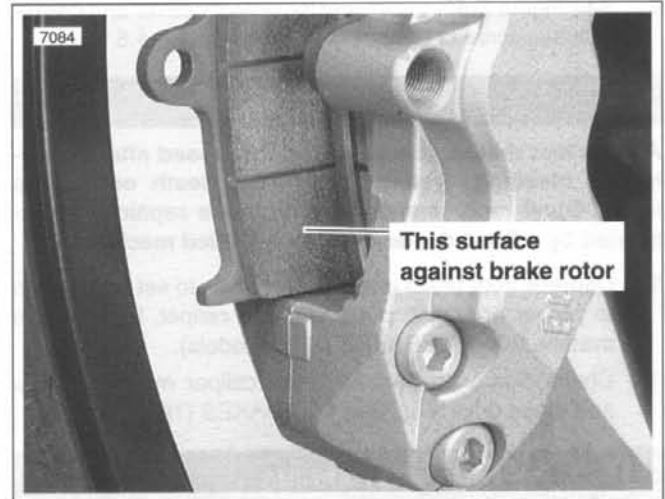


Figure 2-38. Installing Brake Pads

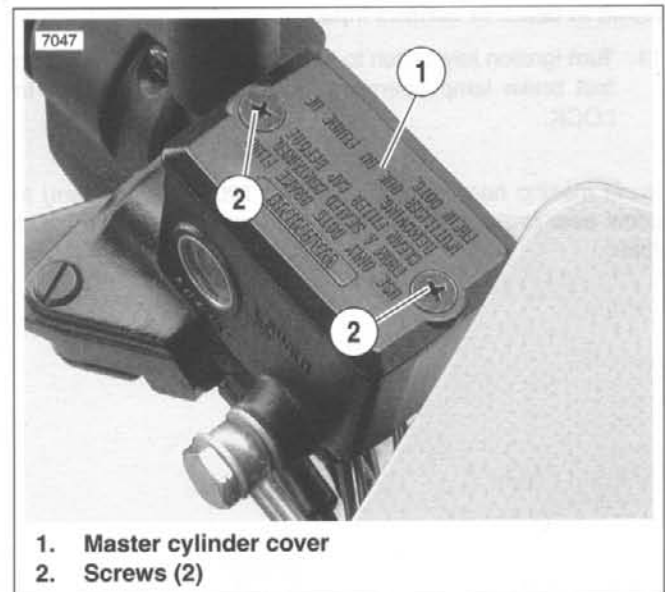


Figure 2-39. Master Cylinder Cover

- See Figure 2-40. Install master cylinder cover and gasket with two screws. Tighten to 9-13 **in-lbs** (1.0-1.5 Nm).

⚠ WARNING

Always test motorcycle brakes at low speed after servicing or bleeding system. To prevent death or serious injury, Buell recommends that all brake repairs be performed by a Buell dealer or other qualified mechanic.

- Depress front brake lever several times to set brake pads to proper operating position within caliper. Bleed brake system. See 1.7 BRAKES (1999 Models).
- Check clearance between front caliper mounting bolts and brake drive pins. See 1.7 BRAKES (1999 Models).

⚠ WARNING

Check for proper brake lamp operation before riding motorcycle. Visibility is a major concern for motorcyclists. Failure to have proper brake lamp operation could result in death or serious injury.

- Turn ignition key switch to IGN. Apply brake hand lever to test brake lamp operation. Turn ignition key switch to LOCK.

NOTE

*Avoid making hard stops for the first 100 miles (160 km) to allow **new** brake pads to "wear in" properly with the brake rotor.*



Figure 2-40. Front Master Cylinder Gasket

REMOVAL

1. Drain and discard brake fluid. See Step 1 (Removal) in 2.11 FRONT BRAKE MASTER CYLINDER (1999 Models).
2. See Figure 2-41. Remove screw (4) to detach brake line clamp and wire guide (5) from right side of lower triple clamp.

CAUTION

Damaged banjo bolt seating surfaces will leak when reassembled. Prevent damage to seating surfaces by carefully removing brake line components.

3. Remove master cylinder banjo bolt (1) (metric) and two gaskets (2) to disconnect brake line from master cylinder. Discard gaskets.
4. Remove caliper banjo bolt (6) (metric) and two gaskets (7) to disconnect brake line from caliper. Discard gaskets.
5. Carefully inspect the brake line for dents, cuts or other defects. Replace the brake line if any damage is noted.

INSTALLATION

CAUTION

To avoid leakage, verify that gaskets, banjo bolt, hydraulic brake line and master cylinder bore are completely clean.

1. See Figure 2-41. Connect brake line to master cylinder using two **new** gaskets (2) and banjo bolt (1) (metric). Loosely install bolt into master cylinder.
2. See Figure 2-42. From the master cylinder, the brake line runs downward in front of the right handlebar, where it turns inboard at the upper triple clamp. Loosely install clamp and wire guide (5) with screw (4) to attach front brake line clamp to right side of lower triple clamp. Route brake line through wire guide as shown in Figure 2-42.

CAUTION

To avoid leakage, verify that gaskets, banjo bolt, hydraulic brake line and caliper bore are completely clean.

3. See Figure 2-41. Connect brake line to caliper using two **new** gaskets (7) and banjo bolt (6). Loosely install bolt into caliper.

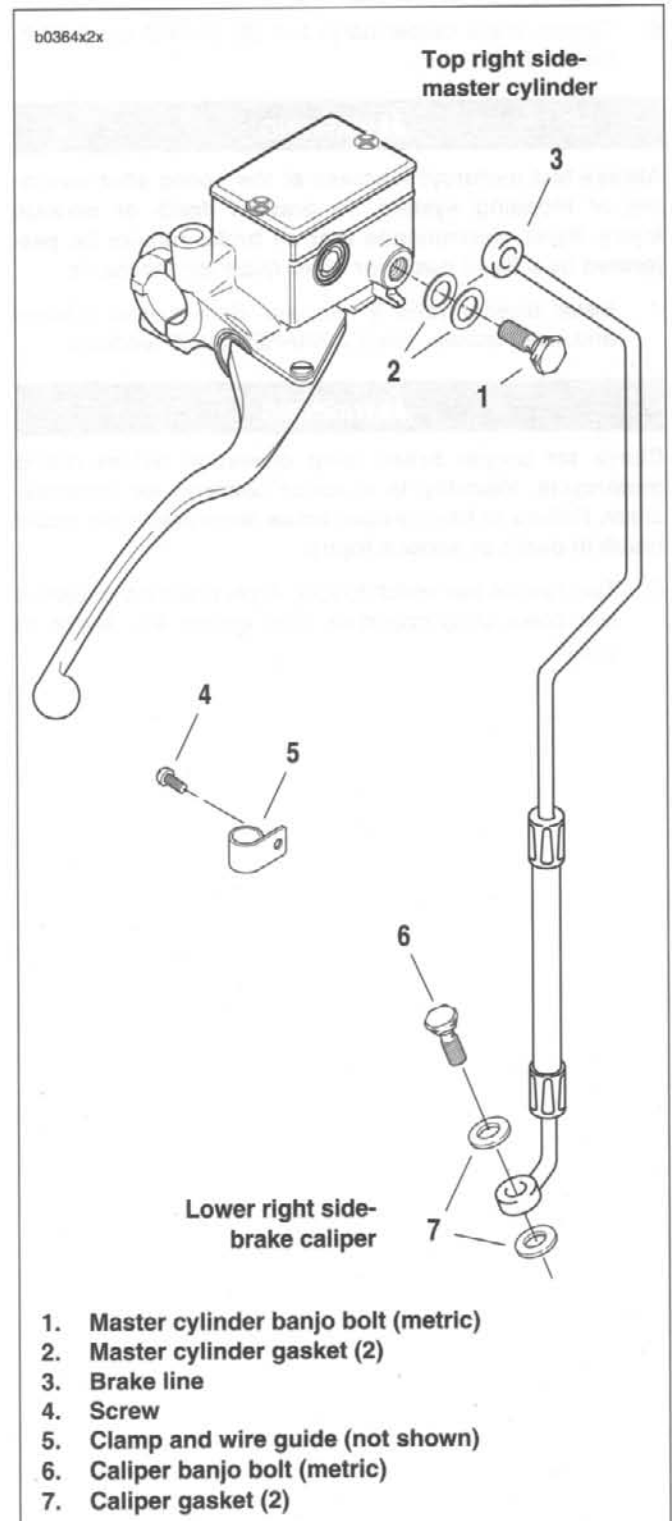


Figure 2-41. Front Brake Line

4. See Figure 2-42. Tighten clamp screw on lower triple clamp to 30-35 in-lbs (3.4-4.0 Nm).
5. See Figure 2-41. Tighten master cylinder banjo bolt (1) (metric) to 16-20 ft-lbs (21.7-27.1 Nm).
6. Tighten brake caliper banjo bolt (6) (metric) to 16-20 ft-lbs (21.7-27.1 Nm).

⚠ WARNING

Always test motorcycle brakes at low speed after servicing or bleeding system. To prevent death or serious injury, Buell recommends that all brake repairs be performed by a Buell dealer or other qualified mechanic.

7. Install bleeder valve if removed. Refill master cylinder and bleed brakes. See 1.7 BRAKES (1999 Models).

⚠ WARNING

Check for proper brake lamp operation before riding motorcycle. Visibility is a major concern for motorcyclists. Failure to have proper brake lamp operation could result in death or serious injury.

8. Turn ignition key switch to IGN. Apply brake hand lever to test brake lamp operation. Turn ignition key switch to LOCK.

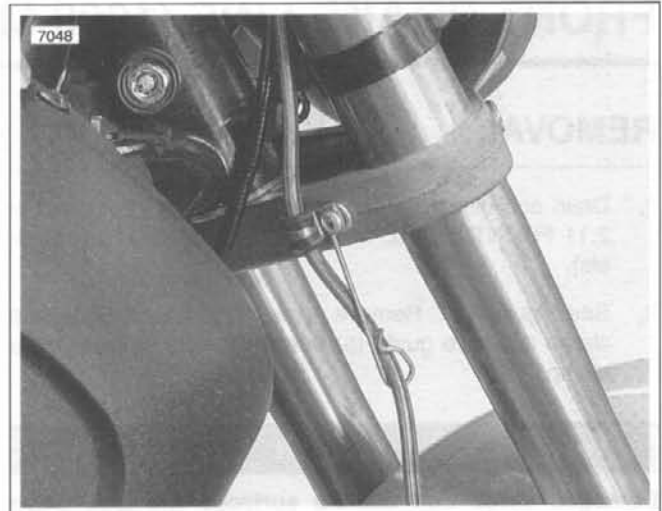


Figure 2-42. Lower Triple Clamp

REMOVAL

1. See Figure 2-43. Drain brake fluid into a suitable container. Discard of used fluids according to local laws.
 - a. Remove cap from rear caliper bleeder valve. Open bleeder valve (metric) about 1/2 turn.
 - b. Install a length of plastic tubing over caliper bleeder valve. Place free end in a suitable container.
 - c. Pump brake pedal to drain brake fluid.
 - d. Tighten bleeder valve (metric) to 3-5 ft-lbs (4.1-6.8 Nm). Reinstall cap.

CAUTION

Damaged banjo bolt surfaces will leak when reassembled. Prevent damage to seating surfaces by carefully removing brake line components.

2. See Figure 2-44. Remove banjo bolt (1) (metric) and two gaskets (2) to detach brake line (3) from master cylinder (4). Discard gaskets.
3. Remove cable strap holding brake reservoir hose to rear brake line.
4. Remove right side footrest mount. See 2.36 FOOTRESTS (1999 Models).
5. See Figure 2-45. Disconnect push rod from brake pedal turn buckle (4).
 - a. Spin locknut (3) away from top surface of turn buckle.
 - b. Turn rod adjuster (2) to free rod from turn buckle (4).
6. See Figure 2-46. Remove screws (2) (metric) to detach master cylinder (3) from frame.
7. See Figure 2-47. Detach remote reservoir.
 - a. Remove seat.
 - b. Remove top or bottom clamp on hose connected to master cylinder.
 - c. Remove screw to detach reservoir from frame if necessary.

DISASSEMBLY

NOTE

Do not disassemble master cylinder unless problems are experienced. Discard all seals during the disassembly procedure. Install a complete rebuild kit upon assembly.

1. See Figure 2-48. Slide rubber boot on rod assembly (3) away from master cylinder body (1).
2. Depress rod assembly (3) and remove internal snap ring (2). Discard snap ring.
3. Remove piston assembly (4) from master cylinder body.

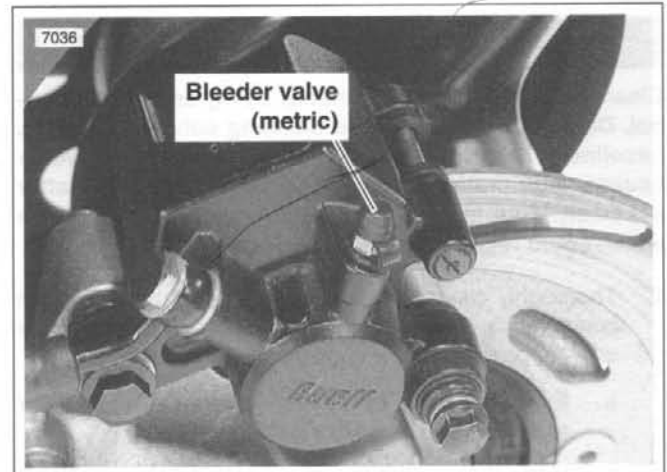


Figure 2-43. Rear Caliper Bleeder Valve (Metric)

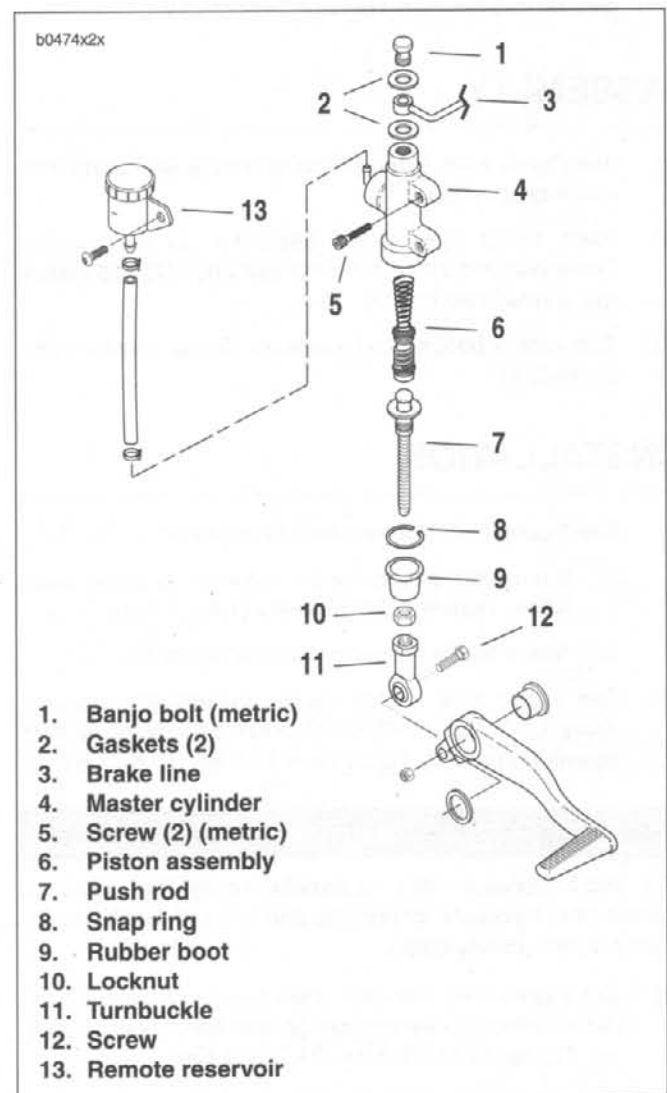


Figure 2-44. Rear Master Cylinder Assembly

CLEANING, INSPECTION AND REPAIR

⚠ WARNING

Clean brake system components using denatured alcohol. Do not use mineral-base cleaning solvents, such as gasoline or paint thinner. Use of mineral-base solvents causes deterioration of rubber parts that continues after assembly. This may result in improper brake operation which could result in death or serious injury.

1. Thoroughly clean master cylinder and all brake system components. Stand master cylinder on wooden block or towel to protect seating surfaces.
 - a. Examine walls of master cylinder reservoir for scratches and grooves. Replace if damaged.
 - b. Verify that vent holes on master cylinder are completely open and free of dirt or debris.
2. Inspect boot on front of master cylinder for cuts, tears or general deterioration. Replace if necessary.

ASSEMBLY

1. See Figure 2-48. Insert piston assembly (4), spring first, into master cylinder.
2. Place round side of rod assembly (3) over piston. Depress piston into master cylinder body (1) and secure with a **new** snap ring (2).
3. Tuck rubber boot on rod assembly (3) into master cylinder body (1).

INSTALLATION

1. See Figure 2-47. Connect remote reservoir.
 - a. If removed, attach remote reservoir to frame using screw. Tighten to 12-15 **in-lbs** (1.4-1.7 Nm).
 - b. Attach line to master cylinder using clamp.
2. See Figure 2-46. Attach master cylinder (3) to frame. Apply **LOCTITE THREADLOCKER 243** (blue) to both screws (2) (metric). Tighten to 8-10 **ft-lbs** (10.8-13.6 Nm).

CAUTION

To avoid leakage after assembly, verify that gaskets, banjo bolt, hydraulic brake line and bore of master cylinder are completely clean.

3. See Figure 2-44. Connect brake line (3) to master cylinder (4) with two **new** gaskets (2) and banjo bolt (1) (metric). Tighten to 16-20 **ft-lbs** (21.7-27.1 Nm).

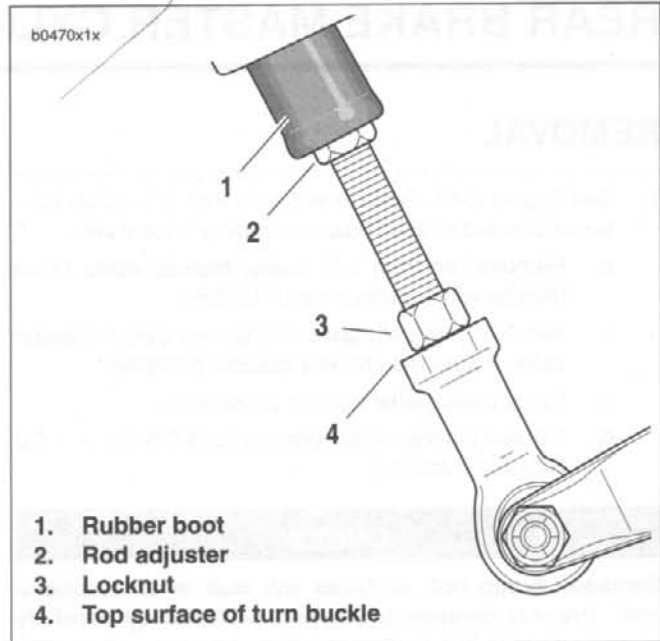


Figure 2-45. Brake Push Rod

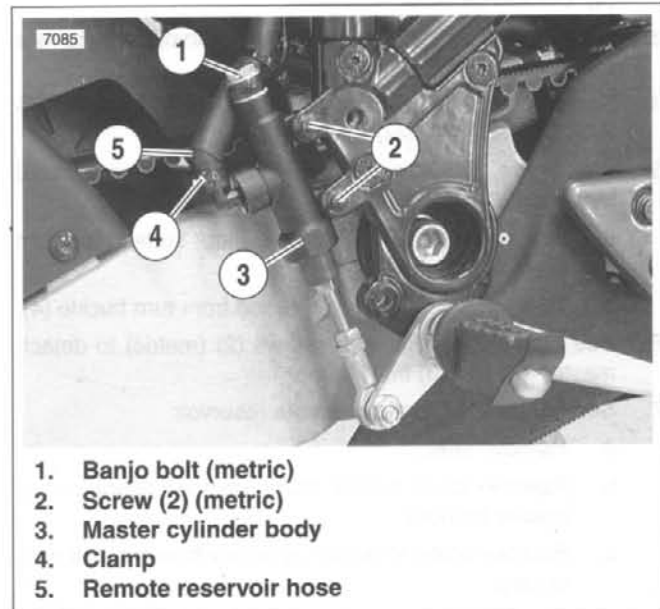


Figure 2-46. Master Cylinder Mounting

4. See Figure 2-45. Install push rod.
 - a. Screw push rod into turn buckle.
 - b. Seat brake pedal height adjustment. See 1.7 BRAKES (1999 Models).

⚠ WARNING

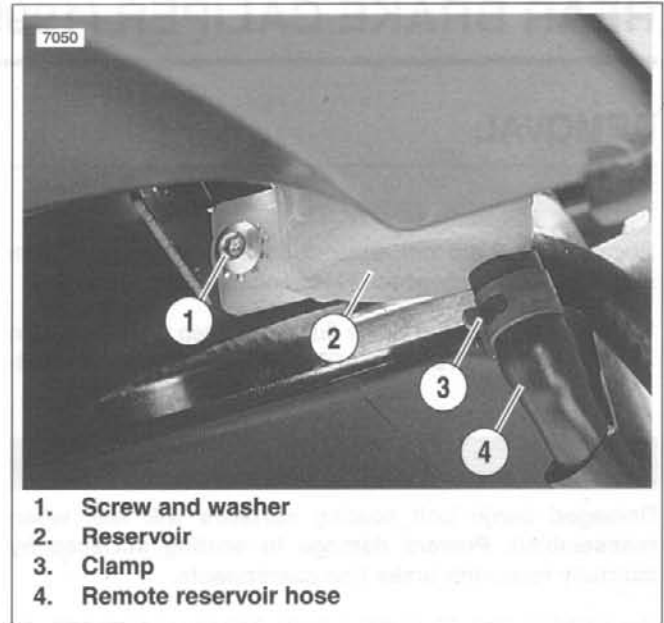
Always test motorcycle brakes at low speed after servicing or bleeding system. To prevent death or serious injury, Buell recommends that all brake repairs be performed by a Buell dealer or other qualified technician.

5. Add brake fluid and bleed brake system. See 1.7 BRAKES (1999 Models).
6. Attach brake reservoir hose to rear brake line with a new cable strap.
7. Install right side footrest mount. See 2.36 FOOTRESTS (1999 Models).
8. With motorcycle in a level position, check that brake fluid is between the upper and lower marks on reservoir. Add D.O.T. 5 SILICONE HYDRAULIC BRAKE FLUID if necessary. Be sure gasket and cap on reservoir fit securely.

⚠ WARNING

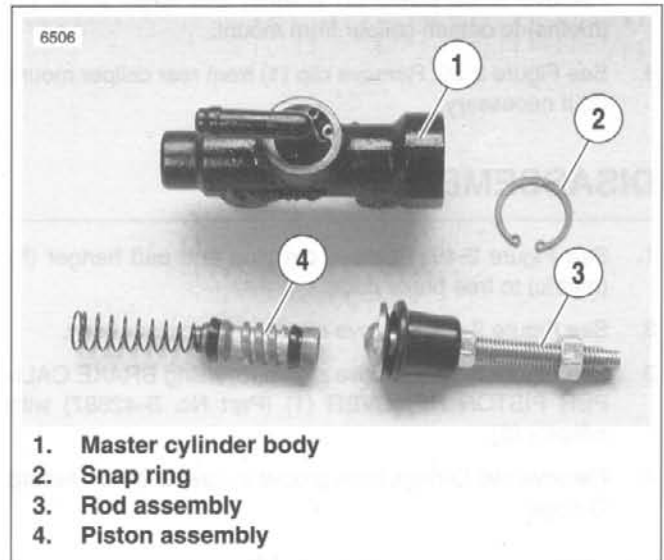
Check for proper brake lamp operation before riding motorcycle. Visibility is a major concern for motorcyclists. Failure to have proper brake lamp operation could result in death or serious injury.

9. Turn ignition key switch to IGN. Apply rear brake pedal to test brake lamp operation. Turn ignition key switch to LOCK.



1. Screw and washer
2. Reservoir
3. Clamp
4. Remote reservoir hose

Figure 2-47. Remote Reservoir



1. Master cylinder body
2. Snap ring
3. Rod assembly
4. Piston assembly

Figure 2-48. Master Cylinder Internals

REMOVAL

NOTE

Steps 1 and 2 are not required for detaching caliper from rotor. Drain fluid only when disassembling caliper.

1. Drain and discard brake fluid. See Step 1 (Removal) in 2.14 REAR BRAKE MASTER CYLINDER (1999 models).

CAUTION

Damaged banjo bolt seating surfaces will leak when reassembled. Prevent damage to seating surfaces by carefully removing brake line components.

2. See Figure 2-49. Remove banjo bolt (2) (metric) and two gaskets (3) to disconnect brake line (1) from caliper. Discard gaskets.
3. Remove small screw (6) (metric) and large screw (7) (metric) to detach caliper from mount.
4. See Figure 2-50. Remove clip (1) from rear caliper mount (2) if necessary.

DISASSEMBLY

1. See Figure 2-49. Remove pin plug and pad hanger (5) (metric) to free brake pads.
2. See Figure 2-51. Remove clip (1) from caliper body.
3. See Figure 2-52. Remove piston (3) using BRAKE CALIPER PISTON REMOVER (1) (Part No. B-42887) with adaptor (2).
4. Remove two O-rings from groove in caliper bore. Discard O-rings.

CLEANING, INSPECTION AND REPAIR

WARNING

Clean brake system components using denatured alcohol. Do not use mineral-base cleaning solvents, such as gasoline or paint thinner. Use of mineral-base solvents causes deterioration of rubber parts that continues after assembly. This may result in improper brake operation which could result in death or serious injury.

1. Clean all parts with denatured alcohol or D.O.T. 5 BRAKE FLUID. Do not contaminate with mineral oil or other solvents. Wipe dry with a clean, lint free cloth. Blow out drilled passages and bore with a clean air supply. Do not use a wire or similar instrument to clean drilled passages.

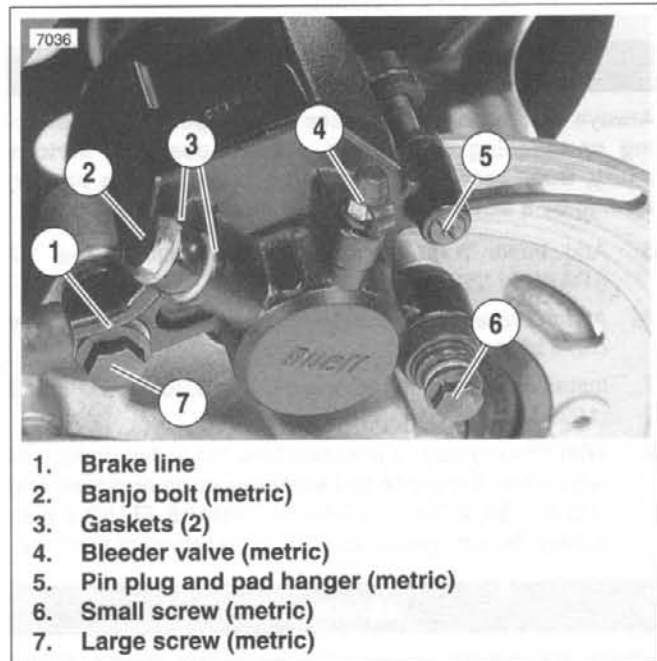


Figure 2-49. Rear Brake Caliper

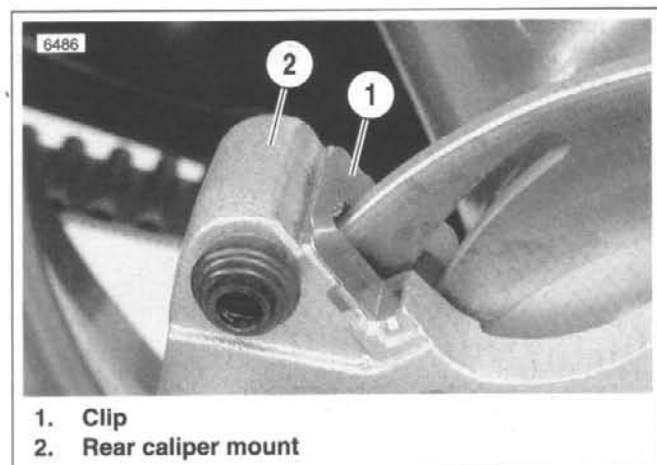


Figure 2-50. Caliper Mount Clip

2. Carefully inspect all components. Replace any parts that appear damaged or worn. Do not hone caliper piston bore.

WARNING

Always replace brake pads in complete sets for correct brake operation. Never replace just one brake pad. Failure to install brake pads as a set could result in death or serious injury.

3. Inspect brake rotor and pads. See 1.8 BRAKE PADS AND ROTORS (1999 MODELS).

ASSEMBLY

1. See Figure 2-51. Place clip (1) inside caliper body as shown.

NOTE

To ensure proper brake pad-to-brake rotor clearance when the caliper is installed, piston must be pressed all the way into the bore whenever **new** brake pads are used.

2. See Figure 2-52. Install pistons and O-rings.
 - a. Apply a light coat of D.O.T. 5 SILICONE HYDRAULIC BRAKE FLUID to O-rings, piston and caliper piston bore.
 - b. Place two **new** O-rings inside grooves of piston bore.
 - c. Install piston (3) inside caliper body.
3. See Figure 2-51. Install brake pads (3) using pad hanger and pin plug (2).
 - a. Install pad hanger pin (metric). Tighten to 11-14.5 ft-lbs (14.7-19.6 Nm).
 - b. Install pin plug. Tighten to 1.5-2.1 ft-lbs (2.0-2.9 Nm).
4. Install a **new** bleeder valve (metric) if necessary. Tighten to 3-5 ft-lbs (4.1-6.8 Nm).

INSTALLATION

1. See Figure 2-50. Install caliper mount clip (1) if removed.
2. See Figure 2-49. Install caliper assembly on caliper mount. Brake pad surfaces must face rear brake rotor.
 - a. Apply LOCTITE THREADLOCKER 272 (red) to both caliper mounting screws (6, 7) (metric).
 - b. Install large caliper screw (7) (metric). Tighten to 18-22 ft-lbs (24.4-29.8 Nm)
 - c. Install small caliper screw (6) (metric). Tighten to 14.5-18 ft-lbs (19.6-24.4 Nm).

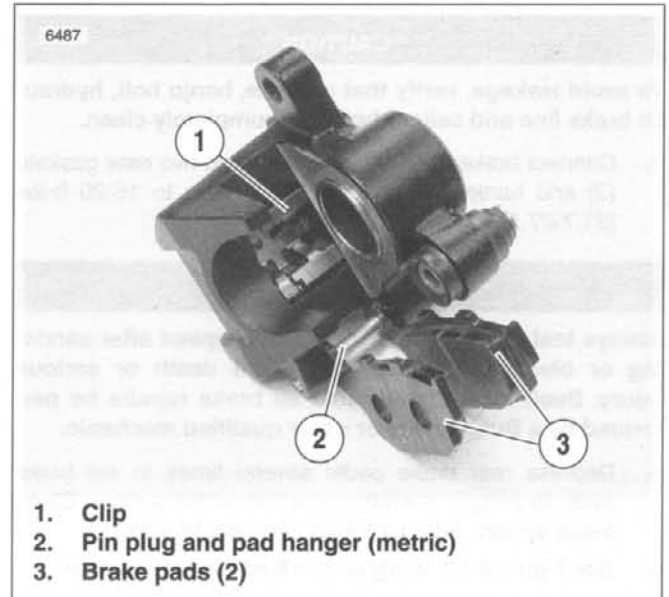


Figure 2-51. Brake Pads

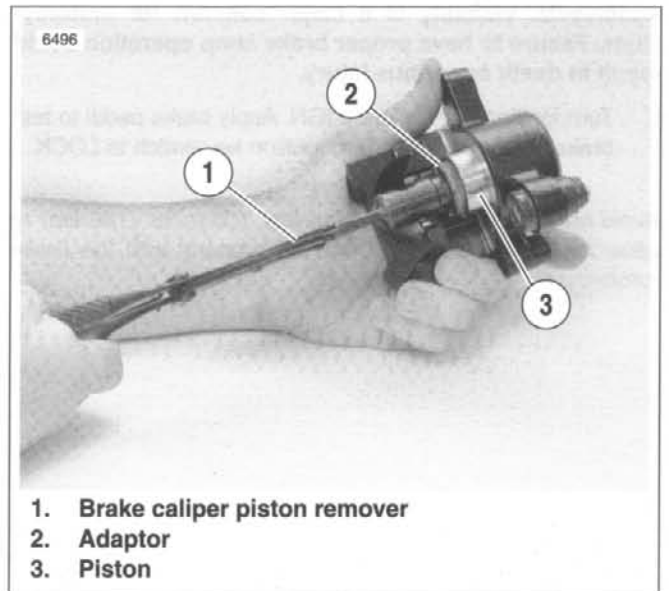


Figure 2-52. Removing Rear Brake Caliper Piston

CAUTION

To avoid leakage, verify that gaskets, banjo bolt, hydraulic brake line and caliper bore are completely clean.

3. Connect brake line (1) to caliper using two new gaskets (3) and banjo bolt (2) (metric). Tighten to 16-20 ft-lbs (21.7-27.1 Nm).

WARNING

Always test motorcycle brakes at low speed after servicing or bleeding system. To prevent death or serious injury, Buell recommends that all brake repairs be performed by a Buell dealer or other qualified mechanic.

4. Depress rear brake pedal several times to set brake pads to proper operating position within caliper. Bleed brake system. See 1.7 BRAKES (1999 Models).
5. See Figure 2-53. Verify proper fluid level in reservoir.

WARNING

Check for proper brake lamp operation before riding motorcycle. Visibility is a major concern for motorcyclists. Failure to have proper brake lamp operation could result in death or serious injury.

6. Turn ignition key switch to IGN. Apply brake pedal to test brake lamp operation. Turn ignition key switch to LOCK.

NOTE

Avoid making hard stops for the first 100 miles (160 km) to allow new brake pads to "wear in" properly with the brake rotor.

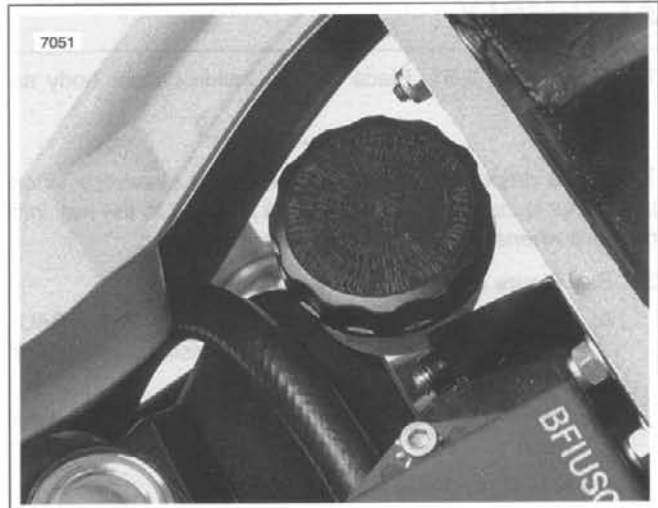


Figure 2-53. Rear Reservoir

REMOVAL

1. Position motorcycle on a suitable lift and position REAR WHEEL SUPPORT STAND (Part No. B41174) under the swing arm. Secure motorcycle to lift.
2. Remove seat. See 2.48 SEAT (1999 Models).

WARNING

To avoid accidental start-up of vehicle, disconnect the battery cables before proceeding. Always disconnect the negative battery cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion, which could result in death or serious injury.

3. Disconnect both battery cables from battery, negative (-) cable first. See 1.4 BATTERY (1999 MODELS).
4. Cut cable tie holding oxygen sensor connector to battery strap. Remove battery strap and battery.
5. Remove rear brake fluid reservoir cap and drain brake fluid from rear brake system into suitable container. See Step 1 (Removal) in 2.14 REAR BRAKE MASTER CYLINDER (1999 models).
6. Remove two top bolts from oil tank.
7. See Figure 2-55. Cut two cable ties holding rear brake reservoir hose to rear brake line above rear master cylinder on right side of motorcycle.
8. See Figure 2-57. Disconnect two wires from rear brake light switch.

CAUTION

Damaged banjo bolt seating surfaces will leak when reassembled. Prevent damage to seating surfaces by carefully removing brake line components.

9. Remove rear master cylinder banjo bolt and two banjo washers. Discard banjo washers.
10. See Figure 2-54. Remove rear brake caliper banjo bolt and two banjo washers. Discard banjo washers.
11. Carefully push up on bottom of oil tank to allow rear brake line tangs to be freed from studs on the bottom of the oil tank.
12. See Figure 2-57. Cut cable tie on wiring harness and cable tie on vent tube on left side of bike.
13. Slide rear brake line into area where battery usually sits and then off of bike through left side of frame.

NOTE

If replacing rear brake light switch, place brake line in vise gently (securing hexagonal rear brake light switch fitting) to prevent bending brake line while removing or installing rear brake lamp switch.

14. See Figure 2-56. Remove rear brake light switch from brake line.

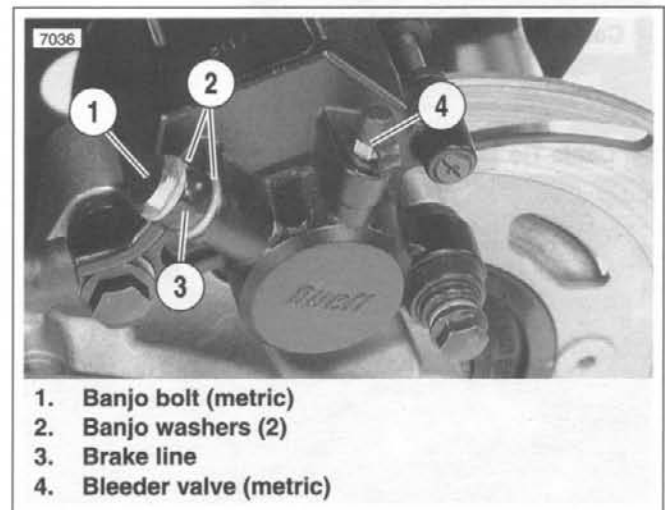


Figure 2-54. Rear Brake Caliper Banjo Bolt

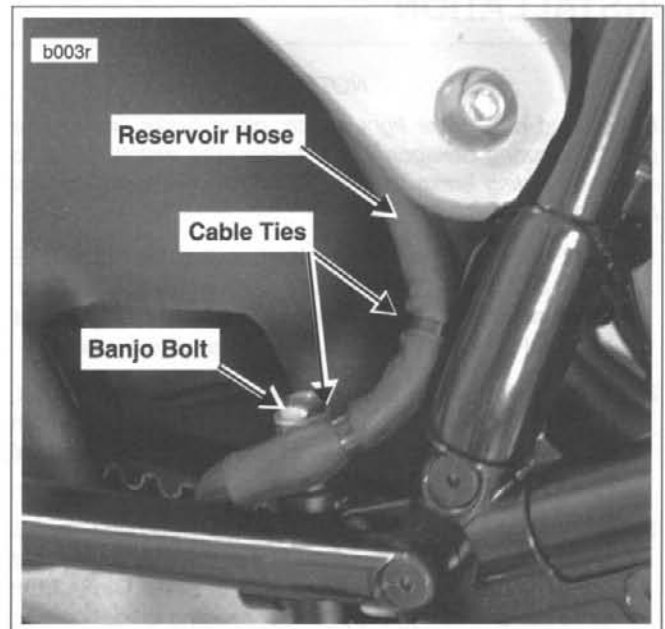


Figure 2-55. Rear Master Cylinder Banjo Bolt

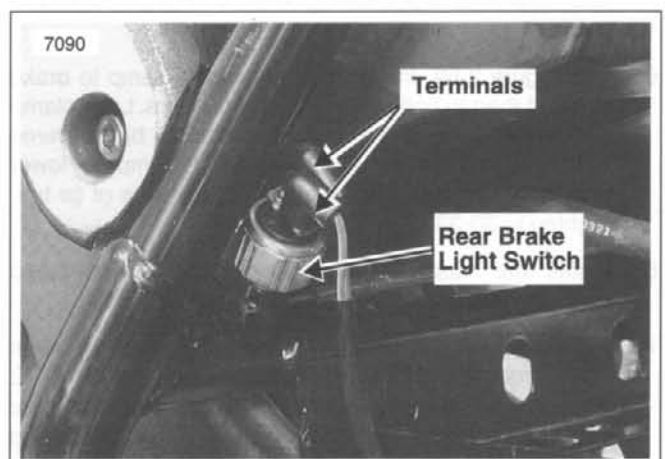


Figure 2-56. Rear Brake Light Switch

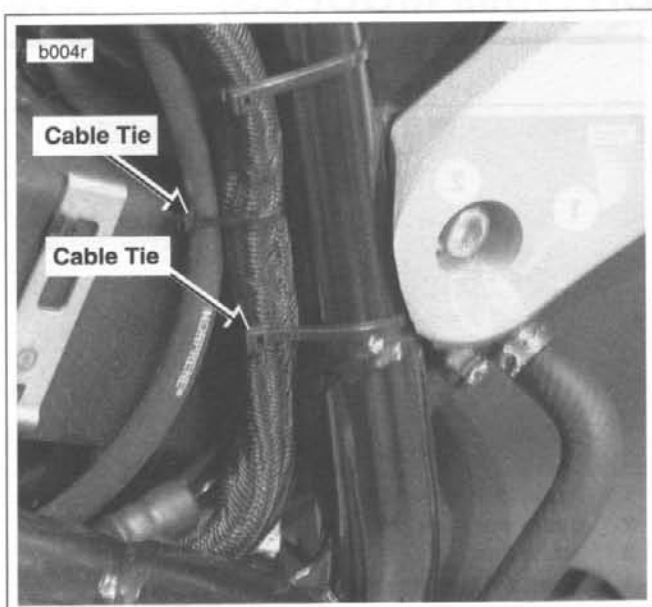


Figure 2-57. Rear Brake Line - Left Side

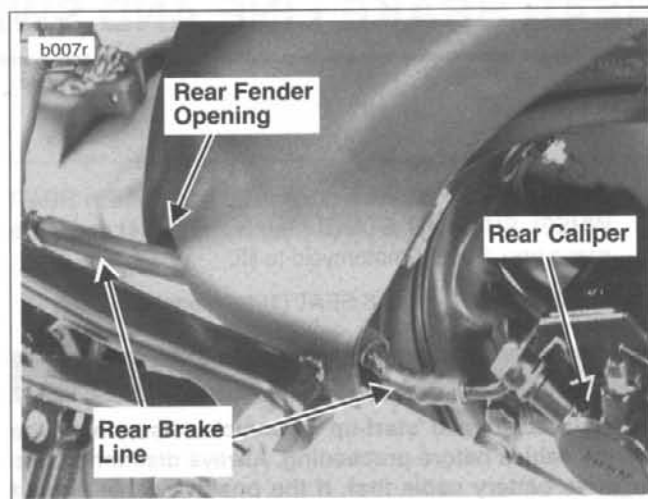


Figure 2-58. Rear Brake Line Routing

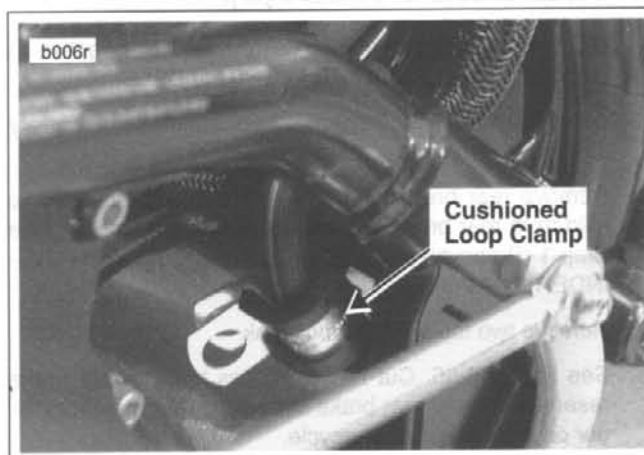


Figure 2-59. Loop Clamp Orientation Before Installation

INSTALLATION

NOTE

If replacing rear brake light switch, place brake line in vise gently (securing hexagonal rear brake light switch fitting) to prevent bending brake line while removing or installing rear brake lamp switch.

1. Coat threads of rear brake lamp switch with LOCTITE PIPE SEALANT WITH TEFLON and install to brake line. Tighten switch to 84-96 in-lbs (9.5-10.8 Nm). Tighten as required to orient terminals perpendicular to brake line.
2. Remove frame side fasteners from rear tie bar (locknut, washer and bolt). Discard locknut. NOTE: Using a 3 inch extension and deep well swivel socket simplifies removal of the tie bar fasteners.
3. See Figure 2-58. Working from the right side, install brake line and align metal portion of brake line with rear master cylinder. Route caliper side of brake line in front of tie bar and through rear fender opening to rear caliper.
4. Carefully push up on bottom of oil tank and position rear brake line tangs under studs on the bottom of the oil tank. Lower oil tank allowing studs to engage pockets in frame.
5. See Figure 2-59. Install loop cushioned clamp to brake line and then to bolt side of tie bar fasteners. Loop clamp is oriented down and to the left. Install tie bar to frame with bolt, washer and loop cushioned clamp on lower side of tie bar and **new** locknut on upper side of tie bar. Tighten to 30-33 ft-lbs (40.7-44.7 Nm).
6. Install rear master cylinder banjo bolt with **new** banjo washers and torque to 16-20 ft-lbs (21.7-27.1 Nm).
7. Install rear caliper banjo bolt with **new** banjo washers and torque to 16-20 ft-lbs (21.7-27.1 Nm). NOTE: Removing inner fender TORX screw and plastic washer will assist in tightening banjo bolt. If TORX screw and plastic washer are removed, tighten to 72-96 in-lbs (8.1-10.8 Nm) when installing.
8. See Figure 2-55. Install two cable ties (thick) to reservoir hose and rear brake line in **two** locations as shown in figure. Use care to avoid pinching hose.
9. Install top two bolts to oil tank. Tighten bolts to 10-12 in-lbs (1.1-1.4 Nm).
10. See Figure 2-57. Cable tie vent hose and wire harness to frame on left side of motorcycle. NOTE: Use thick cable tie on wire harness and thin cable tie on vent hose. Use care to avoid pinching hose.
11. Install battery with strap and nut. Tighten nut to 40 in-lbs (4.5 Nm).
12. Attach oxygen sensor connector to battery strap with **new** thin cable tie on left hand side of motorcycle.
13. See Figure 2-56. Connect rear brake light switch wires to rear brake light switch.
14. Attach rear brake light switch wires to battery strap with **new** thin cable tie on right hand side of motorcycle.
15. Connect positive battery cable. Tighten to 40 in-lbs (4.5 Nm).

⚠ WARNING

Always connect the positive battery cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion, which could result in death or serious injury.

16. Connect negative battery cable. Tighten to 40 in-lbs (4.5 Nm).
17. Bleed rear brake system and install reservoir cap. See 1.7 BRAKES (1999 Models)

⚠ WARNING

After installing seat, pull upward on front of seat to be sure it is locked in position. If seat is loose, it could shift during vehicle operation resulting in loss of control of vehicle and death or serious injury.

18. Install seat. See 2.48 SEAT (1999 Models).

⚠ WARNING

Check for proper brake lamp operation before riding motorcycle. Visibility is a major concern for motorcyclists. Failure to have proper brake lamp operation could result in death or serious injury.

19. Turn ignition key ON, depress rear brake pedal and check for proper brake light operation.

⚠ WARNING

After completing repairs or bleeding the system, always test motorcycle brakes at low speed. If brakes are not operating properly or braking efficiency is poor, testing at high speeds may result in death or serious injury.

20. Test ride motorcycle and check for proper brake operation.

MODEL YEAR CHANGE

All 2000 Model Year Buell motorcycles are equipped with D.O.T. 4 brake fluid and **new**, D.O.T. 4 compatible banjo washers and rear brake lines.

- D.O.T. 4 compatible banjo washers are black in color.
- D.O.T. 4 compatible rear brake lines have an olive drab coating on the metal portion of the line.

GENERAL

The front and rear brakes are fully hydraulic disc brake systems that require little maintenance. The front brake master cylinder is an integral part of the brake hand lever assembly. The rear brake master cylinder is located on the right side of the motorcycle near the brake pedal.

Check the master cylinder reservoirs for proper fluid levels after the first 500 miles (800 km) and every 5000 miles (8000 km) thereafter. Also inspect fluid levels at the end of every riding season. See 1.9 BRAKES (2000 Models).

Check brake pads and rotors for wear at every service interval. See 1.10 BRAKE PADS AND ROTORS (2000 MODELS).

Replace D.O.T. 4 BRAKE FLUID:

- Every 2 years.

Inspect front and rear brake lines and replace as required:

- Every 4 years.

Inspect front and rear caliper and master cylinder seals and replace as required:

- Every 2 years.

If determining probable causes of poor brake operation, see Table 2-6.

WARNING

Clean brake system components using denatured alcohol. Do not use mineral-base cleaning solvents, such as gasoline or paint thinner. Use of mineral-base solvents causes deterioration of rubber parts that continues after assembly. This may result in improper brake operation which could result in death or serious injury.

WARNING

Always test motorcycle brakes at low speed after servicing or bleeding system. To prevent death or serious injury, Buell recommends that all brake repairs be performed by a Buell dealer or other qualified technician.

WARNING

D.O.T. 4 brake fluid can cause irritation of eyes and skin, and may be harmful if swallowed. If large amount of fluid is swallowed, induce vomiting by administering two tablespoons of salt in a glass of warm water. Call a doctor. In case of contact with skin or eyes, flush with plenty of water. Get medical attention for eyes. **KEEP BRAKE FLUID OUT OF THE REACH OF CHILDREN.** Failure to comply could result in death or serious injury.

WARNING

Never mix D.O.T. 4 with other brake fluids (such as D.O.T. 5). Use only D.O.T. 4 brake fluid in motorcycles that specify D.O.T. 4 fluid on the reservoir cap. Mixing different types of fluid may adversely affect braking ability and lead to brake failure which could result in death or serious injury.

WARNING

Use only fresh, uncontaminated D.O.T. 4 Fluid. Cans of fluid that have been opened may have been contaminated by moisture in the air or dirt. Use of contaminated brake fluid may adversely affect braking ability and lead to brake failure which could result in death or serious injury.

WARNING

If rear brake line must be replaced, use only the brake line with the olive drab coating on the metal portion of the line (See Parts Catalog for Part No.) with DOT 4 brake systems. The previous black metal brake line is NOT compatible with DOT 4 brake fluid. Failure to comply may adversely affect braking ability and lead to brake failure which could result in death or serious injury.

WARNING

Use only new black banjo washers (See Parts Catalog for Part No.) with D.O.T. 4 brake fluid. Earlier silver banjo washers are not compatible with D.O.T. 4 fluid and will not seal properly over time. Failure to comply may adversely affect braking ability and lead to brake failure which could result in death or serious injury.

CAUTION

Cover painted surfaces and right handlebar switches and use care when removing brake reservoir cover and adding D.O.T. 4 brake fluid. Spilling D.O.T. 4 brake fluid on painted surfaces will result in cosmetic damage. Spilling brake fluid on switches may render them inoperative.

Table 2-6. Brake Troubleshooting

CONDITION	CHECK FOR	REMEDY
Excessive lever/pedal travel or spongy feel.	Air in system. Master cylinder low on fluid.	Bleed brake(s). Fill master cylinder with approved brake fluid.
Brake fade	Moisture in system.	Bleed brake(s). Fill master cylinder with approved brake fluid.
Chattering sound when brake is applied.	Worn pads. Loose mounting bolts. Warped rotor.	Replace brake pads. Tighten bolts. Replace rotor.
Ineffective brake – lever/pedal travels to limit.	Low fluid level. Piston cup not functioning.	Fill master cylinder with approved brake fluid, and bleed system. Rebuild cylinder.
Ineffective brake – lever/pedal travel normal.	Distorted or glazed rotor. Distorted, glazed or contaminated brake pads.	Replace rotor. Replace pads.
Brake pads drag on rotor – will not retract.	Cup in master cylinder not uncovering relief port. Rear brake pedal linkage out of adjustment.	Inspect master cylinder. Adjust linkage.

FRONT BRAKE MASTER CYLINDER (2000 MODELS) 2.18

REMOVAL

NOTE

Do not remove the master cylinder unless problems are being experienced.

1. See Figure 2-60. Drain brake fluid into a suitable container. Discard of used fluid according to local laws.
 - a. Open bleeder valve (metric) about 1/2-turn.
 - b. Install a length of plastic tubing over caliper bleeder valve. Place free end in a suitable container.
 - c. Pump brake hand lever to drain brake fluid.
 - d. Tighten bleeder valve to 3-5 ft-lbs (4.1-6.8 Nm)
2. Remove mirror from right handlebar.

CAUTION

Damaged banjo bolt seating surfaces will leak when reassembled. Prevent damage to seating surfaces by carefully removing brake line components.

3. See Figure 2-61. Remove banjo bolt (6) (metric) and two banjo washers (4) to disconnect brake line (5) from master cylinder. Discard banjo washers.
4. Remove screw (8) or unplug both terminals to detach brake lamp switch (7).

NOTE

The individual parts of the brake lamp switch are not serviceable. Replace switch upon failure.

5. Remove two screws (1) (metric) and clamp (2) to detach master cylinder assembly from handlebar.

DISASSEMBLY

1. See Figure 2-62. Detach front brake hand lever.
 - a. Remove nut (1) (metric) from lever pivot.
 - b. Remove pivot bolt (2) from lever pivot.
 - c. Detach front brake hand lever (3) from master cylinder assembly.
2. If present, detach front brake lamp switch by removing screw.
3. See Figure 2-63. Compress piston (2) and remove rubber boot (1).
4. Depress piston assembly and remove internal snap ring (3). Discard snap ring.
5. See Figure 2-64. Remove piston assembly (1-4) from front master cylinder.

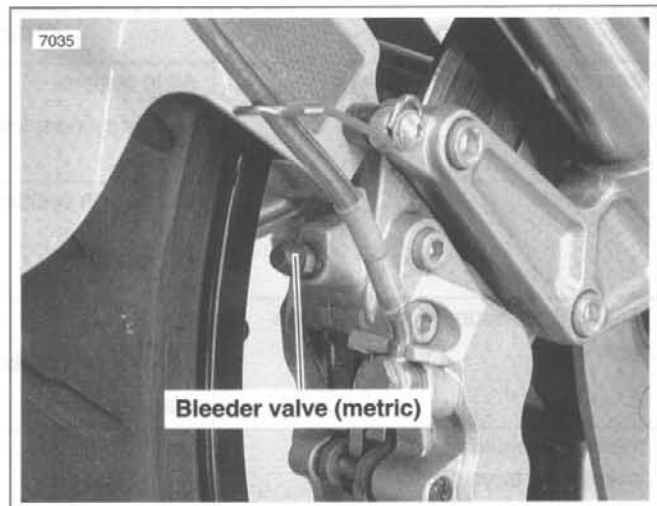


Figure 2-60. Draining Front Brake System

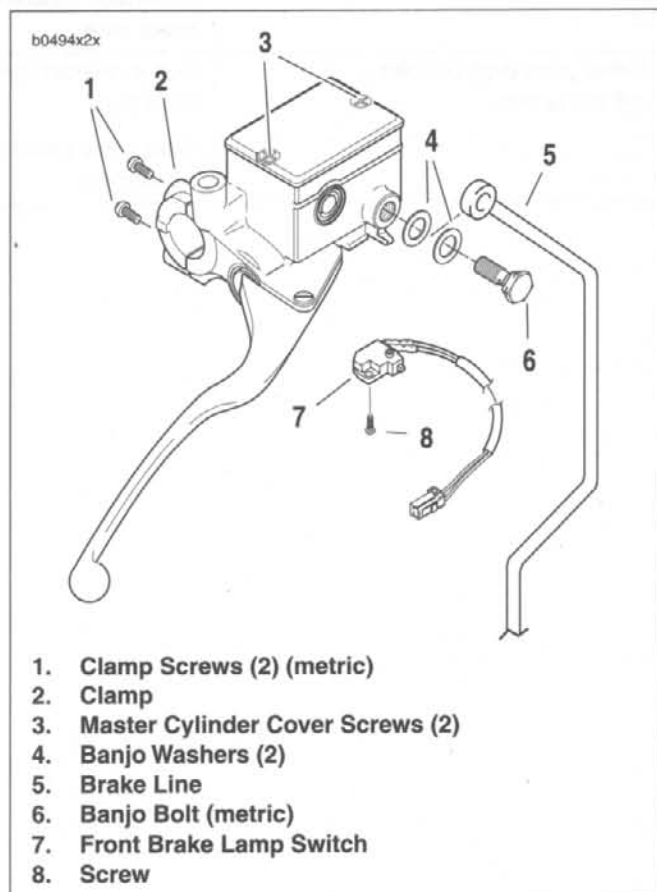


Figure 2-61. Front Master Cylinder

CLEANING AND INSPECTION

⚠ WARNING

Clean brake system components using denatured alcohol. Do not use mineral-base cleaning solvents, such as gasoline or paint thinner. Use of mineral-base solvents causes deterioration of rubber parts that continues after assembly. This could result in improper brake operation which could result in death or serious injury.

1. Clean all parts with denatured alcohol or D.O.T. 4 BRAKE FLUID. Do not contaminate with mineral oil or other solvents. Wipe dry with a clean, lint free cloth. Blow out drilled passages and bore with a clean air supply. Do not use a wire or similar instrument to clean drilled passages in bottom of reservoir.
2. Carefully inspect all parts for wear or damage and replace as necessary.
3. Inspect piston bore in master cylinder housing for scoring, pitting or corrosion. Replace housing if any of these conditions are found.
4. Inspect outlet port that mates with brake line fitting. As a critical sealing surface, replace housing if any scratches, dents or other damage is noted.
5. Inspect boot for cuts, tears or general deterioration. Replace as necessary.

ASSEMBLY

1. See Figure 2-64. Check piston assembly components.
 - a. Small end of spring (1) sits behind primary cup (2). Large side of primary cup faces spring.
 - b. Secondary cup (3) sits within ridge at middle of piston (4).
2. Insert piston assembly, spring first, into master cylinder. Secure with a **new** snap ring (6).
3. Install ridge on boot (5) into groove on piston (4).
4. See Figure 2-62. Install front brake hand lever.
 - a. Align hole in lever (3) with hole in master cylinder assembly.
 - b. Lubricate pivot bolt (2) with LOCTITE ANTI-SEIZE.
 - c. Install pivot bolt through top of assembly. Tighten to 4-13 **in-lbs** (0.5-1.5 Nm).
 - d. Install nut (1) (metric). Tighten to 44-62 **in-lbs** (5.0-7.0 Nm).
5. See Figure 2-61. Install front brake lamp switch (7).
 - a. Attach front brake lamp switch with screw (8). Tighten to 7-13 **in-lbs** (0.8-1.5 Nm).
 - b. Test switch action. Tang on switch must release when hand lever is moved.

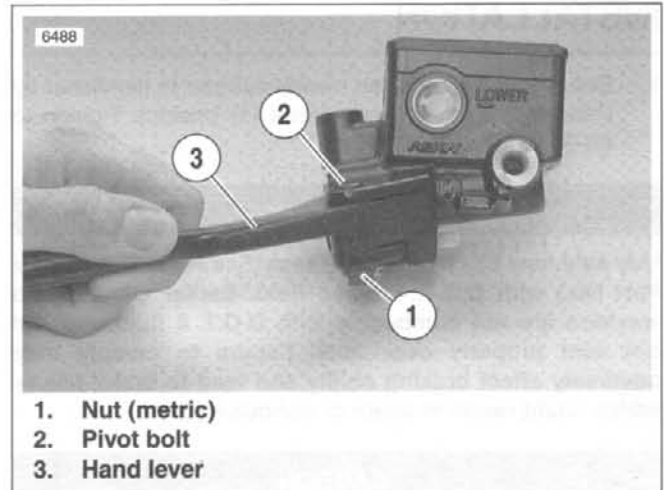


Figure 2-62. Hand Lever

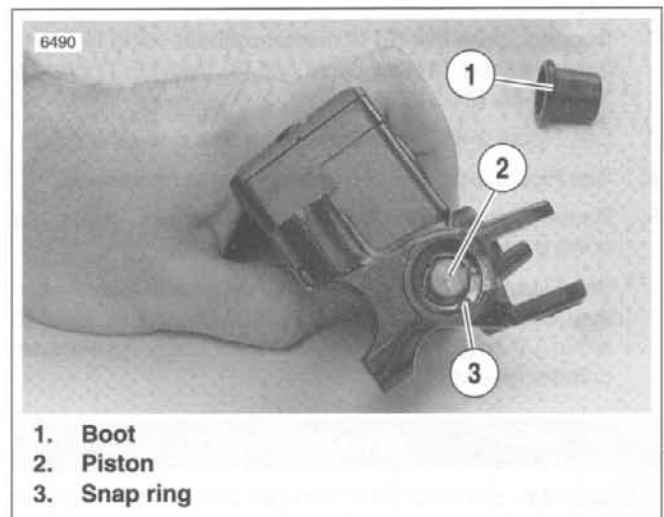


Figure 2-63. Snap Ring

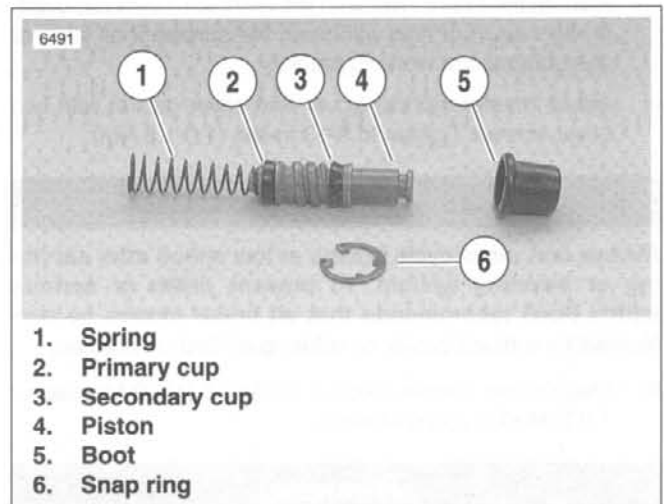


Figure 2-64. Piston Assembly

INSTALLATION

1. See Figure 2-61. Fasten master cylinder to handlebar by installing clamp (2) and screws (1) (metric). Tighten to 80-90 in-lbs (9.0-10.2 Nm).

WARNING

Use only new black banjo washers (See Parts Catalog for Part No.) with D.O.T. 4 brake fluid. Earlier silver banjo washers are not compatible with D.O.T. 4 fluid and will not seal properly over time. Failure to comply may adversely affect braking ability and lead to brake failure which could result in death or serious injury

CAUTION

To avoid leakage, verify that banjo washers, banjo bolt, hydraulic brake line and master cylinder bore are completely clean.

2. Connect brake line (5) to master cylinder using two new banjo washers (4) and banjo bolt (6) (metric). Tighten to 16-20 ft-lbs (21.7-27.1 Nm).
3. See Figure 2-65. Verify brake lamp switch wires are tight.
4. See Figure 2-66. Install mirror parallel to handlebars.
5. Remove two master cylinder cover screws, cover and cover gasket.
6. See Figure 2-67. With the master cylinder in a level position, add D.O.T. 4 BRAKE FLUID. Bring fluid level to within 1/8 in. (3.2 mm) of molded boss inside front master cylinder reservoir.

WARNING

A plugged or covered relief port can cause brake drag or lockup, which could result in loss of vehicle control which could result in death or serious injury.

7. Verify proper operation of the master cylinder relief port. Actuate the brake lever with the reservoir cover removed. A slight spurt of fluid will break the surface if all internal components are working properly.
8. Attach master cylinder cover and cover gasket with two cover screws. Tighten to 9-13 in-lbs (1.0-1.5 Nm).

WARNING

Always test motorcycle brakes at low speed after servicing or bleeding system. To prevent death or serious injury, Buell recommends that all brake repairs be performed by a Buell dealer or other qualified technician.

9. Bleed brake system. See 1.7 BRAKES (1999 Models) or 1.9 BRAKES (2000 Models).

WARNING

Check for proper brake lamp operation before riding motorcycle. Visibility is a major concern for motorcyclists. Failure to have proper brake lamp operation could result in death or serious injury.

10. Turn ignition key switch to IGN. Apply brake hand lever to test brake lamp operation. Turn ignition key switch to LOCK.

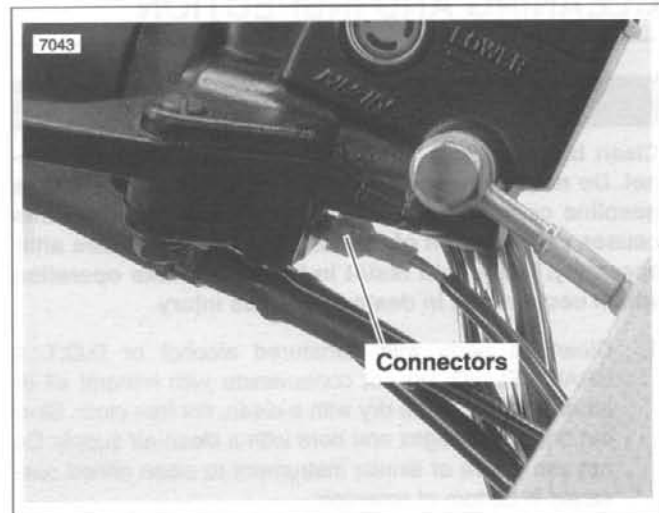


Figure 2-65. Brake Lamp Switch Connectors

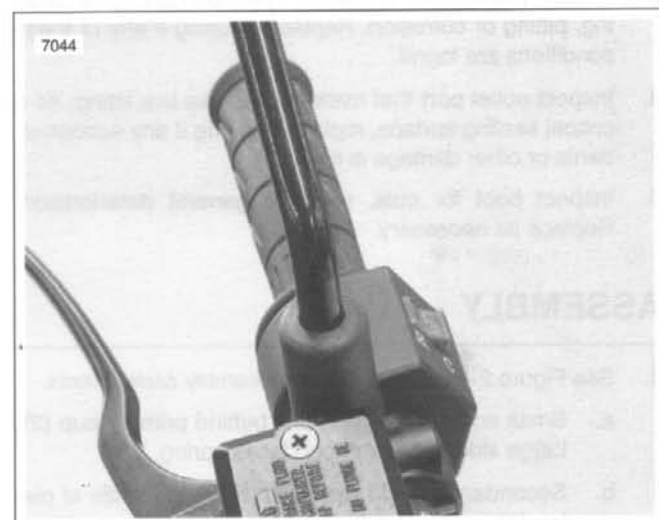


Figure 2-66. Mirror Installation

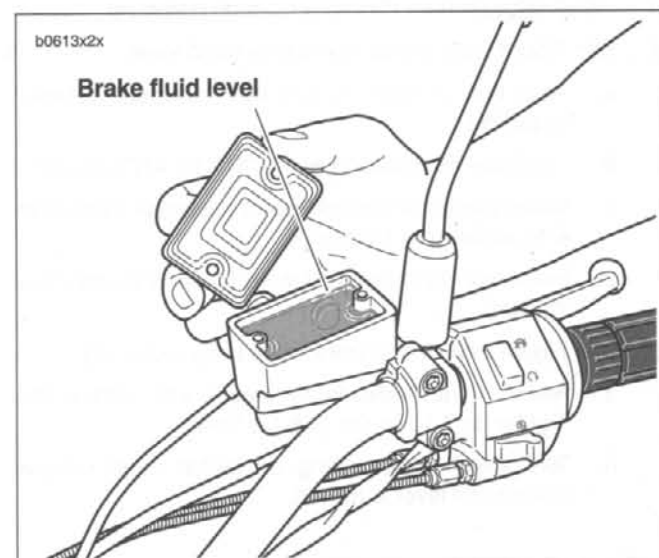


Figure 2-67. Brake Fluid Level

REMOVAL

NOTE

Steps 1 and 2 are not required for detaching caliper from rotor. Drain fluid only when disassembling caliper.

1. Drain and discard brake fluid.

CAUTION

Damaged banjo bolt seating surfaces will leak when reassembled. Prevent damage to seating surfaces by carefully removing brake line components.

2. See Figure 2-68. Remove banjo bolt (2) (metric) and two banjo washers (3) to disconnect brake line (1) from caliper. Discard banjo washers.
3. Remove brake pads.
 - a. Remove pin plug (4).
 - b. See Figure 2-69. Remove pad hanger pin (1) (metric).
 - c. Remove pad spring (2).
 - d. Remove brake pads from caliper.
4. See Figure 2-68. Detach caliper from mounts.
 - a. Remove both mounting screws (5) while supporting caliper above brake rotor.
 - b. Slowly remove caliper by tilting away from wheel and then pulling away from rotor.

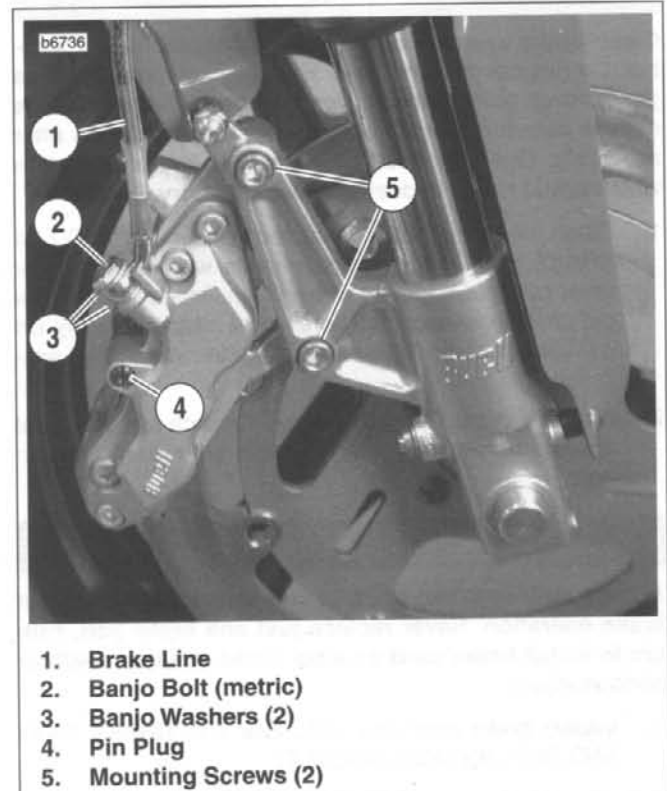


Figure 2-68. Front Brake Caliper Mounts

DISASSEMBLY

1. See Figure 2-69. Remove four screws (3) (metric) to separate caliper halves.
2. Remove two O-rings from between caliper halves and discard.
3. See Figure 2-70. Use BRAKE CALIPER PISTON REMOVER (Part No. B-42887) without adaptor to pull the six pistons from caliper bores.
4. See Figure 2-71. Pry O-rings (6) out of their respective grooves on each side of caliper. Discard O-rings.
5. Check bleeder valve (4) (metric). Remove and replace if damaged.

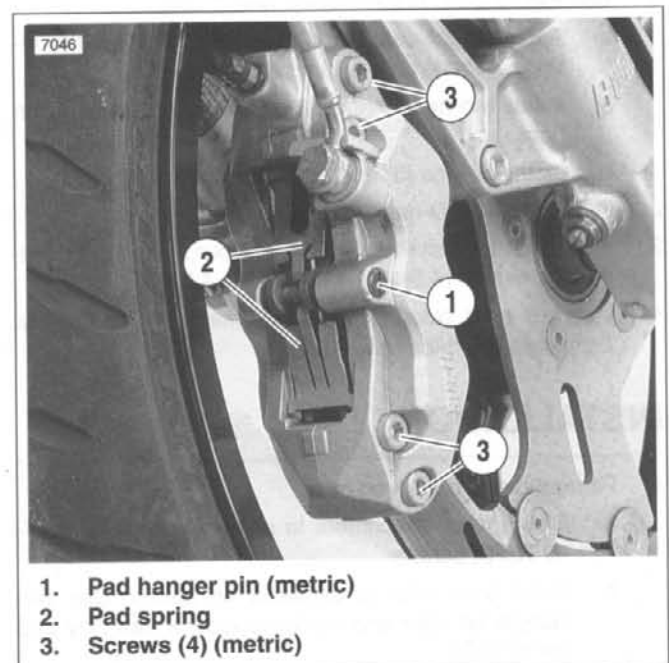


Figure 2-69. Pad Spring (Typical)

CLEANING AND INSPECTION

⚠ WARNING

Clean brake system components using denatured alcohol. Do not use mineral-base cleaning solvents, such as gasoline or paint thinner. Use of mineral-base solvents causes deterioration of rubber parts that continues after assembly. This may result in improper brake operation which could result in death or serious injury.

1. Clean all parts with denatured alcohol or D.O.T. 4 BRAKE FLUID. Do not contaminate with mineral oil or other solvents. Wipe dry with a clean, lint free cloth. Blow out drilled passages and bore with a clean air supply. Do not use a wire or similar instrument to clean drilled passages.
2. Carefully inspect all components. Replace any parts that appear damaged or worn. Do not hone caliper piston bore.

⚠ WARNING

Always replace brake pads in complete sets for correct brake operation. Never replace just one brake pad. Failure to install brake pads as a set could result in death or serious injury.

3. Inspect brake rotor and pads. See 1.10 BRAKE PADS AND ROTORS (2000 MODELS).

ASSEMBLY

1. See Figure 2-71. Install pistons and O-rings.
 - a. Apply a light coat of D.O.T. 4 BRAKE FLUID to O-rings, pistons and caliper piston bores.
 - b. Install two **new** O-rings (6) in grooves of each piston bore.
 - c. Install pistons (5) in each piston bore.
2. Install two **new** O-rings (3) between caliper halves.
3. Attach caliper halves together with four screws (7) (metric). Tighten to 14.5-18 ft-lbs (19.6-24.4 Nm).
4. Install a **new** bleeder valve (4) (metric) if necessary. Tighten to 3-5 ft-lbs (4.1-6.8 Nm).

INSTALLATION

1. Fit front brake caliper on rotor.
 - a. Check rotor attachment to carrier. Inspect all six T-40 TORX screws.
 - b. Make sure rotor is centered on carrier. Use two clamps on rotor and carrier to reduce free play and center rotor.
 - c. Slide caliper over front brake rotor without brake pads installed.
2. See Figure 2-68. Apply LOCTITE THREADLOCKER 272 (red) to both caliper mounting screws (5). Install and tighten to 22-25 ft-lbs (29.8-33.9 Nm).

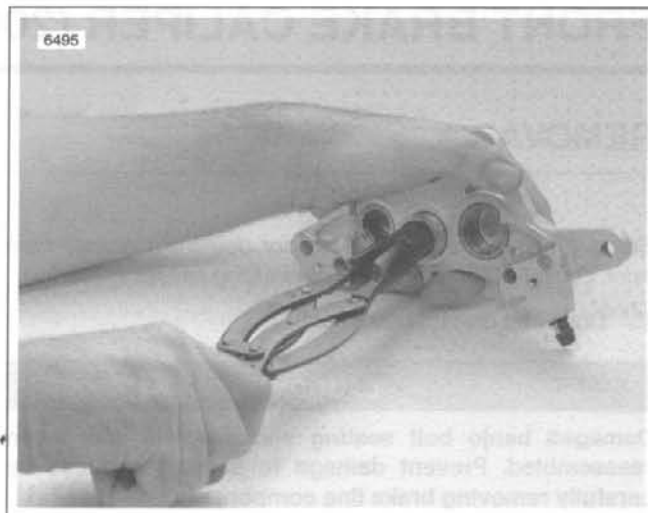


Figure 2-70. Removing Pistons

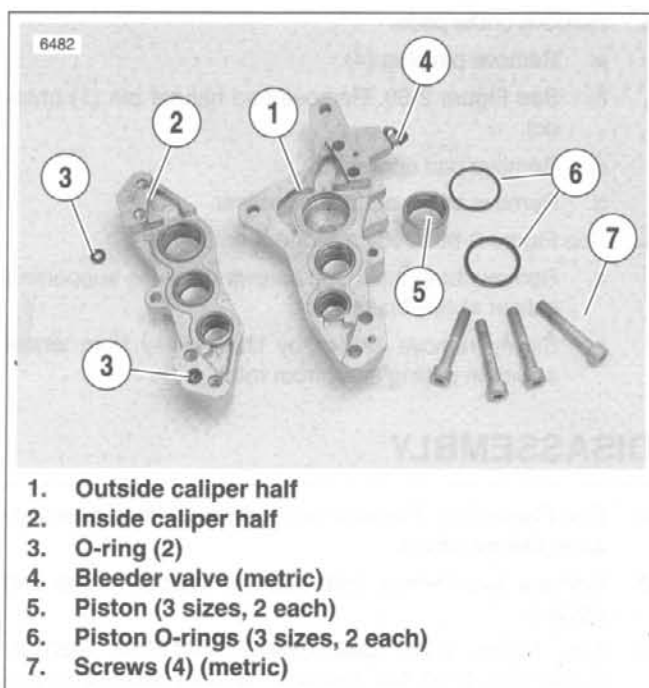


Figure 2-71. Caliper O-rings and Pistons

3. Install brake pads.
 - a. See Figure 2-72. Insert brake pads from behind.
 - b. See Figure 2-69. Install pad spring (2) with opening at top as shown.
 - c. Install pad hanger pin (1) (metric). Tighten to 11-14.5 ft-lbs (14.7-19.6 Nm).
 - d. See Figure 2-68. Install pin plug (4). Tighten to 1.5-2.1 ft-lbs (2.0-2.9 Nm).

⚠ WARNING

Use only new black banjo washers (See Parts Catalog for Part No.) with D.O.T. 4 brake fluid. Earlier silver banjo washers are not compatible with D.O.T. 4 fluid and will not seal properly over time. Failure to comply may adversely affect braking ability and lead to brake failure which could result in death or serious injury

CAUTION

To avoid leakage, verify that banjo washers, banjo bolt, hydraulic brake line and caliper bore are completely clean.

4. Connect brake line (1) to caliper using two **new** banjo washers (3) and banjo bolt (2) (metric). Tighten to 16-20 ft-lbs (21.7-27.1 Nm).
5. See Figure 2-73. Remove both master cylinder cover screws (2). Remove master cylinder cover (1) plastic insert and gasket.
6. With the master cylinder in a level position, verify that the brake fluid level is 1/8 in. (3.2 mm) from molded boss inside reservoir. Add D.O.T. 4 BRAKE FLUID if necessary.

WARNING

A plugged or covered relief port can cause brake drag or lockup, which may result in loss of vehicle control. These events could result in death or serious injury.

7. Verify proper operation of the master cylinder relief port. Actuate the brake lever with the reservoir cover removed. A slight spurt of fluid will break the surface if all internal components are working properly.
8. See Figure 2-73. Install master cylinder cover, plastic insert and gasket with two screws. Tighten to 9-13 in-lbs (1.0-1.5 Nm).

WARNING

Always test motorcycle brakes at low speed after servicing or bleeding system. To prevent death or serious injury, Buell recommends that all brake repairs be performed by a Buell dealer or other qualified mechanic.

9. Depress front brake lever several times to set brake pads to proper operating position within caliper. Bleed brake system. See 1.9 BRAKES (2000 Models).
10. Check clearance between front caliper mounting bolts and T-40 TORX screws on rotor. See 1.9 BRAKES (2000 Models).

WARNING

Check for proper brake lamp operation before riding motorcycle. Visibility is a major concern for motorcyclists. Failure to have proper brake lamp operation could result in death or serious injury.

11. Turn ignition key switch to IGN. Apply brake hand lever to test brake lamp operation. Turn ignition key switch to LOCK.

NOTE

Avoid making hard stops for the first 100 miles (160 km) to allow **new** brake pads to "wear in" properly with the brake rotor.

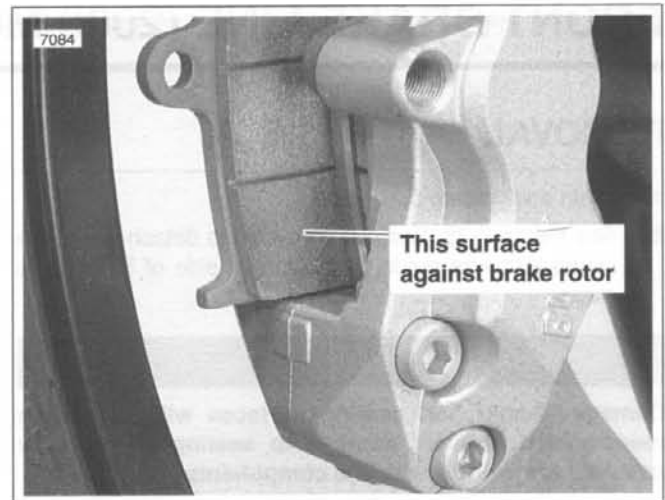


Figure 2-72. Installing Brake Pads

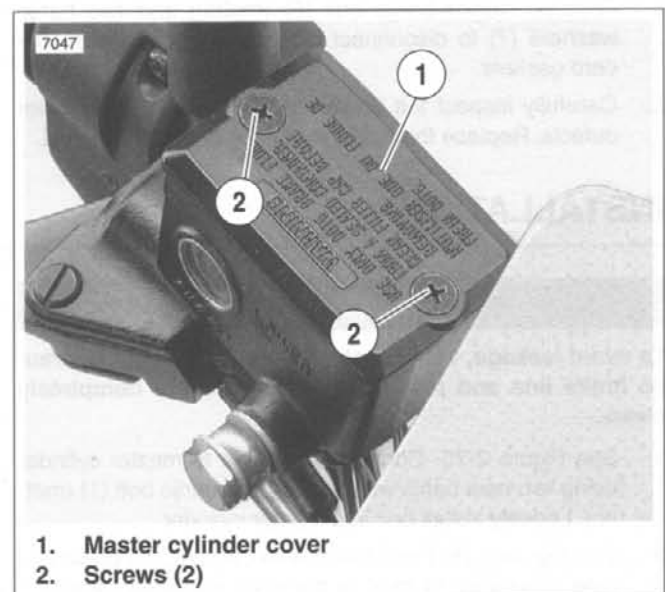


Figure 2-73. Master Cylinder Cover (Typical)



Figure 2-74. Front Master Cylinder Gasket (Insert not shown)

REMOVAL

1. Drain and discard brake fluid.
2. See Figure 2-75. Remove screw (4) to detach brake line clamp and wire guide (5) from right side of lower triple clamp.

CAUTION

Damaged banjo bolt seating surfaces will leak when reassembled. Prevent damage to seating surfaces by carefully removing brake line components.

3. Remove master cylinder banjo bolt (1) (metric) and two banjo washers (2) to disconnect brake line from master cylinder. Discard banjo washers.
4. Remove caliper banjo bolt (6) (metric) and two banjo washers (7) to disconnect brake line from caliper. Discard gaskets.
5. Carefully inspect the brake line for dents, cuts or other defects. Replace the brake line if any damage is noted.

INSTALLATION

CAUTION

To avoid leakage, verify that gaskets, banjo bolt, hydraulic brake line and master cylinder bore are completely clean.

1. See Figure 2-75. Connect brake line to master cylinder using two **new** banjo washers (2) and banjo bolt (1) (metric). Loosely install bolt into master cylinder.
2. See Figure 2-76. From the master cylinder, the brake line runs downward in front of the right handlebar, where it turns inboard at the upper triple clamp. Loosely install clamp and wire guide (5) with screw (4) to attach front brake line clamp to right side of lower triple clamp. Route brake line through wire guide as shown in Figure 2-76.

WARNING

Use only new black banjo washers (See Parts Catalog for Part No.) with D.O.T. 4 brake fluid. Earlier silver banjo washers are not compatible with D.O.T. 4 fluid and will not seal properly over time. Failure to comply may adversely affect braking ability and lead to brake failure which could result in death or serious injury

CAUTION

To avoid leakage, verify that gaskets, banjo bolt, hydraulic brake line and caliper bore are completely clean.

3. See Figure 2-75. Connect brake line to caliper using two **new** banjo washers (7) and banjo bolt (6). Loosely install bolt into caliper.

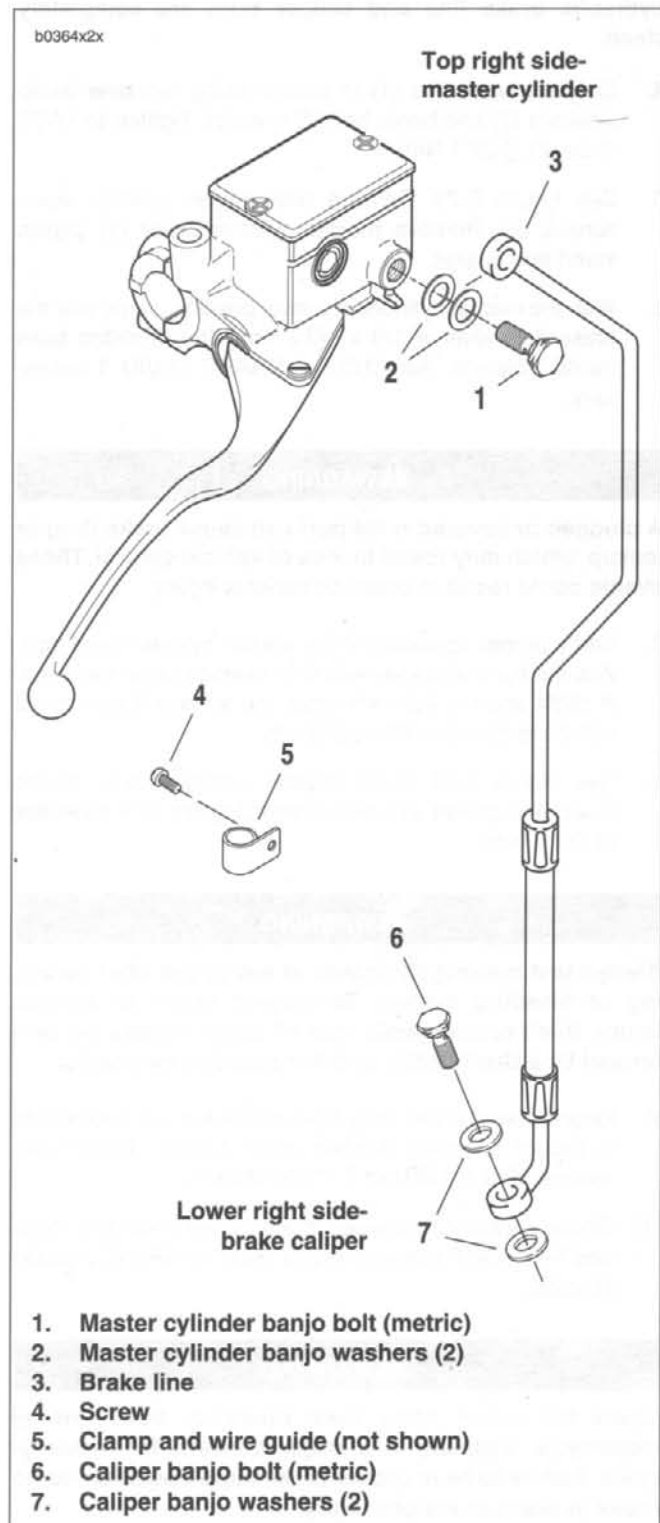


Figure 2-75. Front Brake Line

4. See Figure 2-76. Tighten clamp screw on lower triple clamp to 30-35 **in-lbs** (3.4-4.0 Nm).
5. See Figure 2-75. Tighten master cylinder banjo bolt (1) (metric) to 16-20 ft-lbs (21.7-27.1 Nm).
6. Tighten brake caliper banjo bolt (6) (metric) to 16-20 ft-lbs (21.7-27.1 Nm).

⚠ WARNING

Always test motorcycle brakes at low speed after servicing or bleeding system. To prevent death or serious injury, Buell recommends that all brake repairs be performed by a Buell dealer or other qualified mechanic.

7. Install bleeder valve if removed. Refill master cylinder and bleed brakes. See 1.9 BRAKES (2000 Models).

⚠ WARNING

Check for proper brake lamp operation before riding motorcycle. Visibility is a major concern for motorcyclists. Failure to have proper brake lamp operation could result in death or serious injury.

8. Turn ignition key switch to IGN. Apply brake hand lever to test brake lamp operation. Turn ignition key switch to LOCK.

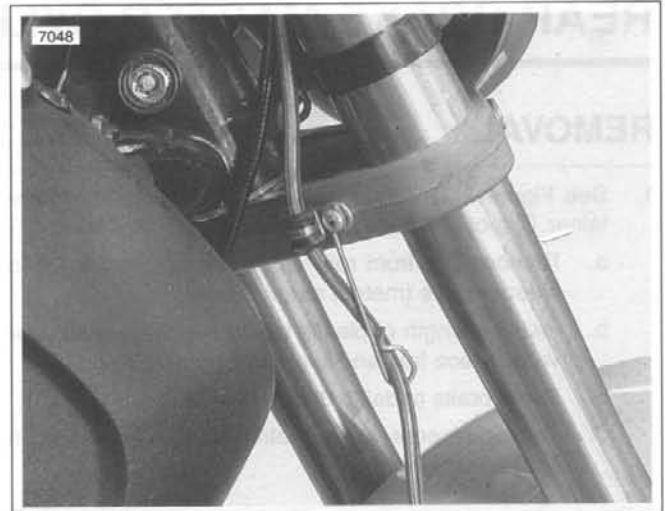


Figure 2-76. Lower Triple Clamp

REMOVAL

1. See Figure 2-77. Drain brake fluid into a suitable container. Dispose of used fluids according to local laws.
 - a. Remove cap from rear caliper bleeder valve. Open bleeder valve (metric) about 1/2 turn.
 - b. Install a length of plastic tubing over caliper bleeder valve. Place free end in a suitable container.
 - c. Pump brake pedal to drain brake fluid.
 - d. Tighten bleeder valve (metric) to 3-5 ft-lbs (4.1-6.8 Nm). Reinstall cap.

CAUTION

Damaged banjo bolt surfaces will leak when reassembled. Prevent damage to seating surfaces by carefully removing brake line components.

2. See Figure 2-78. Remove banjo bolt (1) (metric) and two banjo washers (2) to detach brake line (3) from master cylinder (4). Discard banjo washers.
3. Remove cable strap holding brake reservoir hose to rear brake line.
4. Remove right side footrest mount. See 2.37 FOOTRESTS (2000 Models).
5. See Figure 2-79. Disconnect push rod from brake pedal turn buckle (4).
 - a. Spin locknut (3) away from top surface of turn buckle.
 - b. Turn rod adjuster (2) to free rod from turn buckle (4).
6. See Figure 2-80. Remove screws (2) (metric) to detach master cylinder (3) from frame.
7. See Figure 2-81. Detach remote reservoir.
 - a. Remove seat.
 - b. Remove top or bottom clamp on hose connected to master cylinder.
 - c. Remove screw to detach reservoir from frame if necessary.

DISASSEMBLY

NOTE

Do not disassemble master cylinder unless problems are experienced. Discard all seals during the disassembly procedure. Install a complete rebuild kit upon assembly.

1. See Figure 2-82. Slide rubber boot on rod assembly (3) away from master cylinder body (1).
2. Depress rod assembly (3) and remove internal snap ring (2). Discard snap ring.
3. Remove piston assembly (4) from master cylinder body.

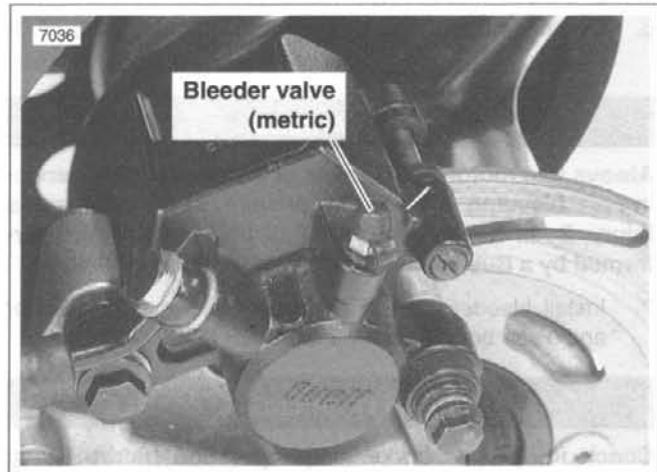


Figure 2-77. Rear Caliper Bleeder Valve (Metric)

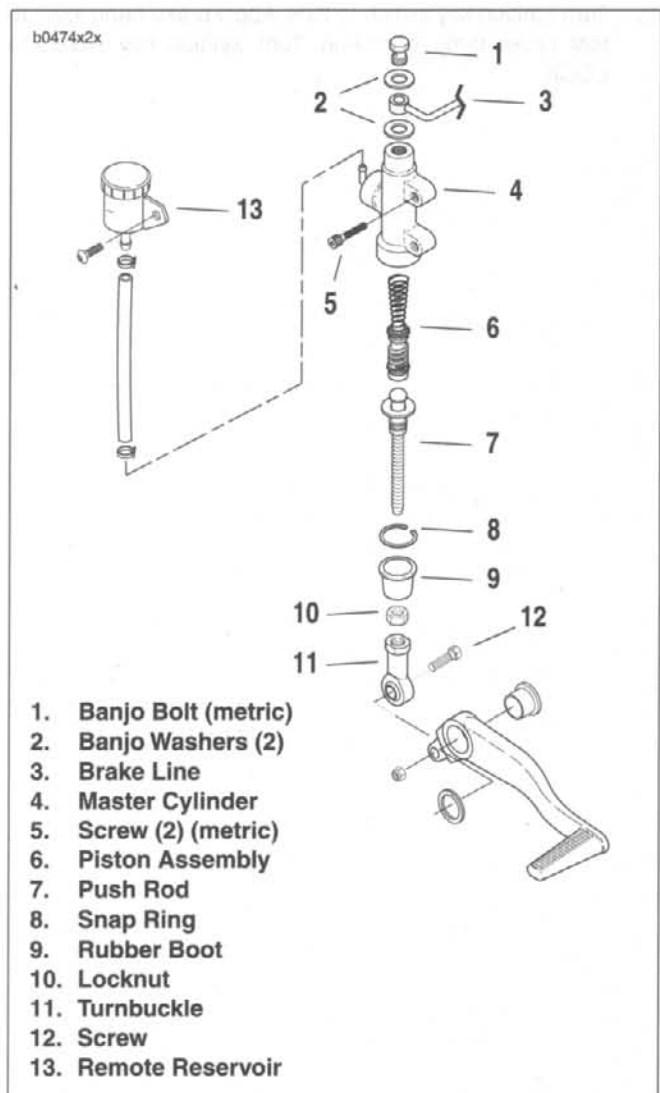


Figure 2-78. Rear Master Cylinder Assembly

CLEANING AND INSPECTION

⚠ WARNING

Clean brake system components using denatured alcohol. Do not use mineral-base cleaning solvents, such as gasoline or paint thinner. Use of mineral-base solvents causes deterioration of rubber parts that continues after assembly. This may result in improper brake operation which could result in death or serious injury.

1. Thoroughly clean master cylinder and all brake system components. Stand master cylinder on wooden block or towel to protect seating surfaces.
 - a. Examine walls of master cylinder reservoir for scratches and grooves. Replace if damaged.
 - b. Verify that vent holes on master cylinder are completely open and free of dirt or debris.
2. Inspect boot on front of master cylinder for cuts, tears or general deterioration. Replace if necessary.

ASSEMBLY

1. See Figure 2-82. Insert piston assembly (4), spring first, into master cylinder.
2. Place round side of rod assembly (3) over piston. Depress piston into master cylinder body (1) and secure with a **new** snap ring (2).
3. Tuck rubber boot on rod assembly (3) into master cylinder body (1).

INSTALLATION

1. See Figure 2-81. Connect remote reservoir.
 - a. If removed, attach remote reservoir to frame using screw. Tighten to 12-15 **in-lbs** (1.4-1.7 Nm).
 - b. Attach line to master cylinder using clamp.
2. See Figure 2-80. Attach master cylinder (3) to frame. Apply **LOCTITE THREADLOCKER 243** (blue) to both screws (2) (metric). Tighten to 8-10 **ft-lbs** (10.8-13.6 Nm).

⚠ WARNING

Use only new black banjo washers (See Parts Catalog for Part No.) with D.O.T. 4 brake fluid. Earlier silver banjo washers are not compatible with D.O.T. 4 fluid and will not seal properly over time. Failure to comply may adversely affect braking ability and lead to brake failure which could result in death or serious injury

CAUTION

To avoid leakage after assembly, verify that banjo washers, banjo bolt, hydraulic brake line and bore of master cylinder are completely clean.

3. See Figure 2-78. Connect brake line (3) to master cylinder (4) with two **new** banjo washers (2) and banjo bolt (1) (metric). Tighten to 16-20 **ft-lbs** (21.7-27.1 Nm).

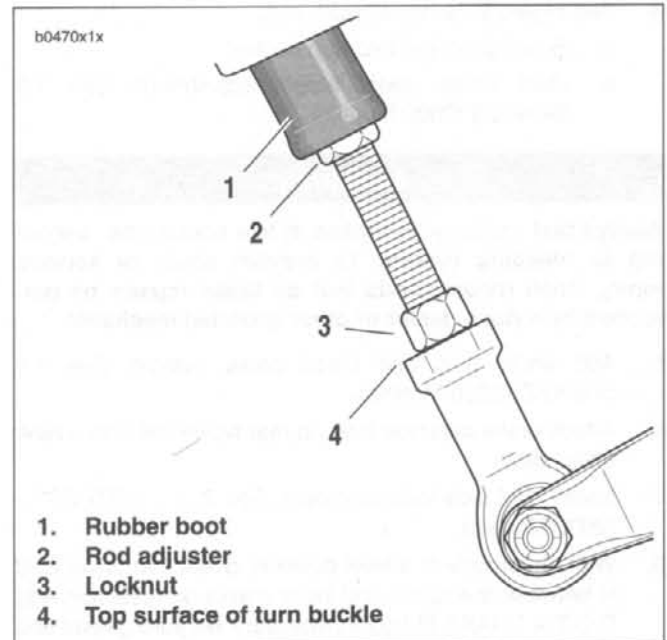


Figure 2-79. Brake Push Rod

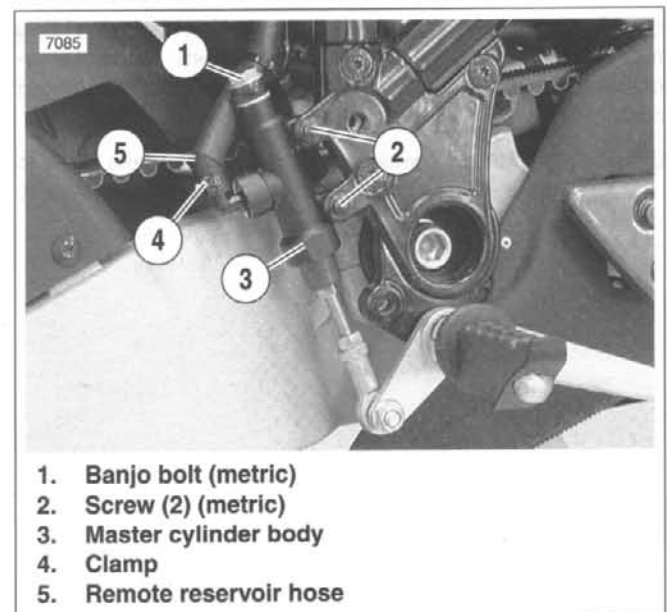


Figure 2-80. Master Cylinder Mounting

4. See Figure 2-79. Install push rod.
 - a. Screw push rod into turn buckle.
 - b. Seat brake pedal height adjustment. See 1.9 BRAKES (2000 Models).

WARNING

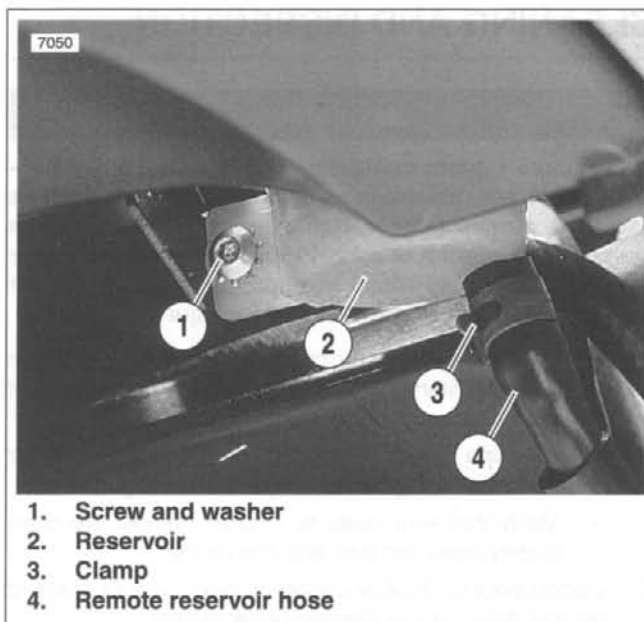
Always test motorcycle brakes at low speed after servicing or bleeding system. To prevent death or serious injury, Buell recommends that all brake repairs be performed by a Buell dealer or other qualified mechanic.

5. Add brake fluid and bleed brake system. See 1.9 BRAKES (2000 Models).
6. Attach brake reservoir hose to rear brake line with a new cable strap.
7. Install right side footrest mount. See 2.37 FOOTRESTS (2000 Models).
8. With motorcycle in a level position, check that brake fluid is between the upper and lower marks on reservoir. Add D.O.T. 4 BRAKE FLUID if necessary. Be sure gasket and cap on reservoir fit securely.

WARNING

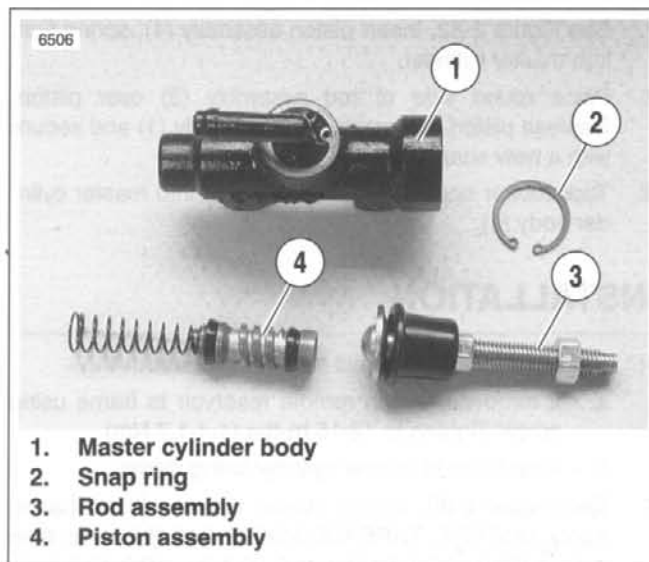
Check for proper brake lamp operation before riding motorcycle. Visibility is a major concern for motorcyclists. Failure to have proper brake lamp operation could result in death or serious injury.

9. Turn ignition key switch to IGN. Apply rear brake pedal to test brake lamp operation. Turn ignition key switch to LOCK.



1. Screw and washer
2. Reservoir
3. Clamp
4. Remote reservoir hose

Figure 2-81. Remote Reservoir



1. Master cylinder body
2. Snap ring
3. Rod assembly
4. Piston assembly

Figure 2-82. Master Cylinder Internals

REMOVAL

NOTE

Steps 1 and 2 are not required for detaching caliper from rotor. Drain fluid only when disassembling caliper.

1. Drain and discard brake fluid. See Step 1 (Removal) in 2.21 REAR BRAKE MASTER CYLINDER (2000 models).

CAUTION

Damaged banjo bolt seating surfaces will leak when reassembled. Prevent damage to seating surfaces by carefully removing brake line components.

2. See Figure 2-83. Remove banjo bolt (2) (metric) and two banjo washers (3) to disconnect brake line (1) from caliper. Discard banjo washers.
3. Remove small screw (6) (metric) and large screw (7) (metric) to detach caliper from mount.
4. See Figure 2-84. Remove clip (1) from rear caliper mount (2) if necessary.

DISASSEMBLY

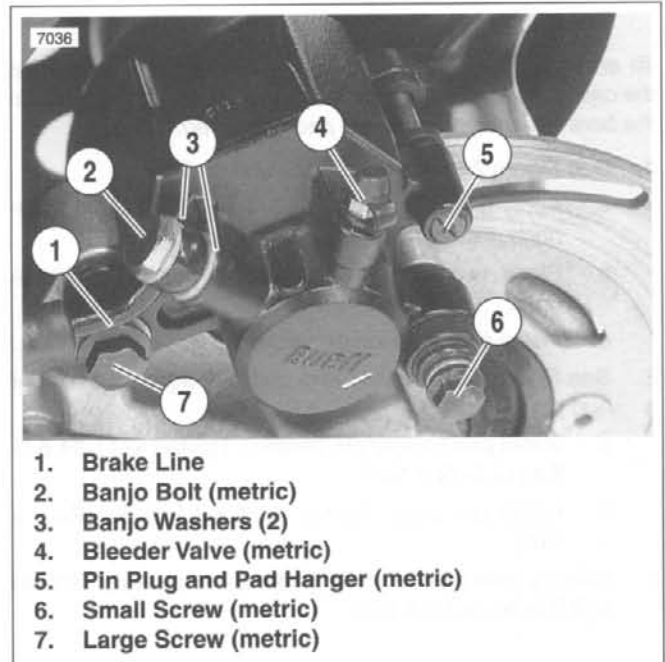
1. See Figure 2-83. Remove pin plug and pad hanger (5) (metric) to free brake pads.
2. See Figure 2-85. Remove clip (1) from caliper body.
3. See Figure 2-86. Remove piston (3) using BRAKE CALIPER PISTON REMOVER (1) (Part No. B-42887) with adaptor (2).
4. Remove two O-rings from groove in caliper bore. Discard O-rings.

CLEANING AND INSPECTION

WARNING

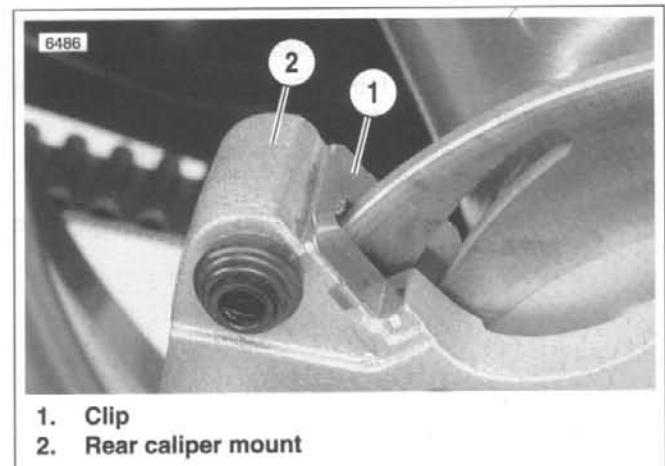
Clean brake system components using denatured alcohol. Do not use mineral-base cleaning solvents, such as gasoline or paint thinner. Use of mineral-base solvents causes deterioration of rubber parts that continues after assembly. This may result in improper brake operation which could result in death or serious injury.

1. Clean all parts with denatured alcohol or D.O.T. 4 BRAKE FLUID. Do not contaminate with mineral oil or other solvents. Wipe dry with a clean, lint free cloth. Blow out drilled passages and bore with a clean air supply. Do not use a wire or similar instrument to clean drilled passages.



1. Brake Line
2. Banjo Bolt (metric)
3. Banjo Washers (2)
4. Bleeder Valve (metric)
5. Pin Plug and Pad Hanger (metric)
6. Small Screw (metric)
7. Large Screw (metric)

Figure 2-83. Rear Brake Caliper



1. Clip
2. Rear caliper mount

Figure 2-84. Caliper Mount Clip

2. Carefully inspect all components. Replace any parts that appear damaged or worn. Do not hone caliper piston bore.

WARNING

Always replace brake pads in complete sets for correct brake operation. Never replace just one brake pad. Failure to install brake pads as a set could result in death or serious injury.

3. Inspect brake rotor and pads. See 1.10 BRAKE PADS AND ROTORS (2000 MODELS).

ASSEMBLY

1. See Figure 2-85. Place clip (1) inside caliper body as shown.

NOTE

To ensure proper brake pad-to-brake rotor clearance when the caliper is installed, piston must be pressed all the way into the bore whenever **new** brake pads are used.

2. See Figure 2-86. Install pistons and O-rings.
 - a. Apply a light coat of D.O.T. 4 BRAKE FLUID to O-rings, piston and caliper piston bore.
 - b. Place two **new** O-rings inside grooves of piston bore.
 - c. Install piston (3) inside caliper body.
3. See Figure 2-85. Install brake pads (3) using pad hanger and pin plug (2).
 - a. Install pad hanger pin (metric). Tighten to 11-14.5 ft-lbs (14.7-19.6 Nm).
 - b. Install pin plug. Tighten to 1.5-2.1 ft-lbs (2.0-2.9 Nm).
4. Install a **new** bleeder valve (metric) if necessary. Tighten to 3-5 ft-lbs (4.1-6.8 Nm).

INSTALLATION

1. See Figure 2-84. Install caliper mount clip (1) if removed.
2. See Figure 2-83. Install caliper assembly on caliper mount. Brake pad surfaces must face rear brake rotor.
 - a. Apply LOCTITE THREADLOCKER 272 (red) to both caliper mounting screws (6, 7) (metric).
 - b. Install large caliper screw (7) (metric). Tighten to 18-22 ft-lbs (24.4-29.8 Nm)
 - c. Install small caliper screw (6) (metric). Tighten to 14.5-18 ft-lbs (19.6-24.4 Nm).

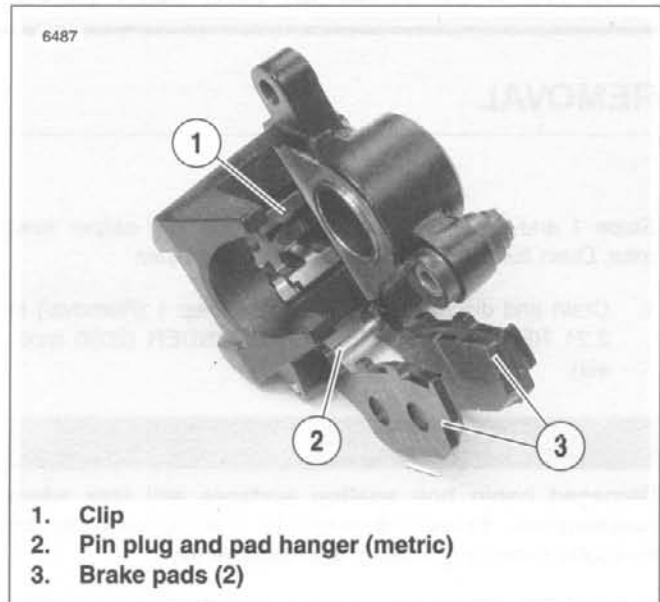


Figure 2-85. Brake Pads

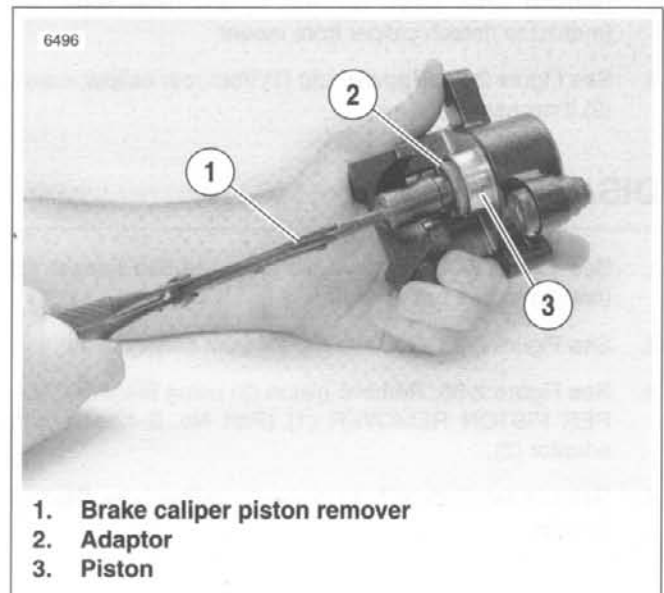


Figure 2-86. Removing Rear Brake Caliper Piston

⚠ WARNING

Use only new black banjo washers (See Parts Catalog for Part No.) with D.O.T. 4 brake fluid. Earlier silver banjo washers are not compatible with D.O.T. 4 fluid and will not seal properly over time. Failure to comply may adversely affect braking ability and lead to brake failure which could result in death or serious injury

CAUTION

To avoid leakage, verify that gaskets, banjo bolt, hydraulic brake line and caliper bore are completely clean.

3. Connect brake line (1) to caliper using two new banjo washers (3) and banjo bolt (2) (metric). Tighten to 16-20 ft-lbs (21.7-27.1 Nm).

⚠ WARNING

Always test motorcycle brakes at low speed after servicing or bleeding system. To prevent death or serious injury, Buell recommends that all brake repairs be performed by a Buell dealer or other qualified mechanic.

4. Depress rear brake pedal several times to set brake pads to proper operating position within caliper. Bleed brake system. See 1.9 BRAKES (2000 Models).
5. See Figure 2-87. Verify proper fluid level in reservoir.

⚠ WARNING

Check for proper brake lamp operation before riding motorcycle. Visibility is a major concern for motorcyclists. Failure to have proper brake lamp operation could result in death or serious injury.

6. Turn ignition key switch to IGN. Apply brake pedal to test brake lamp operation. Turn ignition key switch to LOCK.

NOTE

Avoid making hard stops for the first 100 miles (160 km) to allow new brake pads to "wear in" properly with the brake rotor.

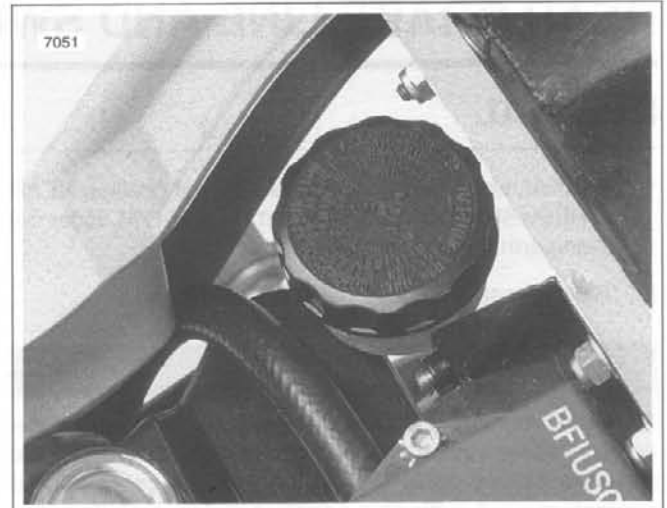


Figure 2-87. Rear Reservoir

REMOVAL

1. Position motorcycle on a suitable lift and position REAR WHEEL SUPPORT STAND (Part No. B41174) under the swing arm. Secure motorcycle to lift.
2. Remove seat. See 2.49 SEAT (2000 Models).

WARNING

To avoid accidental start-up of vehicle, disconnect the battery cables before proceeding. Always disconnect the negative battery cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion, which could result in death or serious injury.

3. Disconnect both battery cables from battery, negative (-) cable first. See 1.5 BATTERY (2000 MODELS).
4. Cut cable tie holding oxygen sensor connector to battery strap. Remove battery strap and battery.
5. Remove rear brake fluid reservoir cap and drain brake fluid from rear brake system into suitable container. See Step 1 (Removal) in 2.21 REAR BRAKE MASTER CYLINDER (2000 models).
6. Remove two top bolts from oil tank.
7. See Figure 2-89. Cut two cable ties holding rear brake reservoir hose to rear brake line above rear master cylinder on right side of motorcycle.
8. See Figure 2-90. Disconnect two wires from rear brake light switch.

CAUTION

Damaged banjo bolt seating surfaces will leak when reassembled. Prevent damage to seating surfaces by carefully removing brake line components.

9. Remove rear master cylinder banjo bolt and two banjo washers. Discard banjo washers.
10. See Figure 2-88. Remove rear brake caliper banjo bolt and two banjo washers. Discard banjo washers.
11. Carefully push up on bottom of oil tank to allow rear brake line tangs to be freed from studs on the bottom of the oil tank.
12. See Figure 2-91. Cut cable tie on wiring harness and cable tie on vent tube on left side of bike.
13. Slide rear brake line into area where battery usually sits and then off of bike through left side of frame.

NOTE

If replacing rear brake light switch, place brake line in vise gently (securing hexagonal rear brake light switch fitting) to prevent bending brake line while removing or installing rear brake lamp switch.

14. See Figure 2-90. Remove rear brake light switch from brake line.

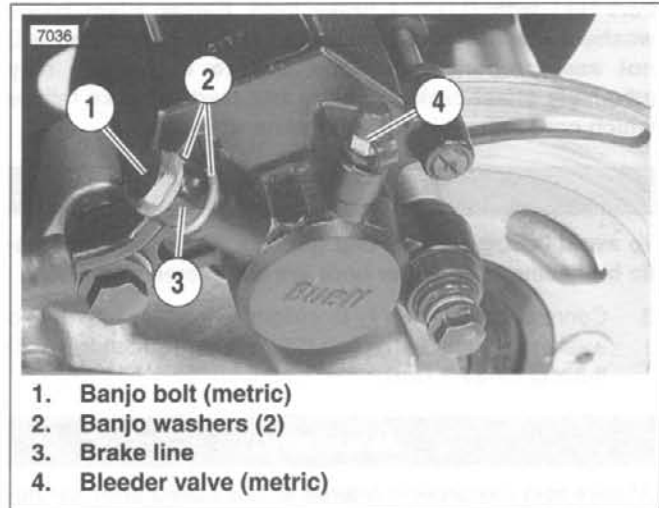


Figure 2-88. Rear Brake Caliper Banjo Bolt

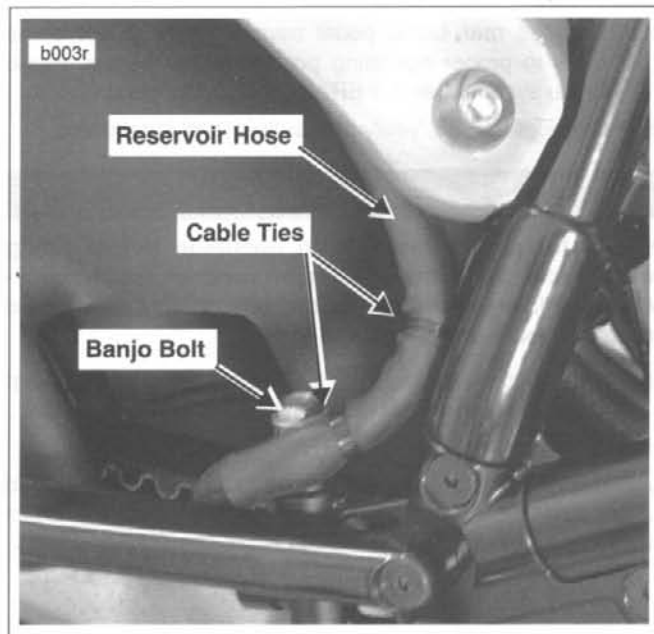


Figure 2-89. Rear Master Cylinder Banjo Bolt

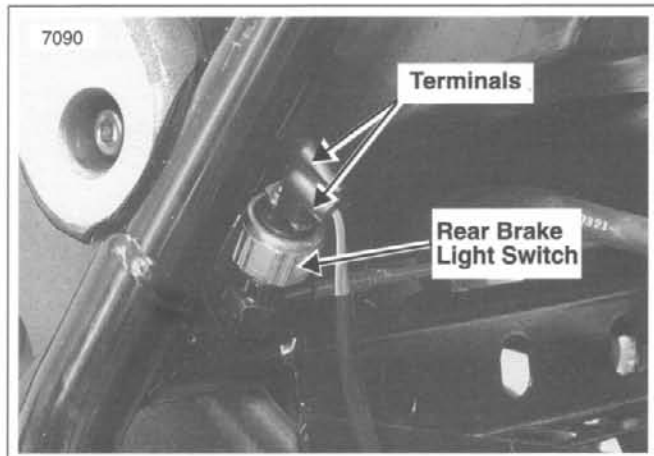


Figure 2-90. Rear Brake Light Switch

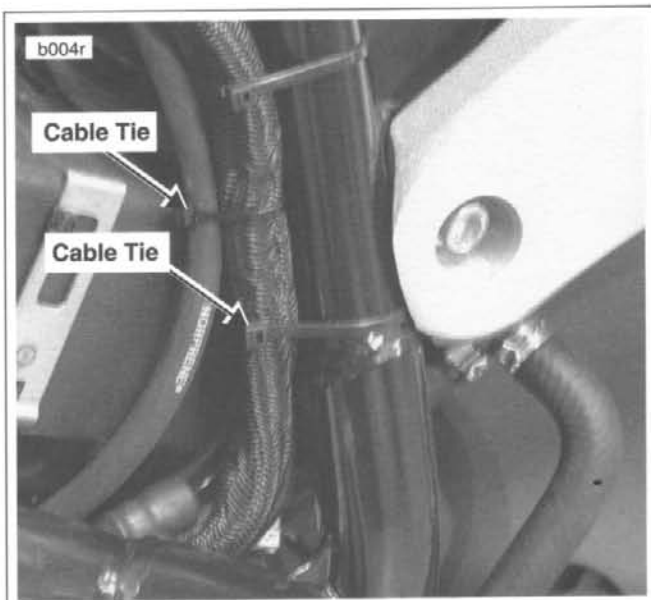


Figure 2-91. Rear Brake Line - Left Side

INSTALLATION

⚠ WARNING

If rear brake line must be replaced, use only the brake line with the olive drab coating on the metal portion of the line (See Parts Catalog for Part No.) with DOT 4 brake systems. The previous black metal brake line is **NOT** compatible with DOT 4 brake fluid. Failure to comply may adversely affect braking ability and lead to brake failure which could result in death or serious injury.

NOTE

If replacing rear brake light switch, place brake line in vise gently (securing hexagonal rear brake light switch fitting) to prevent bending brake line while removing or installing rear brake lamp switch.

- Coat threads of rear brake lamp switch with LOCTITE PIPE SEALANT WITH TEFLON and install to brake line. Tighten switch to 84-96 in-lbs (9.5-10.8 Nm). Tighten as required to orient terminals perpendicular to brake line.
- Remove frame side fasteners from rear tie bar (locknut, washer and bolt). Discard locknut. NOTE: Using a 3 inch extension and deep well swivel socket simplifies removal of the tie bar fasteners.
- See Figure 2-92. Working from the right side, install brake line and align metal portion of brake line with rear master cylinder. Route caliper side of brake line in front of tie bar and through rear fender opening to rear caliper.
- Carefully push up on bottom of oil tank and position rear brake line tangs under studs on the bottom of the oil tank. Lower oil tank allowing studs to engage pockets in frame.
- See Figure 2-93. Install loop cushioned clamp to brake line and then to bolt side of tie bar fasteners. Loop clamp is oriented down and to the left. Install tie bar to frame with bolt, washer and loop cushioned clamp on lower side of tie bar and **new** locknut on upper side of tie bar. Tighten to 30-33 ft-lbs (40.7-44.7 Nm).
- Install rear master cylinder banjo bolt with **new** banjo washers and torque to 16-20 ft-lbs (21.7-27.1 Nm).
- Install rear caliper banjo bolt with **new** banjo washers and torque to 16-20 ft-lbs (21.7-27.1 Nm). NOTE: Removing inner fender TORX screw and plastic washer will assist in tightening banjo bolt. If TORX screw and plastic washer are removed, tighten to 72-96 in-lbs (8.1-10.8 Nm) when installing.
- See Figure 2-89. Install two cable ties (thick) to reservoir hose and rear brake line in **two** locations as shown in figure. Use care to avoid pinching hose.
- Install top two bolts to oil tank. Tighten bolts to 10-12 in-lbs (1.1-1.4 Nm).
- See Figure 2-91. Cable tie vent hose and wire harness to frame on left side of motorcycle. NOTE: Use thick cable tie on wire harness and thin cable tie on vent hose. Use care to avoid pinching hose.

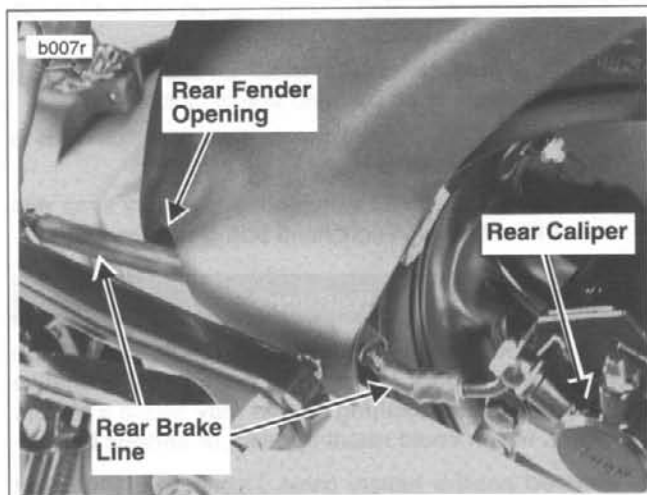


Figure 2-92. Rear Brake Line Routing

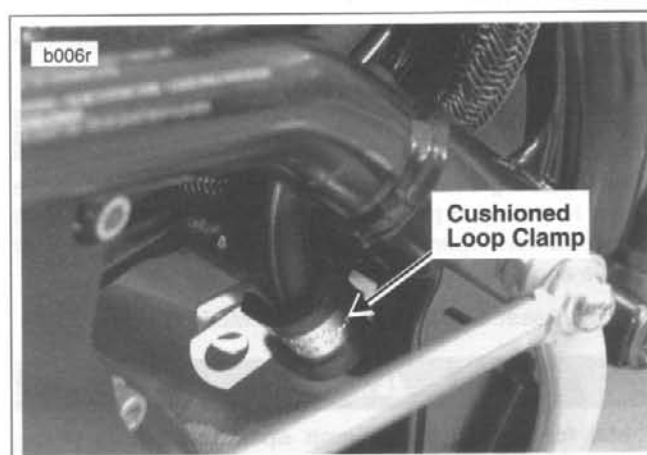


Figure 2-93. Loop Clamp Orientation Before Installation

⚠ WARNING

Use only new black banjo washers (See Parts Catalog for Part No.) with D.O.T. 4 brake fluid. Earlier silver banjo washers are not compatible with D.O.T. 4 fluid and will not seal properly over time. Failure to comply may adversely affect braking ability and lead to brake failure which could result in death or serious injury

11. Install battery with strap and nut. Tighten nut to 40 **in-lbs** (4.5 Nm).
12. Attach oxygen sensor connector to battery strap with **new** thin cable tie on left hand side of motorcycle.
13. See Figure 2-90. Connect rear brake light switch wires to rear brake light switch.
14. Attach rear brake light switch wires to battery strap with **new** thin cable tie on right hand side of motorcycle.

⚠ WARNING

Always connect the positive battery cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion, which could result in death or serious injury.

15. Connect positive battery cable. Tighten to 60-96 **in-lbs** (6.8-10.9 Nm).
16. Connect negative battery cable. Tighten to 60-96 **in-lbs** (6.8-10.9 Nm).
17. Bleed rear brake system and install reservoir cap. See 1.9 BRAKES (2000 Models)

⚠ WARNING

After installing seat, pull upward on front of seat to be sure it is locked in position. If seat is loose, it could shift during vehicle operation resulting in loss of control of vehicle and death or serious injury.

18. Install seat. See 2.49 SEAT (2000 Models).

⚠ WARNING

Check for proper brake lamp operation before riding motorcycle. Visibility is a major concern for motorcyclists. Failure to have proper brake lamp operation could result in death or serious injury.

19. Turn ignition key ON, depress rear brake pedal and check for proper brake light operation.

⚠ WARNING

After completing repairs or bleeding the system, always test motorcycle brakes at low speed. If brakes are not operating properly or braking efficiency is poor, testing at high speeds may result in death or serious injury.

20. Test ride motorcycle and check for proper brake operation.

GENERAL

The following information is intended to provide a general overview of the project and its objectives. It is not intended to be a substitute for the detailed technical specifications and drawings provided elsewhere in this document.

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CHARACTERISTICS

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GENERAL

The front fork consists of two telescoping outer tube/inner slider assemblies. Each assembly has an internal compression spring which supports the forward weight of the vehicle and rider. The compression spring extends and retracts to cushion the ride over rough or irregular road surfaces. An oil filled damping mechanism controls the telescoping action of each tube/slider assembly.

See 1.17 SUSPENSION for more information.

REMOVAL

1. Raise front wheel off floor using procedure under 1.19 STEERING HEAD BEARINGS.
2. Detach front brake caliper from rotor. See 2.12 FRONT BRAKE CALIPER (1999 Models) or 2.19 FRONT BRAKE CALIPER (2000 Models)
3. Remove front wheel. See 2.5 FRONT WHEEL (1999 Models) or 2.6 FRONT WHEEL (2000 Models)
4. Remove front fender. See 2.39 FRONT FENDER.
5. Loosen left and right headlamp brackets.
6. Loosen the four large pinch screws on both the upper and lower triple clamps.
7. Remove front forks through bottom of triple clamps.

DISASSEMBLY

NOTE

To prevent change in set position of damping force adjuster needle, do not loosen the lock nut.

1. See Figure 2-94. Loosen the fork bolt (1) (metric) from the outer tube and slightly compress the fork leg. Remove the fork bolt with attached O-ring (2).
2. See Figure 2-95. Set the FRONT FORK SPRING COMPRESSOR (Part No. B-43875) (1) onto the spring collar (2). Push down on the collar and remove the spring seat stopper (3).
3. See Figure 2-96. Remove the spring collar (4), the spring joint (5) and the spring (7).
4. Remove the fork oil by pumping the fork leg and rod 8-10 times until the rod moves freely.
5. Clamp the axle holder in a vise with soft jaws or use a shop towel. Remove the center bolt (19) (metric) and the special washer (18).

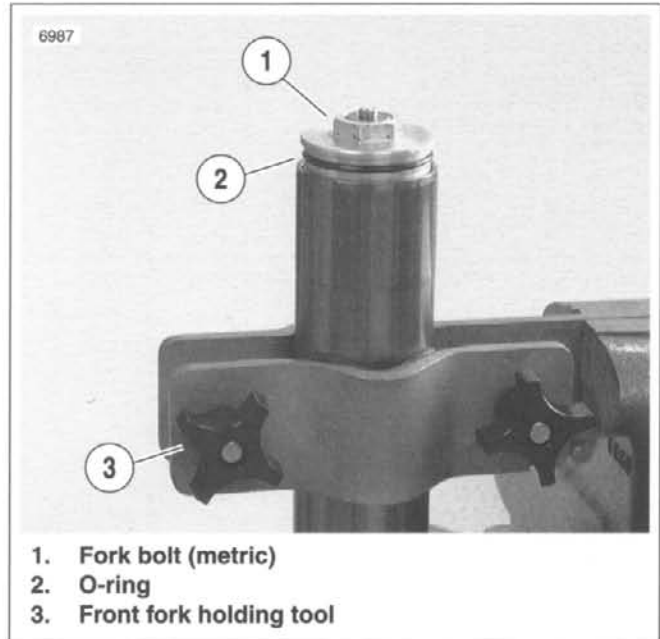


Figure 2-94. Fork Bolt

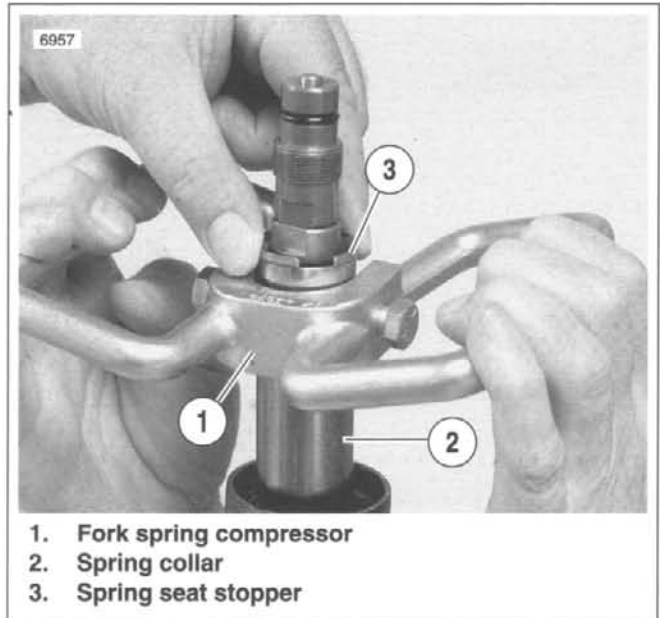
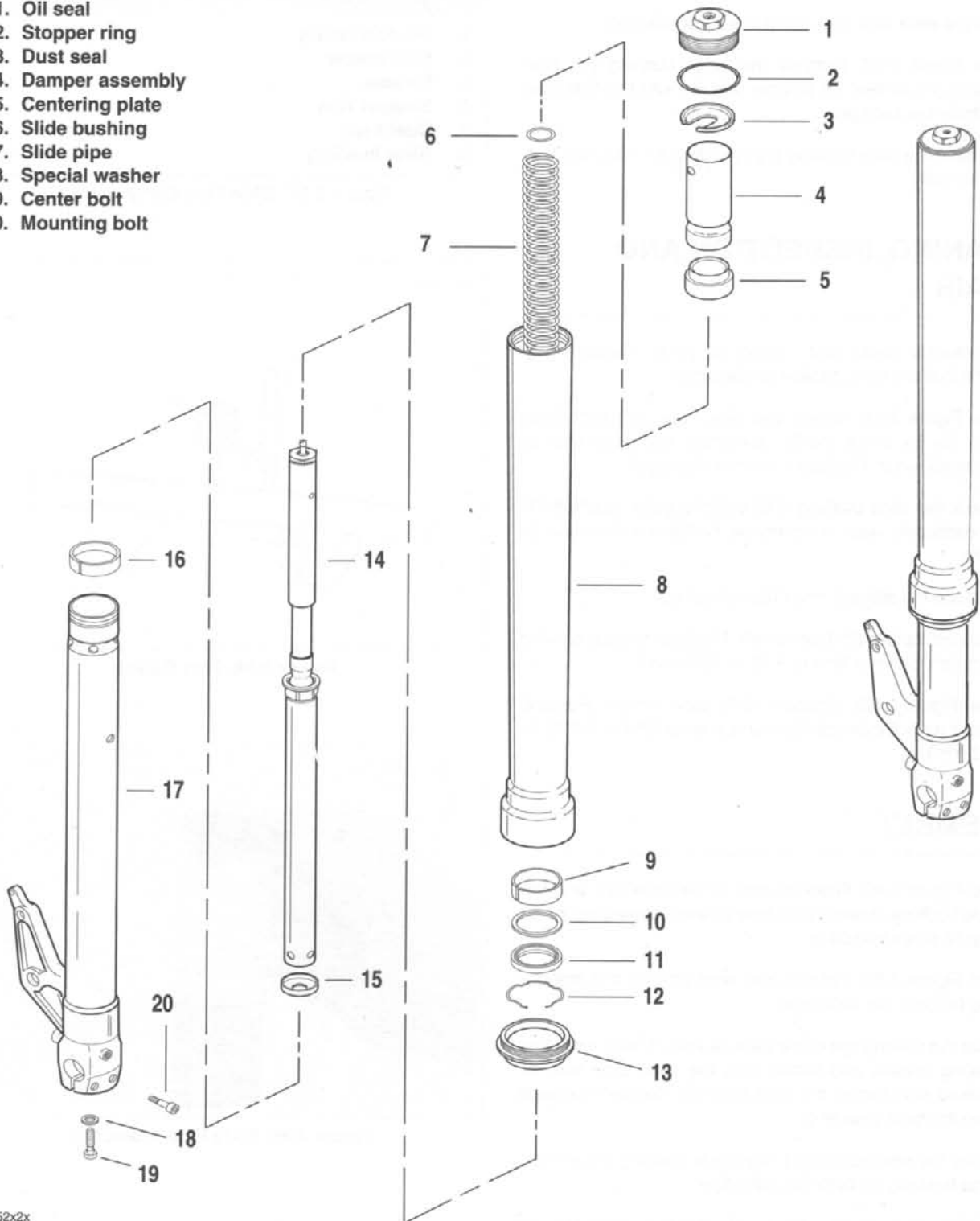


Figure 2-95. Front Fork Spring Compressor

1. Fork bolt
2. O-ring
3. Spring seat stopper
4. Spring collar
5. Spring joint
6. O-ring
7. Spring
8. Outer tube
9. Guide bushing
10. Seal spacer
11. Oil seal
12. Stopper ring
13. Dust seal
14. Damper assembly
15. Centering plate
16. Slide bushing
17. Slide pipe
18. Special washer
19. Center bolt
20. Mounting bolt



b0652x2x

Figure 2-96. Front Fork Assembly

- Remove the damper (14) and the centering plate (15) from the slide pipe (17).

WARNING

Be careful not to scratch the slide pipe or the outer tube. Improperly operating forks may lead to a loss of control and death or serious injury.

- Remove the dust seal (13) and the stopper ring (12) from the outer tube (8).
- Pull the slide pipe (17) out of the outer tube (8).
- See Figure 2-97. Remove the guide bushing (1), seal spacer (2), oil seal (3) stopper ring (4), and the dust seal (5) from the slide pipe.
- Remove the slide bushing (6) by prying the slide bushing at the split.

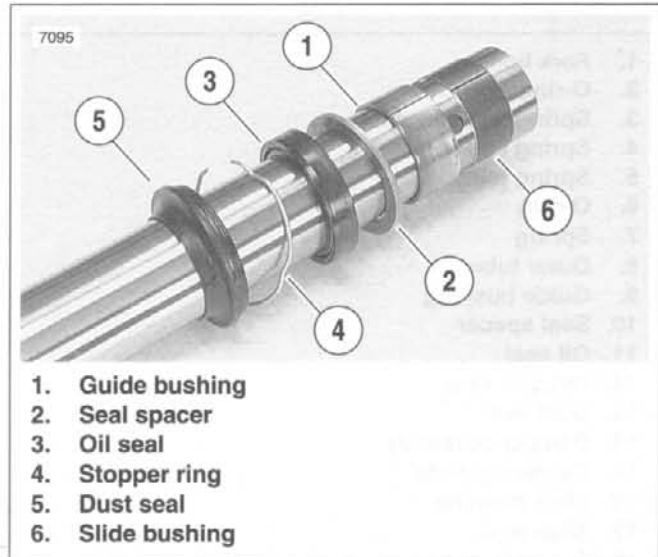


Figure 2-97. Slide Pipe Components

CLEANING, INSPECTION AND REPAIR

- Thoroughly clean and inspect all parts. Replace any parts that are bent, broken or damaged.
- See Figure 2-96. Check the slide pipe (17) and outer tube (8) for score marks, scratches and excessive or abnormal wear. Replace if worn or damaged.
- Check the slide bushing (16) and the guide bushing (9) for excessive wear or scratches. Replace if damaged or worn.
- Replace the stopper ring (12) if distorted.
- Measure spring (7) free length. Replace springs shorter than service wear limit of 9.13 in. (232 mm).
- See Figure 2-98. Measure slide pipe runout. Replace pipe if runout exceeds the service wear limit of 0.008 in. (0.2 mm).

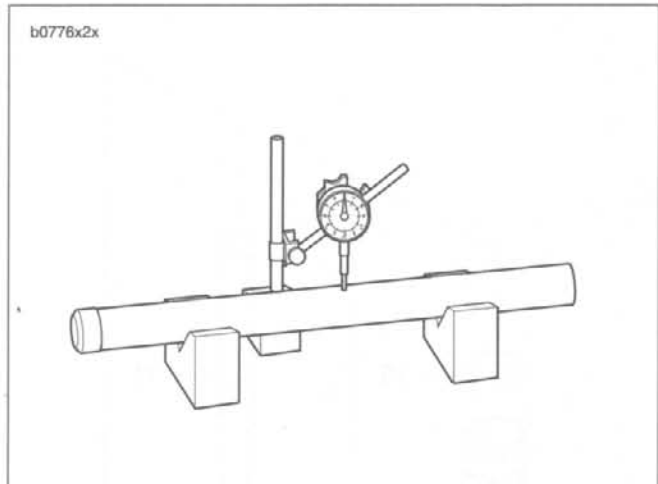


Figure 2-98. Pipe Runout

ASSEMBLY

- See Figure 2-99. Wrap the end of the slide pipe and the slide bushing channel with tape to avoid damaging the oil seal lip when installing.
- See Figure 2-97. Install a **new** dust seal (5) and stopper ring (4) onto the slide pipe.
- Coat the sealing lips of the **new** oil seal (3) with fork oil or sealing grease and install onto the slide pipe with its marked side facing the dust seal (5). Remove the tape from the slide pipe end.
- Install the seal spacer (2), the guide bushing (1) and the slide bushing (6) onto the slide pipe.
- Coat the slide bushing (6) and the guide bushing (1) with fork oil.

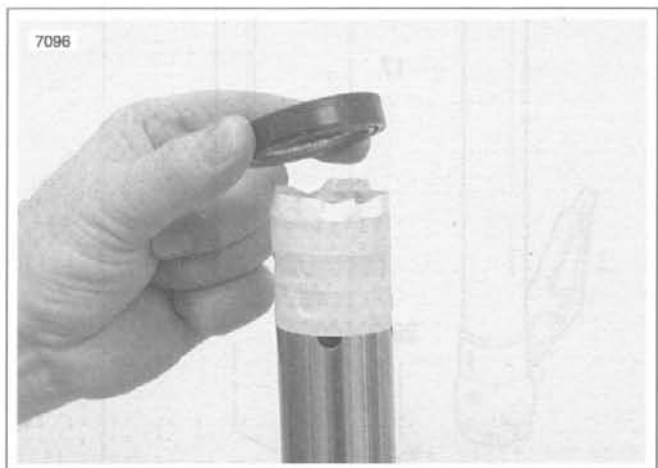


Figure 2-99. Slide Pipe Protection

CAUTION

The outer tube can move freely up and down on the slide pipe. Always hold both the slide pipe and outer tube to prevent damage to bushings and seals.

6. See Figure 2-96. Carefully place the slide pipe (17) into the outer tube (8).
7. Move and tape or tie the dust seal (13) and stopper ring (12) out of the way.
8. Using FORK SEAL DRIVER (Part No. B-43721), drive the guide bushing (9) with the seal spacer (10) and oil seal (11) into position in the outer tube (4). See Figure 2-100.
9. See Figure 2-96. Remove any tape or ties and reinstall the stopper ring (12) and a **new** dust seal (13).
10. Place the centering plate (15) onto the damper (14) and insert the assembly into the slide pipe (17).
11. Clamp the axle holder in a vise with soft jaws or use a shop towel. Replace the special washer (18) and center bolt (19) (metric). Tighten the center bolt to 22-29 ft-lbs (29.8-39.3 Nm).

NOTE

The recommended fork oil is hydraulic fork oil Type "E".

12. While supporting the fork, pour one-half of the recommended amount of fork oil, 8 oz. (225 cc), into the fork pipe.
13. Pump the piston rod and leg slowly at least 10 times, about 6 in. (150 mm) strokes.
14. Place the piston rod and outer tube (8) in the full bottomed position.
15. See Figure 2-101. Pour the recommended fork oil into the slide pipe to a level between the maximum and minimum limits. Additional information on setting oil levels can be found under 1.18 FRONT FORK OIL.
16. See Figure 2-102. Install the spring, with the taper side at top, and the spring collar and spring joint.
17. See Figure 2-95. Place FRONT FORK SPRING COMPRESSOR (1) into position and press down on the spring collar (2).
18. Set the spring seat stopper (3) between the spring collar (2) and the locknut. Remove the FRONT FORK SPRING COMPRESSOR.
19. See Figure 2-94. Apply oil to a **new** O-ring and install it into position on the fork bolt. Install fork bolt. Tighten to 22-29 ft-lbs (29.8-39.3 Nm).
20. Tighten rebound adjuster against the fork bolt.
21. Set rebound and compression adjusters to factory positions. See 1.17 SUSPENSION.

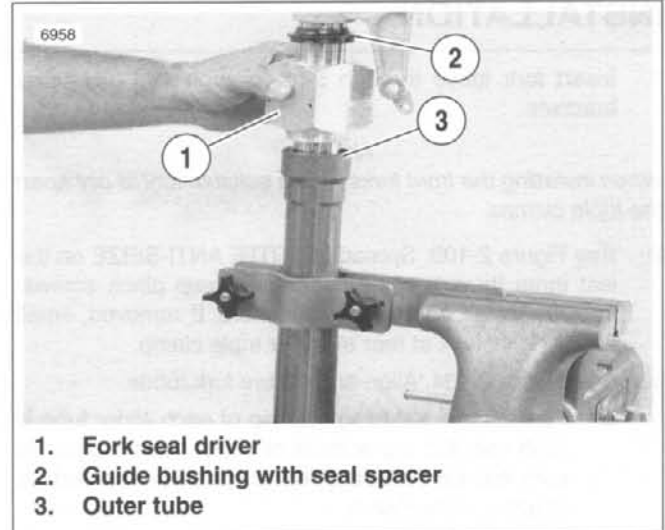


Figure 2-100. Fork Seal Driver

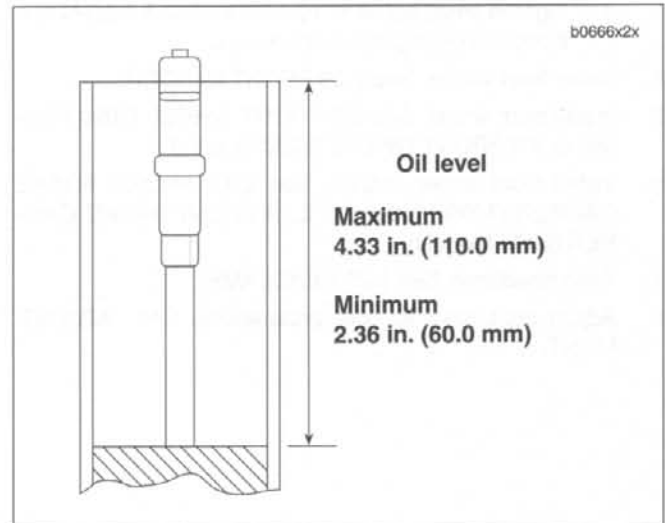


Figure 2-101. Oil Level Measurement

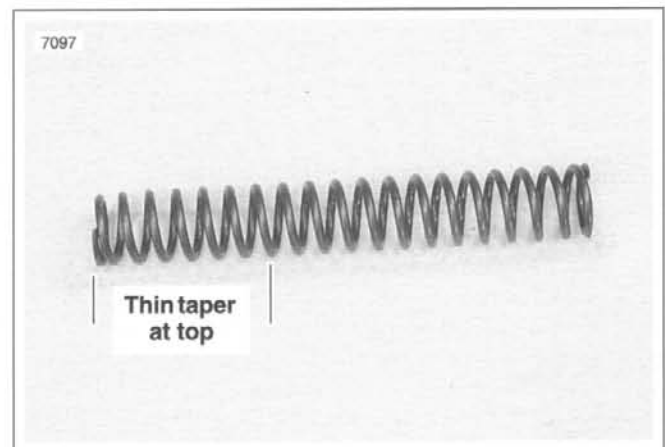


Figure 2-102. Spring Installation

INSTALLATION

1. Insert fork tubes through triple clamps and headlamp brackets.

NOTE

When installing the front forks, use a suitable tool to pry apart the triple clamps.

2. See Figure 2-103. Spread LOCTITE ANTI-SEIZE on the last three threads of all five triple clamp pinch screws. Loosely install triple clamp fasteners. If removed, small screw (1) installs at rear of upper triple clamp.
3. See Figure 2-104. Align and secure fork tubes.
 - a. Position fork tubes so that top of each slider tube is flush with the top surface of upper triple clamp. Be sure that top surface of fork is not below top surface of upper triple clamp.
 - b. Position top of headlamp brackets 2.0 in. (50.8 mm) below upper triple clamp.
 - c. Tighten large screws to 18-20 ft-lbs (24.4-27.1 Nm).
 - d. Tighten small screw to 10-12 ft-lbs (13.6-16.3 Nm) if loosened during fork stem service.
4. Install front fender. See 2.39 FRONT FENDER.
5. Install front wheel. See 2.5 FRONT WHEEL (1999 Models) or 2.6 FRONT WHEEL (2000 Models).
6. Install front brake caliper. See 2.12 FRONT BRAKE CALIPER (1999 Models) or 2.19 FRONT BRAKE CALIPER (2000 Models).
7. Align headlamp. See 1.25 HEADLAMP.
8. Adjust front forks to rider preferences. See ADJUSTMENT.

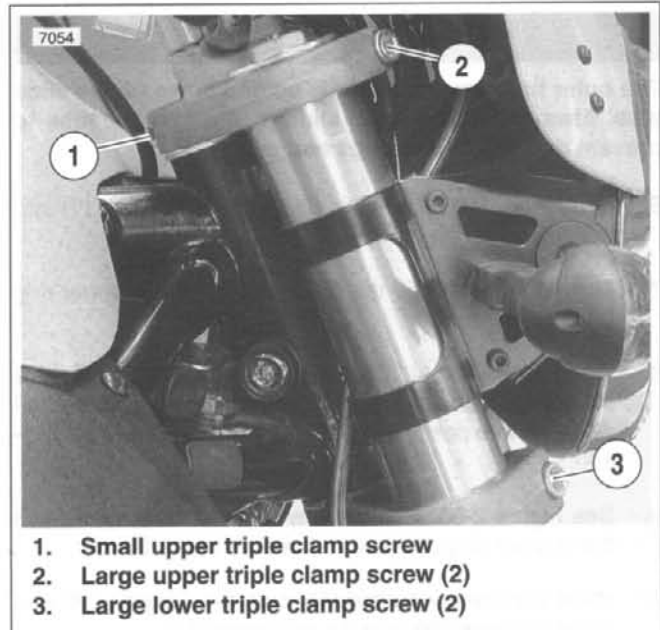


Figure 2-103. Front Fork Fasteners

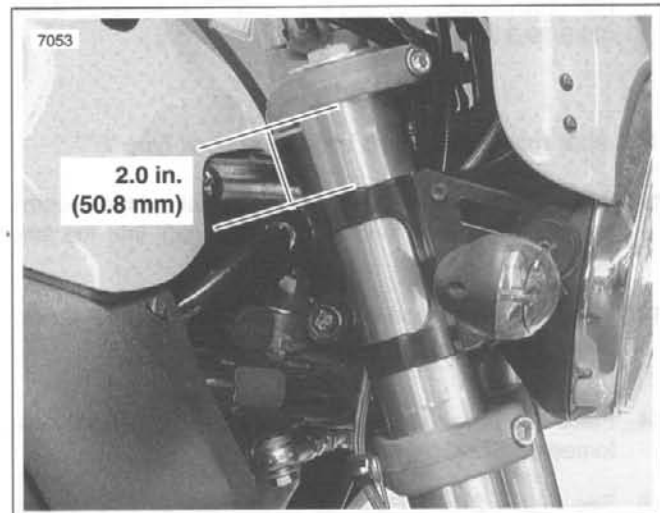


Figure 2-104. Aligning Front Forks

REMOVAL/DISASSEMBLY

1. Remove steering head lock. See 2.26 STEERING HEAD LOCK.
2. Remove fork assemblies. See 2.24 FRONT FORK.
3. Detach instrument support and handlebars. See 2.33 INSTRUMENT SUPPORT.
4. See Figure 2-105. Remove all upper triple clamp screws (7, 11), fork stem bolt (1) and upper triple clamp (2).
5. Remove upper dust shield (3) and roller bearing (4).
6. Remove lower roller bearing.
 - a. Remove two lower triple clamp screws (7). Pull the lower triple clamp (6) downward.
 - b. The lower bearing cone is a press fit on fork stem. Chisel through outer bearing cage to allow rollers to fall free.
 - c. Apply heat to remove the remaining portion of bearing cone. Continuously move flame around its entire circumference until bearing falls free.
 - d. Remove lower dust shield (3).
7. If replacement of bearing cups (5) is necessary, drive cups from steering head using STEERING HEAD BEARING RACE REMOVER (Part No. HD-39301A) and UNIVERSAL DRIVER HANDLE (Part No. HD-33416).

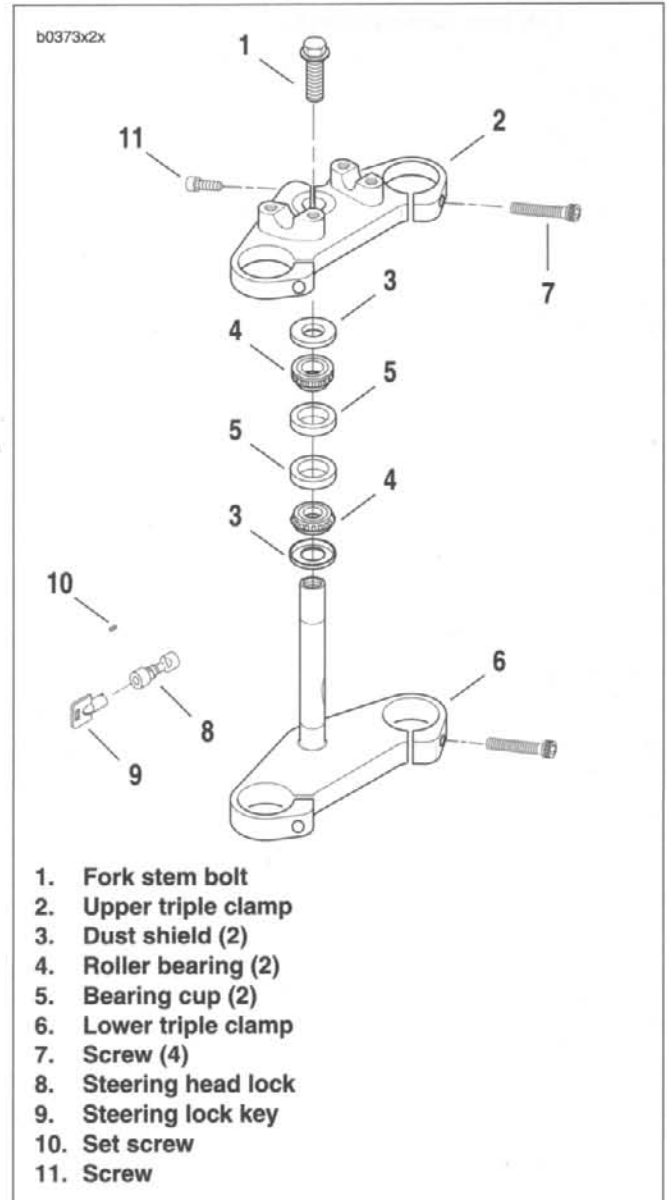
CLEANING, INSPECTION AND REPAIR

See 1.17 SUSPENSION for adjustment procedures.

1. See Figure 2-105. Clean the dust shields (3), bearing cups (5), fork stem and lower triple clamp (6) and frame with solvent.
2. Carefully inspect bearing races and assemblies for pitting, scoring, wear and other damage. Replace damaged bearings (4) as a set (3, 4 and 5).
3. Check the fork stem and lower triple clamp (6) for damage. Replace if necessary.

ASSEMBLY/INSTALLATION

1. See Figure 2-106. If removed, install **new** bearing cups into frame steering head using STEERING HEAD BEARING RACE INSTALLER (Part No. HD-39302).
2. See Figure 2-105. Liberally coat the bearing cones (4) with grease using WHEEL BEARING PACKER TOOL (Part No. HD-33067). Work the grease into the rollers.
3. Install lower bearing.
 - a. Place lower bearing dust shield (3) over fork stem.
 - b. Find a section of pipe having an inside diameter slightly larger than the outside diameter of the fork stem.



1. Fork stem bolt
2. Upper triple clamp
3. Dust shield (2)
4. Roller bearing (2)
5. Bearing cup (2)
6. Lower triple clamp
7. Screw (4)
8. Steering head lock
9. Steering lock key
10. Set screw
11. Screw

Figure 2-105. Fork Stem

- c. Press bearing (4) with small end up onto fork stem and lower triple clamp (6). Use the pipe as a press-on tool.
4. Insert lower triple clamp (6) through the steering head. Install the upper bearing (4) with small end down and dust shield (3) onto fork stem.
5. See Figure 2-107. Apply LOCTITE ANTI-SEIZE to fork stem bolt (1). Loosely install upper triple clamp (2) using fork stem bolt.
6. Install fork assemblies. See 2.24 FRONT FORK.
7. Install steering head lock. See 2.26 STEERING HEAD LOCK.
8. Install instrument support and handlebars. See 2.33 INSTRUMENT SUPPORT.
9. Check adjustment.

- a. Tighten fork stem bolt (1). Check bearing adjustment to set fork stem bolt to proper tension. See 1.19 STEERING HEAD BEARINGS.
- b. Make sure the fork stem turns freely, then tighten the fork stem clamp screw (3).

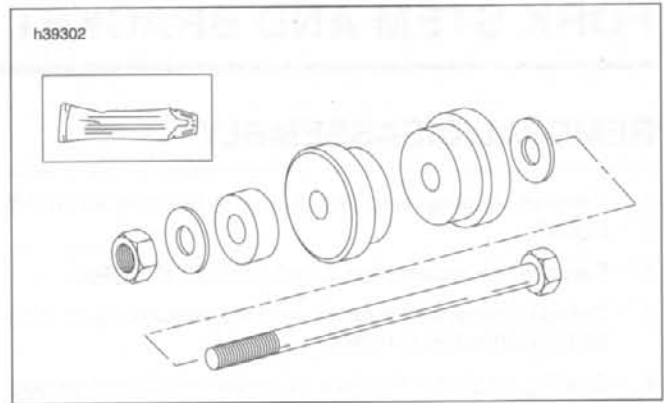
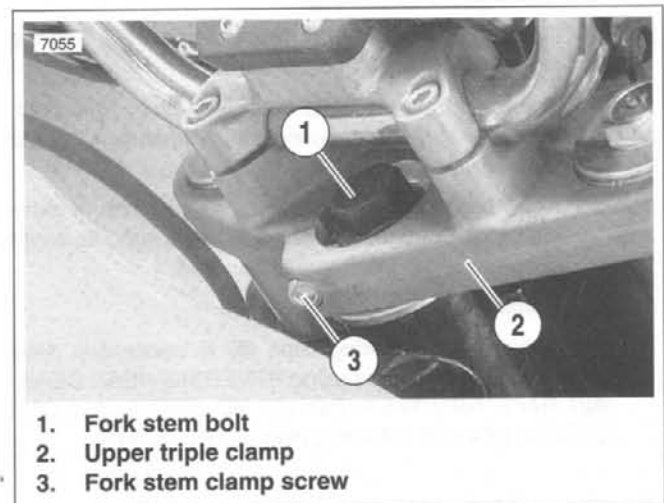


Figure 2-106. Steering Head Bearing Race Installer



- 1. Fork stem bolt
- 2. Upper triple clamp
- 3. Fork stem clamp screw

Figure 2-107. Fork Stem Clamp Screw

REMOVAL

NOTE

Steering head lock is not repairable. Replace the unit if it fails.

1. Raise front wheel off floor using procedure under 1.19 STEERING HEAD BEARINGS.
2. Remove four screws and washers to detach windscreen.
3. Loosen handlebars.
 - a. Place protective cloth over fuel tank cover and headlamp.
 - b. See Figure 2-108. Remove the two front clamp screws (1).
 - c. Remove both rear clamp screws (2) and instrument support (3).
 - d. Place handlebar assembly on headlamp without stretching the attached cables.
4. Loosen the three upper triple clamp screws.
5. See Figure 2-108. Slowly loosen fork stem bolt (4) until forks drop 0.5 in. (12.7 mm) in triple clamps.
6. See Figure 2-109. Remove set screw behind lock.
7. Extract steering head lock from fork stem.
 - a. Insert fork key in lock.
 - b. Lift front wheel upward.
 - c. Twist key to pull steering head lock from fork stem.
 - d. Release front wheel.

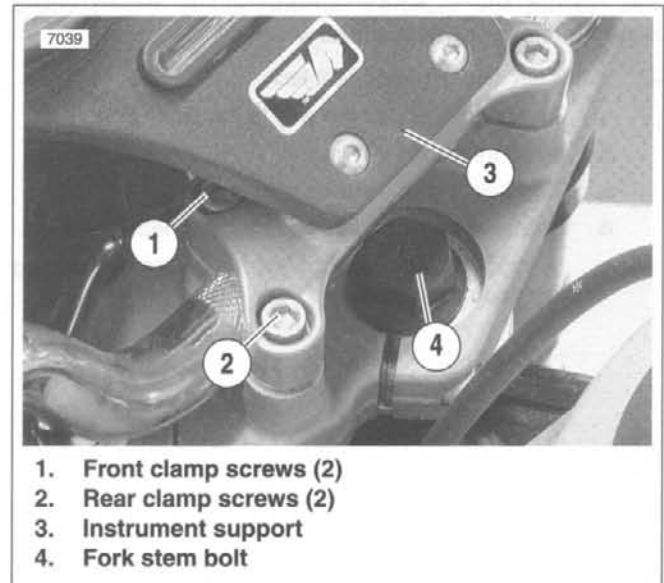


Figure 2-108. Loosening Handlebars

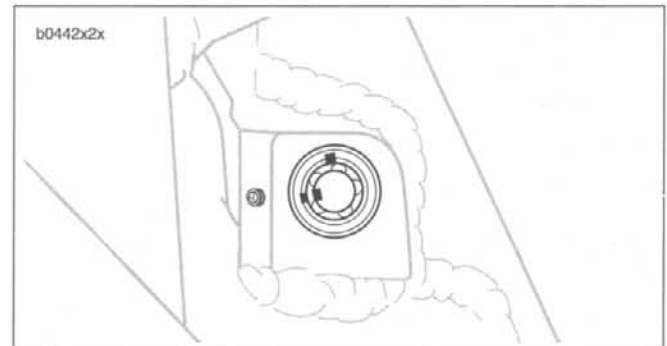


Figure 2-109. Set Screw

INSTALLATION

1. Install steering head lock in fork stem.
 - a. See Figure 2-110. Dished area of steering head lock faces front wheel.
 - b. Lift front wheel upward.
 - c. See Figure 2-109. Lock must be in the unlocked position to install. Insert lock with key openings positioned as shown.
 - d. Release front wheel.
2. Install and adjust handlebars. See 1.24 HANDLEBARS.
3. See Figure 2-108. Tighten fork stem bolt and triple clamp screws. Check bearing adjustment. See 1.19 STEERING HEAD BEARINGS.

⚠ WARNING

Do not operate vehicle with steering head locked. This will restrict the vehicle's turning ability which could result in death or serious injury.

4. Install set screw in lock. Test lock.
 - a. Turn handlebars all the way to the left.
 - b. Insert ignition key in lock.
 - c. Turn key clockwise while pushing in.
 - d. Remove key and verify that steering head is locked.
 - e. Unlock steering head by inserting key and turning key counterclockwise.

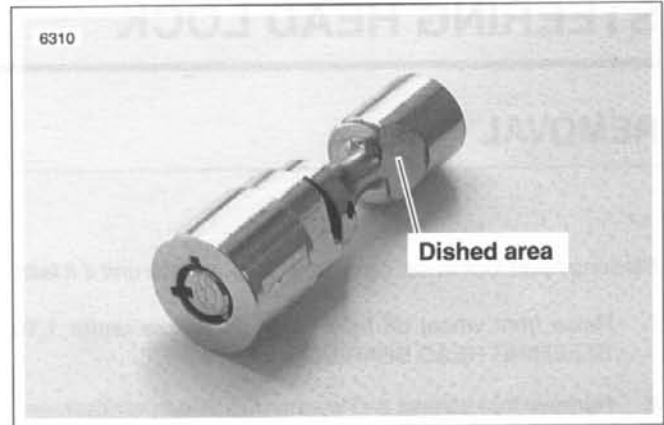


Figure 2-110. Steering Head Lock

REMOVAL

NOTE

Mark all hardware as it is removed so that it may be returned to its original location.

1. Compress suspension to access rear fender fasteners. Remove rear fender and lower belt guard. See 2.40 REAR FENDER.
2. Place vehicle on a lift and anchor front wheel in place.

WARNING

To avoid accidental start-up of vehicle and possible personal injury, disconnect the battery cables before proceeding. Always disconnect the negative cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion which could result in death or serious injury.

3. Disconnect **both** battery cables, negative cable first.
4. Remove seat and attach lifting straps to motorcycle. Insert lifting straps through opening on tail section near tail section mounting bolts.
5. Attach lifting straps to a floor hoist placed behind the lift. Raise motorcycle off lift until rear suspension is unloaded.
6. Remove mounting bolt attaching swingarm to rear shock.
7. Remove rear wheel.
8. Remove cap from oil tank and drain oil.
9. Detach feed line from bottom of oil tank.
10. Detach rear brake pedal from master cylinder pushrod.
11. Remove left side rider footrest and shifter lever.
12. See Figure 2-111. Place a jack under the crankcase.
13. Detach rear tie bar from swingarm.
14. See Figure 2-112. Remove left and right isolator bolts and washers (7).

CAUTION

Remove oil filter before raising frame. Without removal, oil filter will be damaged during procedure.

15. Place a drip pan under the oil filter. Remove oil filter.
16. Using floor hoist, raise frame enough to remove both rubber isolators (6) from frame mounted pins.
17. Loosen swingarm pinch screw (4) on right side.
18. Remove threaded rod (1) from between bearing adjusting bolts (2, 3).

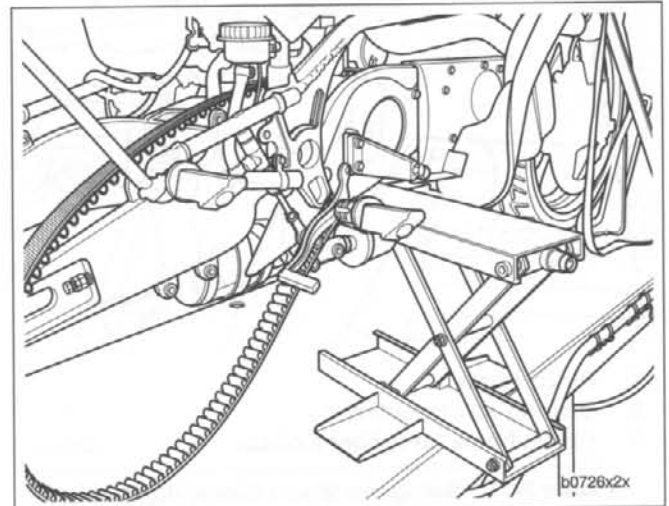


Figure 2-111. Scissors Jack (Typical)

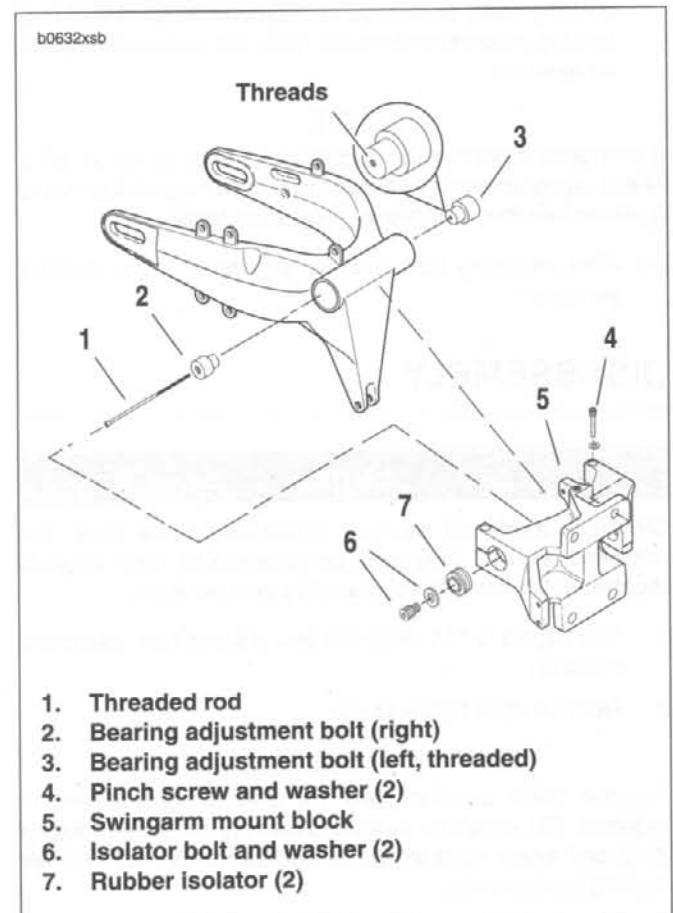


Figure 2-112. Swingarm Assembly

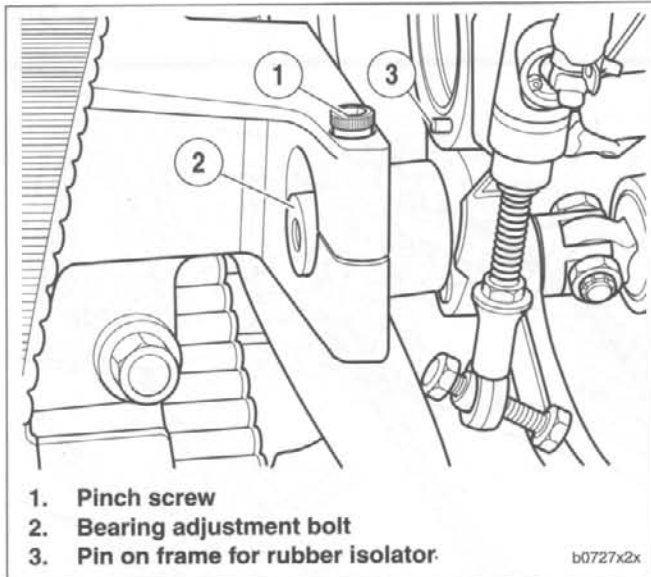


Figure 2-113. Swingarm Mount Block, Right Side

19. Loosen remaining swingarm pinch screw.
20. See Figure 2-113. Using floor hoist, raise frame while pushing down on swingarm. Frame must be raised until bearing adjustment bolts (2) clear pin on frame and can be removed.

NOTE

If swingarm mount block doesn't drop from frame as lift is raised, apply leverage between frame and mount block using a plastic hammer wrapped in clean shop towels.

21. After removing both bearing adjustment bolts, remove swingarm.

DISASSEMBLY

CAUTION

Carefully mark all bearing components as they are removed, so that they may be returned to their original locations. Do not intermix bearing components.

1. See Figure 2-114. Remove and discard both swingarm seals (3).
2. Remove roller bearings (4).

NOTE

Remove roller bearing cups (5) only if replacement is required. The complete bearing assembly must be replaced as a unit when replacement is necessary. Do not intermix bearing components.

3. See Figure 2-115. Carefully press roller bearing cups from swingarm using STEERING HEAD BEARING RACE REMOVER (Part No. HD-39301A) and UNIVERSAL DRIVER HANDLE (Part No. HD-33416).

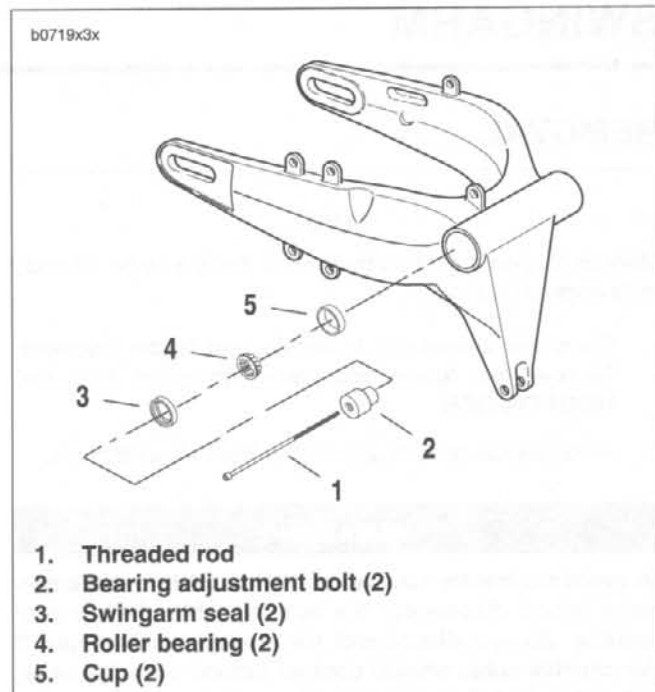


Figure 2-114. Swingarm Bearings

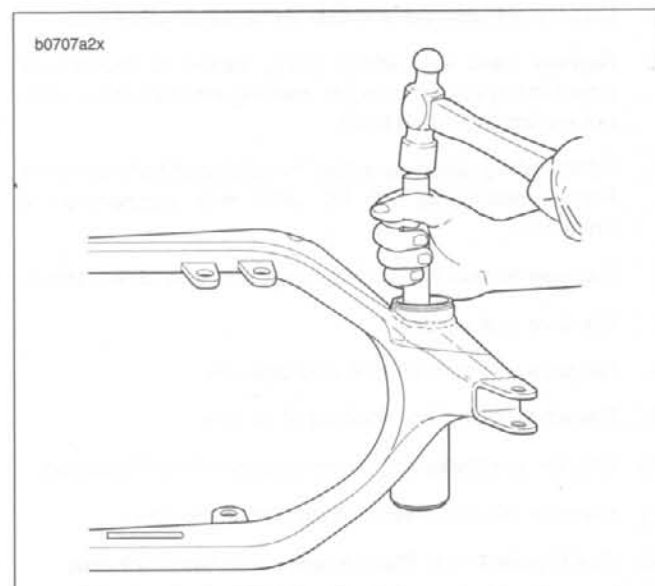


Figure 2-115. Removing Roller Bearing Cups

CLEANING/INSPECTION

1. Thoroughly clean all components in solvent. Blow dry with compressed air.
2. Carefully inspect all bearing components for wear and/or corrosion. Replace complete bearing assembly if any component is damaged.
3. Check that swingarm is not bent or twisted. Replace if damaged.

ASSEMBLY

1. See Figure 2-116. If necessary, draw **new** roller bearing cups into swingarm using BEARING INSTALLATION BOLT (Part No. B-35316-5) and STEERING HEAD BEARING RACE INSTALLER (Part No. HD-39302).

NOTE

Roller bearing assemblies should be replaced as a unit. Do not intermix components. Mark all components so they may be correctly installed.

2. Coat bearing components with WHEEL BEARING GREASE (Part No. HD-99855-89) and assemble.
3. See Figure 2-114. Install **new** swingarm seals (3) flush to the swingarm.
4. Slide swingarm assembly into position.

NOTE

See Figure 2-112. The left side bearing adjustment bolt (3) has additional internal threads.

5. Install bearing adjustment bolts (2, 3).
 - a. Apply LOCTITE THREADLOCKER 222 (purple) to the threaded rod (1).
 - b. Insert the rod through the right side bearing adjusting bolt (2).
 - c. Install and tighten left bearing adjustment bolt (3) (with internal threads) on left side of swingarm.
 - d. Tighten the left pinch screw (4) on the swingarm mount block (5). Do not tighten the right side pinch screw at this time.
 - e. Insert rod through swingarm into left side bearing adjustment bolt. Tighten to an initial torque of 11-12 ft-lbs (14.9-16.3 Nm).

INSTALLATION

1. See Figure 2-112. Align **new** swingarm between posts on swingarm mount block (5).
2. Insert left (threaded) and right bearing adjustment bolts (2, 3) into swingarm until flush with mount block surface.
3. Tighten left side swingarm pinch screw (4) to 18-20 ft-lbs (24.4-27.1 Nm).
4. Install threaded rod (1).
 - a. Apply LOCTITE THREADLOCKER 222 (purple) to threaded rod.
 - b. Insert threaded rod through right side bearing adjustment bolt (2) into threads on left side bolt (3).
 - c. Tighten rod to an initial torque of 10-13 ft-lbs (13.6-17.6 Nm).
5. Check swingarm preload using a scale as shown in Figure 2-117. Preload should be 3.0-3.75 lbs (1.36-1.70 kg). If preload does not meet specifications, tighten or loosen threaded rod and recheck.

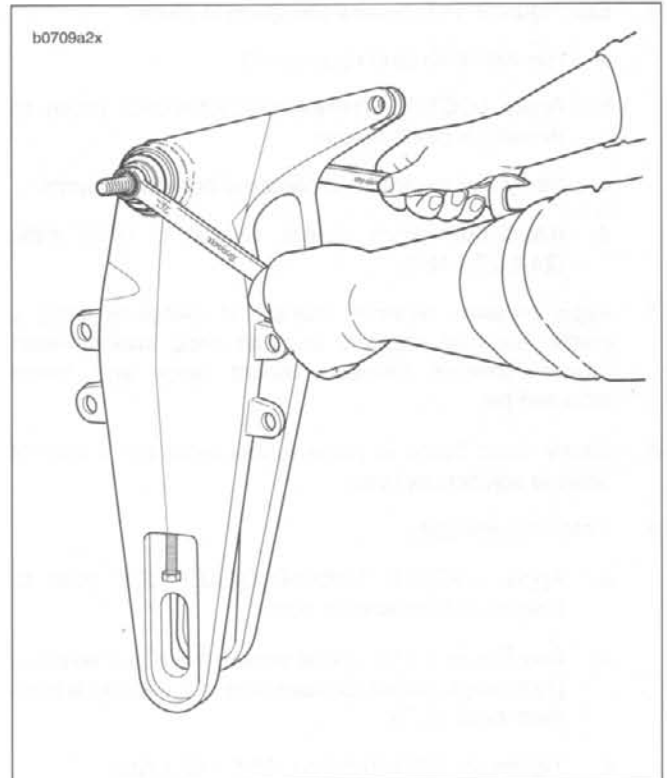


Figure 2-116. Installing Bearings into Swingarm

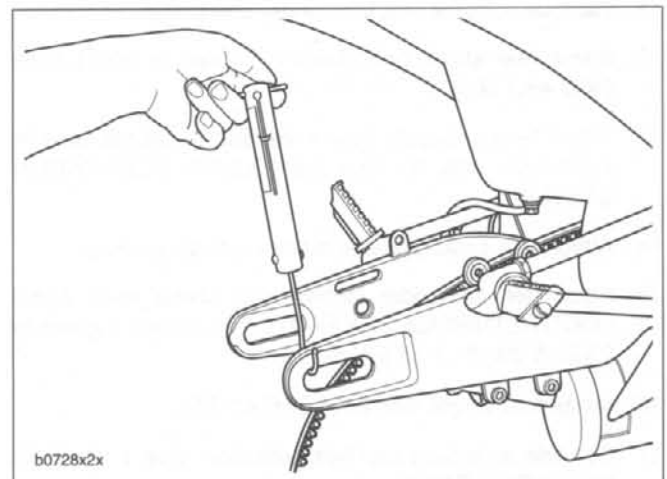


Figure 2-117. Checking Preload

6. See Figure 2-113. Secure swingarm in place.
 - a. Remove both pinch screws (1).
 - b. Apply LOCTITE THREADLOCKER 243 (blue) to threads of pinch screws.
 - c. Verify that swingarm is centered between mounts.
 - d. Install both pinch screws. Tighten to 18-20 ft-lbs (24.4-27.1 Nm).
7. Apply pressure between frame and swingarm using a plastic hammer wrapped in clean shop towels. Insert rubber isolators between mount block and frame mounted pin.
8. Slowly lower frame to place rubber isolators in front of bearing adjustment bolts.
9. Install isolator bolts.
 - a. Apply LOCTITE THREADLOCKER 272 (red) to threads of both isolator bolts.
 - b. See Figure 2-112. Install isolator bolts and washers (7) through rubber isolators and into bearing adjustment bolts (2, 3).
 - c. Tighten to 100-110 ft-lbs (135.6-149.1 Nm).
10. Attach rear tie bar to swingarm mount block. Tighten to 30-33 ft-lbs (40.7-44.7 Nm).
11. Remove scissors jack from under crankcase.
12. Install rear shock bolt (metric). Tighten to 30-33 ft-lbs (40.7-44.7 Nm).
13. Attach feed and drain lines to oil tank. Install filter and fill motorcycle with oil. See 1.6 ENGINE LUBRICATION SYSTEM.
14. Attach rear brake pedal to master cylinder pushrod.
15. Attach left side rider footrest and shifter lever. Apply LOCTITE THREADLOCKER 272 (red) to bolt. Tighten to 23-25 ft-lbs (31.2-33.9 Nm).
16. Install rear wheel. See 2.7 REAR WHEEL.
17. Set axle alignment and belt deflection. See 1.13 REAR BELT DEFLECTION.
 - a. See Figure 2-118. Check rear axle alignment.
 - b. See Figure 2-119. Check belt deflection.
 - c. Proceed to the next step when both axle alignment and belt deflection are correct.
18. See Figure 2-120. Tighten locknut (2) flush against nut (3). Tighten axle nut (metric) to 66-73 ft-lbs (89.5-98.9 Nm). Verify that belt deflection is correct. Lower motorcycle onto lift.

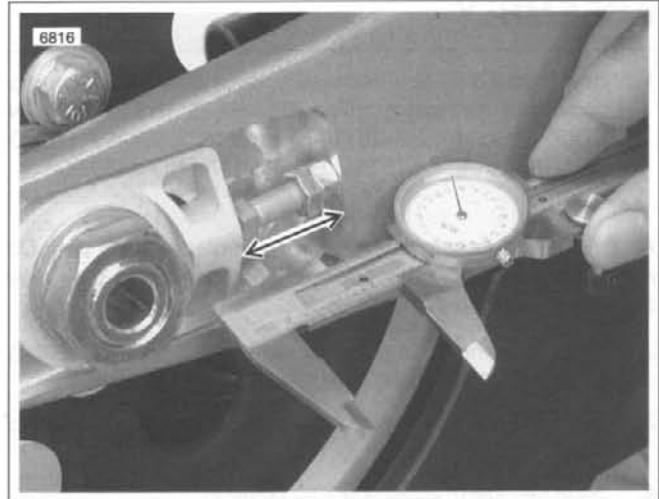


Figure 2-118. Checking Rear Wheel Alignment, Right Side Shown

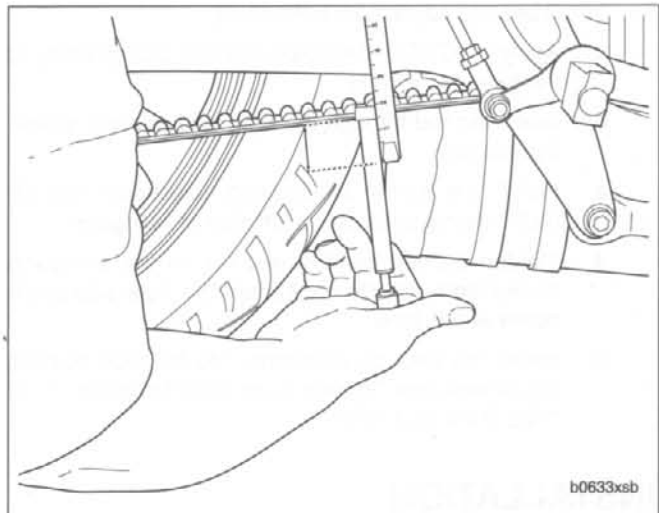
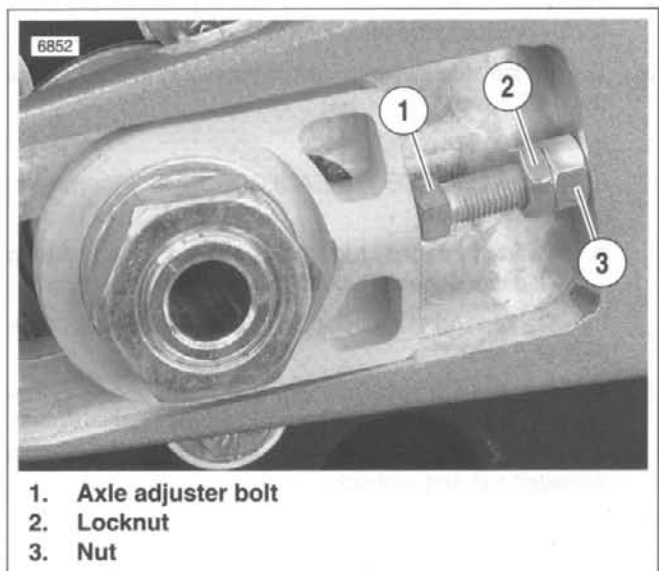


Figure 2-119. Belt Deflection



1. Axle adjuster bolt
2. Locknut
3. Nut

Figure 2-120. Axle Adjuster Bolt, Right Side Shown

⚠ WARNING

After installing seat, pull upward on front of seat to be sure it is locked in position. If seat is loose, it could shift during vehicle operation and startle the rider, causing loss of control which could result in death or serious injury.

19. Remove lifting straps and install seat.

⚠ WARNING

Always connect positive battery cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion which could result in death or serious injury.

20. Attach both battery cables.

21. Remove motorcycle from lift.
22. Compress suspension to install rear fender and lower belt guard. See 2.40 REAR FENDER.
23. Check oil level after starting motorcycle and allowing it to reach operating temperature.

⚠ WARNING

After completing repairs or bleeding the system, always test motorcycle brakes at low speed. If brakes are not operating properly or braking efficiency is poor, testing at high speeds could result in death or serious injury.

24. Check rear brake operation.

REMOVAL

NOTE

Rear shock absorber contains no user serviceable parts.

1. Lift rear wheel off ground using REAR WHEEL SUPPORT STAND (Part No. B-41174).
2. Remove chin fairing. See 2.42 CHIN FAIRING.
3. Remove seat and attach lifting straps to motorcycle. Insert lifting straps through opening on tail section near tail section mounting bolts.
4. Attach lifting straps to a floor hoist placed behind the motorcycle. Raise motorcycle off lift until rear suspension is unloaded.
5. See Figure 2-121. Remove reservoir.
 - a. Remove locknut and washer on the front reservoir clamp (3).
 - b. Loosen rear reservoir clamp (1). Slide reservoir (2) and mount block (4) out of clamps.
6. See Figure 2-122. Remove allen bolt (metric) and locknut on front mount (3).
7. While supporting the shock absorber, remove the allen bolt (metric) and locknut from the rear mount (1).
8. Remove shock absorber assembly.

INSTALLATION

1. See Figure 2-123. Place **new** bushings (2, 8) into mounting holes of shock absorber
2. See Figure 2-122. Loosely install rear allen bolt (1) (metric) and locknut.
3. Loosely install front allen bolt (3) (metric) and locknut.
4. See Figure 2-121. Loosely install rear clamp (1) and front clamp (3) around reservoir (2) and mounting block (4).

NOTE

Torque front allen bolt and nut from the bolt side only.

5. Tighten front bolt to 49-53 ft-lbs (66.4-71.9 Nm).
6. Tighten nut on rear bolt to 30-33 ft-lbs (40.7-47.4 Nm).
7. Tighten clamps around reservoir.

WARNING

After installing seat, pull upward on front of seat to be sure it is locked in position. If seat is loose, it could shift during vehicle operation and startle the rider, causing loss of control which could result in death or serious injury.

8. Remove lifting straps and install seat.
9. Install chin fairing. See 2.42 CHIN FAIRING.
10. Check rear shock preload. See 1.16 PRELOAD ADJUSTMENT.

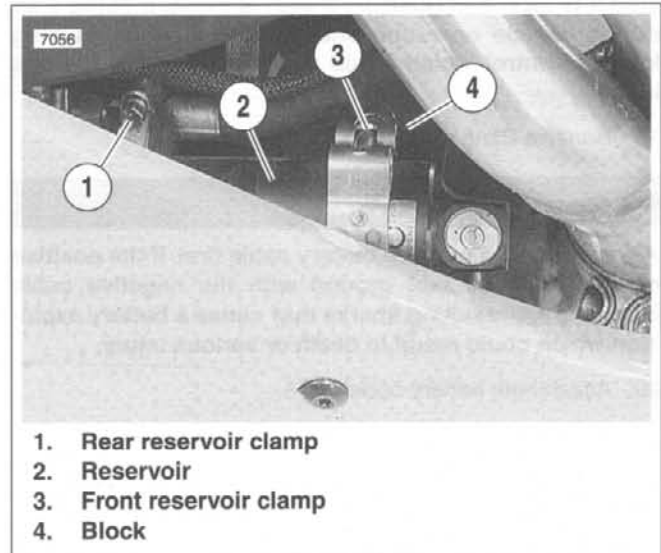


Figure 2-121. Reservoir Clamps

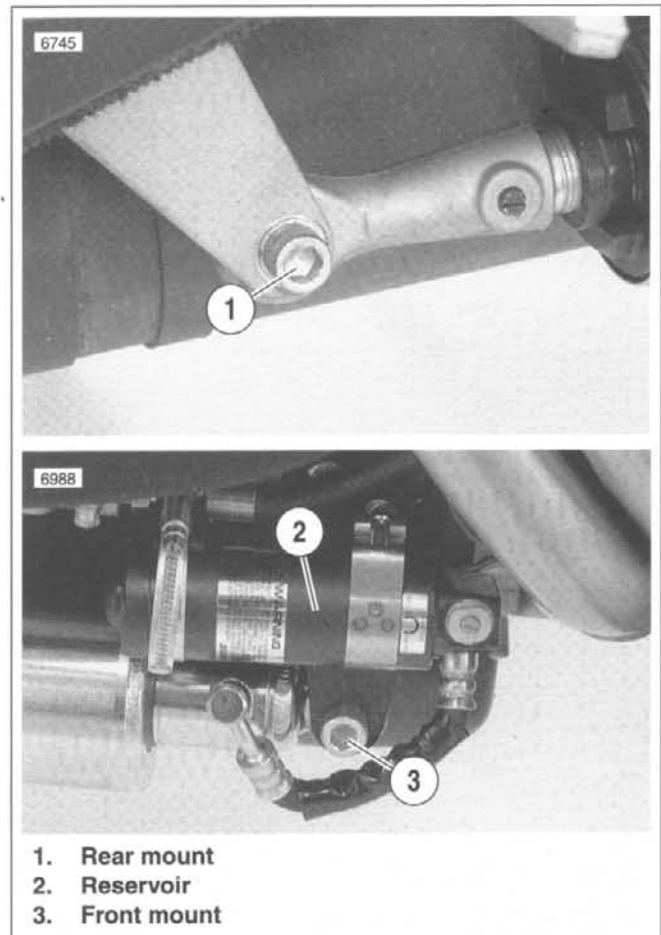
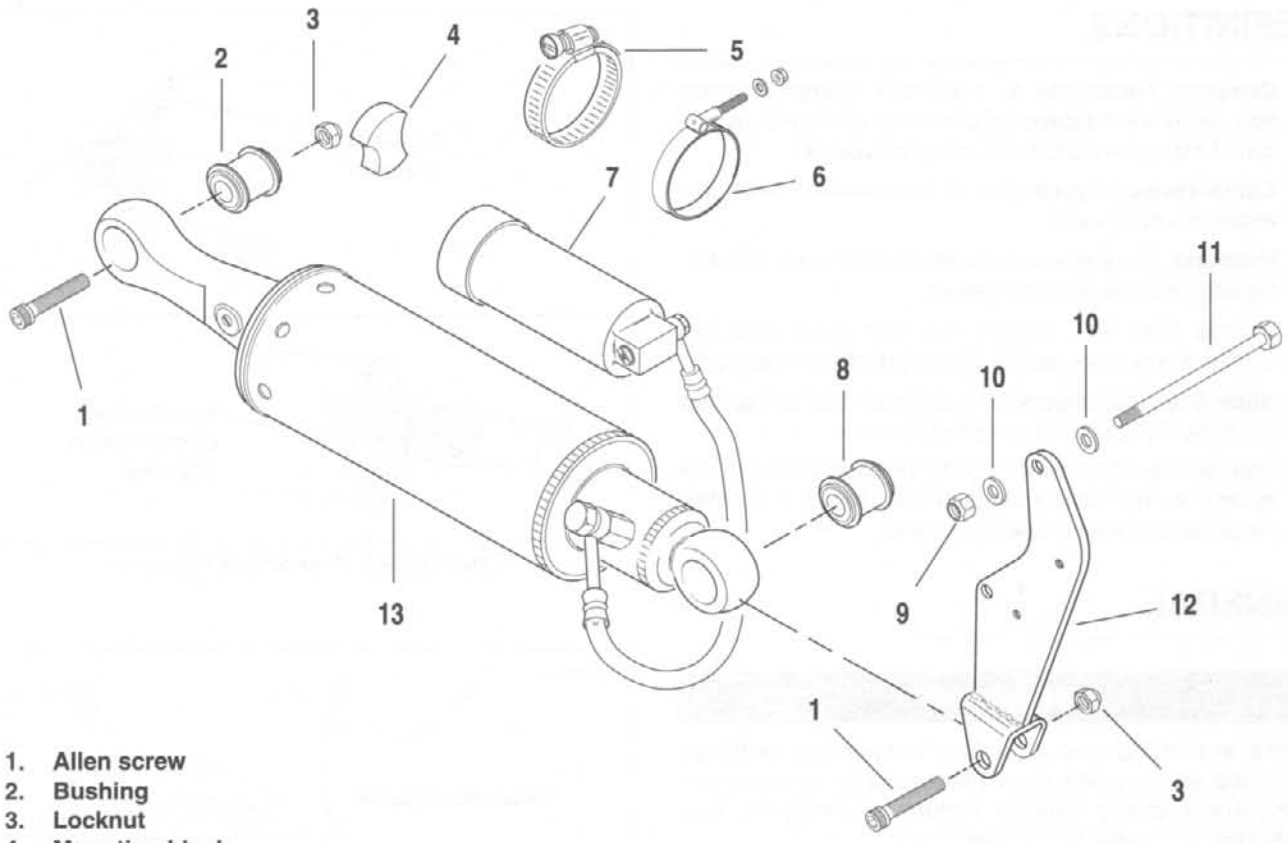


Figure 2-122. Shock Mounting Hardware



- 1. Allen screw
- 2. Bushing
- 3. Locknut
- 4. Mounting block
- 5. Clamp
- 6. Clamp
- 7. Reservoir
- 8. Bushing
- 9. Locknut
- 10. Washer
- 11. Bolt
- 12. Mounting bracket
- 13. Shock absorber assembly

Figure 2-123. Rear Shock Absorber

DEFINITIONS

- **Damping:** Resistance to movement. Damping affects how easily the suspension can move and limits oscillation of the system once movement has begun.
- **Compression:** Suspension is compressed when the wheel moves upward.
- **Rebound:** The suspension is rebounding when it is moving back from being compressed.
- **Vehicle Sag:** The amount the rear shock and fork springs are compressed by the weight of the motorcycle.
- **Rider Sag:** The amount the rear shock and fork springs are compressed by the weight of the rider.
- **Preload:** An adjustment made to the rear shock and fork springs to limit vehicle sag and rider sag to a standard percentage of total suspension travel.

GENERAL

⚠ WARNING

Before evaluating and adjusting suspension settings, check the motorcycle's tires. Tires must be in good condition and properly inflated. Failure to check the tires could result in death or serious injury.

See Figure 2-124. The rear suspension adjusts for compression and rebound damping and spring preload.

See Figure 2-125. The front suspension adjusts for compression and rebound damping.

If the rear preload adjustment is correct, and you have the rebound and compression damping set at the factory recommended points, the motorcycle should handle and ride properly. If you are unhappy with these settings they can be changed according to the following procedures.

NOTE

Evaluating and changing the rebound and compression damping is a very subjective process. Many variables affect motorcycle handling under different circumstances. Approach all changes carefully and consult Table 2-4.

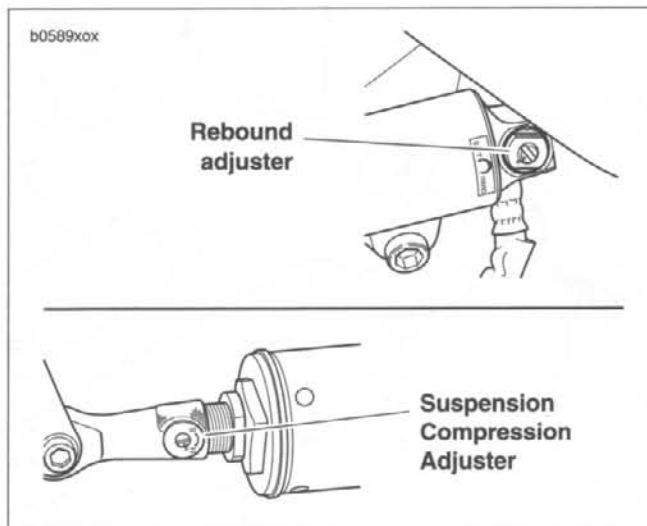


Figure 2-124. Rear Shock Adjusters

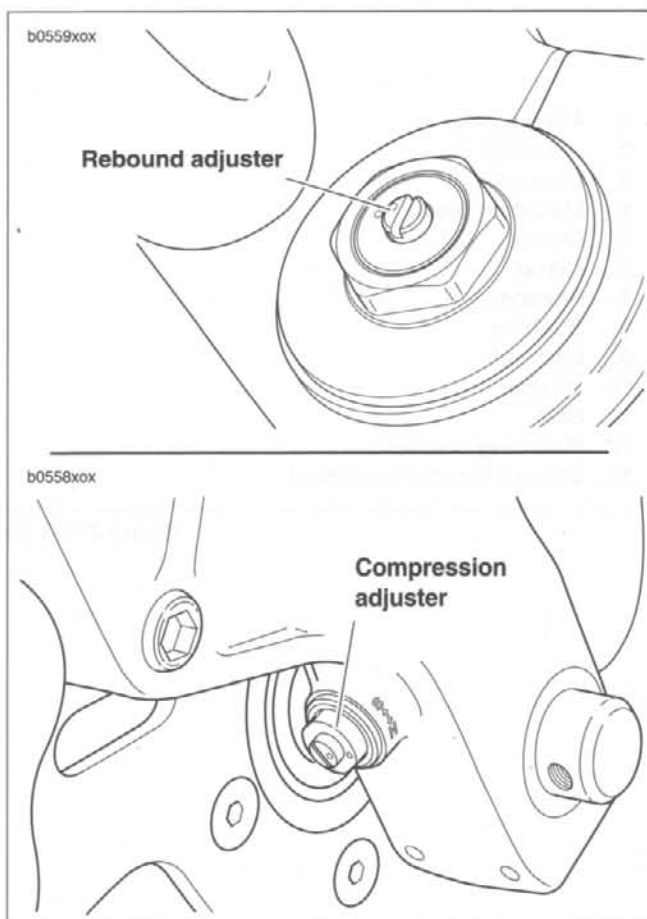


Figure 2-125. Fork Adjustments

SPRING PRELOAD

Adjust rear spring preload before attempting any other adjustments. See 1.16 PRELOAD ADJUSTMENT. This setting assures that the rear suspension has the proper amount of travel for the rider's weight and the motorcycle's cargo load.

Make this adjustment before the motorcycle is ridden any distance. Your Buell dealer can assist you if necessary.

ADJUSTMENTS

Evaluating and changing the rebound and compression damping is a very subjective process. A good performing suspension finds a proper balance between spring, spring preload, damping, track conditions and riding speed. However, all settings are at best a compromise. If a rider fails to find a good set-up, go back to the factory recommended settings and start over again.

Make all suspension adjustments in one or two click increments. Adjusting more than one or two clicks at a time may cause you to skip the best adjustment. Test ride after each adjustment. When an adjustment makes no difference, return to the previous adjustment and try a different approach.

To find the optimum settings you will need the preload properly adjusted, the tires properly inflated and a familiar bumpy road. It is useful if the road contains a variety of different bumps from small sharp bumps such as potholes or frost

heaves to large undulations. Begin the process by putting all the damping adjustments at the factory recommended settings. See Table 2-4. Ride the bike over a variety of different surfaces and bumps at different speeds. When the suspension is set properly the motorcycle will be stable and comfortable.

TROUBLESHOOTING

WARNING

This section is intended solely as a guide to diagnosing problems. Carefully read the appropriate sections of this manual before performing any work. Improper suspension adjustments could cause loss of control and result in death or serious injury.

The following tables list possible suspension and operating troubles and their probable causes. Use the tables to keep your motorcycle in good operating condition.

When making adjustments, remember there are two mediums in setting up a bike, geometry and suspension. Both components work together because suspension is a part of geometry. In order to solve handling problems, it is important to diagnose the problem's true nature. Chattering, sliding or an uncomfortable feeling are suspension problems. Handling and a swinging fork are geometry problems, but often these problems can be solved by suspension adjustments.

Table 2-1. General Suspension Problems

TROUBLESHOOTING CONDITION	ADJUSTMENT SOLUTION
Bike wallows through turns. Feels loose or vague after bumps. Wheel tends to "pogo" after passing over a bump. This is noticeable by watching the bike continue to bounce as it travels over multiple bumps.	Increase rebound damping.
Wheel responds to bump, but doesn't return to ground quickly after bumps. This is more pronounced over a series of bumps and is often referred to as "packing down."	Reduce rebound damping.
The bike bottoms out or dips while cornering. Bike has excessive brake dive.	Increase compression damping.
Harsh ride particularly over washboard surfaces. Bumps kick through handlebars or seat. Suspension seems not to respond to bumps. This is evidenced by tire chattering (a movement with short stroke and high frequency) through corners or by jolting the rider over rough roads.	Reduce compression damping.

Table 2-2. Rear Suspension Problems

TROUBLESHOOTING CONDITION	ADJUSTMENT SOLUTION
"Pumping on the Rear" occurs when you are accelerating out of a corner. This problems occurs in two varieties. 1. The first type has a movement with a long stroke and a high frequency. 2. The second version has a movement with a short stroke and high frequency.	1. The shock is too soft. Increase compression damping. If the adjuster is already set to the maximum, add more preload to the spring (one turn maximum). 2. In this case the shock is too hard. Decrease compression damping.
Chattering during braking.	Decrease the compression damping. If the problem persists, decrease rebound damping for a faster rebound rate. Less spring preload may also help.
Lack of tire feedback.	The suspension is too soft. Increase compression damping.
Sliding during cornering. Sliding may occur going into the corner or accelerating out of the corner.	The suspension is too hard. Decrease compression damping.

Table 2-3. Front Suspension Problems

TROUBLESHOOTING CONDITION	ADJUSTMENT SOLUTION
Not absorbing bumps.	A good suspension is a balance between damping and track condition. Finding this balance requires exploring all possible compression settings.
Lack of tire feedback.	Increase compression damping.
Tire slides.	Decrease compression damping.

Table 2-4. Rider Suspension Preferences

NOTE

All adjustments require rear shock preload to be properly adjusted for the rider's size and weight. For information on setting rear shock preload, see 1.16 PRELOAD ADJUSTMENT.

DATE	FRONT FORK REBOUND	FRONT FORK COMPRESSION	REAR SHOCK REBOUND	REAR SHOCK COMPRESSION	RESULTS
	Max damping minus 0.5 turn	Max damping minus 1.25 turns	Max damping minus 0.5 turn	Max damping minus 1.0 turn	Factory recommended settings.

MODEL YEAR CHANGE

All 2000 model Buell motorcycles have throttle cable clamps located by the ferrules on the throttle body.

REMOVAL/DISASSEMBLY

1. See Figure 2-126. Slide rubber boot (5) off the cable adjusters (4). Loosen cable adjuster lock (3) on each adjuster.
2. See Figure 2-127. Remove two screws (1, 6) on front housing. Separate housings from handlebar.
3. Unhook ferrules (7) from cable wheel (8).
4. Remove cables from notches in housings (5, 9).
5. Remove air cleaner cover and backplate. See 4.39 AIR CLEANER.
6. **2000 Models Only:** Remove screw and throttle cable clamps from cables by throttle body.
7. Disconnect cables from throttle body manifold to remove.

CLEANING, INSPECTION AND REPAIR

Clean all parts in a non-flammable cleaning solvent. Blow dry with compressed air. Replace cables if frayed, kinked or bent.

ASSEMBLY/INSTALLATION

1. See Figure 2-127. Place cable assemblies (3, 4) into housings (5, 9). Throttle control cable (4) has a molded fitting end and is positioned inside the front housing (5). Idle control cable (3) has a smaller fitting end and is positioned inside the rear housing (9).
2. Run cables inside grooves of each housing (5, 9).
3. Attach ferrules (7) to cable wheel (8). When properly assembled, notches for ferrules will be at 12 o'clock.
4. Position housings on right handlebar by engaging locating pin (10) on front housing with hole in handlebar. Attach housings with two screws (1, 6), installing longer screw on bottom. Tighten to 12-17 **in-lbs** (1.4-1.9 Nm).

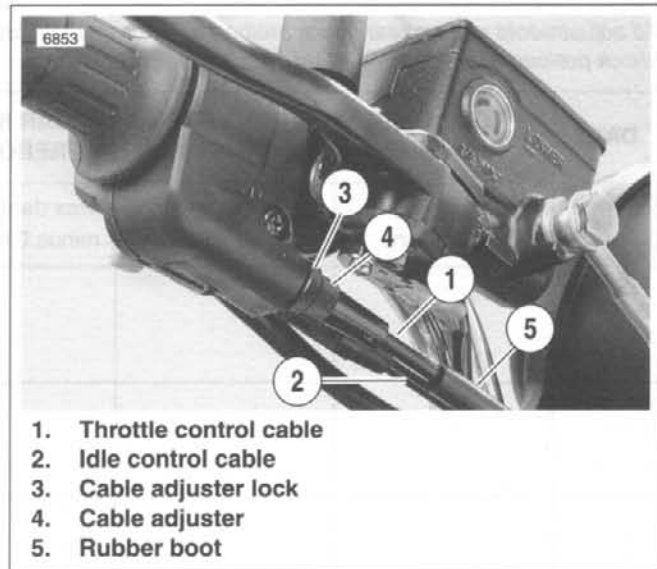


Figure 2-126. Throttle Control Cables

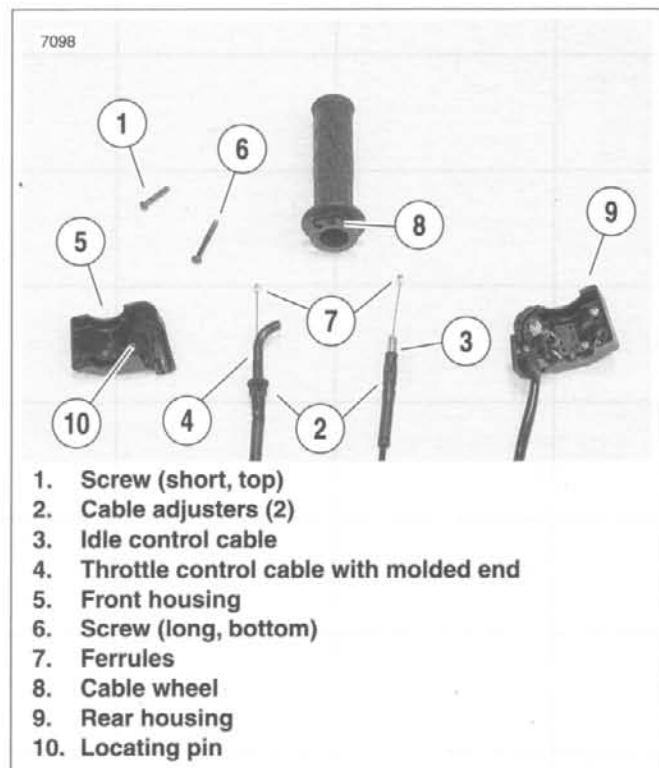


Figure 2-127. Cable Connections



Figure 2-128. Handlebar Routing

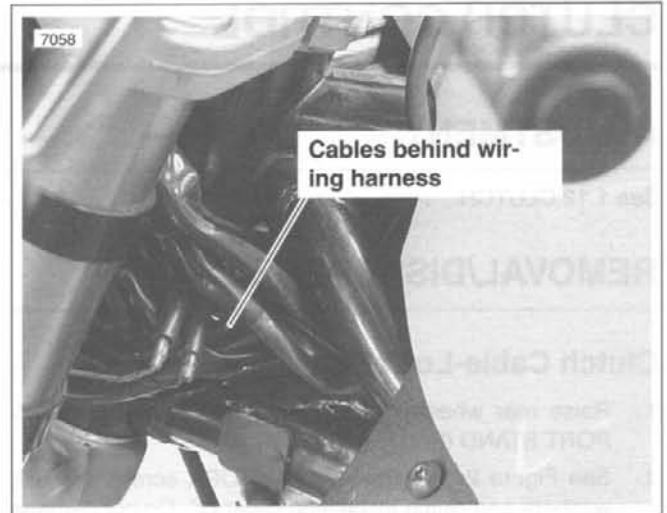


Figure 2-129. Steering Neck Routing

5. Route idle and throttle control cables.
 - a. See Figure 2-128. Cables must be routed forward from throttle control grip, forward of upper triple clamp and to the left.
 - b. See Figure 2-129. Continue between the left side of frame steering head and left frame tube. Cables should be above and to the left of the D-shaped washer behind the steering head.
 - c. See Figure 2-130. Route cables below the fuel tank and continue downward.
6. Attach throttle cables to throttle body manifold and adjust. See 1.22 THROTTLE CABLES.
 - **2000 Models only:** See Figure 2-131. Attach throttle cable clamp to ferrules with screw (arrow on clamp points up).
7. Install air cleaner assembly. See 4.39 AIR CLEANER.



Figure 2-130. TBM Routing

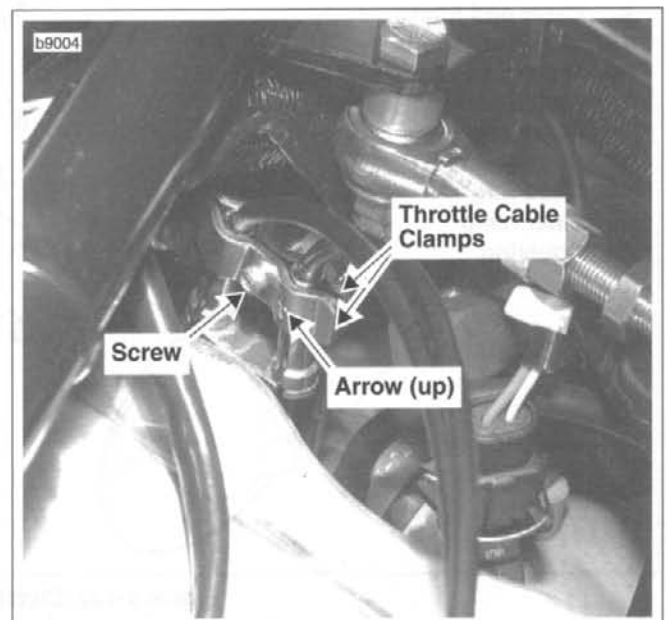


Figure 2-131. Throttle Cable Clamps (2000 Models)

ADJUSTMENT

See 1.12 CLUTCH.

REMOVAL/DISASSEMBLY

Clutch Cable-Lower

1. Raise rear wheel off floor using REAR WHEEL SUPPORT STAND (Part No. B-41174).
2. See Figure 2-132. Remove four TORX screws (1) with washers and clutch inspection cover (2). Do not damage or dislodge quad ring (14) in primary cover (11).
3. Slide spring (3) with attached hex lockplate (4) from flats of adjusting screw (12).
4. Turn adjusting screw clockwise to release ramp and coupling mechanism. As the adjusting screw is turned, ramp assembly moves forward. Unscrew nut (5) from end of adjusting screw.
5. Remove hook of ramp (6) from button at the rear of cable end coupling (16). Remove cable end (10) from slot in coupling.
6. Turn cable end fitting (9) counterclockwise to remove clutch cable lower section from primary cover (11). Remove O-ring (8) from cable end fitting.

Clutch Hand Control

1. See Figure 2-133. Detach clutch switch (7).
 - a. Remove screw (8).
 - b. Depress clutch lever and hold.
 - c. Detach switch by depressing switch trigger button and pulling switch towards the end of the handlebar.

NOTE

The individual parts of the clutch switch are not serviceable. Replace switch upon failure.

2. Remove bolt (2) (metric) and nut (6) (metric).
3. Remove handlebar from clutch clamp (5). Detach clutch cable from handlebar.
4. Remove clutch cable clamp (10) from frame.
5. Remove clutch clamp.
 - a. Cut off left handgrip.
 - b. Remove left handlebar switch housing. See 7.16 HANDLEBAR SWITCHES.
 - c. Remove clamp screw (4) (metric). Slide clamp off the end of the handlebar.

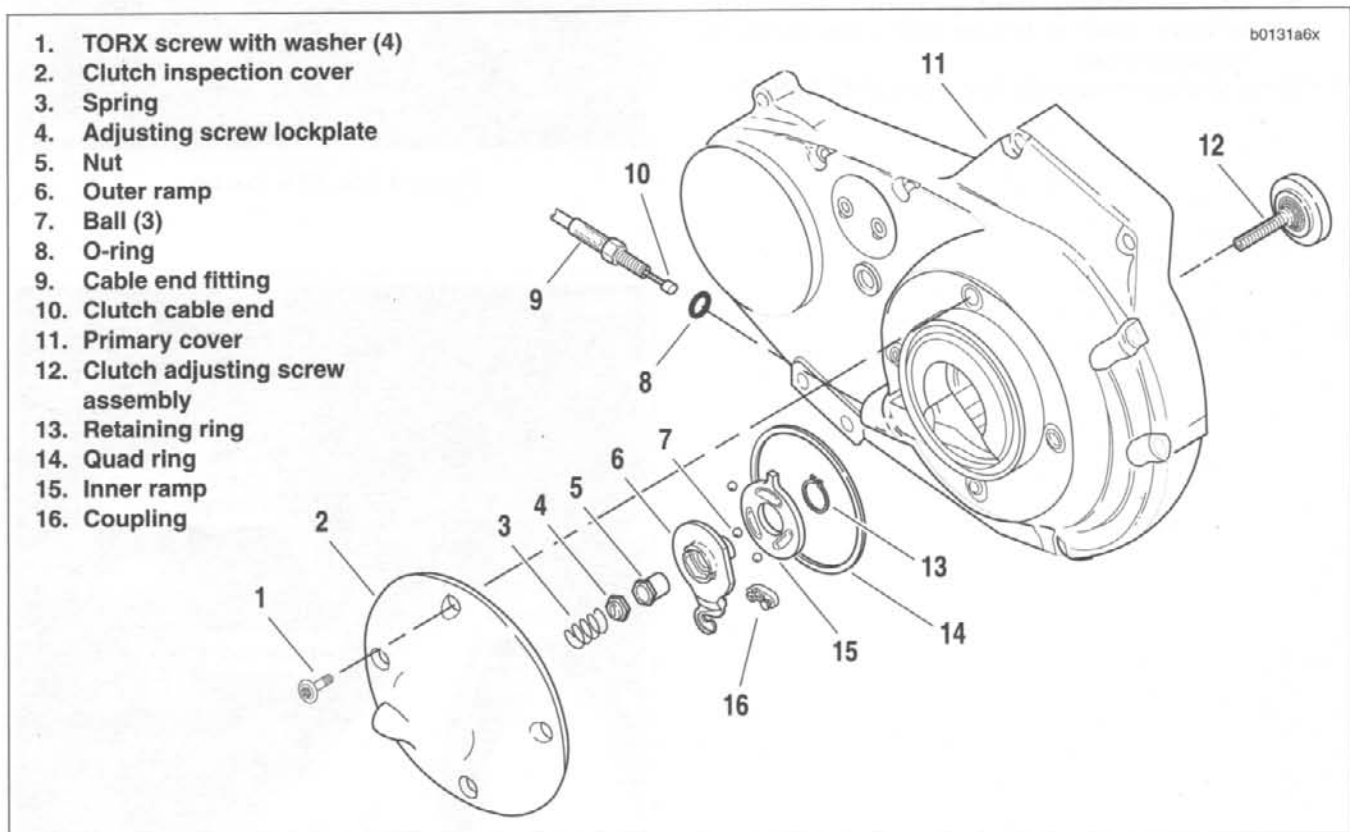


Figure 2-132. Clutch Release Mechanism

ASSEMBLY/INSTALLATION

Clutch Cable-Lower

- See Figure 2-132. Install O-ring (8) over cable end fitting (9) of clutch cable lower section. Turn fitting clockwise to install into primary cover (11). Tighten to 3-5 ft-lbs (4.0-6.8 Nm).
- Fit coupling (16) over cable end. Place hook of ramp around coupling button and rotate assembly counter-clockwise until tang on inner ramp (15) fits in slot of primary cover (11).
- Thread nut (5) on adjusting screw (12) until slot of screw is accessible with a screwdriver. Fit nut hex into recess of outer ramp (6) and turn adjusting screw counter-clockwise.
- If not yet performed, route clutch cable to hand control.
 - See Figure 2-134. Route cable along left side of primary chaincase and up to clamp on front isolator tie bar. Cable must not touch chin fairing.
 - Clamp should be on bottom left of bolt. Brass fitting on cable should be approximately 3.0 in. (76 mm) above clamp.
 - Continue above and behind lower triple clamp, between right side of the steering head and left of front brake line.
 - Route cable across front of upper triple clamp to hand grip.
- With clutch cable upper section connected to clutch lever, check primary chain tension. Adjust if necessary. See 1.15 PRIMARY CHAIN.
- Adjust clutch. See 1.12 CLUTCH.

Clutch Hand Control

- See Figure 2-133. Attach clutch clamp (5) as follows.
 - Slide clamp over handlebar.
 - Install left switchgear housing. See 7.16 HANDLEBAR SWITCHES.
 - Place clamp next to switchgear housing. Fasten to handlebar with screw (4) (metric). Tighten to 30-35 **in-lbs** (3.4-4.0 Nm).
 - Install a **new** left handgrip. See 2.34 HANDLEBARS.
- Connect end of clutch cable upper section to clutch handlebar. Position lever within clutch clamp.
- Apply small amount of LOCTITE ANTI-SEIZE LUBRICANT to bolt (2). Attach handlebar with bolt (2) (metric) and nut (6) (metric).
- Attach clutch switch (7) with screw (8).
- If not yet performed, route clutch cable to primary cover.
 - Route cable from hand grip across front of upper triple clamp.
 - Continue to right side, down between right fork leg and steering neck. Route cable between right side of the steering head and left of front brake line.

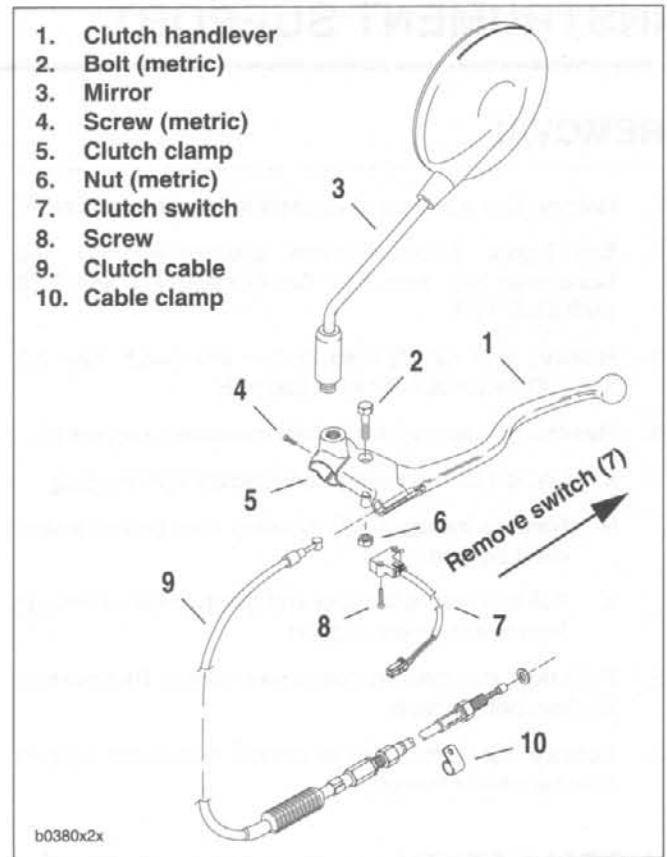


Figure 2-133. Clutch Hand Control

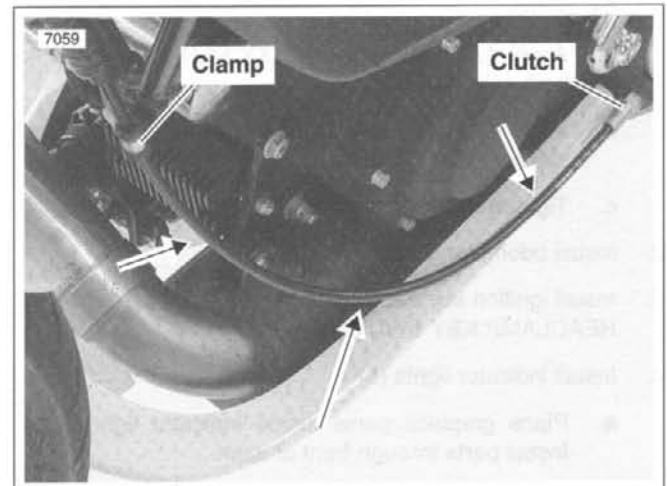


Figure 2-134. Clutch Cable Routing, Lower

- Continue through clamp on front isolator. Clamp should be on bottom left of bolt. Brass fitting on cable should be approximately 3.0 in. (76 mm) above clamp.
 - See Figure 2-134. Route cable down left side of bike, through clamp, along primary chaincase to clutch. Cable must not touch chin fairing.
- With clutch cable lower section connected to primary cover, adjust clutch. See 1.12 CLUTCH.

REMOVAL

1. Remove four screws and washers to detach windscreen.
2. See Figure 2-135. Remove speedometer (1) and tachometer (4). See 7.18 SPEEDOMETER and 7.19 TACHOMETER.
3. Remove face nut (3) from ignition key switch. See 7.3 IGNITION/HEADLAMP KEY SWITCH.
4. Remove indicator lights (5) from instrument support (2).
 - a. Loosen all four catches on indicator light housing.
 - b. Remove indicator light housing from behind instrument support.
 - c. Pull indicator light bezel and graphics panel through front of instrument support.
5. Pull plastic cap from odometer reset button. Remove button from behind dash.
6. Remove two screws (6) to detach instrument support from handlebar clamp.

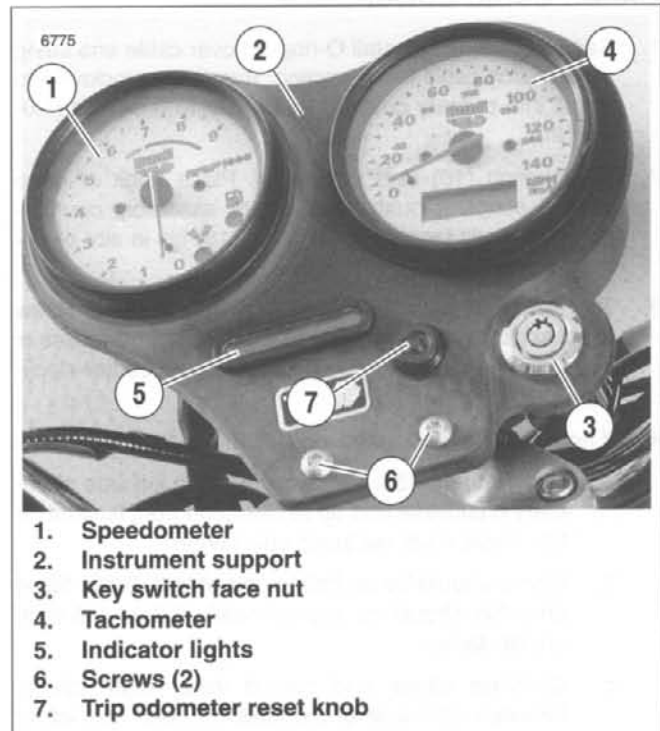


Figure 2-135. Instrument Support

INSTALLATION

1. See Figure 2-135. Attach instrument support to handlebar clamp.
 - a. Apply LOCTITE THREADLOCKER 243 (blue) to both screws (6).
 - b. Align instrument support on handlebar clamp. Install two screws.
 - c. Tighten to 4-5 ft-lbs (5.4-6.8 Nm).
2. Install odometer reset button.
3. Install ignition key switch face nut (3). See 7.3 IGNITION/HEADLAMP KEY SWITCH.
4. Install indicator lights (5).
 - a. Place graphics panel inside indicator light bezel. Install parts through front of dash.
 - b. See Figure 2-136. Align wire colors on indicator light housing with correct symbols on graphics panel.
 - c. Insert indicator light housing into bezel. Secure with four catches.
5. See Figure 2-135. Install both instruments. See 7.18 SPEEDOMETER and 7.19 TACHOMETER.
6. Attach windscreen using four screws and washers.

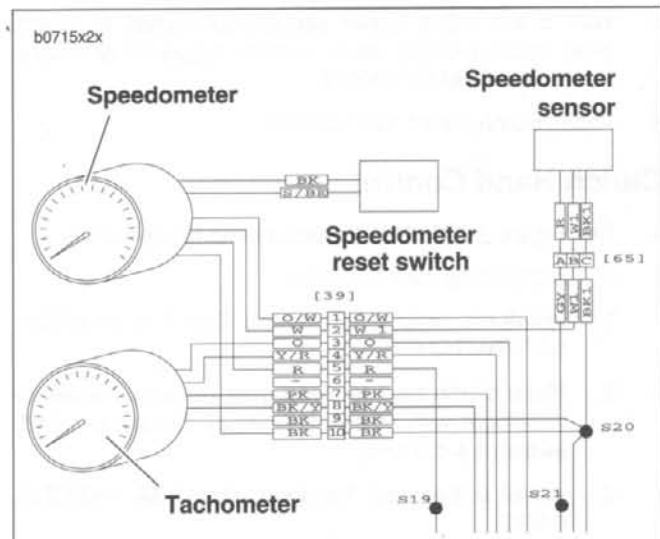


Figure 2-136. Instrument Support Wiring

REMOVAL

1. Remove left handlebar switch housing. See 7.16 HANDLEBAR SWITCHES. Cut left handlebar grip and remove.
2. Detach clutch hand control from handlebars. See 2.32 CLUTCH CONTROL.
3. Remove front brake master cylinder. See 2.11 FRONT BRAKE MASTER CYLINDER (1999 Models) or 2.18 FRONT BRAKE MASTER CYLINDER (2000 Models).
4. Loosen screws on right handlebar switch housing, but do not detach throttle grip assembly from handlebar. See 2.31 THROTTLE CONTROL.
5. Remove four screws and washers to detach windscreen.
6. See Figure 2-137. Remove four screws (1, 2) from instrument support (3).
7. Lift instruments and remove handlebars without stretching throttle cables.
8. Remove throttle grip assembly.

INSTALLATION

1. Slide handlebars into throttle grip assembly. Fasten right handlebar switch housing to handlebar. See 2.31 THROTTLE CONTROL.
2. Attach handlebars.
 - a. See Figure 2-137. Lift instruments and place handlebars under instrument support. Loosely install four screws (1, 2).
 - b. Tighten both front screws (1) to 10-12 ft-lbs (13.6-16.2 Nm).
 - c. Then tighten both rear screws (2) 10-12 ft-lbs (13.6-16.2 Nm).
3. Install clutch hand control. See 2.32 CLUTCH CONTROL.
4. Install left switch housing. See 7.16 HANDLEBAR SWITCHES.
5. Check control wire routings.
 - a. See Figure 2-138. Route right hand control wires (1) in front of handlebar and triple clamp (4).
 - b. Route left hand control wires (2) in front of handlebar and triple clamp (4).
6. Install a **new** left handgrip.
 - a. Clean end of handlebar with M600.
 - b. Place LOCTITE 411 ADHESIVE around inside of grip.
 - c. Push grip onto handlebar end. Twist grip on bar until end touches left switchgear housing.
 - d. Wipe off excess adhesive with a rag.
7. Install front brake master cylinder. See 2.11 FRONT BRAKE MASTER CYLINDER (1999 Models) or 2.18 FRONT BRAKE MASTER CYLINDER (2000 Models).
8. Attach windscreen using four screws and washers.

9. Check steering motion range to both fork stops. See 1.24 HANDLEBARS.

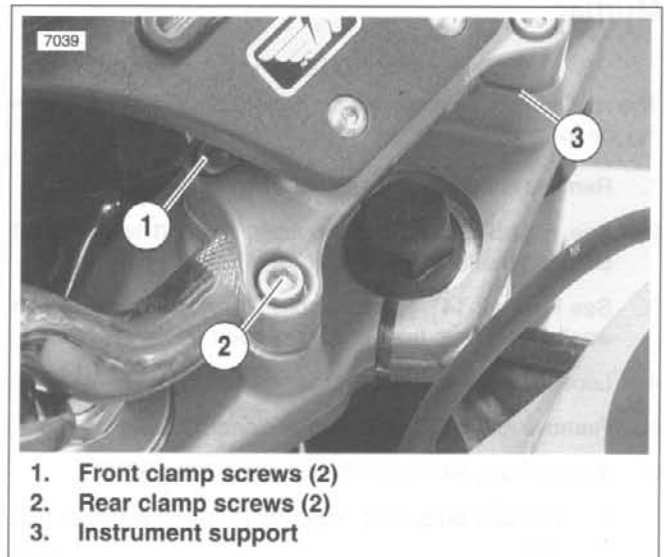


Figure 2-137. Instrument Support Screws

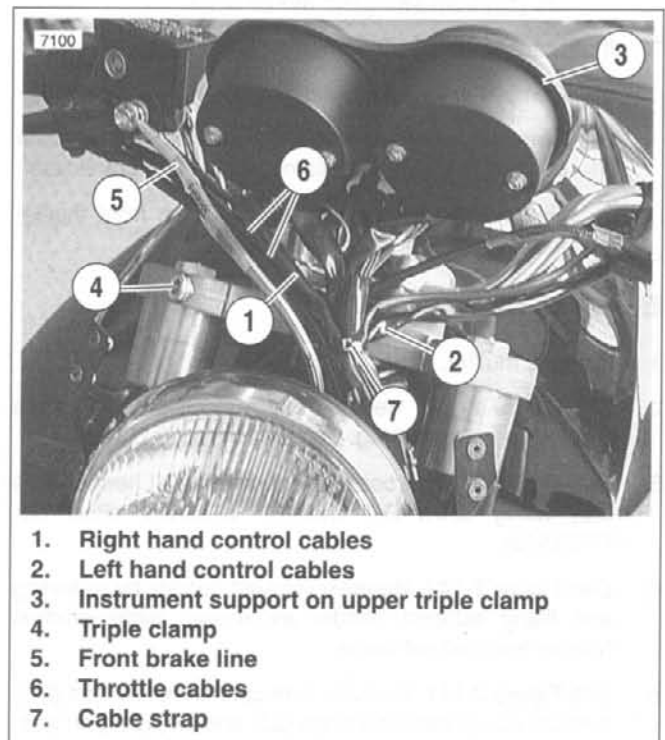


Figure 2-138. Routing Hand Control Wires

REMOVAL/DISASSEMBLY

Muffler

NOTE

The muffler may be removed for replacement without removing the exhaust header.

1. Remove chin fairing. See 2.42 CHIN FAIRING.
2. See Figure 2-139. Remove bolts (1) and washers (2) securing muffler (3) to Z-bracket (4).
3. See Figure 2-141. Remove bolts (5) and locknuts (6) with washers (7) from front muffler support (8).
4. Loosen screw securing muffler clamp (9).
5. Remove muffler (3) and muffler clamp. Discard clamp.
6. If necessary, remove muffler support Z-bracket (4).
 - a. Remove bolts (10), locknuts (11) and washers (12, 13).
 - b. Remove muffler support Z-bracket (4).
 - c. Remove rear muffler mounts (14) and mount spacers (15) from swingarm mount block.
7. If necessary, remove front muffler support (8).
 - a. Remove bolts (16), locknuts (17) and washers (18).
 - b. Remove nuts and washers securing front muffler support to voltage regulator bracket and crankcase.
 - c. Remove muffler support (8). Remove front muffler mounts (19) and mount spacer (15).

Exhaust Header

1. Remove muffler.
2. See Figure 2-140. Remove any restrictive cable straps on oxygen sensor wiring. Detach connector [137].
3. See Figure 2-141. Loosen the four exhaust header nuts (20) using SNAP-ON SWIVEL SOCKET (Part No. PFSX916).
4. See Figure 2-142. Remove exhaust header by swiveling and lifting exhaust header as shown. Slide exhaust header from behind frame.
5. See Figure 2-141. Remove exhaust header clamps (22), exhaust clamp retaining rings (23) and exhaust port gaskets (24) from exhaust header.

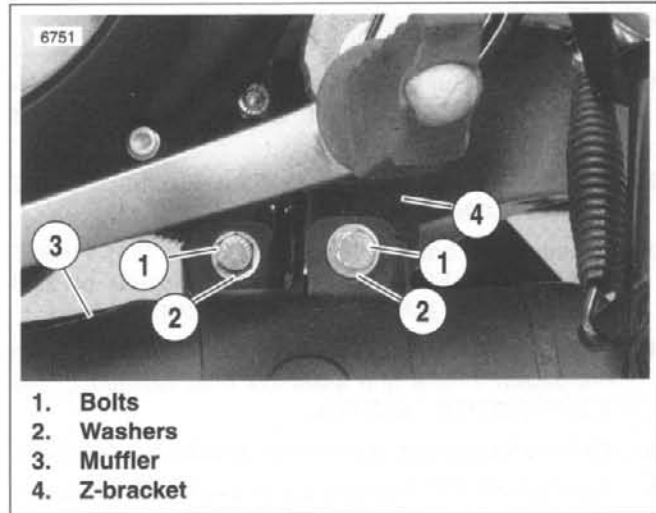


Figure 2-139. Rear Muffler Mounts

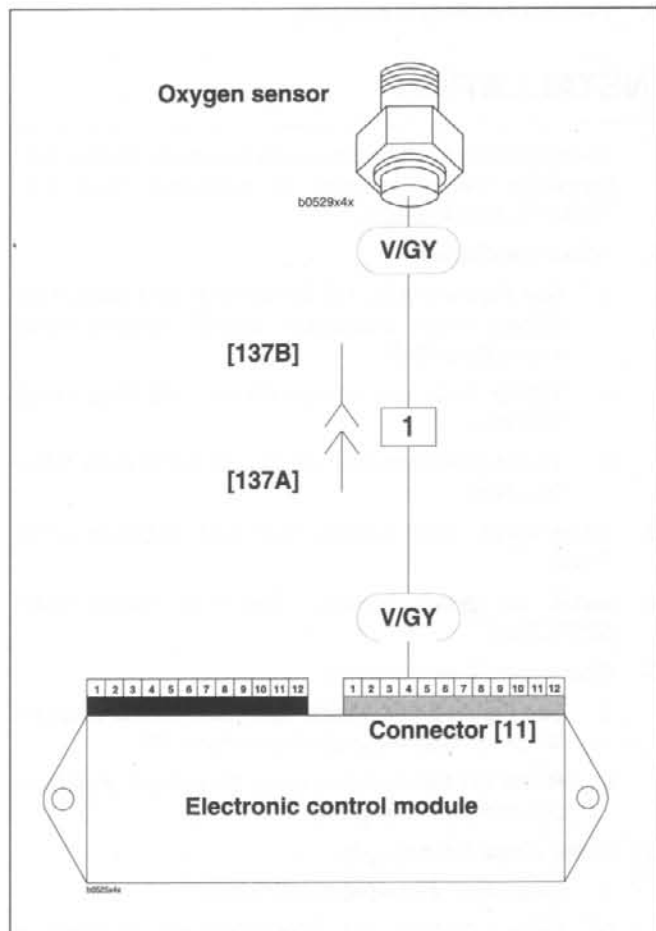
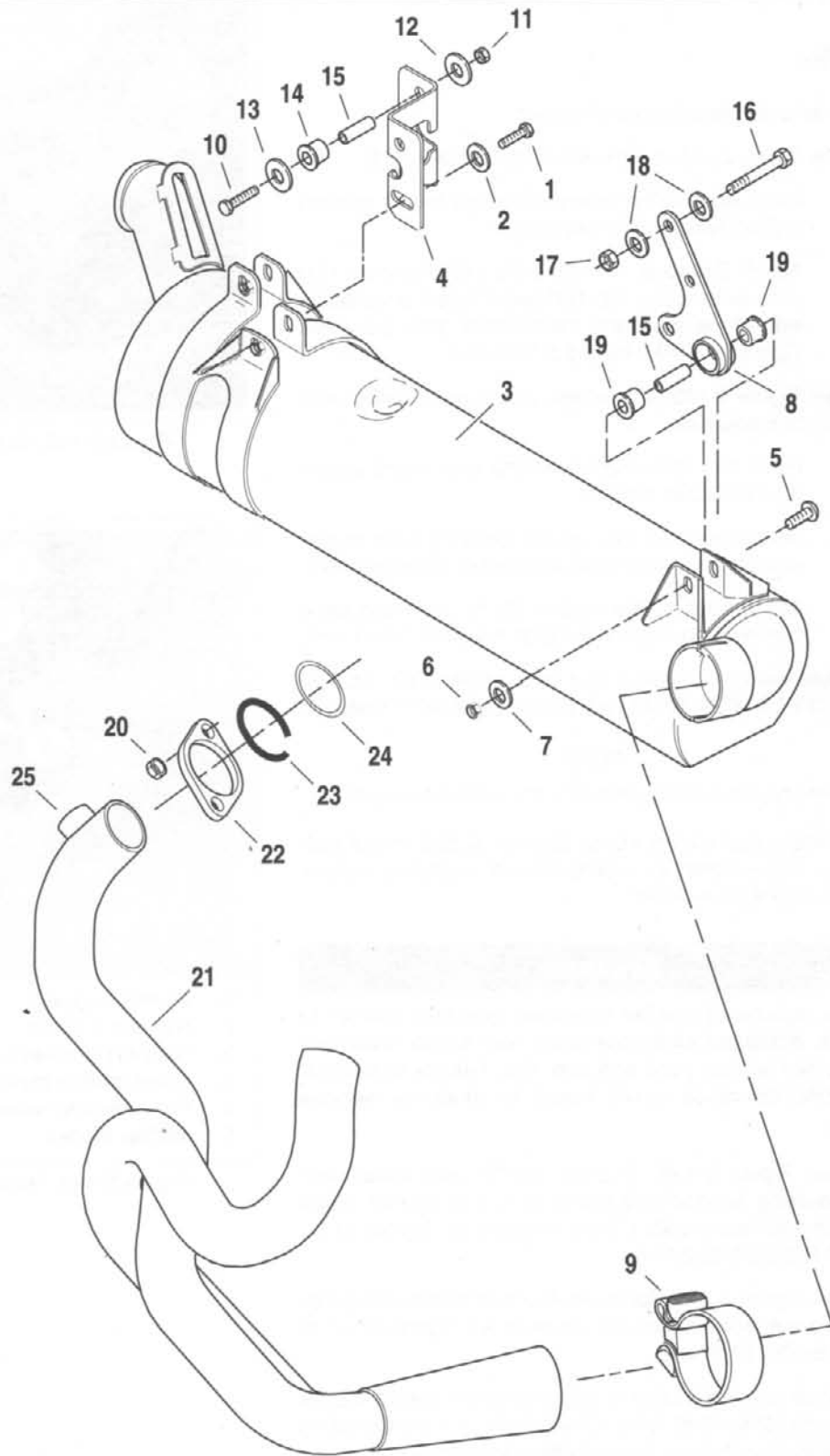


Figure 2-140. Oxygen Sensor Wiring

b0605x2x



1. Bolt (2)
2. Washer (2)
3. Muffler
4. Z-bracket
5. Bolt
6. Locknut
7. Washer
8. Muffler support
9. Muffler clamp
10. Bolt (2)
11. Locknut (2)
12. Washer (2)
13. Washer (2)
14. Rear muffler mount (2)
15. Mount spacer (3)
16. Bolt (2)
17. Locknut (2)
18. Washer (4)
19. Front muffler mount (2)
20. Exhaust header nut (4)
21. Exhaust header
22. Exhaust header clamp (2)
23. Exhaust clamp retaining ring (2)
24. Exhaust port gasket (2)
25. Oxygen sensor mount

Figure 2-141. Exhaust System

ASSEMBLY/INSTALLATION

Muffler

1. If removed, install exhaust header.
2. See Figure 2-141. If removed, install Z-bracket (4).
 - a. Install rear muffler mounts (14) and mount spacers (15) on swingarm mount block.
 - b. Attach Z-bracket (4) with bolts (10), locknuts (11) and washers (12, 13). Bolt heads install on opposite side of the swingarm mount block from Z-bracket. Tighten to 8-10 ft-lbs (10.8-13.6 Nm).
3. See Figure 2-143. If removed, attach front muffler support to crankcase.
 - a. Insert two front muffler mounts and mount spacer (5) into muffler support.
 - b. Install nuts and washers (2) securing front muffler support to voltage regulator bracket and crankcase.
 - c. Attach front muffler support (1) to crankcase using fasteners (3). Tighten to 30-33 ft-lbs (40.7-44.7 Nm).
4. Coat inside of muffler inlet with PERMATEX ULTRA-COPPER HIGH TEMP RTV SILICON GASKET material.

NOTE

If necessary, use a fiber hammer to fit muffler on header.

5. Place a **new** muffler clamp (6) over slotted end of muffler. Place muffler and clamp on end of exhaust header. Loosely tighten clamp.

WARNING

Before tightening muffler hardware, position muffler to provide adequate clearance from rear shock absorber, side stand spring post and rear tire. Failure to provide adequate clearance could result in death or serious injury.

6. See Figure 2-139. Position muffler and install rear mounting support and weldnuts in rear muffler straps with two sets of bolts (1) and washers (2). Tighten to 17-19 ft-lbs (23-25.8 Nm).
7. See Figure 2-143. Secure muffler to front mounting support with bolt, locknut and washers (4). Tighten to 17-19 ft-lbs (23-25.8 Nm).
8. When only the muffler is being replaced, tighten muffler clamp (6) to 40-45 ft-lbs (54.2-61.0 Nm). If also installing the exhaust header, leave muffler clamp loose.

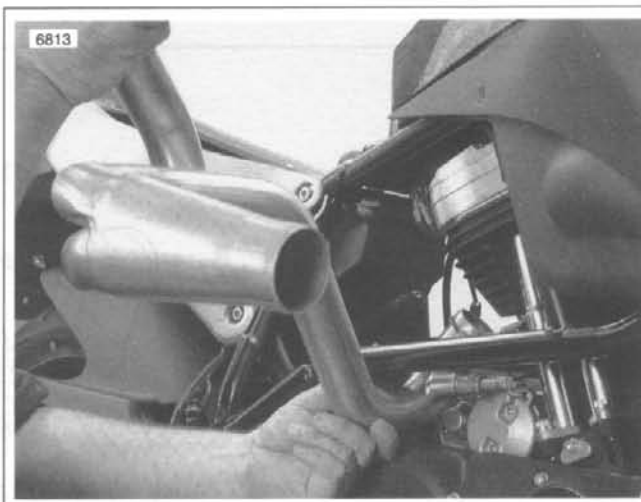
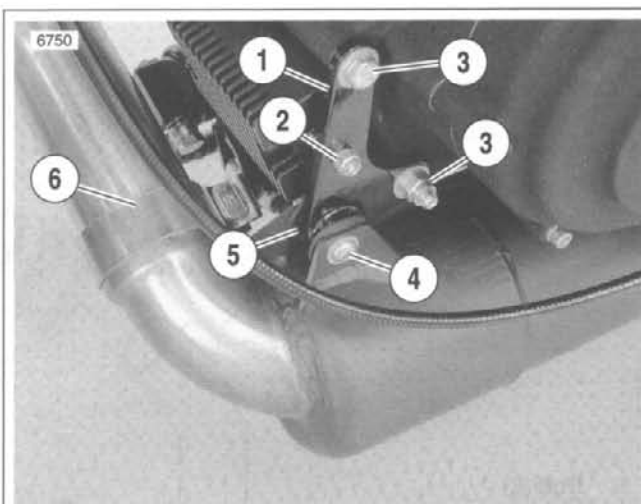


Figure 2-142. Exhaust Header Positioning



1. Muffler support
2. Nut and washer
3. Support bracket fasteners
4. Front muffler mounting hardware
5. Front muffler mounts and spacer
6. Muffler clamp

Figure 2-143. Front Muffler Support Installed

Exhaust Header

NOTE

Muffler hardware must be tightened before tightening exhaust header hardware.

1. See Figure 2-144. Install **new** exhaust port gaskets (5) and exhaust clamp retaining rings (4).
2. Slide exhaust header clamps (3) over ends of exhaust header (1).
3. See Figure 2-142. Slide exhaust header under frame by positioning as shown, threading oxygen sensor wire under frame.
4. See Figure 2-145. Position rear end of exhaust header in port as shown. Do not install exhaust header clamp over port.
5. Rotate exhaust header so that front end of exhaust header is in position at front port to cylinder head.
6. See Figure 2-144. Fasten exhaust header to cylinder heads with exhaust header clamps (3) and nuts (2). Tighten nuts to 6-8 ft-lbs (8.1-10.8 Nm) using SNAP-ON SWIVEL SOCKET (Part No. PFSX916).
7. Install oxygen sensor to header if removed. Apply LOC-TITE ANTI-SEIZE LUBRICANT to threads of sensor and install to exhaust header. Tighten sensor to 42-45 ft-lbs (56.9-61 Nm). Attach oxygen sensor connector [137]. Secure wiring and sensor with **new** cable ties.
8. Tighten muffler clamp to 40-45 ft-lbs (54.2-61.0 Nm).
9. Install chin fairing. See 2.42 CHIN FAIRING.

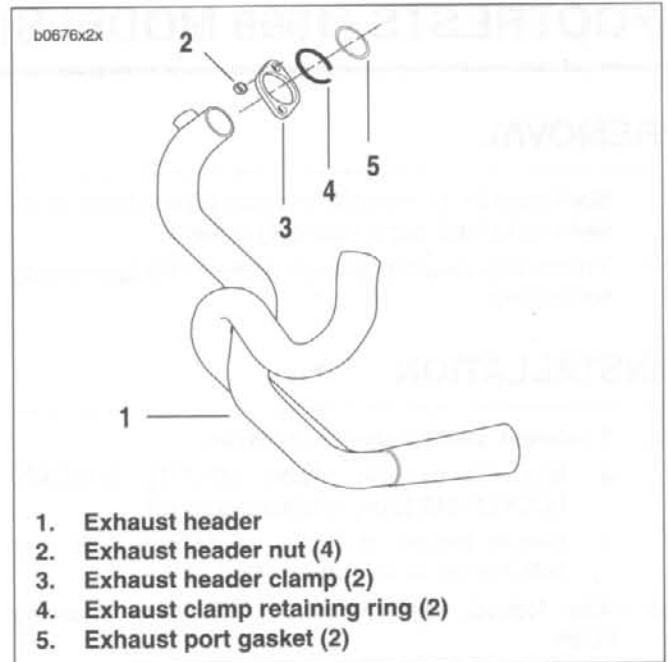


Figure 2-144. Exhaust Header



Figure 2-145. Exhaust Header Alignment

REMOVAL

1. See Figure 2-147. Remove two bolts (1) and locknuts (3) securing footrest frame mount (4) to frame.
2. If necessary, detach passenger footrests (2) by removing bolt and nut.

INSTALLATION

1. If removed, install passenger footrests.
 - a. See Figure 2-147. Apply LOCTITE THREADLOCKER 243 (blue) to footrest bolts (2).
 - b. Secure footrest to frame mount with bolts and nuts. Tighten to 10-15 ft-lbs (13.6-20.3 Nm).
2. Align footrest frame mount (4) with frame mounting holes.
 - a. Apply LOCTITE THREADLOCKER 272 (red) to mounting bolts (1).
 - b. Secure mounts with bolts (1) and locknuts (3). Tighten to 13-16 ft-lbs (17.6 -21.7 Nm).

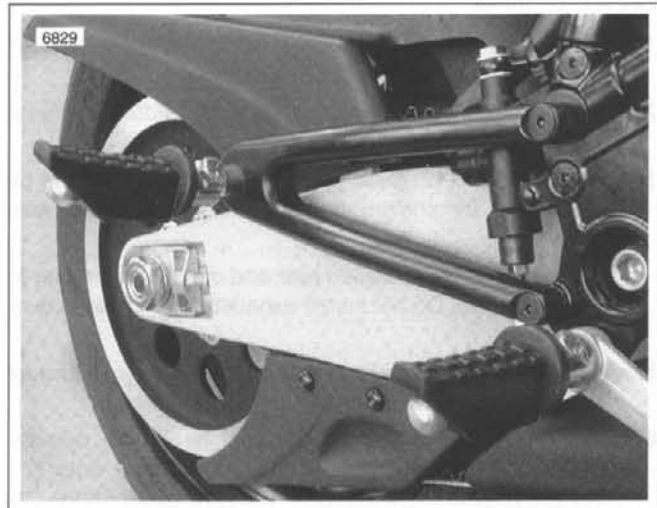


Figure 2-146. Footrest Frame Mount

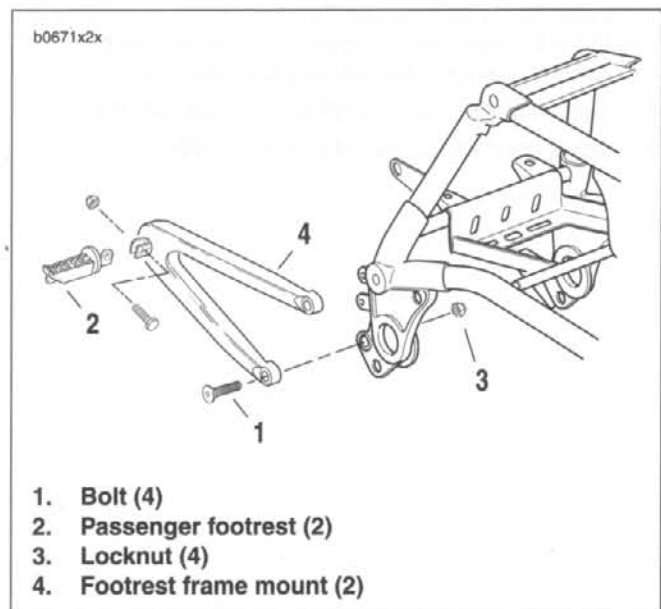


Figure 2-147. Footrest Frame Mount—Exploded View

MODEL YEAR CHANGE

All 2000 Model Year Buell Motorcycles are equipped with spring-loaded rider footrests.

REMOVAL

1. See Figure 2-148. To remove rider footrest.
 - a. Remove retaining ring (1) and washer (2) from pin (3).
 - b. Hold hand over spring (4) and remove pin, spring and footpeg (5) from mount (6).
2. If necessary, detach passenger footrest (7) by removing bolt (8) and nut (9) from frame mount.

INSTALLATION

1. If removed, install passenger footrest.
 - a. See Figure 2-148. Apply LOCTITE THREAD-LOCKER 243 (blue) to footrest bolts (8).
 - b. Secure footrest to frame mount with bolt (8) and nut (9). Tighten to 10-15 ft-lbs (13.6-20.3 Nm).
2. To install rider footrest.
 - a. Position spring (4) on mount (6) with thick side of spring inboard.
 - b. Install pin (3) through spring (4), mount (6) and footrest (5).
 - c. Install washer (2) and retaining ring (1) to pin (3). Make sure retaining ring engages groove in pin.

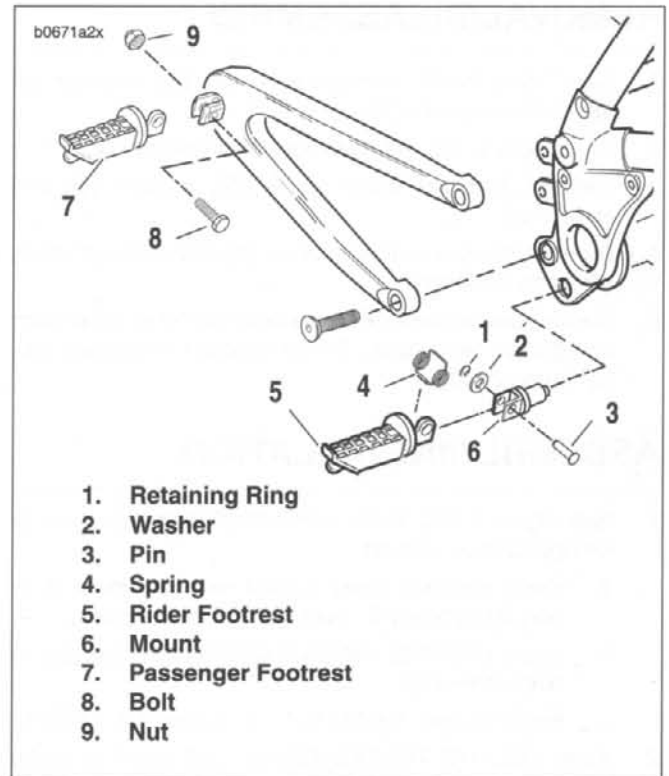


Figure 2-148. Footrests (2000 Models)

REMOVAL/DISASSEMBLY

1. See Figure 2-149. Remove two bolts (1), washers (2) and rubber washers (3).
2. See Figure 2-150. Remove nut (1) and washer (2).
3. Remove sprocket cover screw (5), washer (6) and spacer (8).
4. Remove swingarm drive/support (4) and sprocket cover (7) as an assembly.
5. Remove two screws (9) to separate sprocket cover from swingarm/drive support. Do not remove rivet holding rubber bumper (10).

ASSEMBLY/INSTALLATION

1. See Figure 2-150. If removed, attach sprocket cover to swingarm/drive support.
 - a. Place sprocket cover behind swingarm/drive support. Align holes in cover with holes in support.
 - b. Apply LOCTITE THREADLOCKER 222 (purple) to both screws (9).
 - c. Install screws. Tighten to 12-17 **in-lbs** (1.4-1.9 Nm).
2. Apply LOCTITE THREADLOCKER 243 (blue) to screw (5). Install sprocket cover assembly with screw (5), washer (6) and spacer (8). Tighten to 4-6 **ft-lbs** (5.4-8.6 Nm).
3. See Figure 2-149. Apply LOCTITE THREADLOCKER 272 (red) to bolts (1). Place metal washer over screw and then install rubber washer. Install and tighten to 9-10 **ft-lbs** (12.2-13.6 Nm).
4. Install nut (1) and washer (2). Tighten to 30-35 **ft-lbs** (40.7-47.4 Nm).

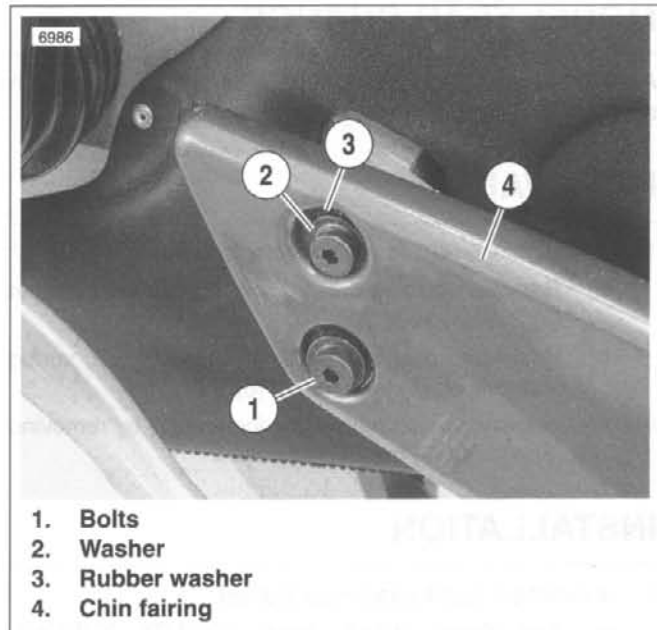


Figure 2-149. Chin Fairing, Right Side

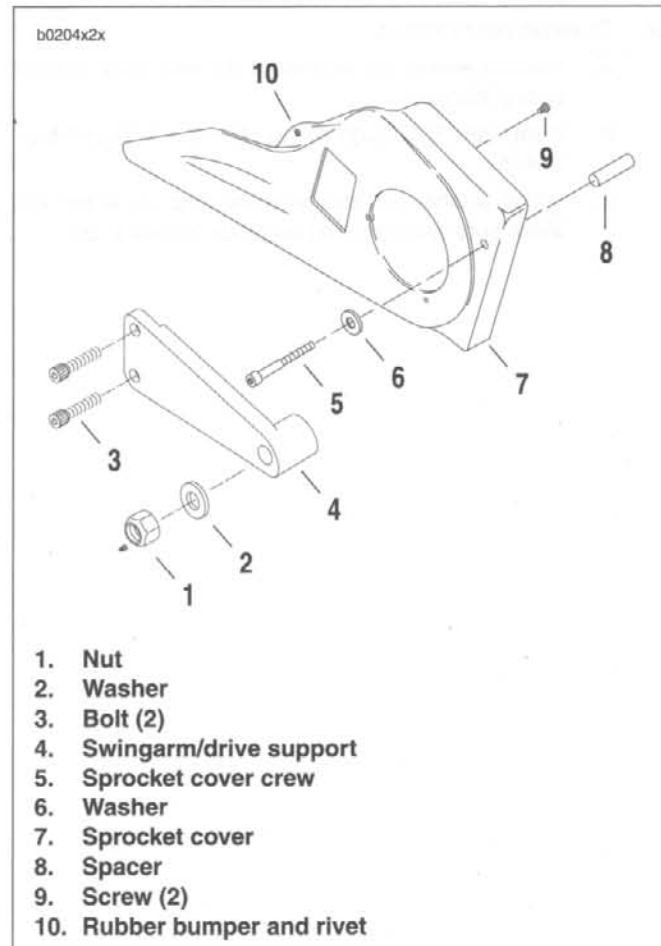


Figure 2-150. Sprocket Cover

REMOVAL/INSTALLATION

1. Raise front wheel off floor using procedure under 1.19 STEERING HEAD BEARINGS.
2. Remove front wheel. See 2.5 FRONT WHEEL (1999 Models) or 2.6 FRONT WHEEL (2000 Models).
3. See Figure 2-151. Remove lower fender mounting screws (8) (metric), washers (9) and plastic spacers (6).
4. Remove upper fender mounting screws (3), washers (4), wire guides (5), plastic spacers (6) and locknuts (7).
5. Carefully remove fender (1) from between front forks.
6. Install in reverse order.
 - a. Tighten upper fender mounting screws (3) to 20-25 **in-lbs** (2.3-2.8 Nm).
 - b. Tighten lower fender mounting screws (8) (metric) to 10-15 **in-lbs** (1.1-1.7 Nm).

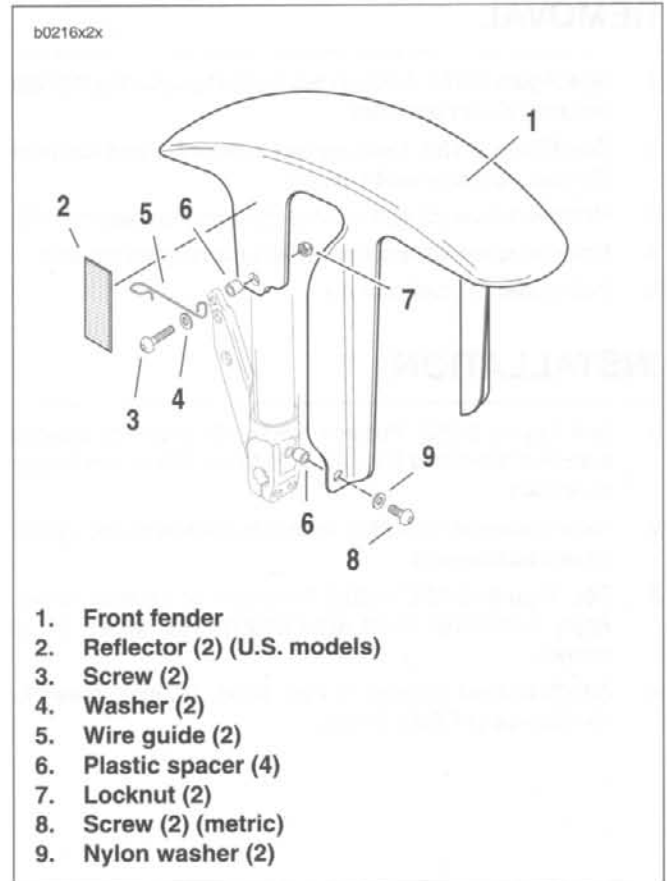


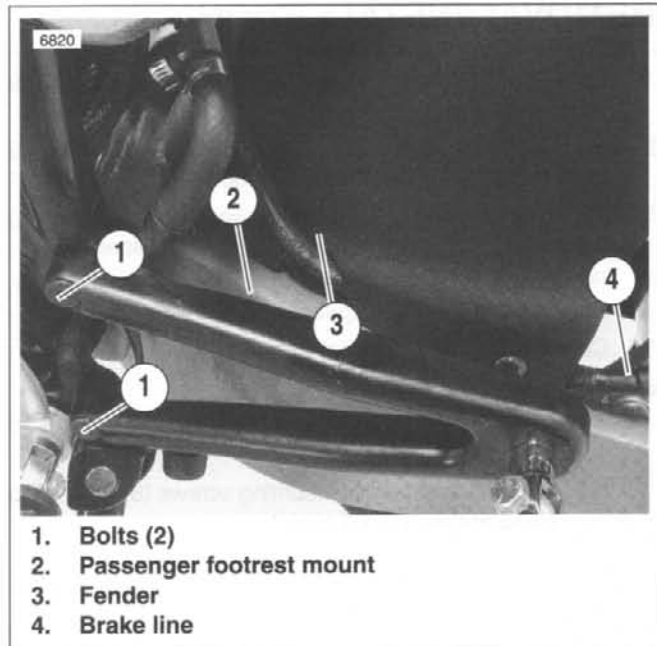
Figure 2-151. Front Fender

REMOVAL

1. See Figure 2-152. Loosen two bolts (1) securing footrest mounts (2) on both sides.
2. See Figure 2-153. Remove two screws (1) and washers (2) from right side well nuts (4).
3. Remove screw (5) and washer (6) from front well nut (7).
4. Remove screw (8) washer (9) and clamp from left side.
5. Pull fender (3) over rear tire.

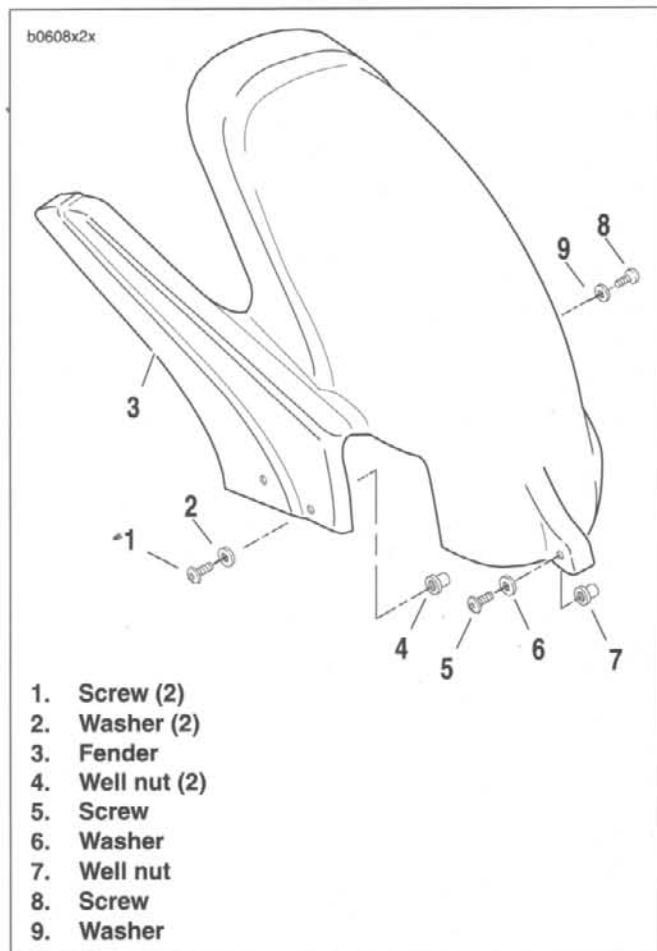
INSTALLATION

1. See Figure 2-152. Position fender (3) over tire, making sure that the brake line (4) is on the inside of the fender as shown.
2. Have someone sit on the vehicle to compress the motorcycle's suspension.
3. See Figure 2-153. Install hardware in reverse order. Apply LOCTITE THREADLOCKER 243 (blue) to all screws.
4. Attach footrest mounts on both sides. Tighten screws to 13-16 ft-lbs (17.6-21.7 Nm).



1. Bolts (2)
2. Passenger footrest mount
3. Fender
4. Brake line

Figure 2-152. Rear Fender With Brake Line (Left Side)



1. Screw (2)
2. Washer (2)
3. Fender
4. Well nut (2)
5. Screw
6. Washer
7. Well nut
8. Screw
9. Washer

Figure 2-153. Rear Fender

REMOVAL

1. See Figure 2-154. Remove two screws (1) and washers (2) securing lower belt guard (3) to swingarm.
2. Remove lower belt guard (3), stone guard (4) and well nuts (5).

INSTALLATION

1. See Figure 2-155. Position stone guard (4) with well nuts (5) and lower belt guard (3) on swingarm.
2. Secure with two screws (1) and washers (2).

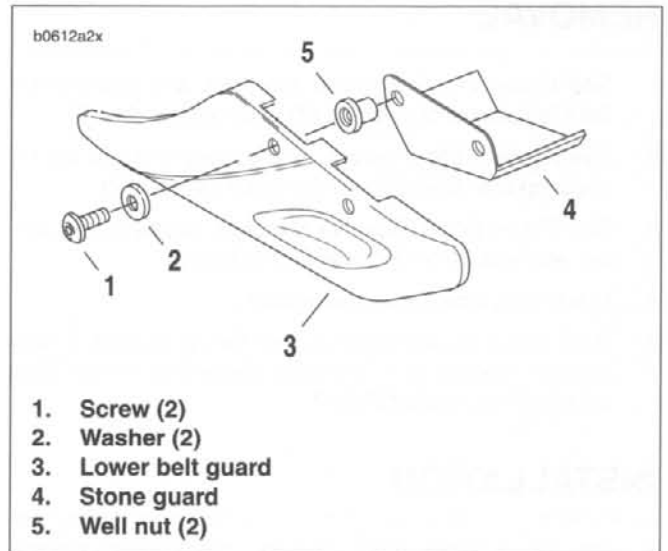


Figure 2-154. Stone Guard Installation

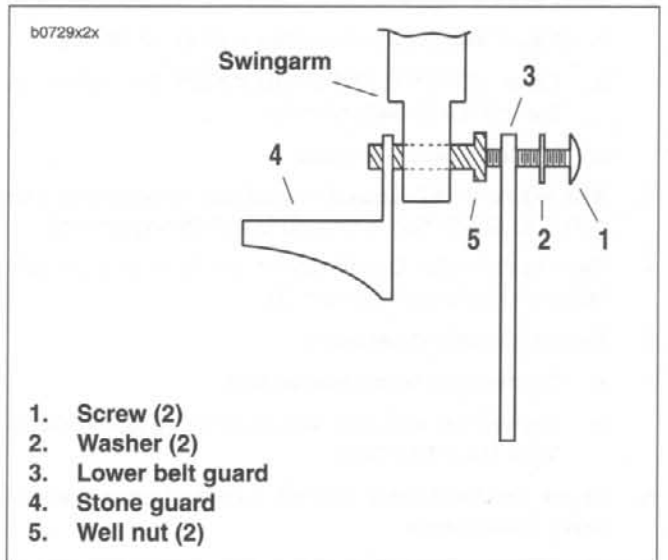


Figure 2-155. Stone Guard Mounting

REMOVAL

1. See Figure 2-156. Remove two bolts and washers (1) from left side of chin fairing (2) near clutch cable (3).
2. See Figure 2-157. Remove bolt, washer and well nut (1) securing chin fairing (2) to chin fairing bracket (3).
3. See Figure 2-158. Remove two bolts, washers and rubber washers from right side of chin fairing.
4. Lower chin fairing from motorcycle.
5. Rear shock mount supports chin fairing bracket. If necessary, remove bolt following procedure under 2.28 REAR SHOCK ABSORBER.

INSTALLATION

1. See Figure 2-157. If removed, install chin fairing bracket (3) on shock mounting hardware. See 2.28 REAR SHOCK ABSORBER.
2. See Figure 2-158. Install right side mounting hardware.
 - a. Install washer (2) and rubber washer (3) on bolt.
 - b. Place LOCTITE THREADLOCKER 243 (blue) on the last few threads of bolts.
 - c. Loosely install both bolts.
3. See Figure 2-157. Loosely install bolt, washer and well nut (1) to attach chin fairing (2) to chin fairing bracket.
4. See Figure 2-156. On left side of chin fairing (2), loosely install two bolts and washers (1).
5. Secure chin fairing hardware.
 - a. Tighten chin fairing bracket bolt.
 - b. Tighten left and right side chin fairing bolts to 9-10 ft-lbs (12.2-13.6 Nm).
6. Check for clutch cable contact. If contact occurs, adjust clutch cable clamp.

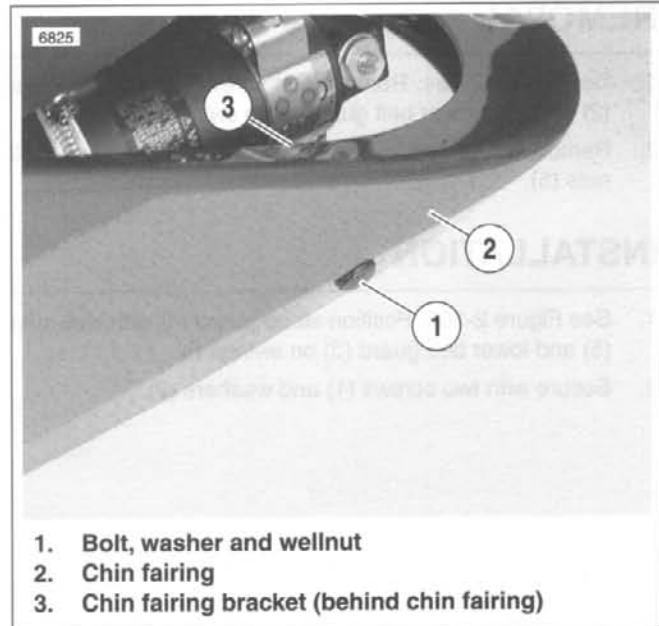


Figure 2-157. Chin Fairing Bracket

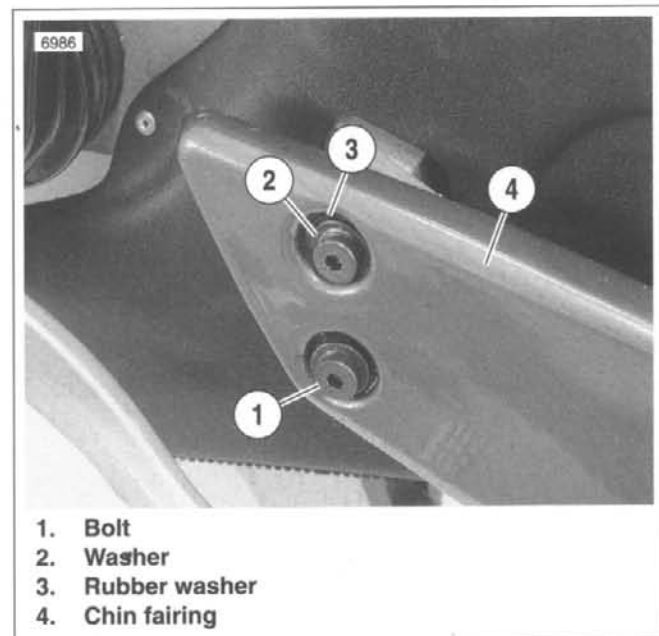


Figure 2-158. Chin Fairing, Right Side

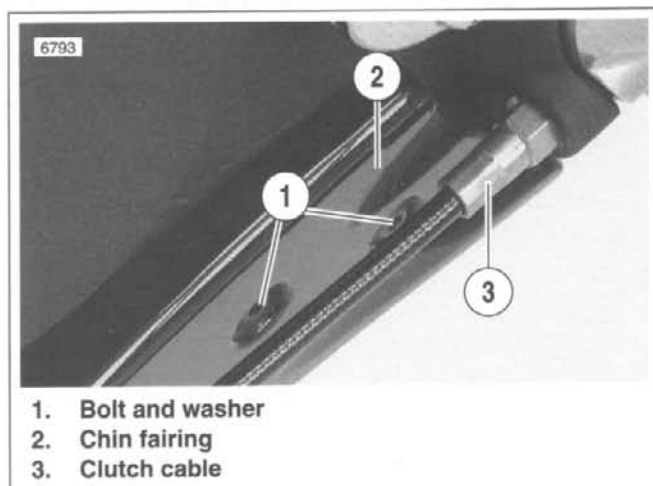


Figure 2-156. Chin Fairing, Left Side

MODEL YEAR CHANGE

The 2000 Model Year Buell X1 fuel tank covers do not have the two vent holes present on the 1999 model covers.

REMOVAL

1. Remove seat.
2. See Figure 2-159. Remove two fuel tank cover screws (1) and washers (2) from bracket (3). Remove bracket.
3. Cut cable strap from vapor vent hose and vent hose fitting on top of fuel tank. Detach vent hose.
4. See Figure 2-160. Remove two screws (1), washers (2) and well nuts (4) at front of tank cover.
5. Remove fuel tank cover from frame.

INSTALLATION

1. Position fuel tank cover on frame.
2. See Figure 2-160. Secure front of fuel tank cover (3) with screws (1) and washers (2) through well nuts (4).
3. Attach vent hose to vent hose fitting with a **new** cable strap.
4. See Figure 2-159. Install bracket.
 - a. Position bracket (3) over fuel tank cover (4). Tab on bracket must face towards rear wheel.
 - b. Install two screws (1) and washers (2). Tighten to 9-11 ft-lbs (12.2-14.9 Nm).

⚠ WARNING

After installing seat, pull upward on front of seat to be sure it is locked in position. If seat is loose, it could shift during vehicle operation and startle the rider, causing loss of control which could result in death or serious injury.

5. Install seat.

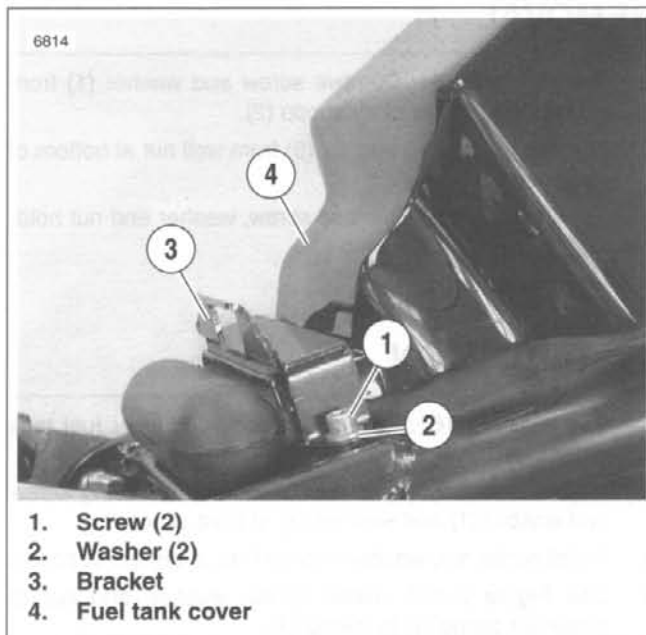


Figure 2-159. Fuel Tank Cover Bracket

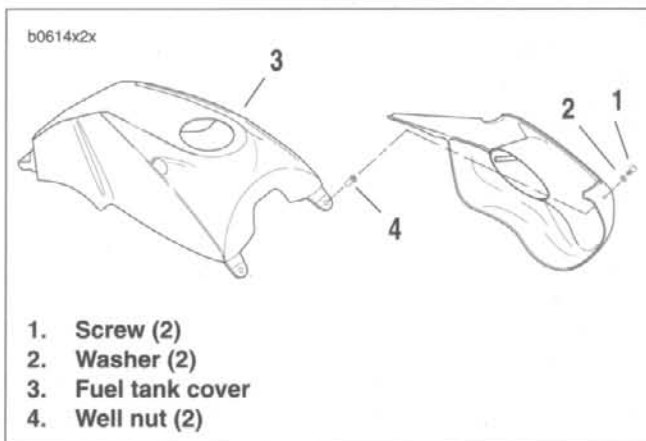


Figure 2-160. Fuel Tank Cover (1999 Model Shown)

REMOVAL

1. See Figure 2-161. Remove screw and washer (1) from well nut (3) at front of air scoop (2).
2. Remove screw and washer (5) from well nut at bottom of air scoop.
3. See Figure 2-162. Remove screw, washer and nut holding air scoop (1) to clamp (3).
4. Remove air scoop.

INSTALLATION

1. See Figure 2-161. Position air scoop (2) over fuel tank cover (4).
2. Fasten air scoop (2) to fuel tank cover (4) using screw and washer (1) and well nut (3) at front of scoop.
3. Install screw and washer into well nut at bottom of scoop.
4. See Figure 2-162. Install screw, washer, and nut to attach air scoop (1) to clamp (3).

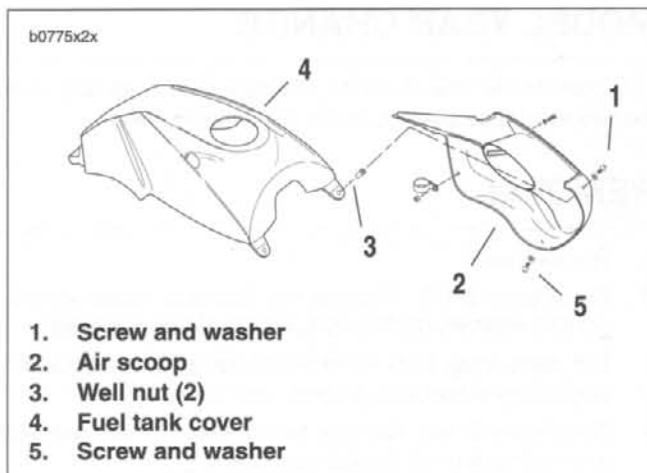


Figure 2-161. Air Scoop

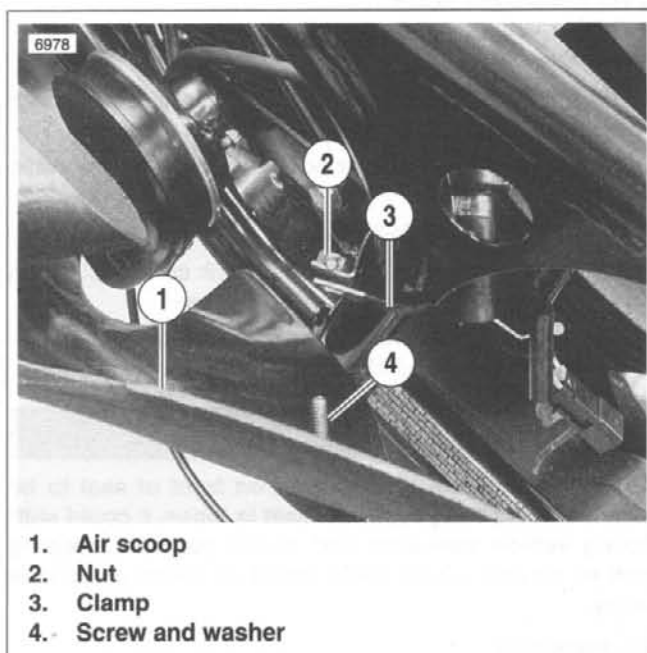


Figure 2-162. Air Scoop Clamp

REMOVAL

1. See Figure 2-163. Remove two screws and washers (1) and nuts and washers (2) securing front of trunk (4) to tail section (5).
2. Remove two screws and washers (3) securing trunk (4) to tail section (5) under edge of tail section.
3. See Figure 2-164. Remove screws and washers (1) from indentation in license plate bracket (2).
4. Push down on center of trunk until trunk pops free of tail section.

INSTALLATION

1. See Figure 2-163. Position trunk (4) in tail section (5).
2. Secure front of trunk (4) to tail section (5) with two screws and washers (1) and washers and nuts (2).
3. Secure trunk (4) to tail section (5) with two screws and washers (3) under edge of tail section.
4. See Figure 2-164. Secure trunk to license plate bracket (2) with screws and washers (1).

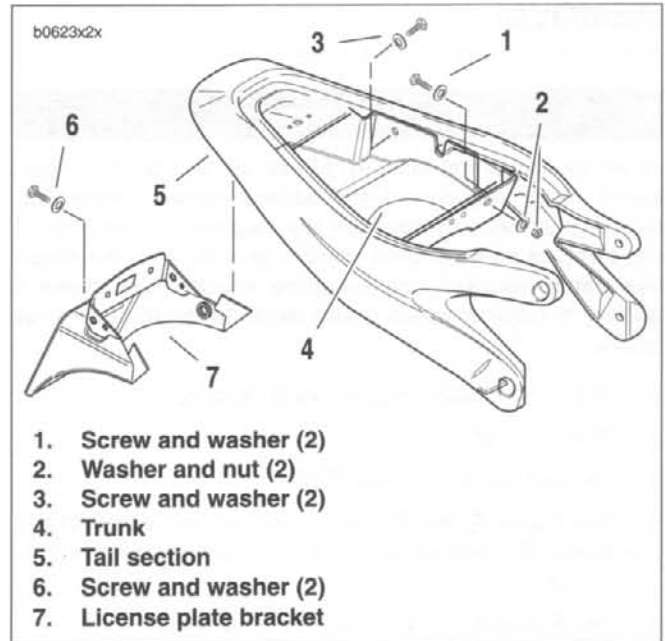


Figure 2-163. Tail Section with Trunk

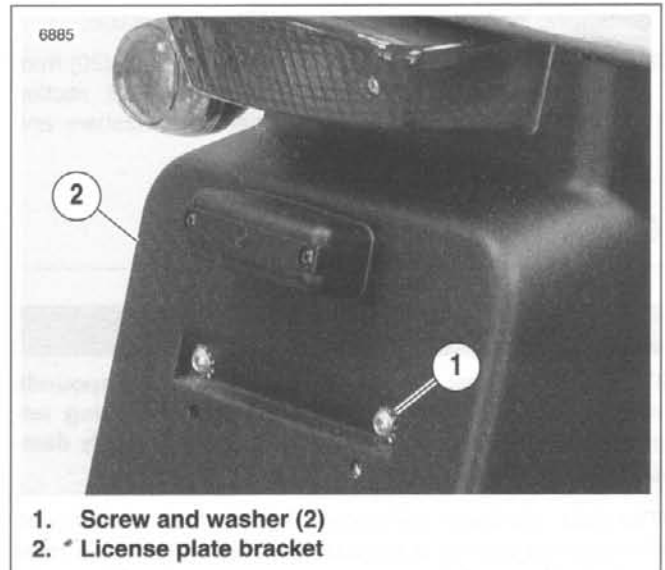


Figure 2-164. License Plate Bracket

REMOVAL

⚠ WARNING

To avoid accidental start-up of vehicle and possible personal injury, disconnect the battery cables before proceeding. Always disconnect the negative cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion which could result in death or serious injury.

1. Disconnect battery cables, negative cable first.
2. Remove seat.
3. Remove trunk. See 2.45 TRUNK.
4. See Figure 2-165. Remove fuse/relay block bracket fasteners (2). Remove bracket (1) containing fuse and relay blocks.
5. See Figure 2-166. Disconnect tail harness.
6. See Figure 2-167. Remove two screws and washers (1) on electronic control module (2).
7. See Figure 2-168. Remove two nuts (2) and washers (8) holding ignition module bracket (17) to tail section.
8. Remove two nuts (18), washers (19) and bolts (20) from the lower frame connection. Rotate the tail section upward and remove the two upper nuts, washers and bolts.

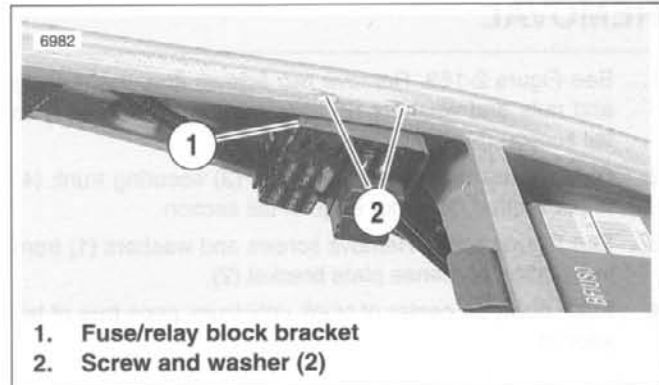


Figure 2-165. Fuse Block



Figure 2-166. Wiring Harness

CLEANING

CAUTION

Do not use wheel care products or other compounds developed specifically for cleaning and polishing uncoated aluminum. These cleaners could potentially damage the tail section finish.

The cast aluminum tail section has a clear powdercoat. Because the surface is not bare polished aluminum, it must be cleaned using only mild soap and warm water. After washing, always dry the surface using a clean, soft cloth.

DISASSEMBLY

1. See Figure 2-169. Remove two nuts (metric) (4) and washers (5) from tail lamp studs to detach the tail lamp (2). Pull the three wires from back of tail lamp.
2. See Figure 2-168. Remove two allen bolts (15), washers (3) and nuts (10) to detach seat lock (11) from tail section (14).
3. See Figure 2-169. Remove turn signal nuts (metric) (6) and washers (7). Disconnect bullet connectors.
4. Tilt license plate bracket (3) forward to remove.

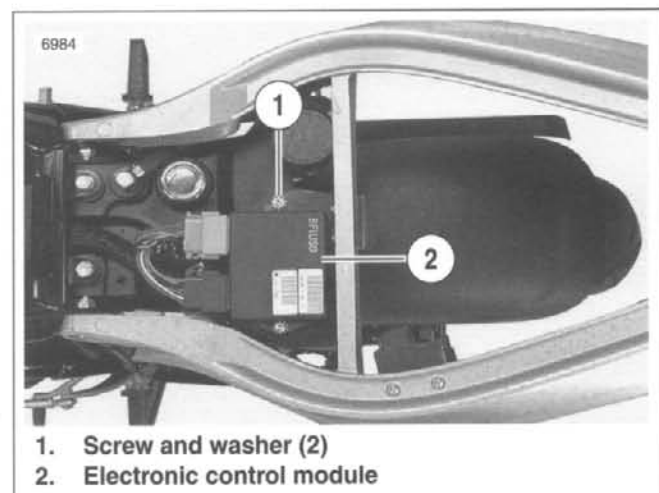
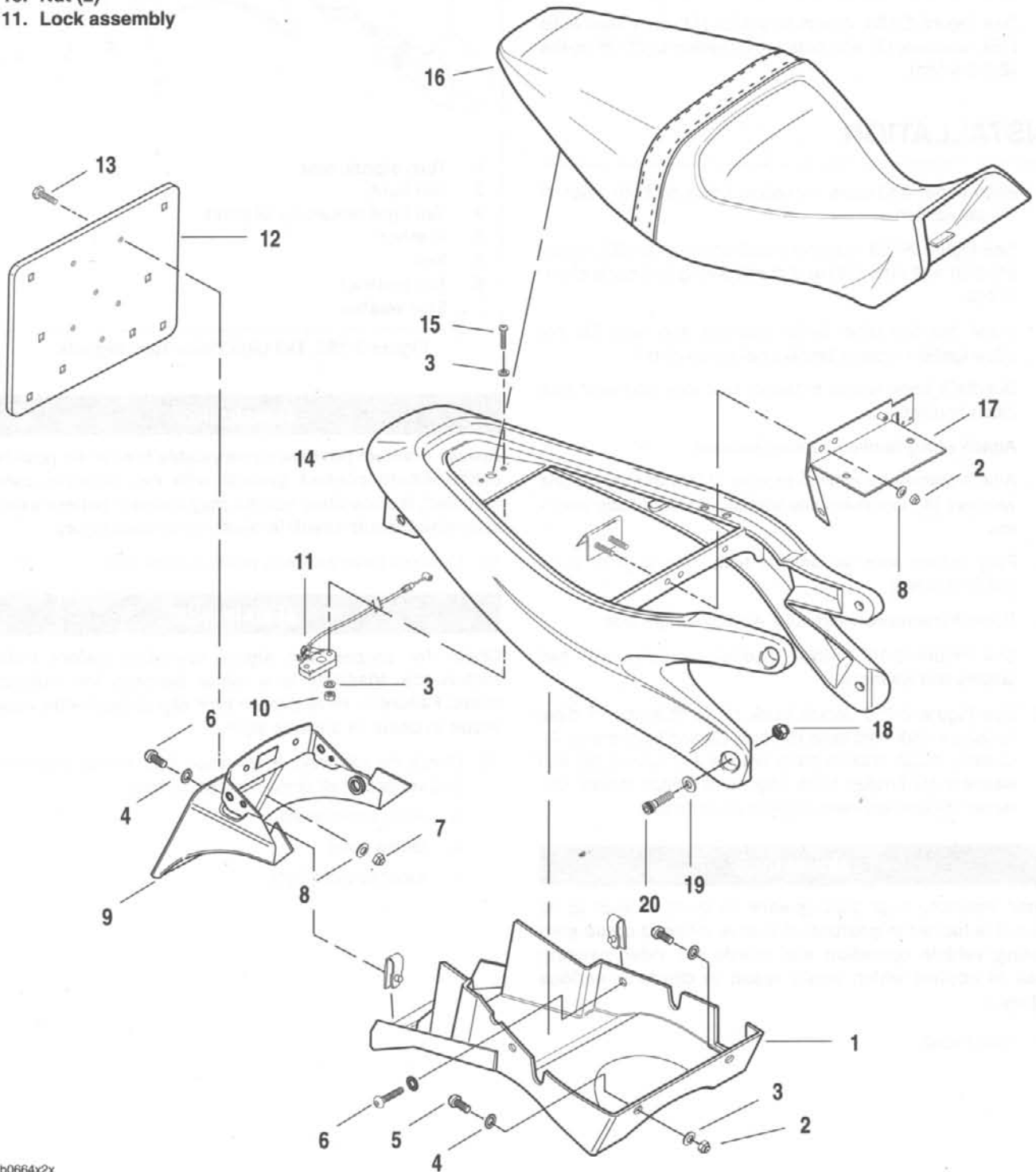


Figure 2-167. Electronic Control Module

1. Trunk
2. Nut (3)
3. Washer (5)
4. Washer (6)
5. Screw (2)
6. Screw (4)
7. Nut (4)
8. Washer (6)
9. Bracket, license plate
10. Nut (2)
11. Lock assembly

12. Holder, license plate
13. Screw (4)
14. Tail section
15. Screw (2)
16. Seat
17. Bracket, electronic control
18. Nut (4)
19. Washer (4)
20. Screw (4)



b0664x2x

Figure 2-168. Tail Section (1999 Configuration Shown)

ASSEMBLY

1. See Figure 2-168. Slide license plate bracket (9) over tail section (14).
2. See Figure 2-169. Install turn signals (1), with drain holes facing down, with star washers (7) and nuts (6) (metric). Tighten to 96-120 **in-lbs** (10.8-13.6 Nm). See 7.14 TURN SIGNALS to connect wiring.
3. Install nuts (metric) (4) and washers (5) for tail lamp (2). Do not connect wires until after installation.
4. See Figure 2-168. Attach seat lock (11) with allen bolts (15), washers (3) and nuts (10). Tighten to 20-25 **in-lbs** (2.3-2.8 Nm).

INSTALLATION

1. Align upper and lower mounting holes on both sides of the tail section.
2. See Figure 2-168. Loosely install upper bolts (20), washers (19) and nuts (18) and check wiring and parts clearances.
3. Install the two other bolts, washers and nuts. Do not allow ignition module bracket below top of tail.
4. Bundle lighting wiring between seat lock and seat lock catch housing.
5. Attach wiring harness to main harness.
6. Attach bracket for ignition module (17) with nuts (2) and washers (8). Install module with two bolts and star washers.
7. Fully tighten four tail section bolts (20) to 9-11 ft-lbs (12.2-14.9 Nm).
8. Route transmission vent tube along the right side.
9. See Figure 2-165. Install fuse/relay bracket with two screws and washers.
10. See Figure 2-168. Install trunk (1) to fit inside of clips. Loosely install front bolts (5), nuts (2) and washers (3, 4). Loosely install license plate bracket (9) screws (6) and washers (4) finalize trunk alignment. Install middle fasteners (6) with washers. Tighten all fasteners.

WARNING

After installing seat, pull upward on front of seat to be sure it is locked in position. If seat is loose, it could shift during vehicle operation and startle the rider, causing loss of control which could result in death or serious injury.

11. Install seat.

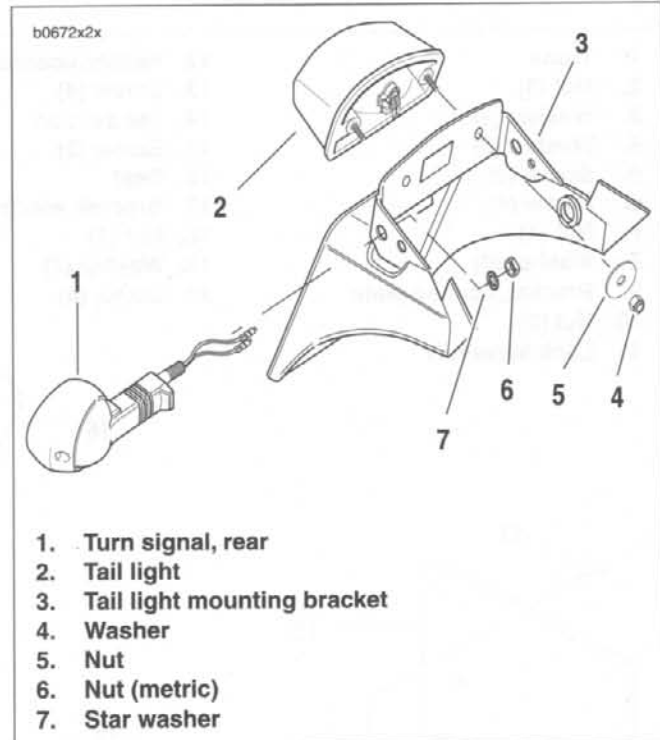


Figure 2-169. Tail Light/Rear Turn Signals

WARNING

Always connect positive battery cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion which could result in death or serious injury.

12. Connect battery cables, positive cable first.

WARNING

Check for proper turn signal operation before riding motorcycle. Visibility is a major concern for motorcyclists. Failure to have proper turn signal operation could result in death or serious injury.

13. Check the following. If operation fails, reread procedure and verify that all steps were performed.
 - a. Rear turn signals.
 - b. Brake lamp.
 - c. License plate light.

REMOVAL

1. See Figure 2-170. Remove two screws and nylon washers on each side.
2. If necessary, remove both windscreen brackets following procedure under 2.24 FRONT FORK.

INSTALLATION

1. If removed, install both windscreen brackets. See 2.24 FRONT FORK.
2. Align windscreen on right and left brackets.
3. See Figure 2-170. Install two screws and nylon washers on each side. Tighten securely.

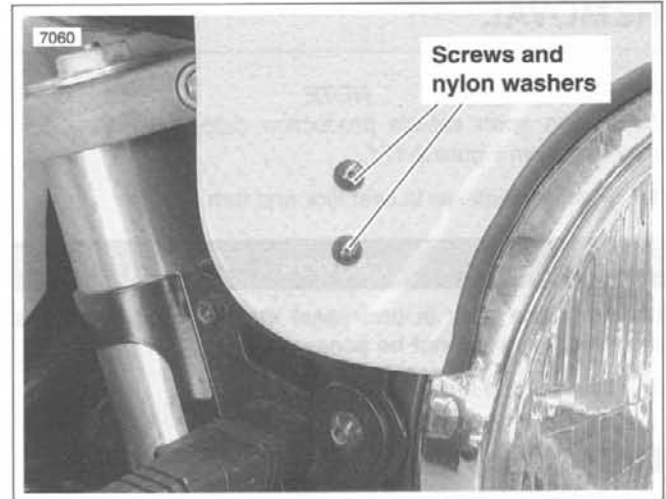


Figure 2-170. Windscreen, Right Side

REMOVAL

NOTE

Depending upon vehicle production date, lock orientation may vary from Figure 2-171.

1. Place ignition key in seat lock and turn.

CAUTION

Do not place keys in underseat storage area. If seat is installed, keys will not be accessible.

2. Lift seat and remove.

INSTALLATION

1. Install seat by sliding metal locating tab on underside of seat into opening on motorcycle.
2. Press down on seat until seat catch clicks.

WARNING

After installing seat, pull upward on front of seat to be sure it is locked in position. If seat is loose, it could shift during vehicle operation and startle the rider, causing loss of control which could result in death or serious injury.

3. Turn ignition key and remove from seat lock.

ATTACHMENT POINTS

CAUTION

Helmet holders will not prevent helmet theft. See your Buell dealer for helmet locking solutions.

See Figure 2-172. Two metal tabs on the tail section serve as helmet holders (1). Place helmet D-ring under tab. Install and lock seat to temporarily secure helmet while motorcycle is stationary.

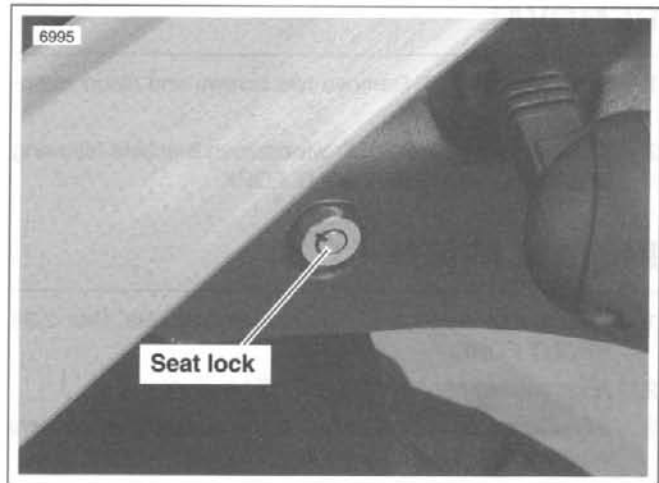


Figure 2-171. Seat Lock

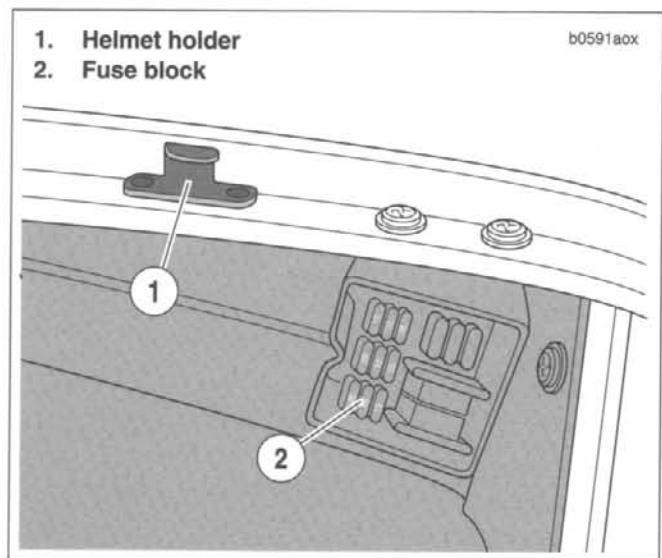


Figure 2-172. Helmet Holder

MODEL YEAR CHANGE

All 2000 Model X1 motorcycles are equipped with a new helmet hook and cable assembly.

REMOVAL

NOTE

Depending upon vehicle production date, lock orientation may vary from Figure 2-173.

1. Place ignition key in seat lock and turn.

CAUTION

Do not place keys in underseat storage area. If seat is installed, keys will not be accessible.

2. Lift seat and remove.

INSTALLATION

1. Install seat by sliding metal locating tab on underside of seat into opening on motorcycle.
2. Press down on seat until seat catch clicks.

WARNING

After installing seat, pull upward on front of seat to be sure it is locked in position. If seat is loose, it could shift during vehicle operation and startle the rider, causing loss of control which could result in death or serious injury.

3. Turn ignition key and remove from seat lock.

ATTACHMENT POINTS

CAUTION

Helmet hook will not prevent helmet theft. See your Buell dealer for helmet locking solutions.

See Figure 2-174. Two metal hooks, cables and locktabs on the tail section serve as helmet holders. To store helmet, place cable through helmet D-ring. Place D-ring on helmet hook and route cable loop under locktabs. Install and lock seat to store helmet while motorcycle is stationary.

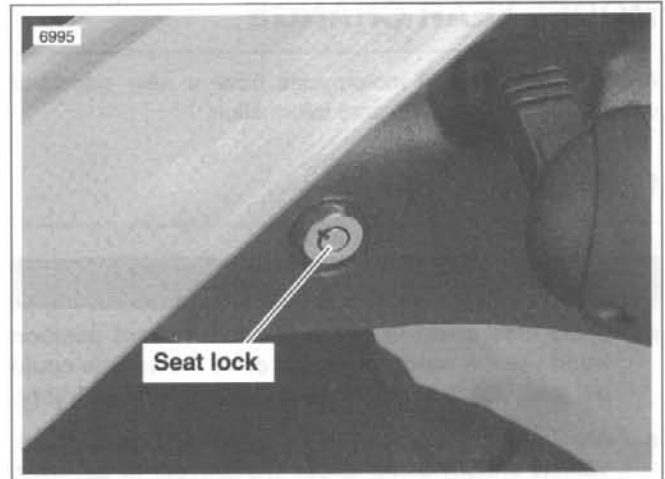


Figure 2-173. Seat Lock

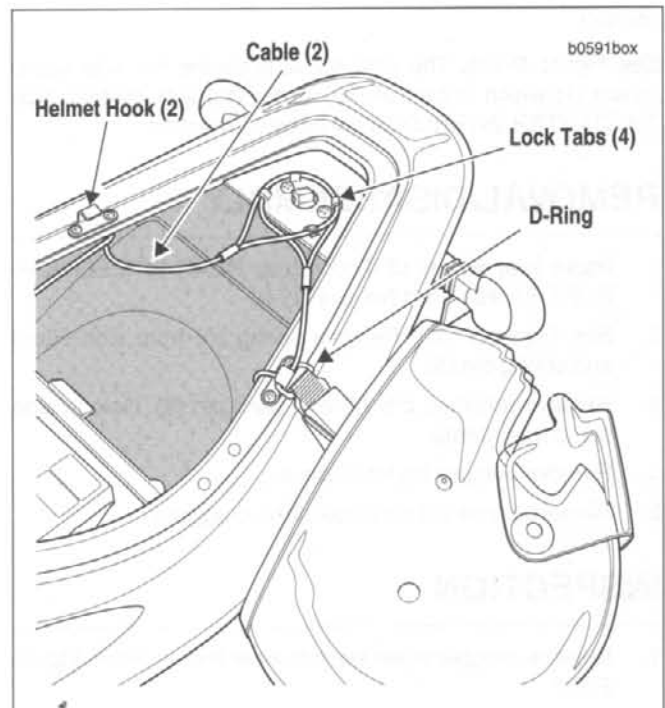


Figure 2-174. Helmet Hook

MODEL YEAR CHANGE

All 2000 Model Buell motorcycles have a **new** sidestand switch. See Section 7 for more information.

GENERAL

⚠ WARNING

- If the side stand is not in the full forward position when vehicle weight is rested on it, the vehicle could fall over, which could result in death or serious injury.
- Always park motorcycle on a level, firm surface. Vehicle weight could cause motorcycle to fall over, which could result in death or serious injury.

The side stand is located on the left side of the motorcycle. The side stand swings outward to support the motorcycle for parking.

See Figure 2-175. The side stand activates the side stand switch (1) which is part of the starter interlock system. See 7.5 STARTER INTERLOCK for more information.

REMOVAL/DISASSEMBLY

1. Raise rear wheel off floor using REAR WHEEL SUPPORT STAND (Part No. B-41174).
2. See Figure 2-176. Remove spring (6) from side stand and spring pin (5).
3. Remove retaining clip (7) and pivot pin (8). Detach side stand from frame.
4. Remove bumper (3) from frame.
5. Remove screw (2) and side stand dragger (1).

INSPECTION

1. Replace dragger when worn to wear line shown in Figure 2-177.
2. Test the side stand in the following manner. Without vehicle weight resting on it, side stand should move freely into extended (down) and retracted (up) positions.
3. Check sidestand switch (starter interlock) for proper operation after the first 500 miles and every 2500 miles thereafter. See 7.5 STARTER INTERLOCK.

ASSEMBLY/INSTALLATION

1. See Figure 2-176. Attach bumper (3) to frame.
2. Attach side stand dragger (1) to side stand with screw (2).
3. Apply LOCTITE ANTI-SEIZE to pivot pin (8). Install side stand using pivot pin (8) and retaining clip (7). Do not crush side stand switch during installation.
4. Connect spring (6) to side stand and spring pin (5).
5. Remove REAR WHEEL STAND.

6. With side stand retracted, there should be 0.5 in. (12.7 mm) clearance between side stand and swingarm at the closest point of contact.

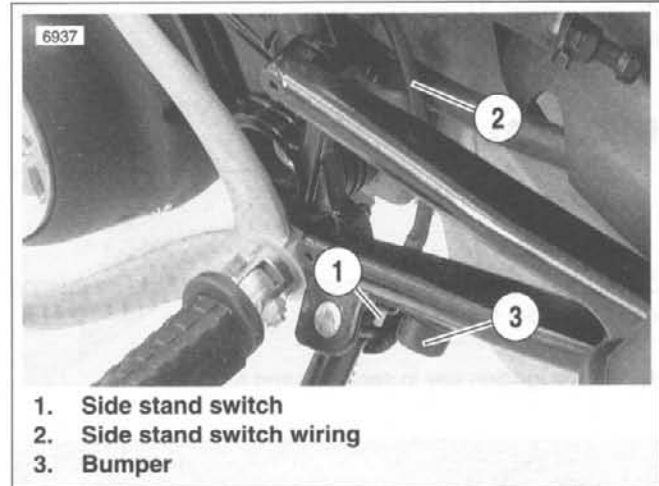


Figure 2-175. Side Stand Switch (1999 Model Shown)

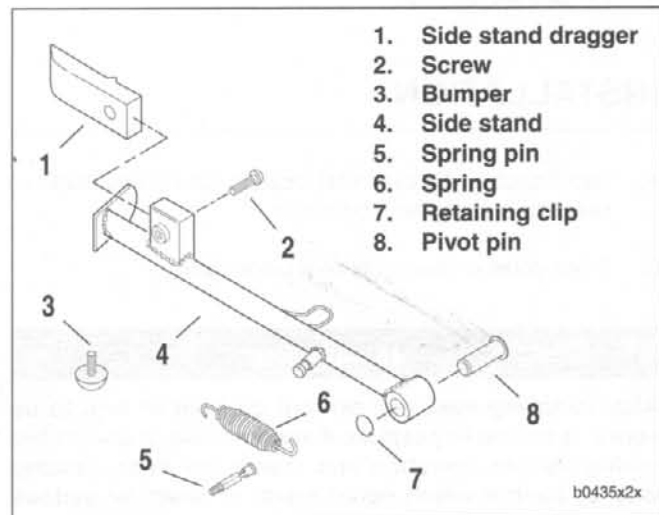


Figure 2-176. Side Stand

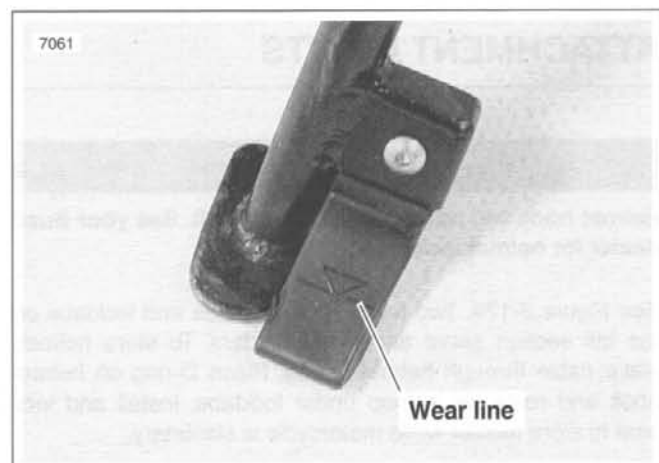


Figure 2-177. Side Stand Dragger Wear Limit

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3.3 Stripping Motorcycle For Engine Repair	3-8
3.4 Installing The Engine	3-10
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SPECIFICATIONS

3.1

GENERAL		
Type	2 cylinder, air cooled, four-stroke 45 Degree V-twin	
Horsepower (ft-lbs)	101 @ 6200 RPM	
Torque (ft-lbs)	90 @ 5500 RPM	
Compression ratio	10.0 to 1	
Bore	3.498 in.	88.849 mm
Stroke	3.8125 in.	96.838 mm
Engine displacement	73.4 cu. in.	1203 cc
Oil tank capacity with filter change	2.5 quarts	2.37 liters

ENGINE IGNITION SPECIFICATIONS		
Type	Sequential, non waste spark	
Regular idle	850-1050 RPM	
Spark plug size	12 mm	
Spark plug type	Harley-Davidson No. 6R12	
Spark plug gap	0.038-0.043 in.	0.97-1.09 mm
Spark plug torque	11-18 ft-lbs	15-24 Nm

NOTE

Service wear limits are given as a guideline for measuring components that are not **new**. For measurement specifications not given under **SERVICE WEAR LIMITS**, see **NEW COMPONENTS**.

CAMSHAFT SPECIFICATIONS	
Lift @ valve (TDC) Intake/Exhaust	0.211 in./0.191 in.
Duration @ 0.053 lift Intake/Exhaust	256°/256°
Timing @ 0.053 lift Open/Close	Intake: 28° BTDC/48° ABDC Exhaust: 52° BBDC/24° ATDC

VALVE		NEW COMPONENTS		SERVICE WEAR LIMITS	
Fit in guide	Exhaust	0.0015-0.0033 in.	0.0381-0.0838 mm	0.0040 in.	0.1016 mm
	Intake	0.008-0.0026 in.	0.203-0.0660 mm	0.0035 in.	0.0889 mm
Seat width		0.040-0.062 in.	1.016-1.575 mm	0.090 in.	2.286 mm
Stem protrusion from cylinder valve pocket		1.975-2.011 in.	50.165-51.079 mm	2.031 in.	51.587 mm

OUTER VALVE SPRING		NEW COMPONENTS		SERVICE WEAR LIMITS	
Free length		2.105-2.177 in.	53.467-55.296 mm	2.105 in. (min)	53.467 mm (min)
Intake	1.751-1.848 in. (closed)	72-92 lbs	33-42 kg		
	1.286-1.383 in. (open)	183-207 lbs	83-94 kg		
Exhaust	1.751-1.848 in. (closed)	72-92 lbs	33-42 kg		
	1.332-1.429 in. (open)	171-195 lbs	78-88 kg		

INNER VALVE SPRING		NEW COMPONENTS		SERVICE WEAR LIMITS	
Free length		1.926-1.996 in.	48.920-50.698 mm	1.926 in. (min)	48.920 mm (min)
Intake	1.577-1.683 in. (closed)	38-49 lbs	17-22 kg		
	1.112-1.218 in. (open)	98-112 lbs	44-51 kg		
Exhaust	1.577-1.683 in. (closed)	38-49 lbs	17-22 kg		
	1.158-1.264 in. (open)	91-106 lbs	41-48 kg		

ROCKER ARM		NEW COMPONENTS		SERVICE WEAR LIMITS	
Shaft fit in bushing (loose)		0.0005-0.0020 in.	0.0127-0.0508 mm	0.0035 in.	0.0889 mm
End clearance		0.003-0.013 in.	0.076-0.330 mm	0.025 in.	0.635 mm
Bushing fit in rocker arm (tight)		0.004-0.002 in.	0.102-0.0559 mm		
Rocker arm shaft fit in rocker cover (loose)		0.0007-0.0022 in.	0.018-0.056 mm	0.0035 in.	0.0889 mm

PISTON		NEW COMPONENTS		SERVICE WEAR LIMITS	
Compression ring gap (top and 2nd)		0.007-0.020 in.	0.178-0.508 mm	0.032 in.	0.813 mm
Oil control ring rail gap		0.009-0.052 in.	0.229-1.321 mm	0.065 in.	1.651 mm
Compression ring side clearance	Top	0.0020-0.0045 in.	0.0508-0.1143 mm	0.0065 in.	0.1651 mm
	2nd	0.0016-0.0041 in.	0.0406-0.1041 mm	0.0065 in.	0.1651 mm
Oil control ring side clearance		0.0016-0.0076 in.	0.0406-0.1930 mm	0.0094 in.	0.2388 mm
Pin fit (loose, at room temperature)		0.00005-0.00045 in.	0.00127-0.01143 mm	0.00100 in.	0.02540 mm

CYLINDER HEAD		NEW COMPONENTS		SERVICE WEAR LIMITS	
Valve guide in head (tight)		0.0033-0.0020 in.	0.0838-0.0508 mm		
Valve seat in head (tight)		0.0035-0.0010 in.	0.0889-0.0254 mm		
Head gasket surface (flatness)		0.006 in. total	0.152 mm total	0.006 in. total	0.152 mm total

CYLINDER		NEW COMPONENTS		SERVICE WEAR LIMITS	
Taper				0.002 in.	0.051 mm
Out of round				0.003 in.	0.076 mm
Warpage (gasket surfaces)	Top			0.006 in.	0.152 mm
	Base			0.008 in.	0.203 mm
Bore diameter ± 0.0002 in.	Standard	3.4978 in.	88.8441 mm	3.5008 in.	88.9203 mm
	0.005 OS	3.502 in.	88.951 mm	3.5050 in.	89.0270 mm
	0.010 OS	3.507 in.	89.078 mm	3.5100 in.	89.1540 mm
OS=over size	0.020 OS	3.517 in.	89.332 mm	3.5200 in.	89.4080 mm
	0.030 OS	3.527 in.	89.586 mm	3.5300 in.	89.6620 mm

CONNECTING ROD	NEW COMPONENTS		SERVICE WEAR LIMITS	
	Piston pin fit (loose)	0.00125-0.00175 in.	0.03175-0.04445 mm	0.00200 in.
Side play between flywheels	0.005-0.025 in.	0.127-0.635 mm	0.030 in.	0.762 mm
Fit on crankpin (loose)	0.0004-0.0017 in.	0.0102-0.0432 mm	0.0027 in.	0.0686 mm
Connecting rod race ID	1.6245-1.6250 in.	41.2623-41.2750 mm	1.6270 in.	41.3258 mm

TAPPET/HYDRAULIC LIFTER	NEW COMPONENTS		SERVICE WEAR LIMITS	
	Fit in guide	0.0008-0.0020 in.	0.0203-0.0508 mm	0.0030 in.
Roller fit	0.0006-0.0010 in.	0.0152-0.0254 mm	0.0015 in.	0.0381 mm
Roller end clearance	0.008-0.022 in.	0.203-0.559 mm	0.026 in.	0.660 mm

OIL PUMP	NEW COMPONENTS		SERVICE WEAR LIMITS	
	Oil pressure	1000 RPM	7-12 PSI	48-83 kN/m ²
2500 RPM		10-17 PSI	69-117 kN/m ²	
Shaft to pump clearance	0.0025 in.	0.0635 mm		
Feed/scavenge inner/outer gerotor clearance	0.003 in.	0.076 mm	0.004 in.	0.102 mm

GEARCASE	NEW COMPONENTS		SERVICE WEAR LIMITS	
	Cam gear shaft in bushing (loose)	0.0007-0.0022 in.	0.0178-0.0559 mm	0.003 in.
Cam gear shaft end play (min) (except rear intake)	0.005-0.024 in.	0.127-0.610 mm	0.025 in.	0.635 mm
Rear intake cam gear shaft end play (min)	0.006-0.024 in.	0.152-0.610 mm	0.040 in.	1.016 mm

FLYWHEEL	NEW COMPONENTS		SERVICE WEAR LIMITS	
	Runout	Flywheels at rim	0.000-0.010 in.	0.000-0.254 mm
Shaft at flywheel end		0.000-0.002 in.	0.000-0.051 mm	0.002 in.
End play	0.001-0.005 in.	0.025-0.127 mm	0.005 in.	0.127 mm

SPROCKET SHAFT BEARING	NEW COMPONENTS		SERVICE WEAR LIMITS	
	Outer race fit in crankcase (tight)	0.0004-0.0024 in.	0.0102-0.0610 mm	
Bearing inner race fit on shaft (tight)	0.0002-0.0015 in.	0.0051-0.0381 mm		

PINION SHAFT BEARINGS	NEW COMPONENTS		SERVICE WEAR LIMITS	
	Pinion shaft journal diameter	1.2496-1.2500 in.	31.7398-31.7500 mm	1.2496 in. (min)
Outer race diameter in right crankcase	1.5646-1.5652 in.	39.7408-39.7561 mm	1.5672 in. (max)	39.8069 mm (max)
Bearing running clearance	0.00012-0.00088 in.	0.00305-0.02235 mm		
Fit in cover bushing (loose)	0.0023-0.0043 in.	0.0584-0.1092 mm	0.0050 in.	0.1270 mm

TORQUE VALUES

ITEM	TORQUE		NOTES
Anti-rotation screws (2000 models)	80-110 in-lbs	9.0-12.4 Nm	page 3-43
Crank pin nut (1999 Models)	150-185 ft-lbs	203.4-250.8 Nm	LOCTITE 620 RETAINING COMPOUND, page 3-71, page 3-72
Crankcase 1/4 in. screws	70-110 in-lbs	7.9-12.4 Nm	page 3-75
Crankcase 5/16 in. screws	15-19 ft-lbs	20.3-25.8 Nm	page 3-75
Cylinder head screws	7-9 ft-lbs then 13-15 ft- lbs then loosen and repeat torque sequence	9.5-12.2 Nm then 17.6-20.3 Nm then loosen and repeat torque sequence	special pattern to tighten, page 3-21
Cylinder studs	10-20 ft-lbs	13.6 -27.1Nm	special method to tighten, page 3-76
Front isolator to cylinder head bolt	73-78 ft-lbs	98.9-105.7 Nm	LOCTITE THREADLOCKER 262 (red), page 3-20
Gearcase cover screws	80-110 in-lbs	9.0-12.4 Nm	special pattern to tighten, page 3-59
Isolator bolt, front	100-110 ft-lbs	135.6-149.1 Nm	page 3-10
Isolator bolts, side	100-110 ft-lbs	135.6-149.1 Nm	LOCTITE THREADLOCKER 262 (red), page 3-10
Oil filter adapter	8-12 ft-lbs	10.8-16.3 Nm	LOCTITE THREADLOCKER 243 (blue), page 3-39
Oil pressure indicator switch	4-6 ft-lbs	5.4-8.1 Nm	page 3-39
Oil pump cover screws	125-150 in-lbs	14.1-16.9 Nm	TORX, page 3-38
Oil pump mounting screws	125-150 in-lbs	14.1-16.9 Nm	page 3-38
Pinion shaft nut	35-45 ft-lbs	47.5-61.0 Nm	LOCTITE THREADLOCKER 262 (red), page 3-50
Rocker box bolts	10-14 ft-lbs	13.6-19.0 Nm	page 3-22
Rocker box cover screws	10-14 ft-lbs	13.6-19.0 Nm	page 3-22
Rocker box screws	130-150 in- lbs	14.7-16.9 Nm	page 3-22
Rocker box to head bolts	15-19 ft-lbs	20.3-25.8 Nm	2 sizes, page 3-22
Swingarm mount block bolts, lower	68-75 ft-lbs	92.2-101.7 Nm	page 3-10
Swingarm mount block bolts, upper	41-45 ft-lbs	55.6-61.0 Nm	page 3-10
Tappet plate screw (1999 Models)	80-110 in-lbs	9.0-12.4 Nm	page 3-41
Tappet retainer screw (1999 Models)	11-15 ft-lbs	20.3-24.4 Nm	page 3-41
Tie bar bolts	30-33 ft-lbs	40.7-44.7 Nm	page 3-10

MODEL YEAR CHANGE

All 2000 Model Year Thunderstorm™ engines are equipped with **new** hydraulic lifters, redesigned lifter blocks, **new** gearcase cover and gasket, a straight, pressed-in crank pin and **new** low inertia flywheels.

GENERAL

The Thunderstorm™ high performance engine is a two-cylinder, four-cycle, air-cooled, overhead-valve V-twin. It has three major component assemblies.

Cylinder

The cylinder assembly includes cylinder head, valves, rocker arm cover, rocker arms and piston. Cylinders mount on the crankcase in a 45 degree "V" with both connecting rods connected to a single crank pin.

Thunderstorm engines have modified cylinder heads with a black finish and unique pistons.

Crankcase

The up-and-down motion of the piston in the cylinder is converted to circular motion in the crankcase. The multi-piece crankshaft consists of a crank pin mounted between two counterweighted flywheels, which rotate on two end shaft bearings. The lower end of the rear cylinder connecting rod is forked to fit around the single-end front cylinder connecting rod, allowing a single connecting rod crank pin connection to the flywheel.

Gearcase

The gearcase is located on the right side of the crankcase. The gearcase houses the gear train, which operates and times the valves and ignition. The cam gear train, consisting of four cam shafts with one cam lobe on each shaft, is gear driven. The engine valves are opened and closed through the mechanical linkage of hydraulic lifters, push rods and rocker arms. Hydraulic lifters, located in the lifter bores, automatically compensate for heat expansion to maintain the no-lash fit of valve train components. Hydraulic lifters and pushrods transmit the cam action to the valve linkage. Valve timing is obtained by aligning timing marks when installing cam gears.

Ignition spark is produced by the operation of a microprocessor-controlled electronic control module (ECM), ignition coil and spark plugs. Spark timing is determined by a trigger rotor, magnetic sensing unit and the ECM.

The trigger rotor has six openings which time the cylinders and communicate engine speed to the ECM.

The spark plugs fire independently during the compression stroke on each cylinder (no waste spark).

FUEL

Gasoline/alcohol Blends

Buell motorcycles were designed to obtain the best performance and efficiency using unleaded gasoline (91 pump octane or higher). Some fuel suppliers sell gasoline/alcohol blends as a fuel. The type and amount of alcohol added to the fuel is important.

- **DO NOT USE GASOLINES CONTAINING METHANOL.** Using gasoline/methanol blends will result in starting and driveability deterioration and damage to critical fuel system components.
- **ETHANOL** is a mixture of 10% ethanol (Grain alcohol) and 90% unleaded gasoline. Gasoline/ethanol blends can be used in your motorcycle if the ethanol content does not exceed 10%.
- **Gasolines containing ETHER:** Gasoline/ether blends are a mixture of gasoline and as much as 15% ether. Gasoline/ether blends can be used in your motorcycle if the ether content does not exceed 17%.
- **REFORMULATED OR OXYGENATED GASOLINES (RFG):** "Reformulated gasoline" is a term used to describe gasoline blends that are specifically designed to burn cleaner than other types of gasoline, leaving fewer "tailpipe" emissions. They are also formulated to evaporate less when you are filling your tank. Reformulated gasolines use additives to "oxygenate" the gas. Your motorcycle will run normally using this type of gas. Buell recommends you use it when possible, as an aid to cleaner air in our environment.

Because of their generally higher volatility, these blends may adversely affect the starting, driveability and fuel efficiency of your motorcycle. If you experience these problems, Buell recommends you operate your motorcycle on straight, unleaded gasoline.

LUBRICATION

The engine has a force-feed (pressure) type oiling system, incorporating oil feed and return pumps in one pump body, with one check valve on the oil feed side. The feed pump forces oil to the engine, lubricating lower connecting rod bearings, rocker arm bushings, valve stems, valve springs, push rods and tappets. Cylinder walls, pistons, piston pins, timing gears and bushings and main bearings are lubricated by oil spray thrown off connecting rods and crankshaft, and by oil draining from each rocker box through an internal drain passage in each cylinder and each tappet guide. A small amount of oil is sprayed through an oil galley jet onto the rear intake cam gear in the gearcase; oil is transferred to the teeth of all the cam gears by way of the gear meshing action. The oil-scavenging section of the pump returns oil to the tank from the engine. See 3.7 LUBRICATION SYSTEM for more information.

ADJUSTMENT/TESTING

General

When an engine needs repair, it is not always possible to determine definitely beforehand whether repair is possible with only cylinder heads, cylinders and pistons disassembled or whether complete engine disassembly is required for crankcase repair.

Most commonly, only cylinder head and cylinder repair is needed (valves, rings, piston, etc.) and it is recommended procedure to service these units first, allowing engine crankcase to remain in frame.

See 3.3 STRIPPING MOTORCYCLE FOR ENGINE REPAIR to strip motorcycle for removal of cylinder heads, cylinders, and pistons.

After disassembling "upper end" only, it may be found that crankcase repair is necessary. In this situation, remove the engine crankcase from the chassis. See 3.3 STRIPPING MOTORCYCLE FOR ENGINE REPAIR.

CAUTION

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

Symptoms indicating a need for engine repair are often misleading, but generally, if more than one symptom is present, possible causes can be narrowed down to make at least a partial diagnosis. An above-normal consumption of oil, for example, could be caused by several mechanical faults. See 1.27 TROUBLESHOOTING. However, when accompanied by blue-gray exhaust smoke and low engine compression, it indicates the piston rings need replacing. Low compression by itself, however, may indicate improperly seated valves, in addition to or in lieu of worn piston rings.

Most frequently, valves, rings, pins, bushings, and bearings need attention at about the same time. If the possible causes can be narrowed down through the process of elimination to indicate any one of the above components is worn, it is best to give attention to all of the cylinder head and cylinder parts.

Compression Test Procedure

Combustion chamber leakage can result in unsatisfactory engine performance. A compression test can help determine the source of cylinder leakage. Use CYLINDER COMPRESSION GAUGE (Part No. HD-33223-1).

A proper compression test should be performed with the engine at normal operating temperature when possible. Proceed as follows:

CAUTION

After completing the compression test(s), make sure that the throttle plate is in the closed position before starting engine. Engine will start at an extremely high RPM if throttle plate is left open.

1. Disconnect spark plug wires. Clean around plug base and remove plugs.
2. Connect compression tester to front cylinder.
3. With throttle plates in wide open position, crank engine continuously through 5-7 full compression strokes.
4. Note gauge readings at the end of the first and last compression strokes. Record test results.
5. Connect compression tester to rear cylinder.
6. Repeat Steps 3 and 4 on rear cylinder.
7. Compression is normal if final readings are 120 psi (827 kN/m²) or more and do not indicate more than a 10 psi (69 kN/m²) variance between cylinders. See Table 3-1.
8. Inject approximately 1/2 oz. (15 ml) of SAE 30 oil into each cylinder and repeat the compression tests on both cylinders. Readings that are considerably higher during the second test indicate worn piston rings.

Table 3-1. Compression Test Results

DIAGNOSIS	TEST RESULTS
Ring trouble	Compression low on first stroke; tends to build up on the following strokes but does not reach normal; improves considerably when oil is added to cylinder.
Valve trouble	Compression low on first stroke; does not build up much on following strokes; does not improve considerably with the addition of oil.
Head gasket leak	Same reaction as valve trouble.

Cylinder Leakage Test

The cylinder leakage test pinpoints engine problems including leaking valves, worn, broken or stuck piston rings and blown head gaskets. The cylinder leakage tester applies compressed air to the cylinder at a controlled pressure and volume, and measures the percent of leakage from the cylinder.

Use a CYLINDER LEAKDOWN TESTER (Part No. HD-35667A) and follow the specific instructions supplied with the tester.

The following are some general instructions that apply to Buell motorcycle engines:

1. Run engine until it reaches normal operating temperature.
2. Stop engine. Clean dirt from around spark plugs and remove spark plugs.
3. Remove air cleaner cover. Set throttle in wide open position.
4. Remove timing inspection plug from crankcase.
5. The piston, in cylinder being tested, must be at top dead center of compression stroke during test.
6. To keep engine from turning over when air pressure is applied to cylinder, engage transmission in fifth gear and lock the rear brake.
7. Following the manufacturer's instructions, perform a cylinder leakage test on the front cylinder. Make a note of the percent leakdown. Any cylinder with 12% leakdown, or more, requires further attention.
8. Listen for air leaks at intake, exhaust, head gasket and timing inspection hole. See Table 3-2.

NOTE

If air is escaping through valves, check push rod length.

9. Repeat procedure on rear cylinder.

CAUTION

After completing the compression test(s), make sure that the throttle plate is in the closed position before starting engine. Engine will start at an extremely high RPM if throttle plate is left open.

Table 3-2. Air Leakage Test

AIR LEAK LOCATION	POSSIBLE CAUSES
Manifold intake	Intake valve leaking.
Exhaust pipe	Exhaust valve leaking.
Timing inspection hole	Piston rings leaking. Worn or broken piston. Worn cylinder.
Head gasket	Leaking gasket.

Diagnosing Smoking Engine or High Oil Consumption

Perform COMPRESSION TEST PROCEDURE or CYLINDER LEAKAGE TEST as described previously. If further testing is needed, remove suspect head(s) and inspect the following:

- Valve guide seals.
- Valve guide-to-valve stem clearance.
- Gasket surface of both head and cylinder.
- Oil return passages for clogging.

DISASSEMBLING ENGINE FOR CYLINDER HEAD REPAIR

1. Lift and secure the motorcycle.
 - a. Place vehicle on a lift and anchor front wheel in place. Raise lift so the top of the cylinder head is easy to access.
 - b. Raise rear wheel off lift using REAR WHEEL SUPPORT STAND (Part No. B-41174).

WARNING

To avoid accidental start-up of vehicle and possible personal injury, disconnect the battery cables before proceeding. Always disconnect the negative cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion which could result in death or serious injury.

2. Disconnect both battery cables, negative cable first.

WARNING

The gasoline in the fuel supply line downstream of the fuel pump is under high pressure (49 psi [338 kPa]). To avoid an uncontrolled discharge or spray of gasoline, always purge the system of high pressure gas before attaching fuel pressure gauge. Gasoline is extremely flammable and highly explosive. Inadequate safety precautions could result in death or serious injury.

3. Remove seat and fuel tank. See 4.34 FUEL TANK.
4. Remove air cleaner cover and backplate. See 4.39 AIR CLEANER.
5. Remove throttle body and manifold. See 4.38 THROTTLE BODY AND MANIFOLD.
6. Remove support bracket on left side of cylinder heads.
7. Remove exhaust header and muffler. See 2.35 EXHAUST SYSTEM.
8. Disconnect spark plug cables. Remove spark plugs.
9. If removing front cylinder, remove ignition coil (4.30 IGNITION COIL) and horn (7.22 HORN).

NOTE

At this stage, the lower rocker boxes, cylinder heads and cylinders may be removed. See 3.5 CYLINDER HEAD.

ENGINE CRANKCASE REPLACEMENT OR COMPLETE ENGINE REMOVAL

1. Perform the steps listed above. In addition, remove battery from frame.
2. See Figure 3-1. Place a floor hoist behind the lift. Attach straps to tail section and hoist. Raise hoist until straps tighten.

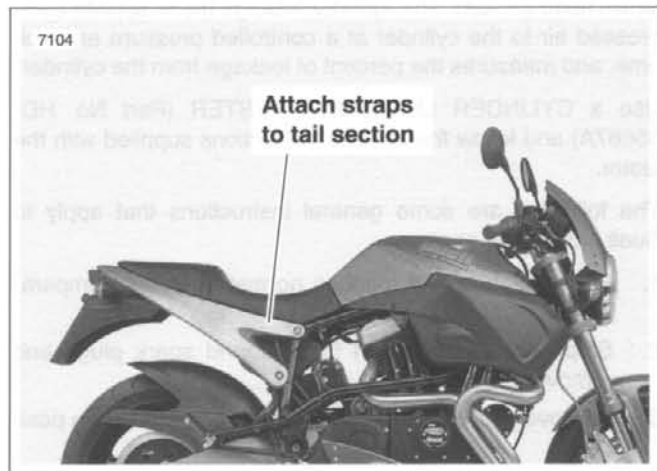


Figure 3-1. Floor Hoist

3. Detach clutch cable from handlebar lever.
4. Remove rear fender and lower belt guard. See 2.40 REAR FENDER.
5. Remove sprocket cover. See 2.38 SPROCKET COVER.
6. Detach rear brake caliper from caliper mount. See 2.15 REAR BRAKE CALIPER (1999 models) or 2.22 REAR BRAKE CALIPER (2000 models).
7. Detach belt from rear sprocket and remove rear wheel. See 2.7 REAR WHEEL.
8. Drain oil tank and remove oil filter. See 1.6 ENGINE LUBRICATION SYSTEM.
9. Detach hoses from oil tank fittings. See 3.9 OIL TANK.
10. Remove both rider footrest mounts from frame. See 2.36 FOOTRESTS (1999 Models) or 2.37 FOOTRESTS (2000 Models).
11. Remove both rear shock mounting bolts (metric).
12. Disconnect wiring. See Section 7.
 - a. Disconnect neutral switch wire from crankcase.
 - b. Unplug cam position sensor from wiring harness.
 - c. Remove solenoid wire, battery positive cable and circuit breaker charging wire from starter motor.
 - d. Locate voltage regulator connector near the oil pump. Disconnect from alternator stator.
 - e. Detach wire from oil pressure indicator switch. See 3.10 OIL PRESSURE INDICATOR SWITCH.
13. See Figure 3-2. Place a wooden cradle underneath the crankcase.

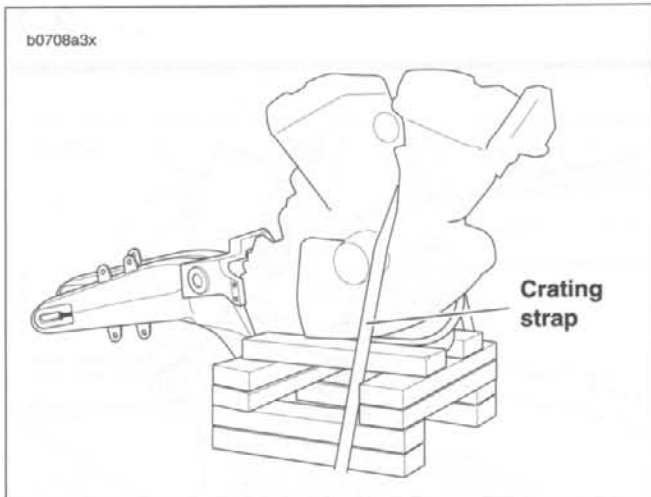


Figure 3-2. Supporting the Engine

14. Place a crating strap between the engine cylinders and around the lift. Tighten crating strap until snug.
15. See Figure 3-3. Remove engine ground strap (1) from swingarm mount block.
16. Detach remaining tie bars from frame.
 - a. Remove rear tie bar using a swivel socket.
 - b. See Figure 3-4. Detach front lower tie bar (1) and clutch cable clamp (3). Remove tie bar bolt (2), clutch cable clamp (3), washer (4) and locknut (5).
 - c. Remove washer and nut to detach front upper tie bar (11) from isolator (8).
17. Detach front isolator (8). Remove front isolator bolt (6), nut (10), D-washer (9) and washer (7).
18. See Figure 3-3. Remove isolator bolt (7) and lockwasher (6) on each side.
19. Slowly raise floor hoist until rubber isolators (5) can be removed. Frame will rise while engine remains secured to lift by crating strap.

NOTE

Rubber isolators align with a frame mounted metal pin.

20. Raise frame and walk forward over and away from the engine.
21. If necessary, remove rear swingarm assembly. See 2.27 SWINGARM.
22. If necessary, detach swingarm mount block from powertrain by removing bolts (3, 4), washers and locknuts.

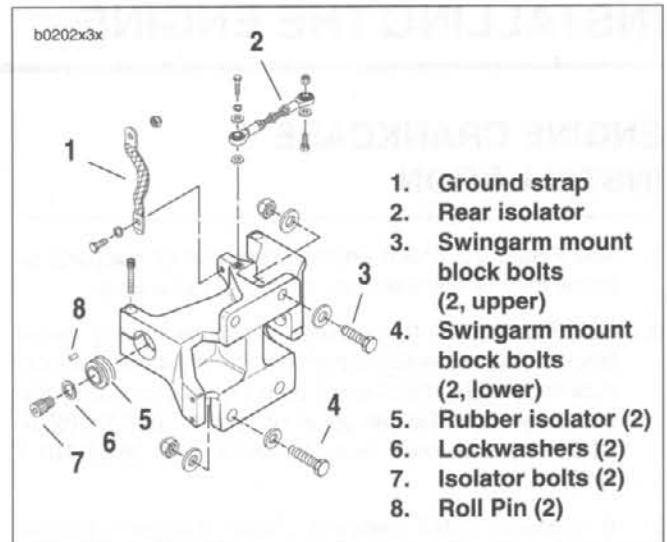


Figure 3-3. Rear Tie Bar Assembly

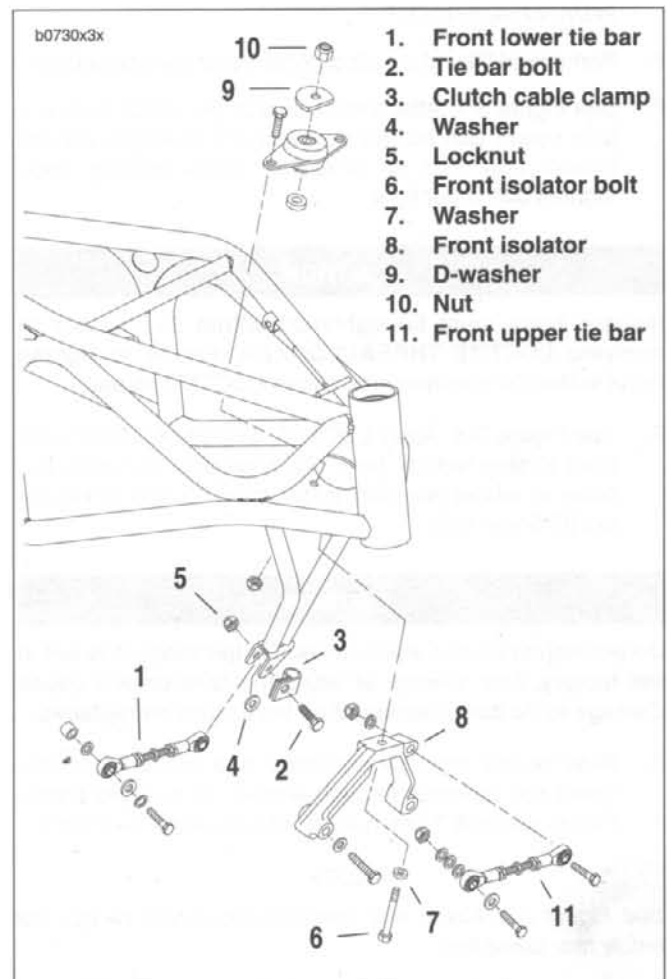


Figure 3-4. Front Tie Bar Assembly

ENGINE CRANKCASE INSTALLATION

1. See Figure 3-2. Place engine crankcase on supports so frame may be installed over the top of the engine.
2. See Figure 3-3. If removed, attach swingarm mount block to engine. Install upper bolts (3), washers and locknuts finger tight. Install lower bolts (4), washers and locknuts finger tight. Tighten upper bolts to 41-45 ft-lbs (55.6-61.0 Nm) and lower bolts to 68-75 ft-lbs (92.2-101.7 Nm).
3. If removed, install swingarm. Adjust swingarm bearing preload. See 2.27 SWINGARM.
4. If removed, install transmission mainshaft sprocket. See 6.13 TRANSMISSION INSTALLATION AND SHIFTER PAWL ADJUSTMENT.
5. Remove oil filter (if installed). Walk frame over powertrain.
6. See Figure 3-4. Attach front isolator (8). Install front isolator mount with bolt (6), washers (7), D-washer (9) and locknut (10). Flat on D-washer faces steering neck. Tighten bolt finger tight.

CAUTION

Isolator bolts must be tightened within 30 minutes of applying LOCTITE THREADLOCKER. Failure to tighten bolts within 30 minutes may cause LOCTITE to set.

7. See Figure 3-3. Apply LOCTITE THREADLOCKER 262 (red) to side isolator bolts (7). Align pins on frame into holes in rubber isolators. Install bolts (7) and lockwashers (6) finger tight.

CAUTION

Do not adjust tie bar assemblies. Tie bar tension is set at the factory. Any attempt at adjusting tension will cause damage to tie bars. Damaged tie bars must be replaced.

8. Rear tie bar must be horizontal and below frame tab. Insert bolt upwards through washer, tie bar and frame. Fasten with nut. Tighten to 30-33 ft-lbs (40.7-44.7 Nm).

NOTE

See Figure 3-5. Route wire harness above rear tie bar, but below rear brake line.

9. See Figure 3-4. Place clutch cable clamp (3) on front tie bar bolt (2). Clamp should hold cable on primary cover side of motor. Insert bolt from front through frame and install washer (4). Continue through tie bar (1) and frame. Install locknut (5) and tighten to 30-33 ft-lbs (40.7-44.7 Nm).
10. Attach front upper tie bar (11). Insert bolt through tie bar front isolator, and frame. Secure with nut and washer. Tighten to 30-33 ft-lbs (40.7-44.7 Nm).

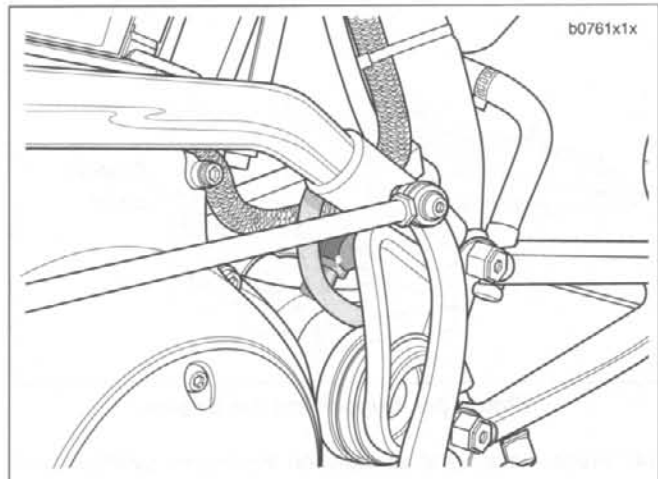


Figure 3-5. Wire Harness Routing

11. See Figure 3-3. Tighten the two side isolator bolts (7) to 100-110 ft-lbs (135.6-149.1 Nm).
12. See Figure 3-4. Tighten front isolator bolt (6) to 100-110 ft-lbs (135.6-149.1 Nm).
13. Connect hoses to oil tank. See 3.8 OIL HOSE ROUTING. Use **new** hose clamps.
14. Attach battery ground strap to swingarm mount block.
15. Attach clutch cable to handlebar lever.
16. Remove strap from between engine cylinders. Using a floor hoist, lift motorcycle by the frame and remove the wooden cradle from underneath the crankcase.
17. Install rear shock. See 2.28 REAR SHOCK ABSORBER.
18. Install rear wheel and attach secondary drive belt. See 2.7 REAR WHEEL. After rear wheel and belt are installed, remove floor hoist straps.
19. Install rear brake caliper. See 2.15 REAR BRAKE CALIPER (1999 models) or 2.22 REAR BRAKE CALIPER (2000 models).
20. Attach disconnected wires. See Section 7.
 - a. Connect solenoid wire, circuit breaker charging wire and battery positive cable to starter.
 - b. Connect voltage regulator connector to alternator stator wiring.
 - c. Attach cam position sensor to wire harness.
 - d. Connect neutral switch wire to crankcase.
 - e. Attach oil pressure indicator switch wire.
21. Install rear fender and lower belt guard. See 2.40 REAR FENDER.
22. Install sprocket cover. See 2.38 SPROCKET COVER.
23. Install footrests. See 2.36 FOOTRESTS (1999 Models) or 2.37 FOOTRESTS (2000 Models).
24. Continue with the steps listed under ENGINE INSTALLATION AFTER CYLINDER HEAD REPAIR.

ENGINE INSTALLATION AFTER CYLINDER HEAD REPAIR

1. Install **new** oil filter, engine oil and primary chaincase fluid as necessary. See Section 1.
2. Install throttle body and manifold and support bracket. See 4.38 THROTTLE BODY AND MANIFOLD.
3. Install exhaust system. See 2.35 EXHAUST SYSTEM.
4. Install air cleaner assembly. See 4.39 AIR CLEANER.
5. If removed, install horn (7.22 HORN) and ignition coil (4.30 IGNITION COIL).
6. Install spark plugs and connect cables. See 1.20 SPARK PLUGS.

WARNING

Always connect positive battery cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion which could result in death or serious injury.

7. Install battery. Connect both battery cables, positive cable first.

WARNING

After installing seat, pull upward on front of seat to be sure it is locked in position. If seat is loose, it could shift during vehicle operation and startle the rider, causing loss of control which could result in death or serious injury.

8. Install fuel tank, fuel tank cover and seat. See 4.34 FUEL TANK.
9. If engine crankcase installation was performed:
 - a. Adjust rear belt deflection. See 1.13 REAR BELT DEFLECTION.
 - b. Adjust rear shock spring preload. See 1.16 PRE-LOAD ADJUSTMENT.
 - c. Adjust clutch lever. See 1.12 CLUTCH.
 - d. Check rear brake pedal height. See 1.7 BRAKES (1999 Models) or 1.9 BRAKES (2000 Models).
10. Check all electrical components for proper operation.
11. Calibrate (re-zero) TPS. See 4.33 THROTTLE POSITION SENSOR

REMOVAL

Before removing the cylinder head assembly, see **DISASSEMBLING ENGINE FOR CYLINDER HEAD REPAIR**. The rocker arm covers and internal components must be removed before removing cylinder heads.

1. See Figure 3-6. Remove screws with washers (1) and fiber seals (2). Discard fiber seals.

CAUTION

All washers and fasteners used in the V²_{TM} engine are hardened. Do not mix or replace hardened washers and fasteners with unhardened parts. Do not reuse fiber cover seals. These actions may result in accelerated wear and increased noise.

2. Remove upper (4) and middle (5) sections of rocker cover. Remove and discard gaskets (6, 7 and 8).
3. Rotate crankshaft until piston on head being repaired reaches top dead center of compression stroke.

NOTE

Both valves in the cylinder head will be closed when viewed through the spark plug hole.

4. Remove the two rocker arm retaining bolts (12) near the push rods.
5. Remove remaining hardware holding lower rocker cover to cylinder head in the following order.
 - a. Remove two screws and washers (14).
 - b. Remove three bolts and washers (15).
 - c. Remove the remaining two rocker arm retaining bolts (13).
6. Remove lower rocker cover (18).

NOTE

Remove lower rocker boxes as an assembly; then disassemble as required.

7. Mark the location and orientation (top/bottom) of each push rod. Remove push rods.

CAUTION

Mark rocker arm shafts for reassembly in their original positions. Valve train components must be reinstalled in their original positions to prevent accelerated wear and increased valve train noise.

8. See Figure 3-7. Remove rocker arm shafts by tapping them out using a hammer and a soft metal punch.
9. See Figure 3-6. Remove rocker arms (10, 11); mark them for reassembly in their original locations.

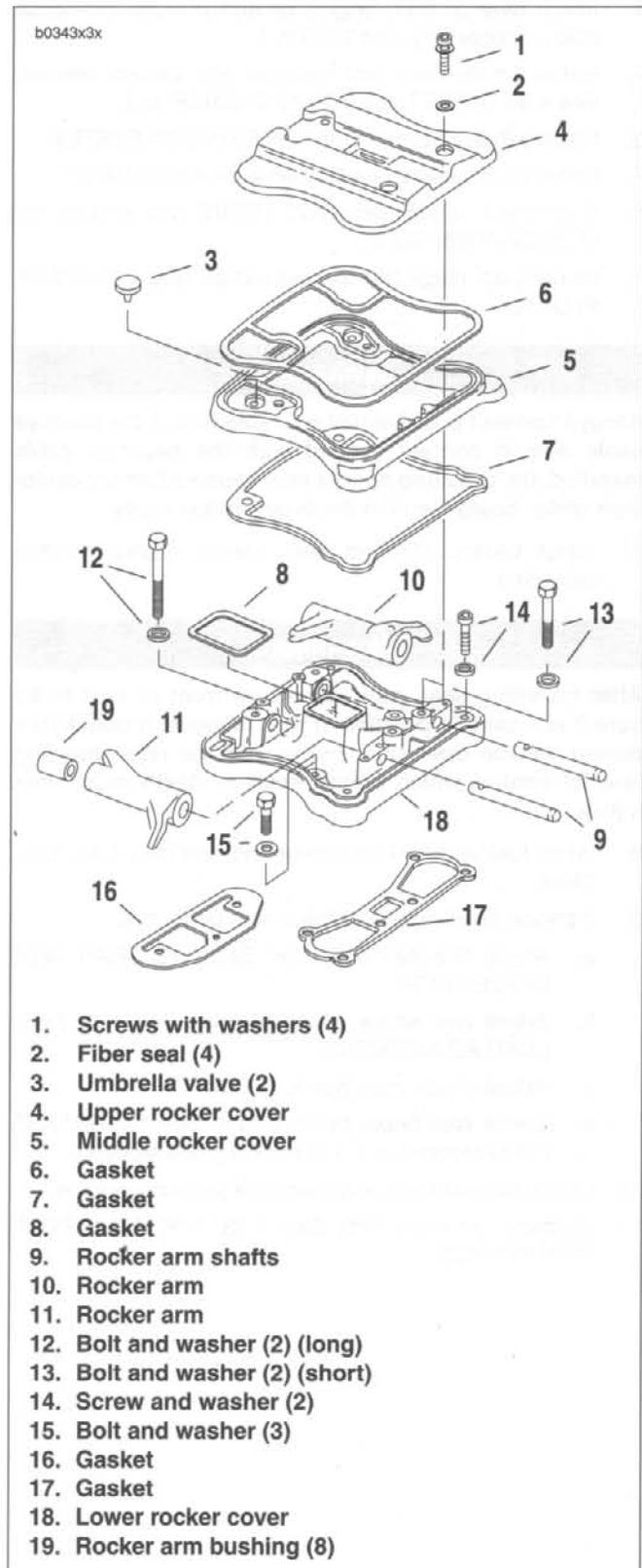


Figure 3-6. Rocker Arm Cover

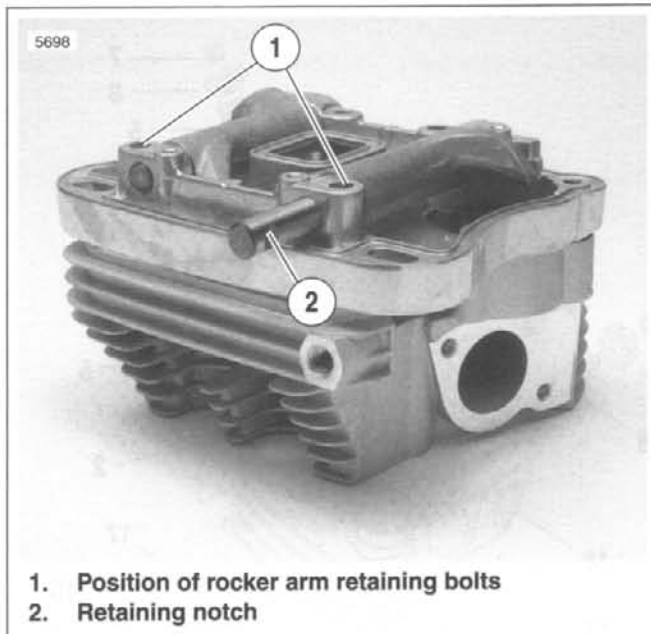


Figure 3-7. Removing Rocker Arm Shafts

CAUTION

Distortion to the head, cylinder and crankcase studs may result if head screws are not loosened (or tightened) gradually in the sequence shown in Figure 3-8.

- See Figure 3-8. Loosen each head screw 1/8-turn following the sequence shown.

CAUTION

See Figure 3-9. Do not attempt to remove the front isolator mount from front cylinder head. Isolator mount is an integral component and is not meant to be removed unless absolutely necessary. Repeated removals and installations will damage cylinder head threads.

- Support motorcycle under front header mount. Do not allow engine to drop when performing the next steps.
- Remove nut, washer and bolt to detach front upper tie bar from isolator and frame.
- Continue loosening in 1/8-turn increments until screws are loose. Remove head screws.
- See Figure 3-10. Remove cylinder head (18), head gasket (4), and O-rings (14).

NOTE

Front cylinder head must be removed through upper triangular frame members with front isolator mount attached.

- Remove both push rod covers and valve tappets. See 3.15 VALVE TAPPETS (1999 models) or 3.16 HYDRAULIC LIFTERS (2000 models).
- Repeat the above procedure for the other cylinder head.

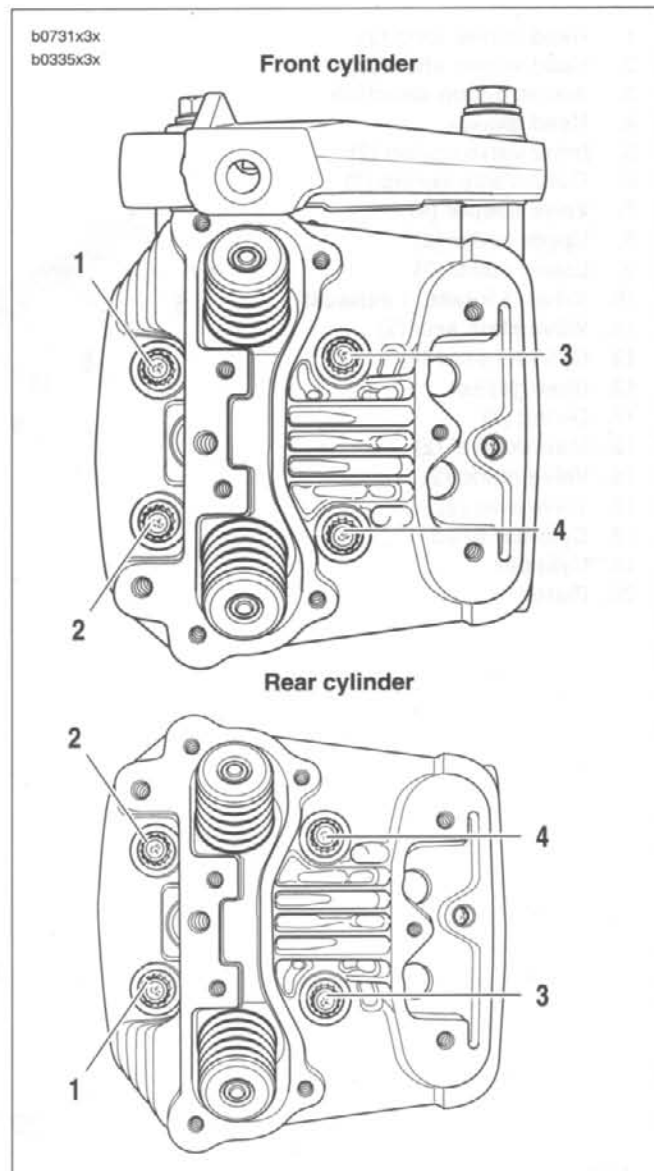


Figure 3-8. Head Screw Loosening/Tightening Sequence

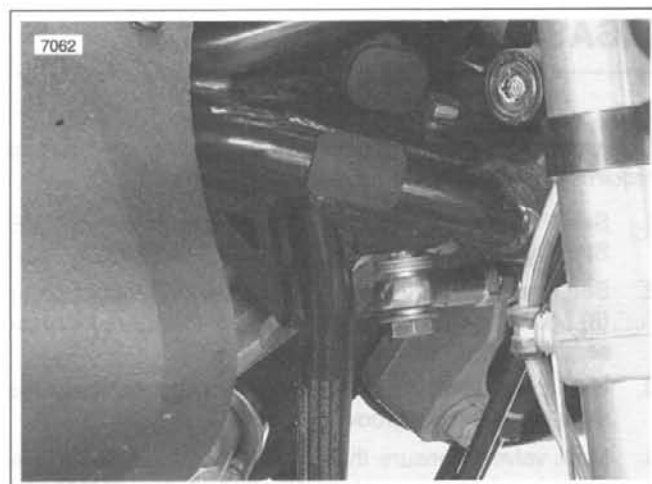


Figure 3-9. Front Isolator Mount and Tie Bar

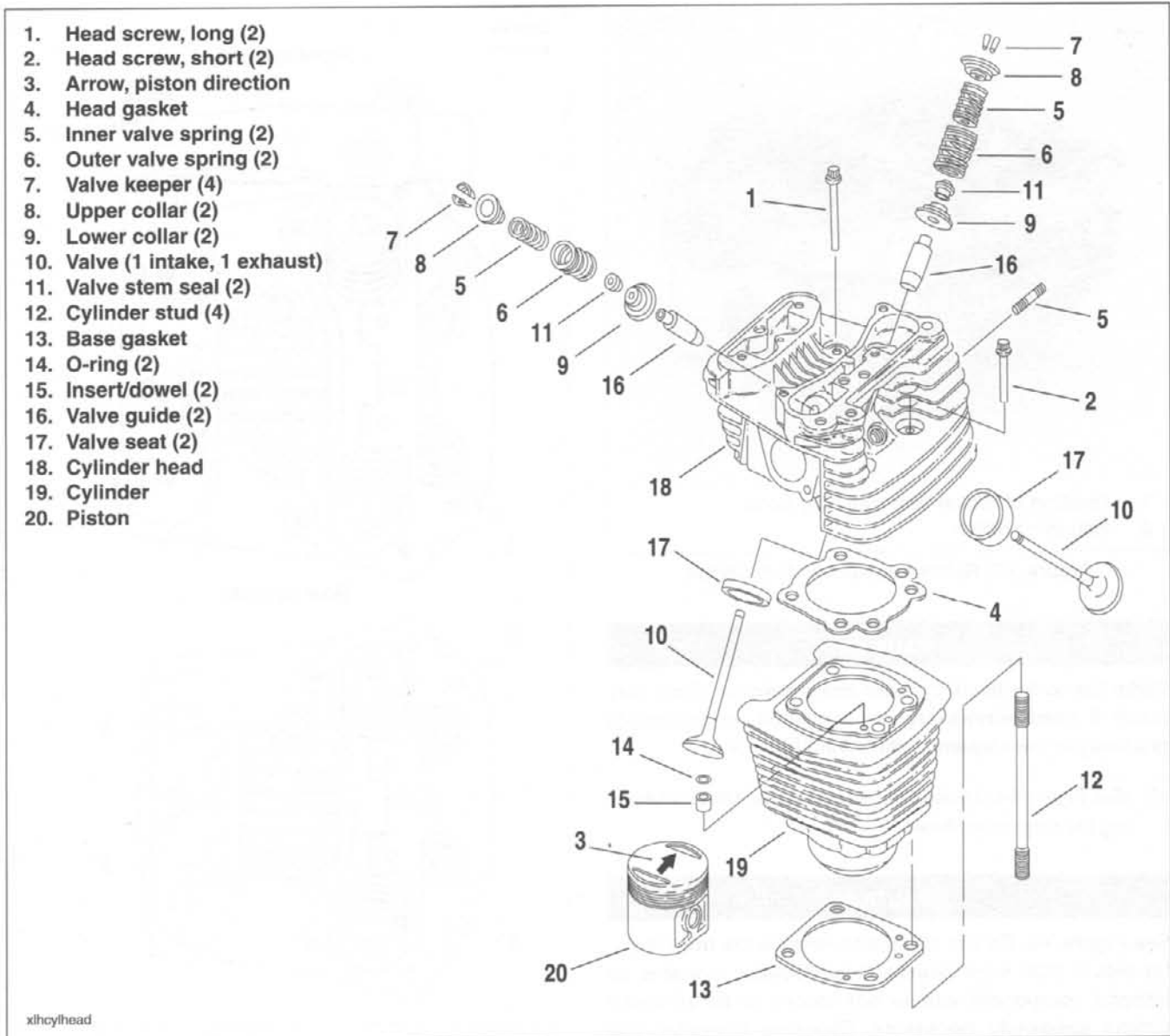


Figure 3-10. Cylinder Head, Cylinder and Piston

DISASSEMBLY

NOTE

Disassembly of front cylinder exhaust valve components requires front isolator mount removal.

1. See Figure 3-11. Compress valve springs with VALVE SPRING COMPRESSOR (Part No. HD-34736B).
2. See Figure 3-10. Remove valve keepers (7), upper collar (8) and valve springs (5, 6). Mark valve keepers for reassembly in their original locations.
3. Use a fine tooth file to remove any burrs on the valve stem at the keeper groove.
4. Mark valve to ensure that it will be reassembled in the same head. Remove valve (10), valve stem seal (11) and lower collar (9).
5. Repeat the above procedure for the other valve.
6. Disassemble the other head using the same procedure.

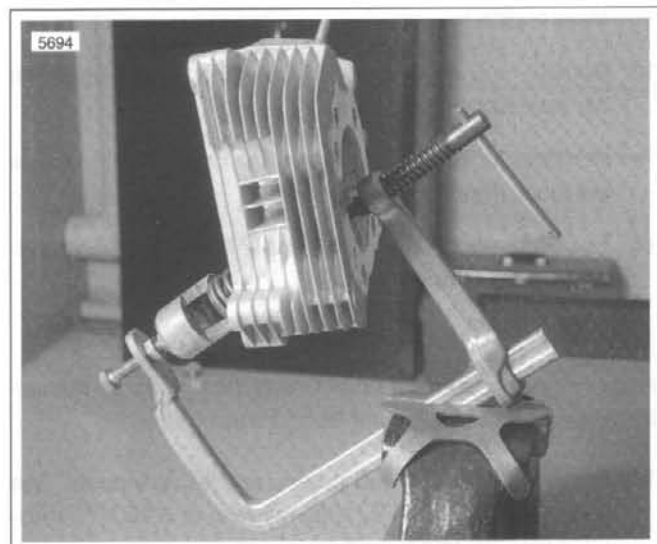


Figure 3-11. Valve Spring Compressor (Part No. HD-34736B)

CLEANING, INSPECTION AND REPAIR

1. Bead blast or scrape carbon from head, top of cylinder and valve ports. Be careful to avoid scratching or nicking cylinder head and cylinder joint faces. Blow off loosened carbon or dirt with compressed air.
2. Soak cylinder head in an aluminum-compatible cleaner/solvent to loosen carbon deposits.
3. Wash all parts in non-flammable solvent, followed by a thorough washing with hot, soapy water. Blow out oil passages in head. Be sure they are free of sludge and carbon particles. Remove loosened carbon from valve head and stem using a wire wheel. Never use a file or other hardened tool which could scratch or nick valve. Polish valve stem with very fine emery cloth or steel wool.
4. Check each rocker arm, at pad end and push rod end, for uneven wear or pitting. Replace rocker arm if either condition exists.

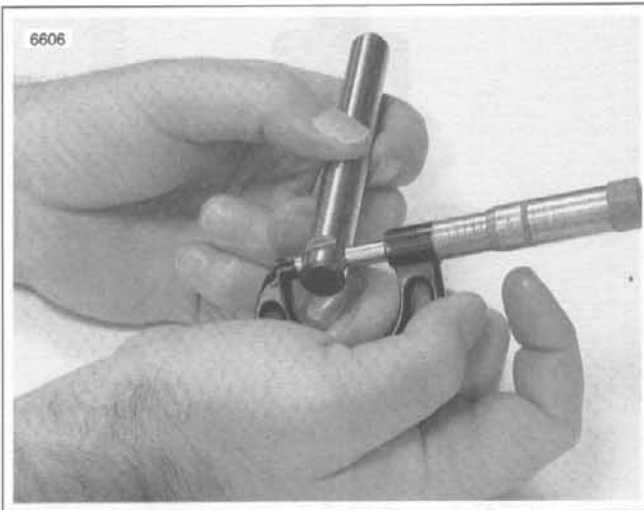


Figure 3-12. Measuring Rocker Arm Shaft Diameter (Rocker Cover Position)

5. Measure and record rocker arm shaft diameter.
 - a. See Figure 3-12. Measure where shaft fits in lower rocker arm cover.
 - b. See Figure 3-13. Measure where rocker arm bushings ride.
6. Measure and record rocker arm shaft bore diameter.
 - a. See Figure 3-14. Measure bore of lower rocker cover.
 - b. See Figure 3-15. Measure rocker arm bushing inner diameter.
7. Check the measurements obtained in Steps 5-6 against the SERVICE WEAR LIMITS. Repair or replace parts exceeding limits.
8. Assemble rocker arms and rocker arm shafts into lower rocker cover.
9. Check end play of rocker arm with feeler gauge.
10. Replace rocker arm or lower cover or both if end play exceeds 0.025 in. (0.635 mm).

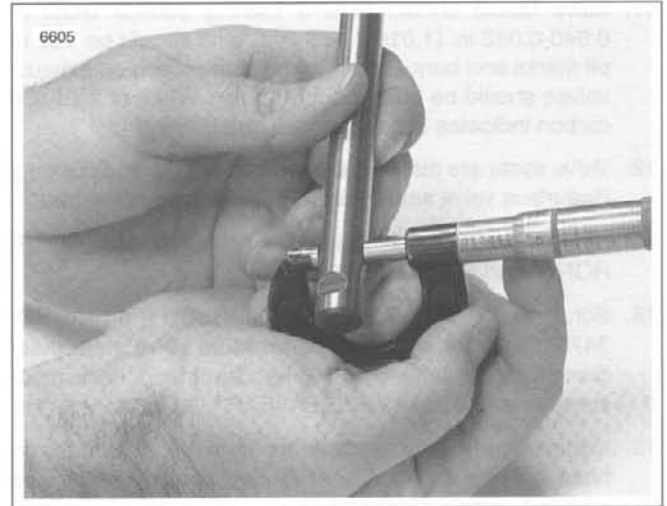


Figure 3-13. Measuring Rocker Arm Shaft Diameter (Rocker Arm Bushing Position)

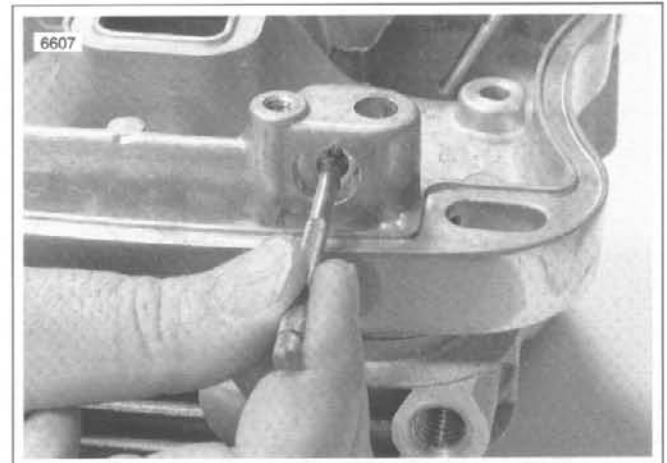


Figure 3-14. Measuring Rocker Arm Shaft Bore Diameter in Lower Rocker Cover

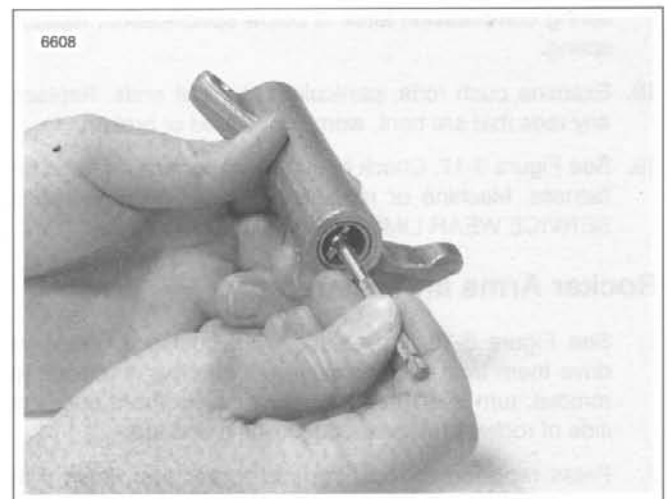


Figure 3-15. Measuring Rocker Arm Bushing Inner Diameter

11. Valve heads should have a seating surface width of 0.040-0.062 in. (1.016-1.575 mm), and should be free of pit marks and burn spots. The color of carbon on exhaust valves should be black or dark brown. White or light buff carbon indicates excessive heat and burning.
12. Valve seats are also subject to wear, pitting, and burning. Resurface valve seats whenever valves are refinished.
13. Clean valve guides by lightly honing with VALVE GUIDE HONE (Part No. HD-34723).
14. Scrub guides with VALVE GUIDE BRUSH (Part No. HD-34751) and hot soapy water. Measure valve stem outer diameter and valve guide inner diameter. Check measurements against SERVICE WEAR LIMITS.
15. Inspect spark plug threads for damage. If threads in head are damaged, a special plug type insert can be installed using a 12 mm spark plug repair kit.
16. Inspect valve springs for broken or discolored coils.

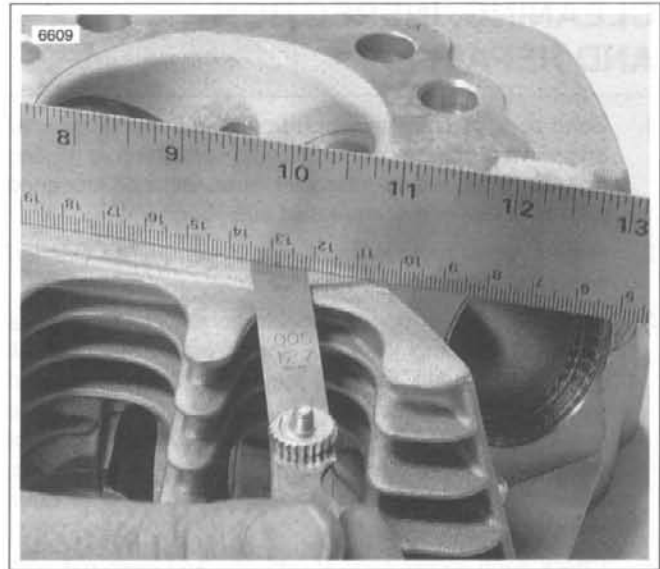


Figure 3-17. Checking Gasket Surface

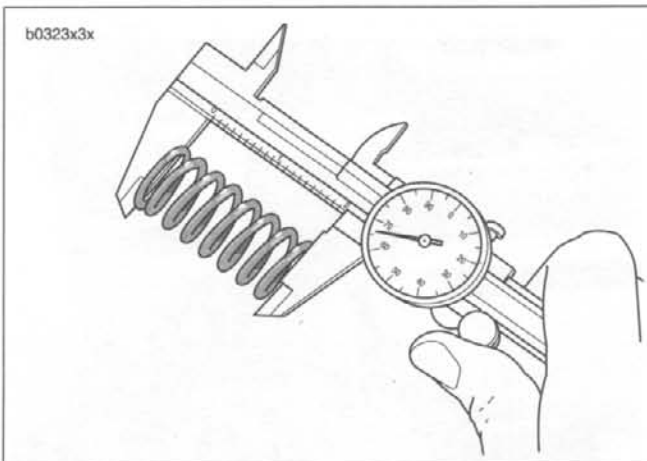


Figure 3-16. Checking Spring Free Length

17. See Figure 3-16. Check free length and compression force of each spring. Compare with SERVICE WEAR LIMITS. If spring length is shorter than specification or if spring compression force is below specification, replace spring.
18. Examine push rods, particularly the ball ends. Replace any rods that are bent, worn, discolored or broken.
19. See Figure 3-17. Check head gasket surface on head for flatness. Machine or replace any head which exceeds SERVICE WEAR LIMIT of 0.006 in. (0.152 mm).

Rocker Arms and Bushings

1. See Figure 3-18. To replace worn bushings, press or drive them from the rocker arm. If bushing is difficult to remove, turn a 9/16-18 tap into bushing. From opposite side of rocker arm, press out bushing and tap.
2. Press replacement bushing into rocker arm, flush with arm end, and split portion of bushing towards top of arm.
3. Using remaining old bushing as a pilot, line ream new bushing with ROCKER ARM BUSHING REAMER (Part No. HD-94804-57).
4. Repeat for other end of rocker arm.

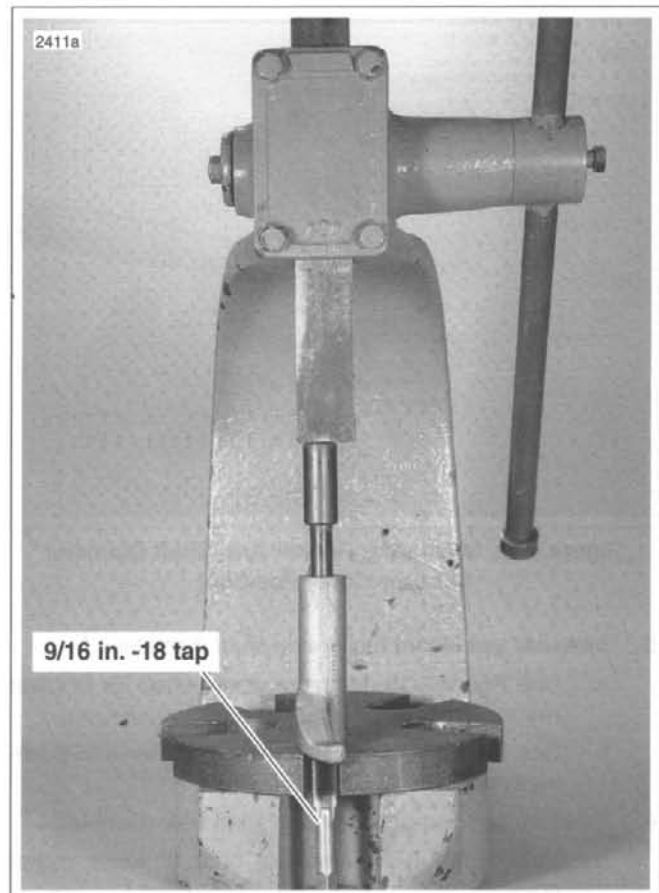


Figure 3-18. Removing Rocker Arm Bushing

Replacing Valve Guides

Valve guide replacement, if necessary, must be done before valve seat is ground. It is the valve stem hole in valve guide that determines seat grinding location. Valve stem-to-valve guide clearances are listed in Table 3-3. If valve stems and/or guides are worn beyond limits, install **new** parts.

Table 3-3. Valve Stem Clearances and Service Wear Limits

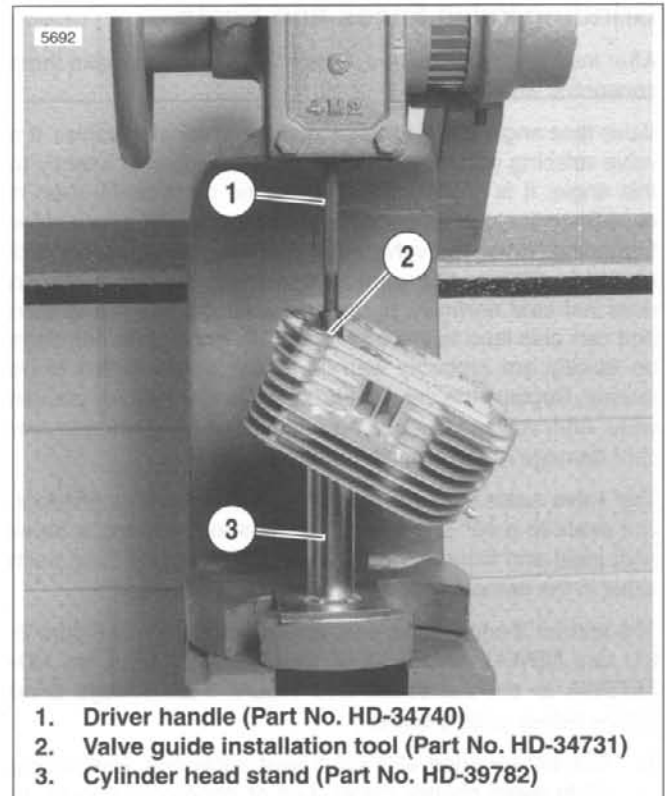
VALVE	CLEARANCE	SERVICE WEAR LIMIT
Exhaust	0.0015-0.0033 in. (0.0381-0.0838 mm)	0.0040 in. (0.1016 mm)
Intake	0.008-0.0026 in. (0.203-0.0660 mm)	0.0035 in. (0.0889 mm)

- To remove shoulderless guides, press or tap guides toward combustion chamber using DRIVER HANDLE AND REMOVER (Part No. HD-34740).
- Clean and measure valve guide bore in head.
- Measure outer diameter of a new standard valve guide. The guide diameter should be 0.0020-0.0033 in. (0.0508-0.0838 mm), larger than bore in head. If it is not, select one of the following oversizes: +0.001 in. (+0.025 mm), +0.002 in. (+0.051 mm) or +0.003 in. (+0.076 mm) (intake and exhaust).
- See Figure 3-19. Install shoulderless guides using VALVE GUIDE INSTALLATION TOOL (2) (Part No. HD-34731) and DRIVER HANDLE (1) (Part No. HD-34740). Press or drive guide until the tool touches the machined surface surrounding the guide. At this point, the correct guide height has been reached.
- Ream guides to final size or within 0.0010 in. (0.0254 mm) of final size using VALVE GUIDE REAMER (Steel, Part No. HD-39932 or Carbide, Part No. HD-39932-CAR). Use REAMER LUBRICANT (Part No. HD-39964) or liberal amounts of suitable cutting oil to prevent reamer chatter.
- Apply the proper surface finish to the valve guide bores using the VALVE GUIDE HONE (Part No. HD-34723). Lubricate hone with honing oil. Driving hone with an electric drill, work for a crosshatch pattern with an angle of approximately 60°.

NOTE

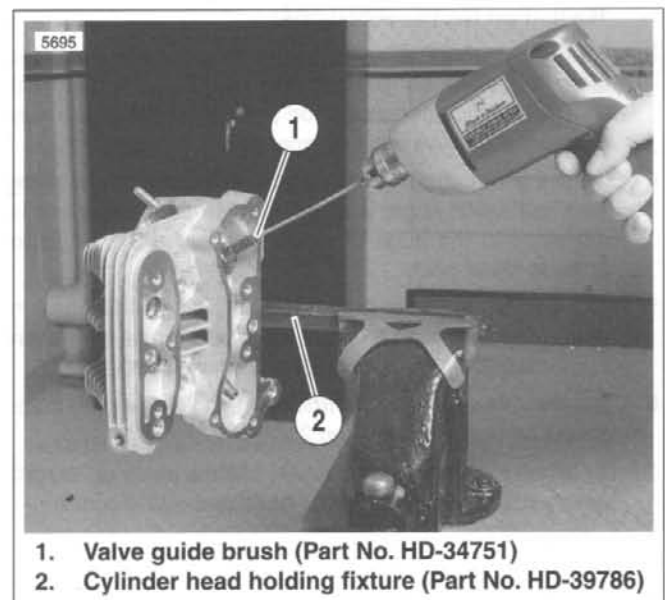
The hone is not intended to remove material.

- See Figure 3-20. Thoroughly clean valve guide bores using VALVE GUIDE BRUSH (1) (Part No. HD-34751) and hot soapy water.



- Driver handle (Part No. HD-34740)
- Valve guide installation tool (Part No. HD-34731)
- Cylinder head stand (Part No. HD-39782)

Figure 3-19. Installing Shoulderless Valve Guide



- Valve guide brush (Part No. HD-34751)
- Cylinder head holding fixture (Part No. HD-39786)

Figure 3-20. Cleaning Valve Guides

Grinding Valve Faces and Seats

After installing valve guides, reface valve seats to make them concentric with guides.

Valve face angle is 45° for both intake and exhaust valves. If a valve refacing grinder is used, it must be adjusted exactly to this angle. It is important to remove no more metal than is necessary to clean up and true valve face. Install a **new** valve if grinding leaves the valve edge (the margin) with a width of less than 1/32 in. (0.8 mm). A valve with too thin a margin does not seat normally, burns easily, may cause pre-ignition and can also lead to valve cracking. Valves that do not clean up quickly are probably warped or too deeply pitted to be reused. Replace the valve if end of valve stem shows uneven wear. After valves have been ground, handle with care to prevent damage to the ground faces.

The valve seats may be refinished with cutters or grinders. Cut seats to a 46° angle or grind seats to a 45° angle. Valve seat tools and fixtures are available commercially. Seat each valve in the same position from which it was removed.

The correct 3-angle valve seat angles are shown in Figure 3-21. Use NEWAY VALVE SEAT CUTTER SET (Part No. HD-35758A) to cut the seats. See Figure 3-22. Always grind valves before cutting seats.

1. Cut 46° (or grind 45°) valve seat angle first. Use cutting oil to avoid chatter marks. Cut or grind only enough to clean up the seat.
2. Apply a small amount of lapping compound to the valve face. Rotate valve against seat using VALVE LAPPING TOOL (Part No. HD-96550-36A).
3. See Figure 3-21. Check the contact pattern on valve face. It should be 0.040-0.062 in. (1.016-1.575 mm) wide, and its center should be positioned 2/3 of the way toward the outside edge of face.
4. If valve seat pattern is too close to the stem side of valve face, cut a 60° angle in order to raise seat. If pattern is too close to the edge of valve face, cut a 31° angle in order to lower seat.
5. After cutting either or both 31° or 60° angles to position seat, final cut 46° (or grind 45°) seat angle to obtain proper 0.040-0.062 in. (1.016-1.575 mm) width.
6. Recheck valve seat width and location with lapping compound as described in Step 2.
7. To achieve a smooth even finish, place a piece of 280 grit emery paper under the cutter head and rotate cutter.

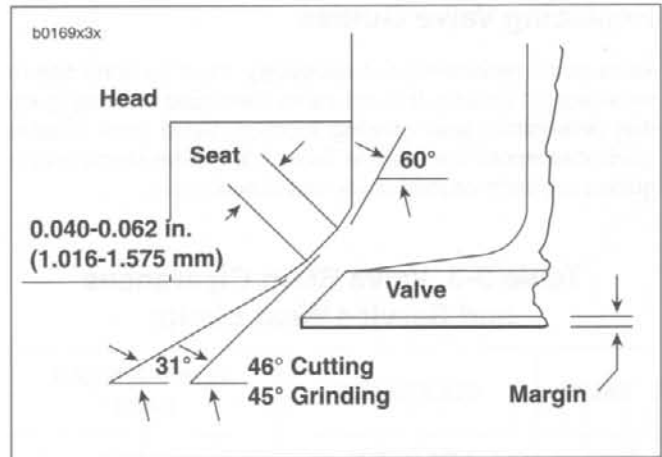


Figure 3-21. Valve Seat Angles



Figure 3-22. Valve Seat Cutter

Table 3-4. Neway Valve Seat Cutters

VALVE SEAT	60° CUTTER	31° AND 46° CUTTERS
Exhaust	Part No. 205	Part No. 622
Intake	Part No. 293	Part No. 642

CAUTION

Do not grind valve to shorten. Grinding will remove the case hardening and expose the stem's mild steel core resulting in rapid end wear.

8. See Figure 3-23. Wipe valve seats and valve faces clean. Measure valve stem protrusion.
 - a. If valve stem protrudes more than 2.031 in. (51.587 mm), replace valve seat or cylinder head.
 - b. If valve stem protrusion is acceptable, valves and seats are ready for lapping.

Replacing Valve Seats

Replacing a valve seat is a complex operation requiring special equipment. If the seat is loose or is not fully seated in the head, then seat movement will prevent the proper transfer of heat from the valve. The seat surface must be flush with (or below) the head surface. See 3.1 SPECIFICATIONS for valve seat-to-cylinder head fit.

To remove the old seat, lay a bead of weld material around the inside diameter of the seat. This will shrink the seat outside diameter and provide a surface for driving the seat out the port side.

Lapping Valve Faces and Seats

NOTE

If valve faces and seats have been smoothly and accurately refaced, very little lapping will be required to complete the seating operation.

1. See Figure 3-24. Use CYLINDER HEAD HOLDING FIXTURE (2) (Part No. HD-39786) to secure cylinder head.
 - a. Apply a light coat of fine lapping compound to valve face. Insert valve in guide.
 - b. Place one rubber cup end of VALVE LAPPING TOOL (1) (Part No. HD-96550-36A) onto head of valve.
 - c. Holding lapping tool as shown, apply only very light pressure against valve head.
 - d. Rotate lapping tool and valve alternately clockwise and counterclockwise a few times.
2. Lift valve and rotate it about 1/3 of a turn clockwise. Repeat lapping procedure in Step 1.
3. Repeat Step 2. Then, remove valve.
4. Wash valve face and seat. Dry parts with a **new**, clean cloth or towel.
5. Inspect valve and seat.
 - a. If inspection shows an unbroken lapped finish of uniform width around both valve and seat, valve is well seated.
 - b. If lapped finish is not complete, further lapping (or grinding and lapping) is necessary.

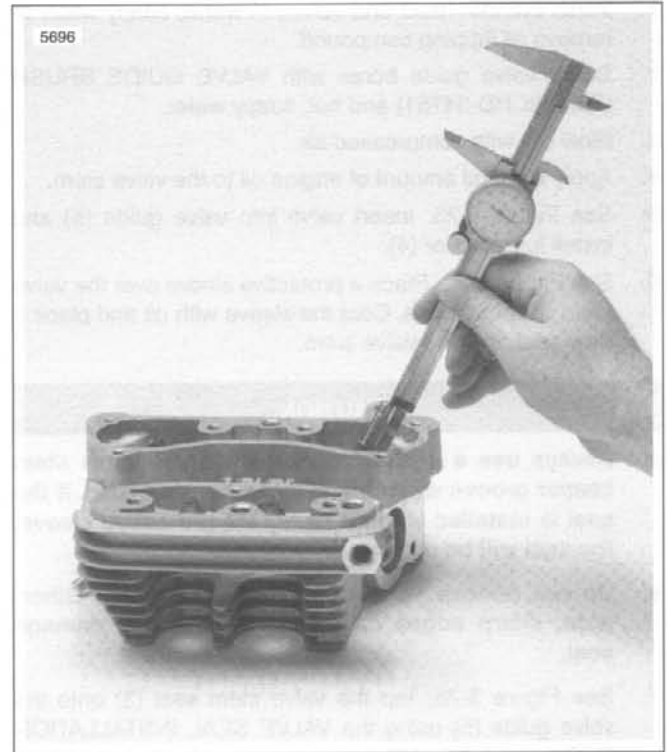
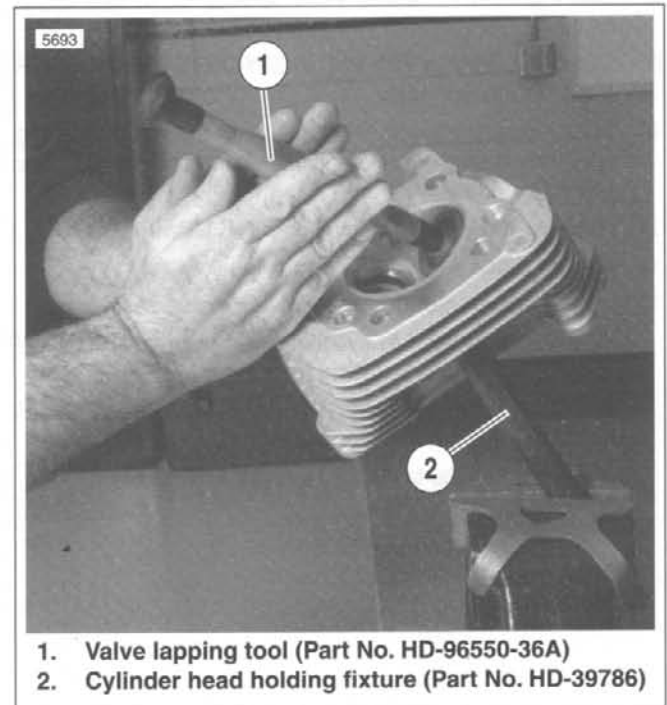


Figure 3-23. Measuring Valve Stem Protrusion



1. Valve lapping tool (Part No. HD-96550-36A)
2. Cylinder head holding fixture (Part No. HD-39786)

Figure 3-24. Lapping Valves

ASSEMBLY

CAUTION

Make sure all lapping compound is removed from cylinder head and valves after lapping is completed. If lapping compound contaminates any internal engine components or engine oil, excessive engine wear and damage may result.

1. Wash cylinder head and valves in warm, soapy water to remove all lapping compound.
2. Scrub valve guide bores with VALVE GUIDE BRUSH (Part No. HD-34751) and hot, soapy water.
3. Blow dry with compressed air.
4. Apply a liberal amount of engine oil to the valve stem.
5. See Figure 3-25. Insert valve into valve guide (5) and install lower collar (4).
6. See Figure 3-26. Place a protective sleeve over the valve stem keeper groove. Coat the sleeve with oil and place a new seal over the valve stem.

CAUTION

- Always use a protective sleeve on the valve stem keeper groove when installing valve stem seal. If the seal is installed without using the protective sleeve, the seal will be damaged.
 - Do not remove valve after seal is installed. Otherwise, sharp edges on keeper groove will damage seal.
7. See Figure 3-25. Tap the valve stem seal (3) onto the valve guide (5) using the VALVE SEAL INSTALLATION TOOL (Part No. HD-34643A) and DRIVER HANDLE (Part No. HD-34740). The seal is completely installed when the tool touches the lower collar (4).
 8. See Figure 3-10. Install valve springs (5, 6) and upper collar (8).
 9. Compress springs with VALVE SPRING COMPRESSOR (Part No. HD-34736B).
 10. Insert valve keepers (7) into upper collar (8), making sure they engage groove in valve stem. The keeper gaps should be equal.
 11. Release and remove VALVE SPRING COMPRESSOR.
 12. Repeat Steps 4-11 for the remaining valve(s).
 13. If front isolator mount was removed, install as follows.
 - a. Chase threads in cylinder head with a 7/16-14 TPI NC tap before installing new bolts.
 - b. Coat new bolts with LOCTITE THREADLOCKER 262 (red).
 - c. Tighten bolts to 73-78 ft-lbs (98.9-105.7 Nm).

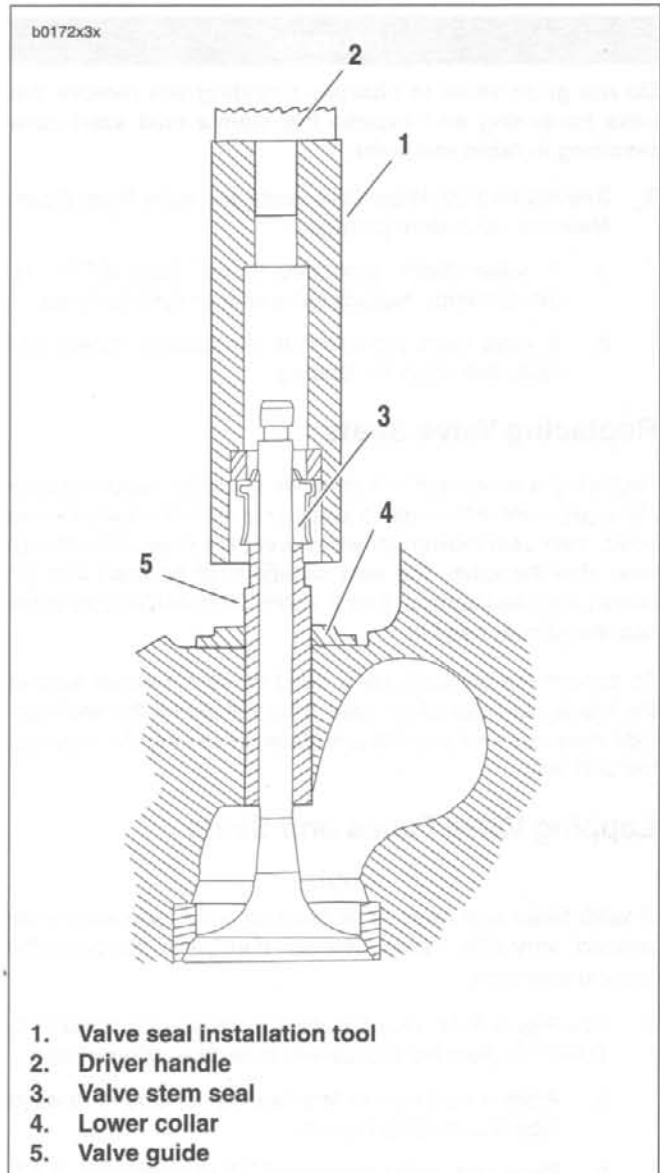


Figure 3-25. Valve Seal Installation

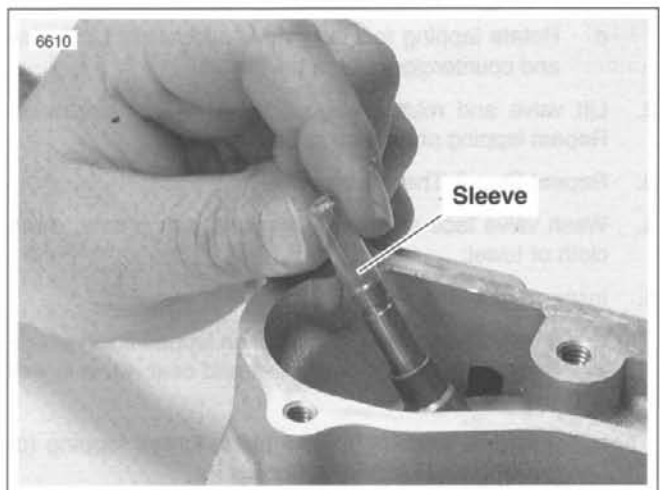


Figure 3-26. Valve Guide Seal Protector Sleeve

INSTALLATION

If only cylinder head work was needed, reinstall cylinder head following these instructions. If further repair is required, see 3.6 CYLINDER AND PISTON.

1. See Figure 3-10. Coat mating surfaces of cylinder studs (12) and head screws (1, 2) with parts cleaning solution.
2. Scrape old oil and any carbon deposits from threads by using a back-and-forth motion, threading each head screw onto its mating cylinder stud.
3. Remove head screws from studs. Wipe or blow dry thread surfaces.
4. Apply oil to stud threads and to the underside of the head screw shoulder.

CAUTION

Only oil film must remain on the head screw surfaces. Too much oil will pool in the head screw sleeve. Pooled oil may prevent proper torque application and full thread engagement.

5. Blow or wipe off excess oil from head screws.
6. Thoroughly clean and dry the gasket surfaces of cylinder (19) and cylinder head (18).
7. Install a **new** O-ring (14) on each dowel (15).

NOTE

O-rings (14) help to properly position the head gasket (4). O-rings must be installed before the head gasket.

8. Install a **new** head gasket (4) to cylinder.
9. Carefully lower cylinder head over studs and position on dowels. Use great care so as not to disturb head gasket.

CAUTION

The procedure for tightening the head screws is critical to proper distribution of pressure over gasket area. It prevents gasket leaks, stud failure, and head and cylinder distortion.

10. See Figure 3-8. For each cylinder head, start with screw numbered one, as shown. In increasing numerical sequence (i.e. – 1, 2, 3 and 4):
 - a. Tighten each screw to 7-9 ft-lbs (9.5-12.2 Nm).
 - b. Tighten each screw to 13-15 ft-lbs (17.6-20.3 Nm).
 - c. Loosen all screws.
11. After screws are loosened from initial torque, tighten head screws in three stages. Tighten fasteners in increasing numerical sequence (i.e. – 1, 2, 3 and 4).
 - a. Tighten each screw to 7-9 ft-lbs (9.5-12.2 Nm).
 - b. Tighten each screw to 13-15 ft-lbs (17.6-20.3 Nm).
 - c. See Figure 3-27. Mark cylinder head and head screw shoulder with a line as shown (View A). Tighten each screw a 1/4-turn (90°) (View B).

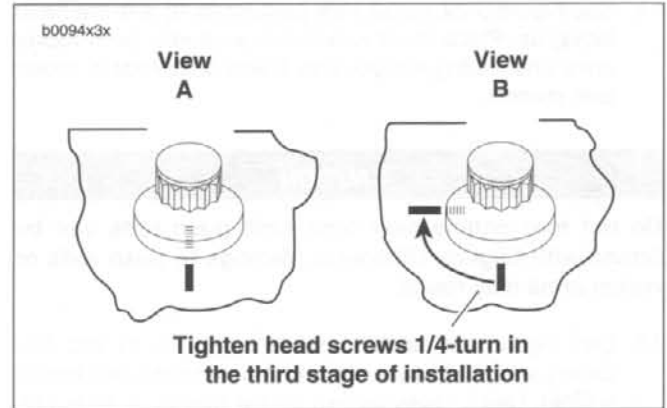
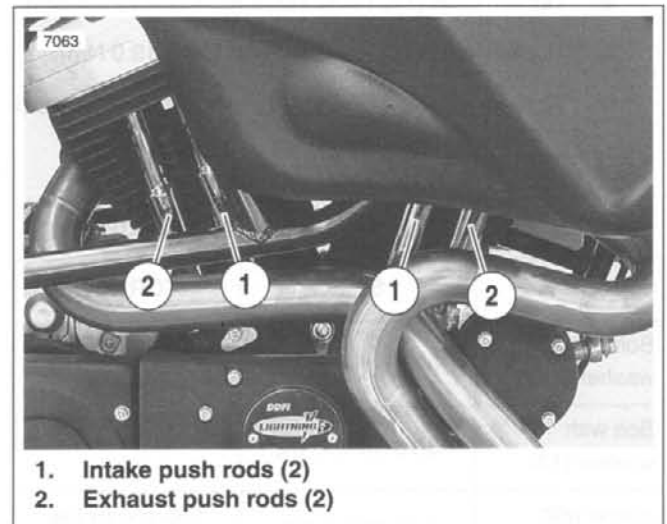


Figure 3-27. Tightening Head Screws



1. Intake push rods (2)
2. Exhaust push rods (2)

Figure 3-28. Push Rod Locations (Shown on Assembled Engine)

Table 3-5. Push Rod Selection

POSITION	COLOR CODE	LENGTH	PART NUMBER
Exhaust (front & rear)	3 Band-Pink	10.800 in. (274.320 mm)	17904-89
Intake (front & rear)	1 Band-Brown	10.746 in. (272.948 mm)	17897-89

12. Install tappets and push rod covers. See 3.15 VALVE TAPPETS (1999 models) or 3.16 HYDRAULIC LIFTERS (2000 models).
13. See Figure 3-28. Identify push rod color coding, length and respective push rod positions in engine. See Table 3-5. Place intake and exhaust push rods onto seat at top of tappet.

14. See Figure 3-29. Install **new** gaskets (8, 9) with the bead facing up. Place lower rocker box assembly (with rocker arms and shafts) into position. Place push rods in rocker arm sockets.

CAUTION

Do not turn engine over until both push rods can be turned with fingers. Otherwise, damage to push rods or rocker arms may result.

15. See Figure 3-30. Install fasteners (12, 13, 14 and 15). Slowly snug all fasteners in small increments (one turn at a time). Use a cross pattern on the four large bolts (12, 13) that fasten the lower rocker box to head. This will bleed the tappets. Fastener sizes are listed in Table 3-6.
- Tighten bolts (12, 13) to 15-19 ft-lbs (20.3-25.8 Nm).
 - Tighten bolts (15) to 10-14 ft-lbs (13.6-19.0 Nm).
 - Tighten screws (14) to 130-150 **in-lbs** (13.6-19.0 Nm).

Table 3-6. Lower Rocker Box Hardware

ITEM	SIZE	TORQUE
Bolt with washer (12)	5/16-18 X 2-3/4	15-19 ft-lbs (20.3-25.8 Nm)
Bolt with washer (13)	5/16-18 X 2-1/2	
Screw with washer (14)	1/4-20 X 1-1/2	130-150 in-lbs (14.7-16.9 Nm)
Bolt with washer (15)	1/4-20 X 1-1/4	10-14 ft-lbs (13.6-19.0 Nm)

NOTES

Tubular frame prohibits direct access to bolt (12) on right rear cylinder. Use TORQUE ADAPTOR (SNAP-ON Part No. FRDH 181) and TORQUE COMPUTER (SNAP-ON Part No. SS-306G) to correctly assemble.

16. See Figure 3-29. Install middle and upper rocker covers.
- Place a **new** gasket (7) on lower rocker box assembly.
 - Install middle rocker cover (5) with umbrella valve next to intake manifold.
 - Place a **new** gasket (6) on middle rocker cover.
 - Install upper rocker cover (4) using screws with washers (1) and **new** fiber seals (2). Tighten screws to 10-14 ft-lbs (13.6-19.0 Nm).
17. Install the other cylinder using the same procedure.

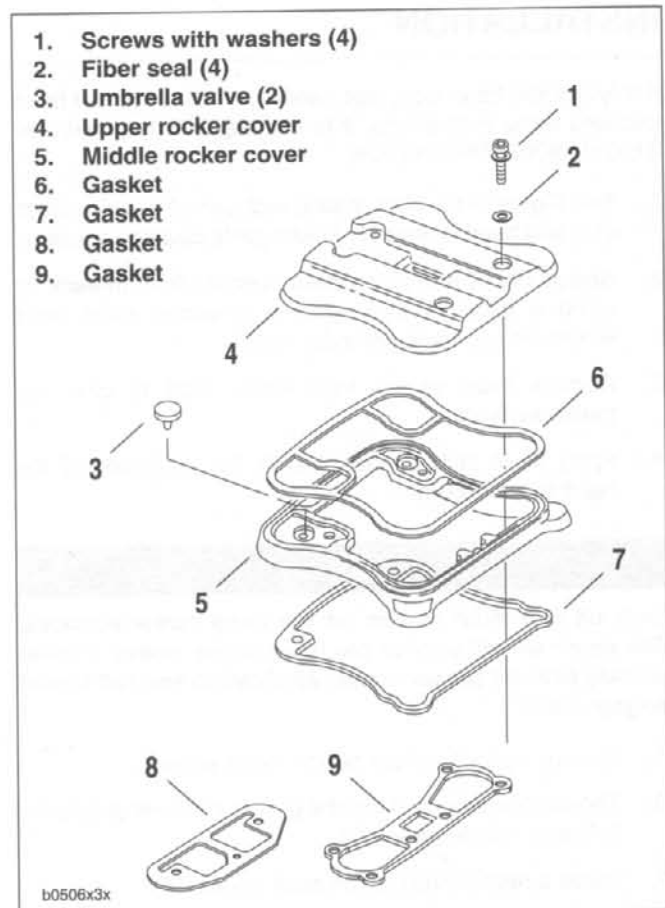
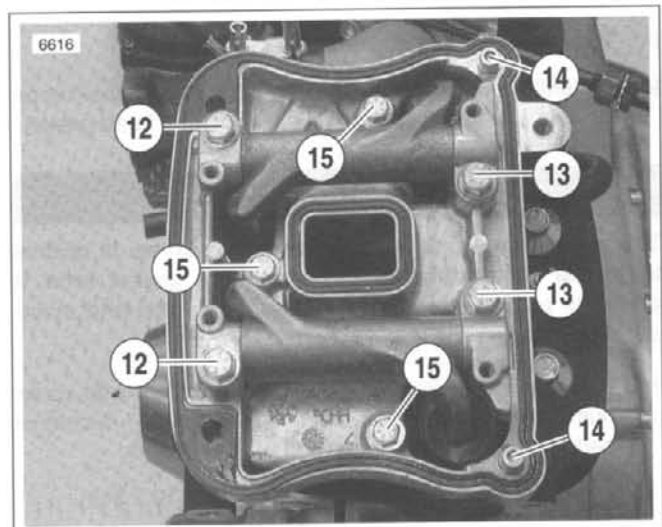


Figure 3-29. Rocker Arm Cover Gaskets



**Figure 3-30. Lower Rocker Box Fasteners
(Same Numbers as Figure 3-6.)**

REMOVAL/DISASSEMBLY

1. Strip motorcycle as described under DISASSEMBLING ENGINE FOR CYLINDER HEAD REPAIR.
2. Remove cylinder head. See 3.5 CYLINDER HEAD.
3. Clean crankcase around cylinder base to prevent dirt and debris from entering crankcase while removing cylinder.
4. See Figure 3-31. Turn engine over until piston (3) of cylinder being removed is at bottom of its stroke.
5. Carefully raise cylinder (1) just enough to permit placing clean towel under piston to prevent any foreign matter from falling into crankcase.

NOTE

If cylinder does not come loose, lightly tap a plastic hammer perpendicular to the cylinder fins. Never try to pry a cylinder up.

6. Carefully lift cylinder over piston and cylinder studs (4). Do not allow piston to fall against cylinder studs. Discard cylinder base gasket (5).

CAUTION

With cylinder removed, be careful not to bend the cylinder studs. The slightest bend could cause a stress riser and lead to stud failure.

7. Install a 6.0 in. (152 mm) length of 1/2 in. (12.7 mm) ID plastic or rubber hose over each cylinder stud. This will protect the studs and the pistons.

WARNING

Always wear proper eye protection when removing the compression rings. Slippage may propel the ring with enough force to cause an accident. This could result in death or serious injury.

CAUTION

The piston pin retaining rings must not be reused. Removal may weaken retaining rings and they may break or dislodge. Either occurrence may damage engine.

8. Insert an awl in the recessed area below the piston pin bore and pry out the piston pin retaining rings. To prevent the ring from flying out, place your thumb over the retaining ring.

NOTE

Since the piston pin is a loose fit in the piston, the pin will easily slide out. The pins have tapered ends to help seat the round retaining rings. See Figure 3-32. 1200cc piston pins are stamped with a V-groove at one end.

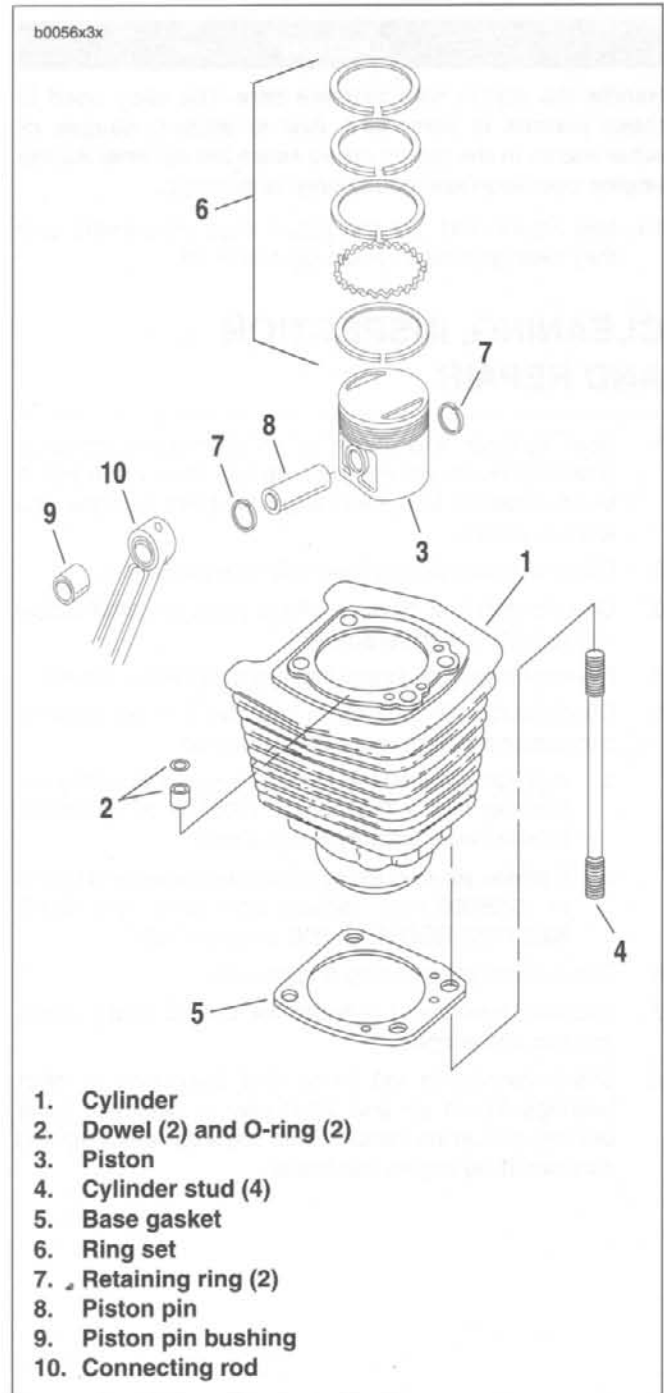


Figure 3-31. Cylinder and Piston

9. Mark each pin boss with either an "F" or an "R" to indicate front or rear cylinder, respectively. See Figure 3-32. The arrow at the top of 1200cc pistons must always point toward the front of the engine.

CAUTION

Handle the piston with extreme care. The alloy used in these pistons is very hard. Any scratches, gouges or other marks in the piston could score the cylinder during engine operation and cause engine damage.

10. See Figure 3-31. Spread piston rings (6) outward until they clear grooves in piston (3) and lift off.

CLEANING, INSPECTION AND REPAIR

1. Soak cylinder and piston in an aluminum-compatible cleaner/solvent until deposits are soft, then clean with a brush. Blow off loosened carbon and dirt particles and wash in solvent.
2. Clean oil passage in cylinder with compressed air.
3. Clean piston ring grooves with a piece of compression ring ground to a chisel shape.
4. Examine piston pin to see that it is not pitted or scored.
5. Check piston pin bushing to see that it is not loose in connecting rod, grooved, pitted or scored.
 - a. A piston pin properly fitted to upper connecting rod bushing has a 0.00125 to 0.00175 in. (0.03175-0.04445 mm) clearance in bushing.
 - b. If piston pin-to-bushing clearance exceeds 0.00200 in. (0.05080 mm), replace worn parts. See CONNECTING ROD BUSHING on page 3-28.
6. Clean piston pin retaining ring grooves.
7. Examine piston and cylinder for cracks, burnt spots, grooves and gouges.
8. Check connecting rod for up and down play in lower bearings. When up and down play is detected, lower bearing should be refitted. This requires removing and disassembling engine crankcase.

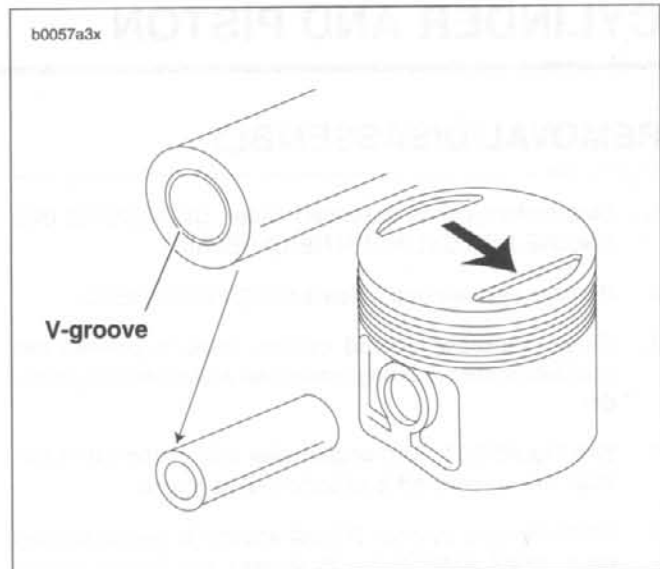


Figure 3-32. Piston Pin and Piston Identification

Checking Gasket Surface

CAUTION

If either cylinder gasket surface does not meet flatness specifications, replace cylinder and piston. Proper tolerances will extend component life and prevent leaks.

1. See Figure 3-33. Check cylinder head gasket surface for flatness.
 - a. Lay a straightedge across the surface.
 - b. Try to insert a feeler gauge between the straight-edge and the gasket surface.
 - c. If cylinder head gasket surface is not flat within 0.006 in. (0.152 mm), replace cylinder and piston.
2. Check cylinder base gasket surface for flatness.
 - a. Lay a straightedge across the surface.
 - b. Try to insert a feeler gauge between the straight-edge and the gasket surface.
 - c. If cylinder base gasket surface is not flat within 0.008 in. (0.203 mm), replace cylinder and piston.

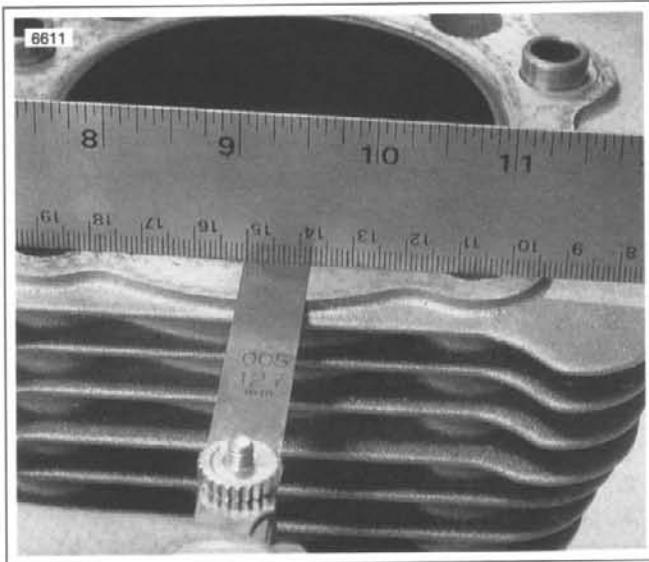


Figure 3-33. Checking Gasket Surfaces

Measuring Cylinder Bore

1. Remove any burrs from the cylinder gasket surfaces.
2. See Figure 3-34. Install a head and base gasket, and CYLINDER TORQUE PLATES (Part No. HD-33446A) and XL EVOLUTION TORQUE PLATE BOLTS (Part No. HD-33446-86). Tighten the bolts using the same method used when installing the cylinder head screws. See 3.5 CYLINDER HEAD.

NOTE

Torque plates, properly tightened and installed with gaskets, simulate engine operating conditions. Measurements will vary as much as 0.001 in. (0.025 mm) without torque plates.

3. Take cylinder bore measurement in ring path, starting about 1/2 in. (12.7 mm) from top of cylinder, measuring from front to rear and then side to side. Record readings.
4. Repeat measurement at center and then at bottom of ring path. Record readings. This process will determine if cylinder is out-of-round (or "egged") and will also show any cylinder taper or bulge.
5. See Table 3-7. If cylinder is not scuffed or scored and is within service limit, see 3.6 CYLINDER AND PISTON on page 3-26.

NOTE

If piston clearance exceeds service limit, cylinders should be rebored and/or honed to next standard oversize, and refitted with the corresponding piston and rings. Do not fit piston tighter than 0.0007 in. (0.0178 mm). See 3.1 SPECIFICATIONS.

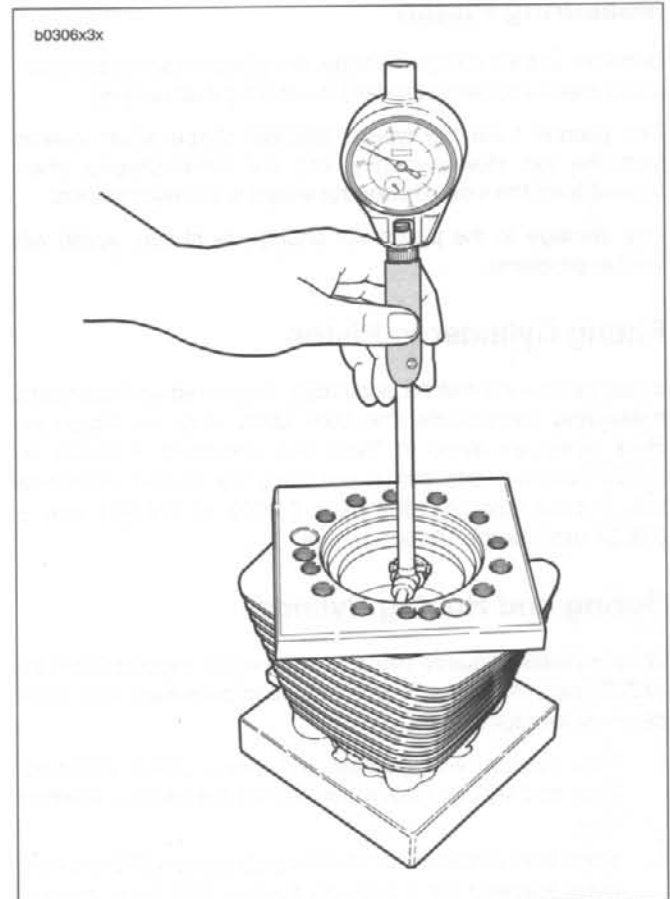


Figure 3-34. Measuring Cylinder Bore Using Torque Plates (Part No. HD-33446A)

Table 3-7. 1200cc Cylinder Bore Service Wear Limits

BORE SIZES	IN.	MM
Standard Bore	3.5008	88.9203
0.005 in. OS bore (0.127 mm)	3.5050	89.0270
0.010 in. OS bore (0.254 mm)	3.5100	89.1540
0.020 in. OS bore (0.508 mm)	3.5200	89.4080
0.030 in. OS bore (0.762 mm)	3.5300	89.6620

Measuring Piston

Because of their complex shape, the pistons cannot be accurately measured with standard measuring instruments.

The pistons have the typical elliptical shape when viewed from the top. However, they also are barrel-shaped when viewed from the side. This barrel shape is not symmetrical.

Any damage to the piston will change its shape, which will lead to problems.

Fitting Cylinder to Piston

Since pistons cannot be accurately measured with standard measuring instruments, the bore sizes must be observed. Bore sizes are listed in Table 3-8. Example: A 0.005 in. (0.127 mm) oversize piston will have the proper clearance with a bore size of 3.502 in. \pm 0.0002 in. (88.951 mm \pm 0.0051 mm) for the 1200cc engine.

Boring and Honing Cylinder

When cylinder requires oversize reboring to beyond 0.030 in. (0.762 mm), the oversize limit has been exceeded and cylinder must be replaced.

1. Bore cylinder with gaskets and torque plates attached. Bore to 0.003 in. (0.076 mm) under the desired finished size.
- 2.hone the cylinder to its finished size using a 280 grit rigid hone followed by a 240 grit flexible ball hone. Honing must be done with the torque plates attached. All honing must be done from the bottom (crankcase) end of the cylinder. Work for a 60° crosshatch pattern.

Fitting Piston Rings

NOTE

Ring sets and pistons, 0.040 in. (1.016 mm) oversize, are not available on 1200cc engines.

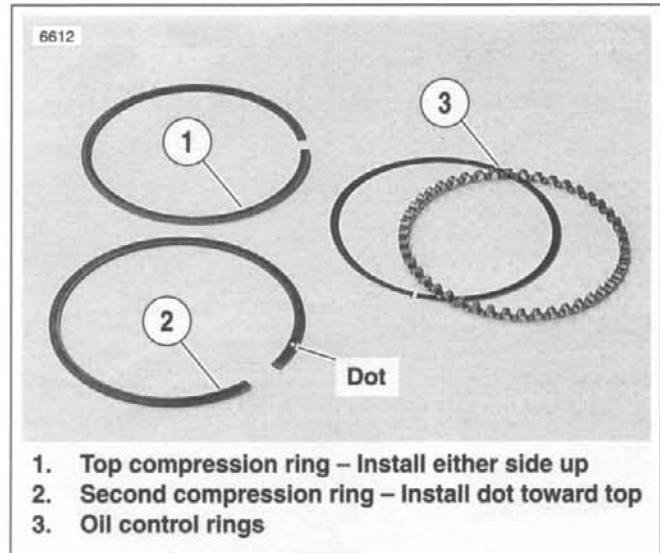
See Figure 3-35. Piston rings are of two types: compression (1, 2) and oil control (3). The two compression rings are positioned in the two upper piston ring grooves. The dot on the second compression ring must face upward. Ring sets are available to fit standard and oversize pistons.

Piston ring sets must be properly fitted to piston and cylinder:

1. See Figure 3-36. Place piston in cylinder about 1/2 in. (12.7 mm) from top. Set ring to be checked squarely against piston as shown. Check end gap with thickness gauge. See 3.1 SPECIFICATIONS for tolerance.

NOTE

See SERVICE WEAR LIMITS for end gap dimensions. Do not file rings to obtain proper gap.



1. Top compression ring – Install either side up
2. Second compression ring – Install dot toward top
3. Oil control rings

Figure 3-35. Piston Rings

Table 3-8. Final Cylinder Bore Sizes

BORE SIZES	IN.	MM
Standard bore*	3.4978 in.	88.8441 mm
0.005 in. OS bore (0.127 mm)	3.502 in.	88.951 mm
0.010 in. OS bore (0.254 mm)	3.507 in.	89.078 mm
0.020 in. OS bore (0.508 mm)	3.517 in.	89.332 mm
0.030 in. OS bore (0.762 mm)	3.527 in.	89.586 mm

*All bore sizes + 0.0002 in. (0.0051 mm)

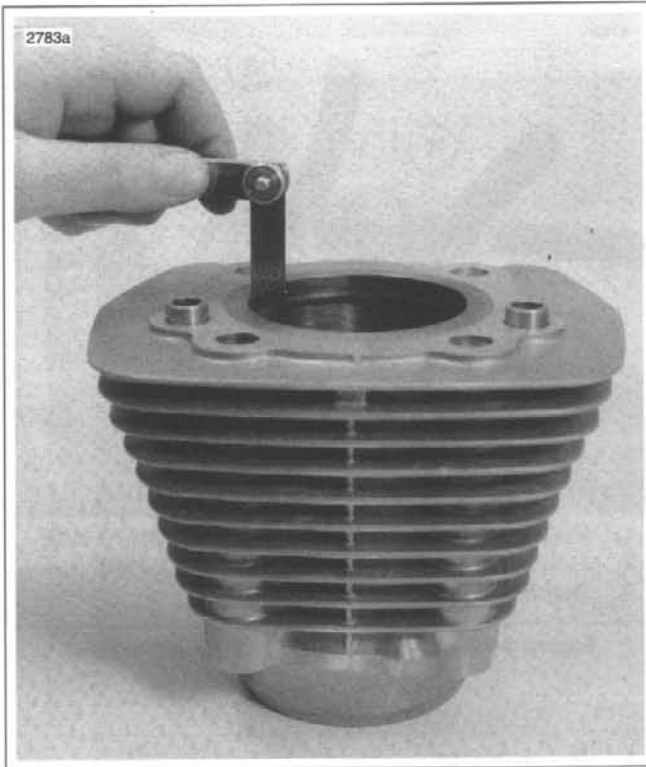


Figure 3-36. Measuring Ring End Gap

NOTE

The same piston may be used if cylinder bore was not changed, unless it is scuffed or grooved. However, replace rings and hone the cylinder walls with a No. 240 grit flexible hone to facilitate ring seating.

2. See Figure 3-37. Apply engine oil to piston grooves. Use TRANSMISSION SHAFT RETAINING RING PLIERS (Part No. J-5586) to slip compression rings over piston into their respective grooves. Be extremely careful not to over expand, twist rings or damage piston surface when installing rings.

NOTE

Install second compression ring with dot towards top.

3. See Figure 3-38. Install rings so end gaps of adjacent rings are a minimum of 90° apart. Ring gaps are not to be within 10° of the thrust face centerline.
4. See Figure 3-39. Check for proper side clearance with thickness gauge, as shown. See 3.1 SPECIFICATIONS for tolerance.

NOTE

If the ring grooves are clean and the side play is still not correct, replace the rings, the piston or both.

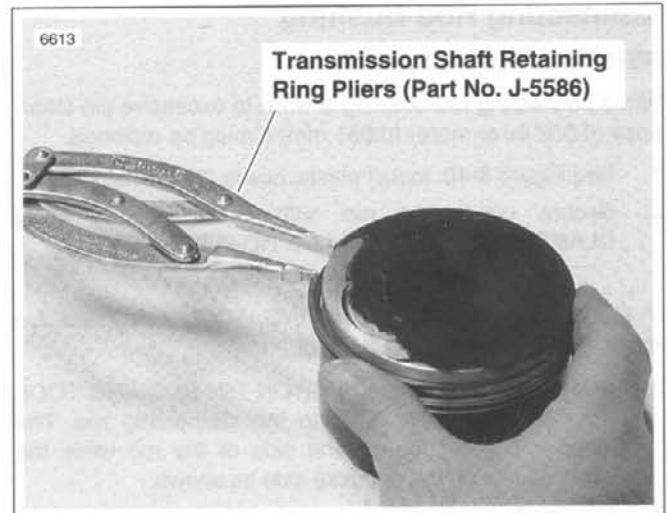


Figure 3-37. Installing Piston Rings

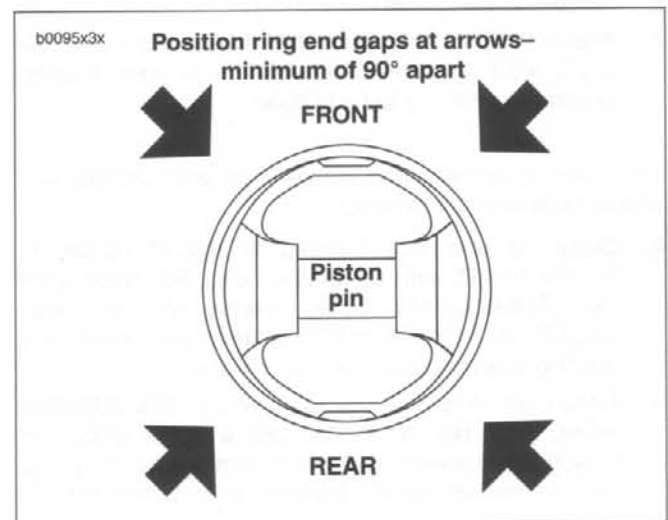


Figure 3-38. Ring End Gap Position

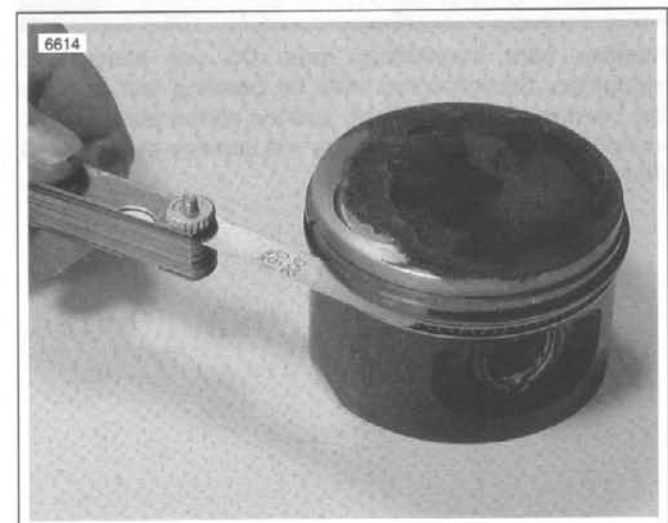


Figure 3-39. Measuring Ring Clearance in Groove

Connecting Rod Bushing

REMOVAL/INSTALLATION

When connecting rod bushing is worn to excessive pin clearance (0.002 in. or more) (0.051 mm) it must be replaced.

1. See Figure 3-40. Install plastic hoses (3) over studs.
2. Secure connecting rod with CONNECTING ROD CLAMPING TOOL (2) (Part No. HD-95952-33B).

NOTE

If CONNECTING ROD CLAMPING TOOL holes are too small, enlarge the holes in the tool.

3. See Figure 3-41. Attach PISTON PIN BUSHING TOOL (Part No. HD-95970-32D) to the connecting rod. The receiver cup (1) fits on one side of the rod while the driver (2) fits on the opposite side as shown.
4. Use two box wrenches and push worn bushing from connecting rod.
5. Remove piston pin bushing tool from connecting rod.
6. Remove bushing from receiver cup.
7. Attach PISTON PIN BUSHING TOOL (Part No. HD-95970-32D) to connecting rod. Place **new** bushing between connecting rod and driver.

NOTE

The driver must be attached facing the opposite direction as it was for removal of the bushing.

8. Clean up and size bushing to 0.0010-0.0005 in. (0.0254-0.0127 mm) undersize using REAMER (Part No. HD-94800-26A). Sizing bushing with less than 0.00125 in. (0.03175 mm) clearance can result in a bushing loosening and/or seized pin in rod.
9. Hone bushing to final size using WRIST PIN BUSHING HONE (Part No. HD-35102). Use a liberal amount of honing oil to prevent damage to hone or bushing. Use care to prevent foreign material from falling into the crankcase.

REPAIR

CAUTION

Replace bent connecting rods. Do not attempt to straighten. Straightening rods by bending will damage the bearing on the crank pin and the piston pin bushing. Installing bent connecting rods will damage cylinder and piston beyond repair.

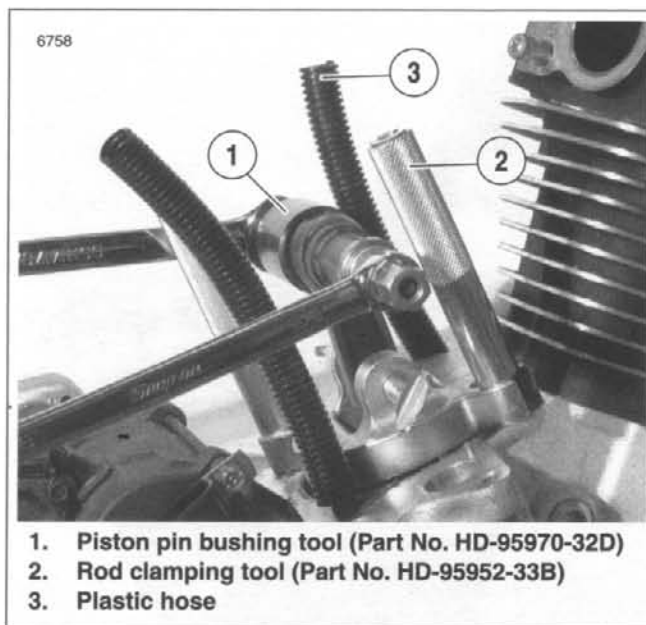


Figure 3-40. Installing New Piston Pin Bushing

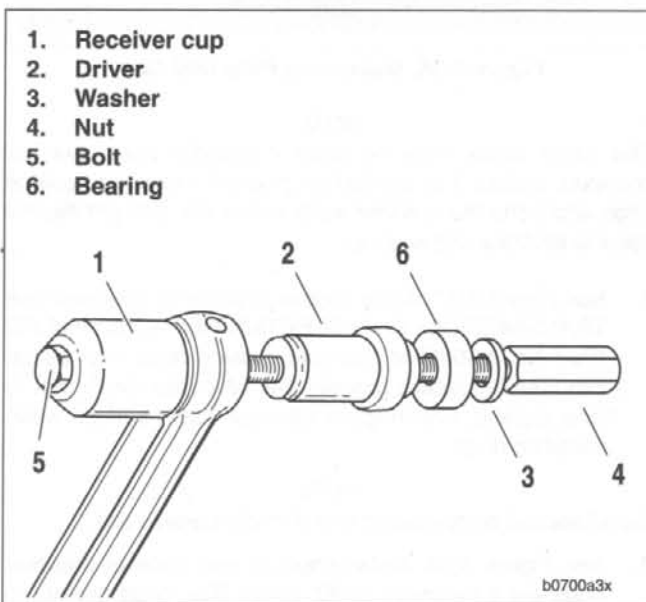


Figure 3-41. Piston Pin Bushing Tool Assembly for Bushing Removal

ASSEMBLY/INSTALLATION

1. See Figure 3-42. Place PISTON SUPPORT PLATE (3) (Part No. HD-42322) around connecting rod.
2. Install piston assembly over connecting rod.

NOTE

New 1200cc pistons must be installed with the arrow, at the top of the piston, pointing towards the front of the engine.

3. Install piston pin.

CAUTION

Always use new retaining ring. Make sure retaining ring groove is clean and that ring seats firmly in groove. If it does not, discard the ring. Never install a used retaining ring or a new one if it has been installed and then removed for any reason. A loosely installed ring will come out of the piston groove and damage cylinder and piston beyond repair.

4. Install **new** piston pin retaining rings (1) using PISTON PIN RETAINING RING INSTALLER (2) (Part No. HD-34623B). Place **new** retaining ring on tool with gap pointing up. See Figure 3-43.

NOTE

Make sure the ring groove is clean. Ring must be fully seated in the groove with the gap away from the slot at the bottom.

5. See Figure 3-38. Make sure the piston ring end gaps are properly positioned as shown.
6. Remove PISTON SUPPORT PLATE.
7. Lubricate cylinder wall, piston, pin and rod bushing with engine oil.
8. Turn engine until piston is at top dead center.
9. See Figure 3-44. Compress the piston rings using PISTON RING COMPRESSOR (Part No. HD-96333-51C).
10. Remove protective sleeves from cylinder studs. Install a **new** cylinder base gasket. Make sure the piston does not bump the studs or crankcase.
11. Install cylinder over piston.
12. Remove PISTON RING COMPRESSOR.
13. Assemble cylinder head. See 3.5 CYLINDER HEAD.
14. Install cylinder head. See 3.5 CYLINDER HEAD.
15. Install assembled engine. See 3.4 INSTALLING THE ENGINE.

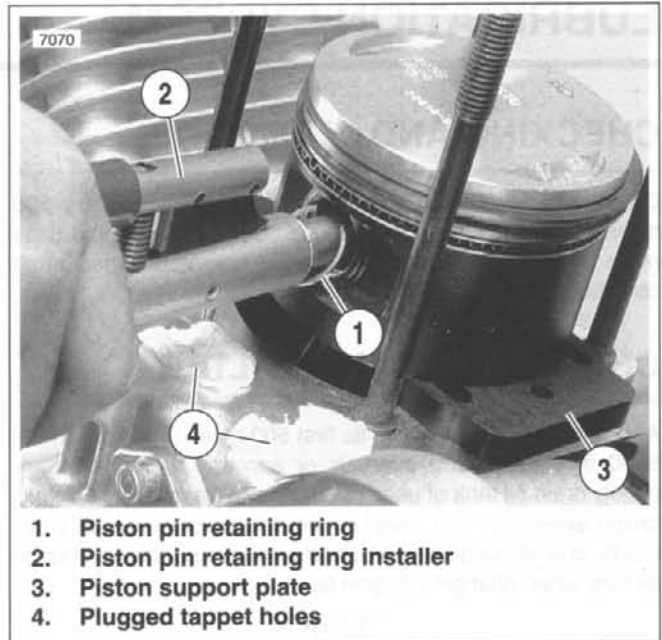


Figure 3-42. Installing Piston Retaining Rings

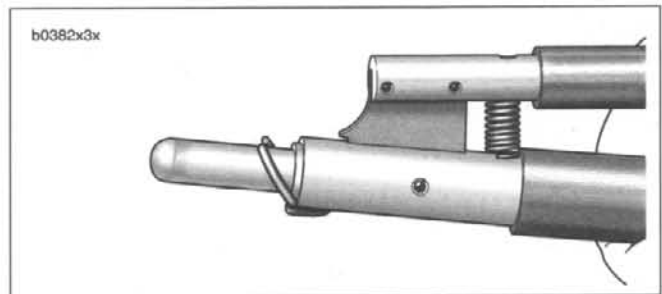


Figure 3-43. Aligning Retaining Ring

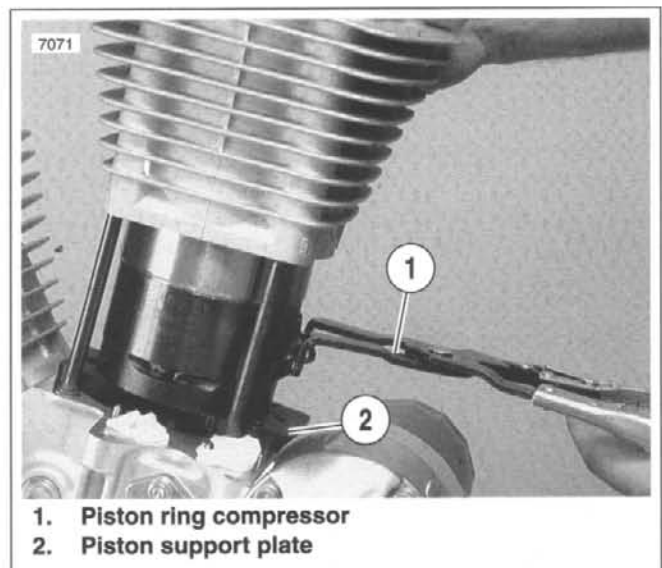


Figure 3-44. Compressing Piston Rings

CHECKING AND ADDING OIL

Check engine oil level in oil tank at least once every 500 miles (800 km). Check level more frequently if engine uses more oil than normal or if vehicle is operated under harsh conditions.

CHANGING OIL AND FILTER

After a new engine has run its first 500 miles (800 km) and at 5000 mile (8000 km) intervals or annually thereafter, completely drain oil tank of used oil. Refill with fresh oil. If vehicle is driven extremely hard, used in competition or driven on dusty roads, change engine oil at shorter intervals. Always change oil filter when changing engine oil.

NOTE

See 1.6 ENGINE LUBRICATION SYSTEM for more information on checking oil level and changing oil and filter.

WINTER LUBRICATION

Normal fuel combustion in a gasoline engine produces water vapor and carbon dioxide along with other gases and particulates. When first starting and warming an engine, some of the water vapor that gets into the engine crankcase condenses to form liquid water. If the engine is driven long enough to thoroughly warm the crankcase, most of this liquid water is again vaporized and exhausted through the crankcase breather system.

A moderately driven vehicle making short runs may not be able to vacate water vapors allowing liquid water to accumulate in the oil tank. This is especially true if the vehicle is operated in cold weather. In freezing weather, an accumulation of water in the engine oil may become slush or ice, which can block oil lines and lead to severe engine damage. Water remaining in the engine oil for long periods of time can form an acidic sludge that is corrosive to metal engine parts and causes accelerated wear of moving components.

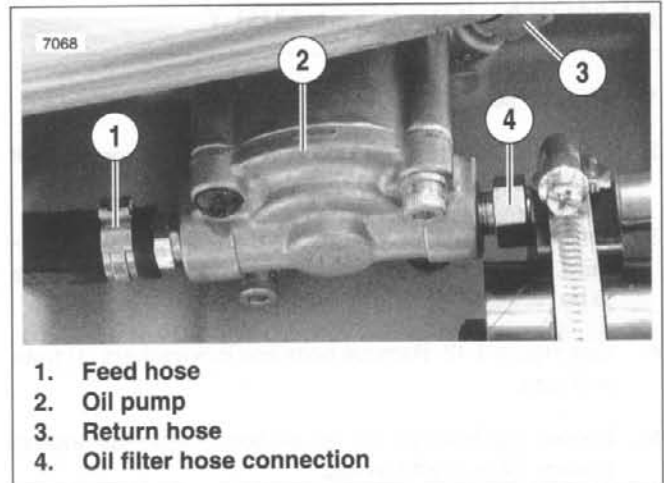
In winter the oil change interval should be shorter than normal. The colder the weather, the shorter the recommended oil change interval. A vehicle used only for short runs in cold weather must have the engine oil drained frequently.

GENERAL

See Figure 3-45. The oil tank has four hoses. The drain hose (2) attaches to a fitting on the left side. From the top of the tank, the vent hose (3) runs along the right side to below the battery tray. The return hose (4) runs along the left side and joins the bottom feed hose (1) under the battery tray.

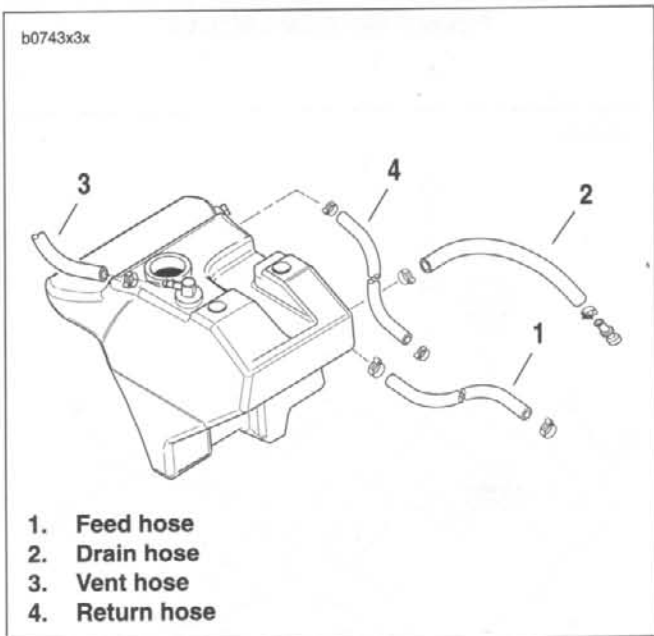
See Figure 3-46. The feed (1) and return hoses (3) run together between the swingarm mount block and crankcase, beneath the engine and forward to the oil pump. The feed hose attaches to the rear most oil pump fitting; the return hose connects forward and above. To prevent unnecessary wear, the hoses have a fitted cover.

After diverging from the feed and return hoses, the vent hose is routed beneath the starter. It continues on to the right side of the motorcycle. See Figure 3-47. Here the vent hose (1) connects to an elbow fitting (3) on the gearcase cover (4).



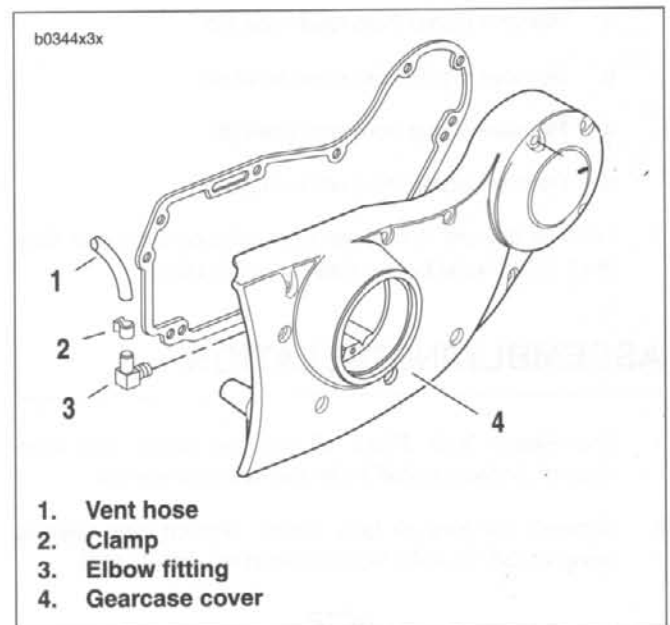
1. Feed hose
2. Oil pump
3. Return hose
4. Oil filter hose connection

Figure 3-46. Oil Pump Connections



1. Feed hose
2. Drain hose
3. Vent hose
4. Return hose

Figure 3-45. Oil Tank Hoses

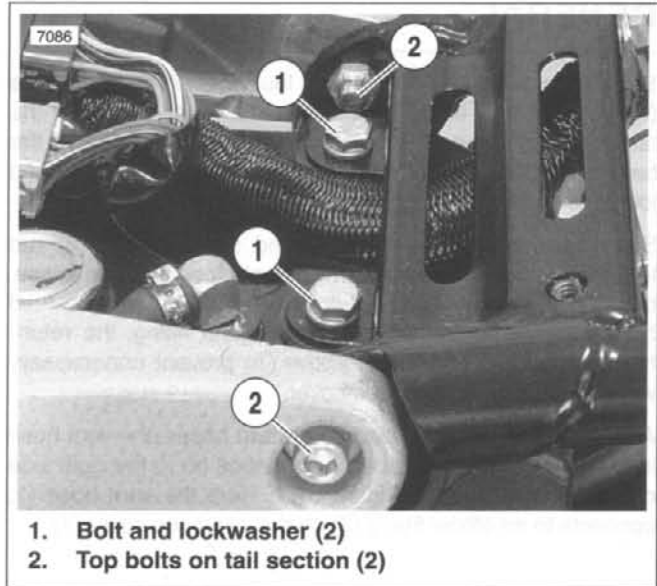


1. Vent hose
2. Clamp
3. Elbow fitting
4. Gearcase cover

Figure 3-47. Vent Hose Connection (1999 Shown)

REMOVAL/DISASSEMBLY

1. Remove seat.
2. Remove lower bolts on tail section and disconnect tail section wiring. See 2.46 TAIL SECTION.
3. Drain oil tank. See 1.6 ENGINE LUBRICATION SYSTEM. The oil filter need not be removed unless it is due to be replaced.
4. See Figure 3-48. Remove bolts and lockwashers (1) from well nuts.
5. Loosen top bolts (2) on tail section. Rotate tail section upward. Secure with straps.
6. See Figure 3-49. Remove clamps to detach hoses from oil tank. Label each hose upon removal.
 - a. Remove clamp from feed hose (3).
 - b. Remove clamp from drain hose (4).
 - c. Remove clamp from vent hose (6).
 - d. Remove clamp from return hose (5).
7. Lift tank upward to remove. Both tabs on bottom of tank must clear frame before detaching oil tank.



1. Bolt and lockwasher (2)
2. Top bolts on tail section (2)

Figure 3-48. Oil Tank Mounts

ASSEMBLY/INSTALLATION

1. See Figure 3-49. Place oil tank on frame and align mounts. Loosely install bolts and lockwashers (1).
2. Connect the four oil tank hoses. Tighten **new** clamps using HOSE CLAMP PLIERS (Part No. HD-41137).

NOTE

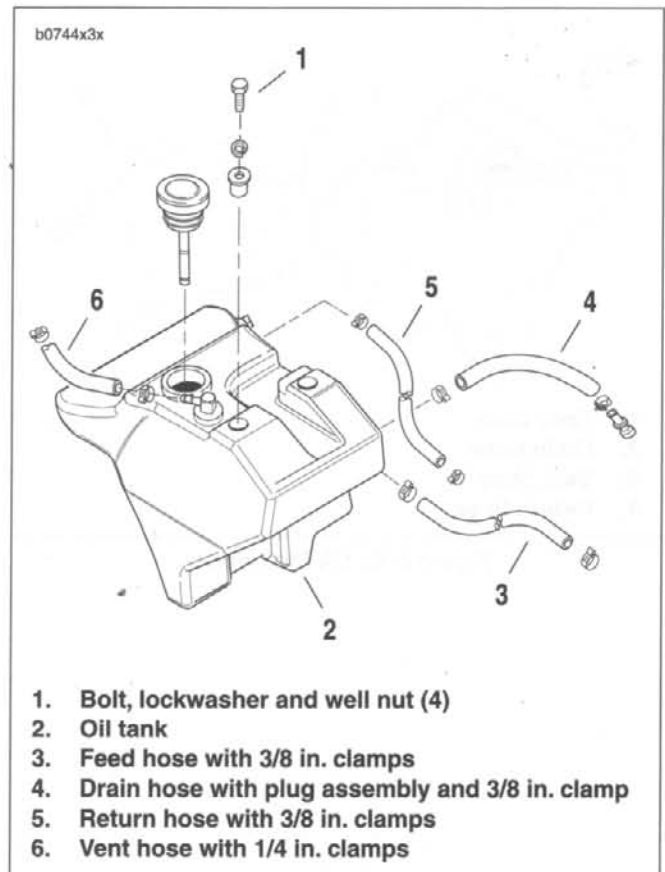
Clamp may be reused on feed hose (3) at oil tank connection.

3. Fill oil tank. See 1.6 ENGINE LUBRICATION SYSTEM.
4. Attach tail section. See 2.46 TAIL SECTION.

WARNING

After installing seat, pull upward on front of seat to be sure it is locked in position. If seat is loose, it could shift during vehicle operation and startle the rider, causing loss of control. These events could result in death or serious injury.

5. Install seat.



1. Bolt, lockwasher and well nut (4)
2. Oil tank
3. Feed hose with 3/8 in. clamps
4. Drain hose with plug assembly and 3/8 in. clamp
5. Return hose with 3/8 in. clamps
6. Vent hose with 1/4 in. clamps

Figure 3-49. Oil Tank

GENERAL

The oil pressure indicator switch is a pressure-actuated diaphragm-type switch. When oil is not circulating through the system or when oil pressure is abnormally low, spring tension holds the switch contacts closed, thereby completing the signal light circuit and causing the indicator lamp to illuminate.

OIL PRESSURE SIGNAL LIGHT

The oil pressure signal light turns ON when:

- Ignition switch is turned on prior to starting engine.
- Oil is not circulating through the running engine.
- Oil pressure is abnormally low on the running engine.
- Engine is idling far below 1000 RPM.

The oil pressure signal light turns OFF when:

- Oil is circulating with adequate pressure through the engine running at 1000 RPM or greater.

Troubleshooting information is listed in Table 3-9.

NOTE

If the ignition is turned back on immediately after the engine is stopped, the oil light may not turn on right away because of oil pressure retained in the filter housing.

OIL PRESSURE

See Figure 3-50. The oil pump is nonregulatory and delivers its entire volume of oil under pressure to the oil filter mount. When an engine is cold, the engine oil will be more viscous (i.e., thicker). During start-up of a cold engine, oil pressure will be higher than normal and oil circulation will be somewhat restricted within the oiling system. As the engine warms to normal operating temperature, the engine oil will warm up and become less viscous — oil pressure decreases.

When an engine is operated at high speeds, the volume of oil circulated through the oiling system increases, resulting in higher oil pressure. As engine speed is reduced, the volume of oil pumped is also reduced, resulting in lower oil pressure.

To check oil pressure, use OIL PRESSURE GAUGE (Part No. HD-96921-52A) and OIL PRESSURE GAUGE ADAPTER (Part No. HD-96940-52A). Remove oil pressure indicator switch and insert pressure gauge fitting. See Figure 3-51.

Ride motorcycle at least 20 miles (32 km) at or above 50 MPH (80 KM/H) until engine oil reaches normal operating temperature. At 2500 RPM, oil pressure will vary from 10-17 psi (69-117 kN/m²). At idle speed (950-1050 RPM), oil pressure will vary from 7-12 psi (48-83 kN/m²).

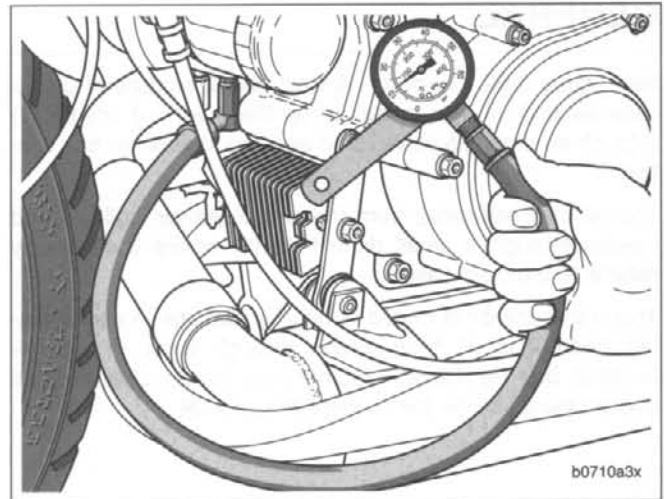


Figure 3-50. Checking Oil Pressure

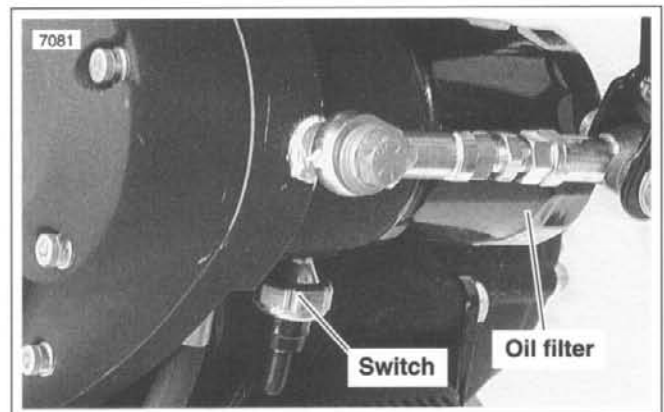


Figure 3-51. Oil Pressure Indicator Switch

Table 3-9. Troubleshooting Oil Pressure Signal Light

OIL PRESSURE SIGNAL LIGHT	PROBABLE CAUSES
Stays on at speeds above idle.	<ul style="list-style-type: none"> ● Empty oil tank. ● Clogged feed line (ice and sludge, freezing temperatures). ● Air-bound oil line. ● Grounded oil switch wire. ● Malfunctioning signal switch. ● Diluted oil. ● Malfunctioning check valve (see 3.14 OIL FILTER MOUNT).
Flickers at idle.	<ul style="list-style-type: none"> ● Incorrect idle speed. Malfunctioning or improperly installed check valve (see 3.14 OIL FILTER MOUNT).
Does not glow when ignition is turned on (prior to operating engine).	<ul style="list-style-type: none"> ● Malfunctioning signal switch. ● Malfunction in wiring. ● Burned-out signal bulb. ● Dead battery (see NOTE above).

CRANKCASE BREATHING SYSTEM 3.11

GENERAL

See Figure 3-52. On piston downstroke, a mixture of crankcase air and oil mist is vented up the push rod covers (1) through an umbrella valve (3) in each middle rocker box section.

The oil mist separates from the crankcase air, collects and passes through a small drain hole (2) where it eventually returns to the crankcase.

The crankcase air is routed through a passage in each cylinder head. The air then travels through each air cleaner breather bolt (4). Hoses leading from the air cleaner bolts deposit the air inside the air cleaner's snorkel.

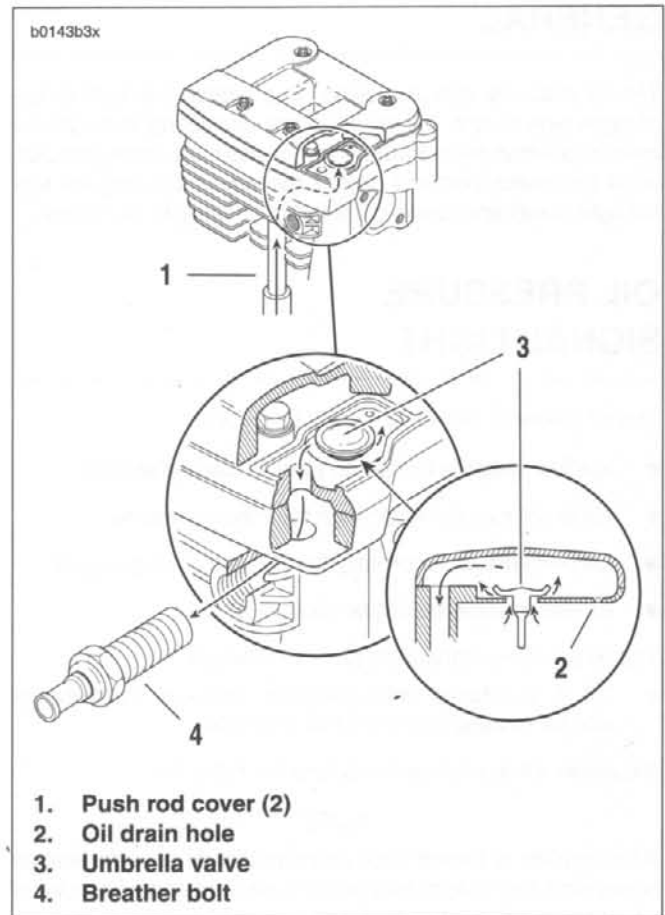


Figure 3-52. Crankcase Breathing System, Typical Cylinder

NOTE

The following paragraph numbers correspond with the numbered callouts in the INTERNAL ENGINE PASSAGES illustration.

1. Oil is gravity-fed from the oil tank to the gerotor-style oil pump through a **feed hose**. Oil enters the **feed section** and fills a cavity located under the feed pump.

NOTE

See 3.13 OIL PUMP for a complete explanation of the gerotor pump sets.

2. The feed pump transfers oil from the inlet cavity through the **feed hose** to the oil filter mount.
3. Oil flows through the **filter mount cavity** to the oil filter.
4. Oil enters the peripheral cavity of the **oil filter**, passes through the filtering medium into the central cavity of the oil filter, and flows into the filter adapter (fitting which connects filter to filter mount).
5. Adequate oil pressure in the filter mount cavity activates the **oil pressure signal light switch** and shuts off the oil pressure signal light.
6. Oil flowing from the filter adapter opens the **check ball**. The check ball opens at 4-6 psi (28-41 kN/m²) oil pressure.
7. With the check ball open, oil flows into the **crankcase feed galley**.
8. Oil flows through the feed galley in the crankcase to the tappet blocks and hydraulic lifters. **Cross-drilled passages** intersect the main feed galley and carry oil to each hydraulic lifter.
9. Oil also enters an **intersecting passage** in the gearcase cover. Oil flow is then routed to the crankshaft area.
10. Oil enters a hole in the end of the **pinion gear shaft** and travels to the right flywheel where it is routed through the flywheel to the **crankpin**. Oil is forced through the crankpin to properly lubricate the rod bearing assembly.
11. Oil flows up passages in the **push rods** to the rocker arm shafts and bushings.
12. The valve stems are lubricated by oil supplied through drilled oil holes in the **rocker arms**.
13. Oil collected in the push rod areas of the cylinder heads flows down the **push rod covers**, through drain holes in the **tappet blocks** and into the gearcase. After providing lubrication to the gearcase components, the oil flows to the left side of the oil pump.
14. Feed oil to the rocker area is returned to the crankcase through a **passage** in the head and cylinder.
15. Oil collected in the **sump** is splash-fed to the pistons, cylinder walls and flywheel components.
16. Oil collected in the sump area returns to the scavenge section of the oil pump through a **passage** located in the rear section of the sump. Oil flow to the pump is accomplished by the scavenging effect of the pump and by the pressure created by the downward stroke of the pistons.
17. Return oil fills a **cavity** above the pump's return gears. The return gears pump oil back to the oil tank.
18. A small amount of oil flows from the feed galley in the right crankcase half through a **restricted orifice**, which sprays the oil onto the rear intake cam gear in the gearcase. Oil is transferred to the teeth of all the cam gears through the gear meshing action.

GENERAL

See Figure 3-53. The oil pump consists of two gerotor gear sets, feed and scavenge (return), housed in one pump body. The feed set distributes oil to the engine, the scavenge set returns oil to the tank.

A gerotor-type gear set has two parts — an inner and an outer gerotor. The inner gerotor has one less tooth than the outer gerotor. Both gerotors have fixed centers which are off-set to each other.

In a gerotor gear set, oil is transferred from inlet to outlet as it is trapped between the rotating inner and outer gerotors. The illustration below shows the principle of gerotor operation:

1. During the first 180° of rotation, the cavity between inner and outer gerotors gradually increases in size until it reaches its maximum size, equivalent to the full volume of the "missing tooth." The gradually enlarging cavity creates a vacuum into which oil flows from the inlet.
2. During the next 180° of rotation, the size of the cavity decreases forcing oil into the outlet.

See Figure 3-55. Gravity-fed oil from the oil tank enters the pump through the feed hose connector (5). It is forced by the gerotor feed set (7) through a hose to the oil filter. Return oil from the flywheel compartment is drawn back into the pump and is forced by the gerotor scavenge set (9) back to the oil tank.

See INTERNAL ENGINE PASSAGES for oil passages within the engine.

The oil pump seldom needs servicing. Before you disassemble an oil pump suspected of not producing adequate oil pressure, be absolutely certain that all possible related malfunctions have been eliminated:

1. Make sure all oil hose clamps are tight and that hoses are not pinched or damaged.
2. Check oil level and condition of oil in tank. Pressure will be affected if oil is diluted. In freezing weather, proper circulation of oil can be affected if the oil feed hose becomes clogged with ice and sludge.
3. Check for a grounded oil pressure switch wire or faulty switch if oil indicator light fails to go out with engine running.

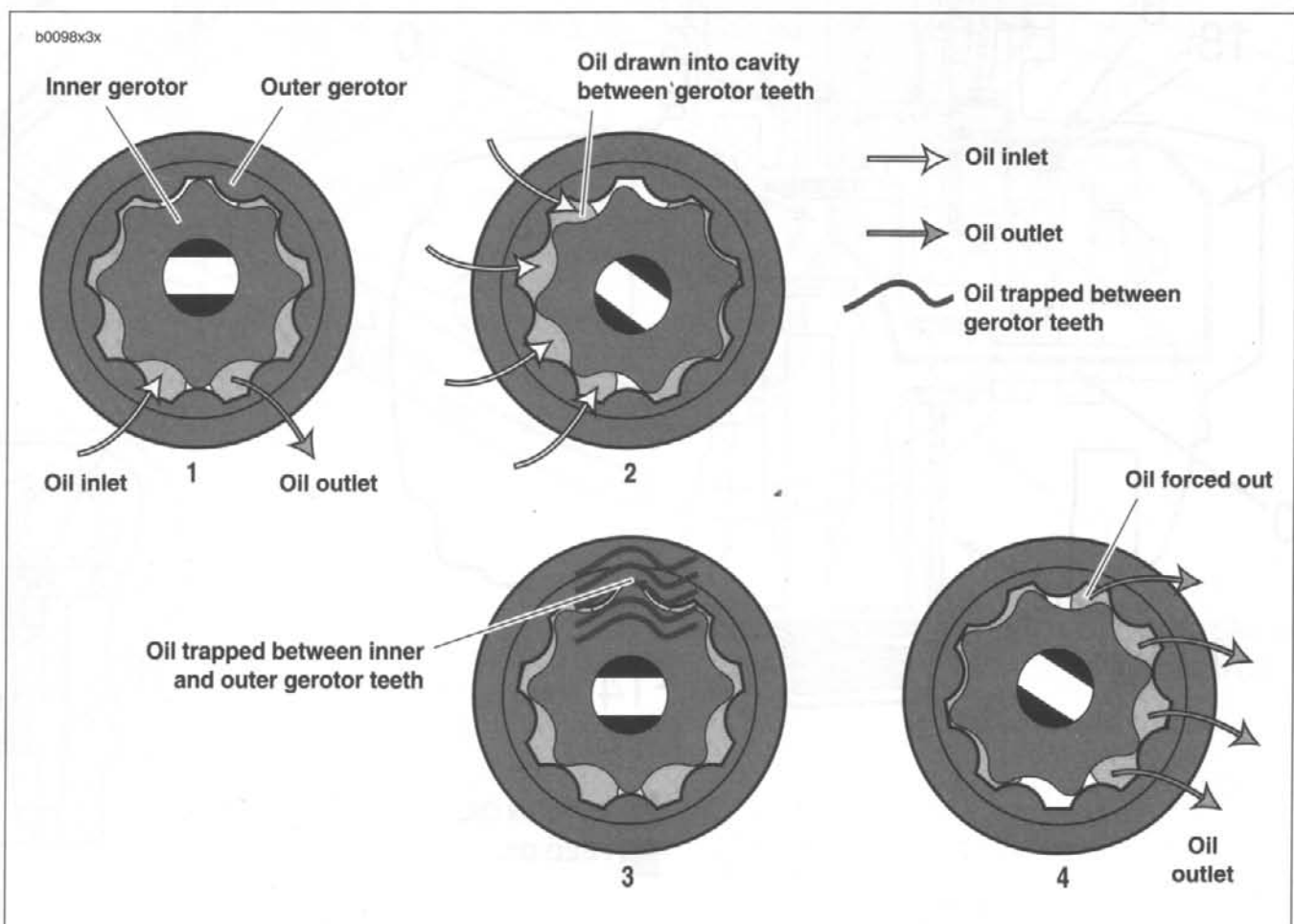
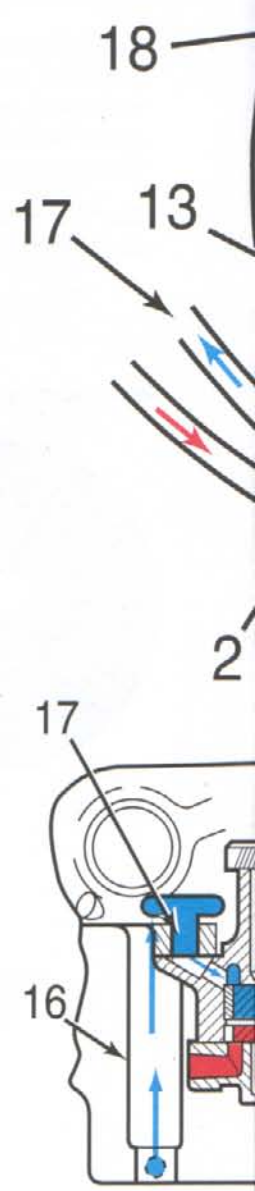
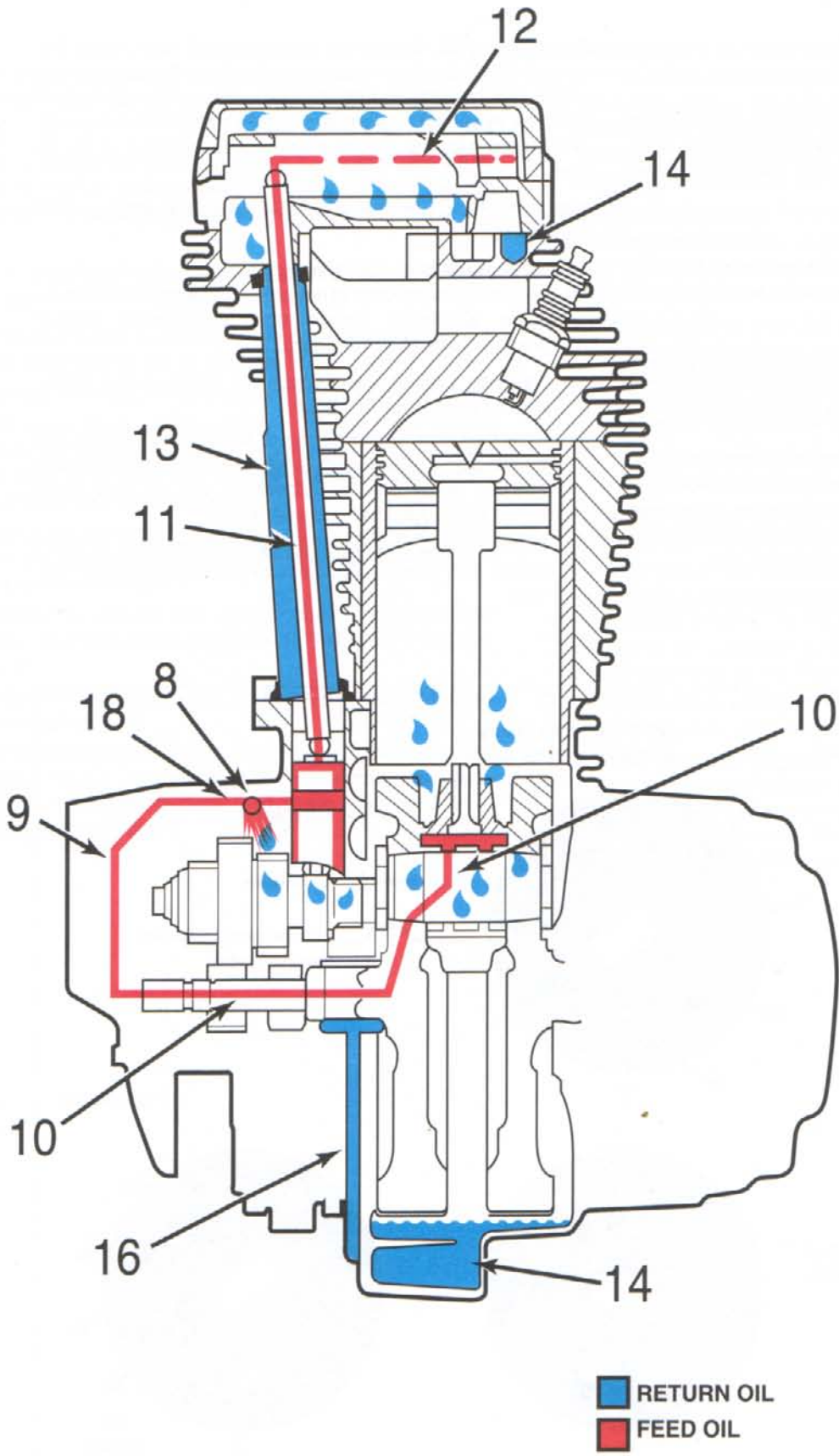
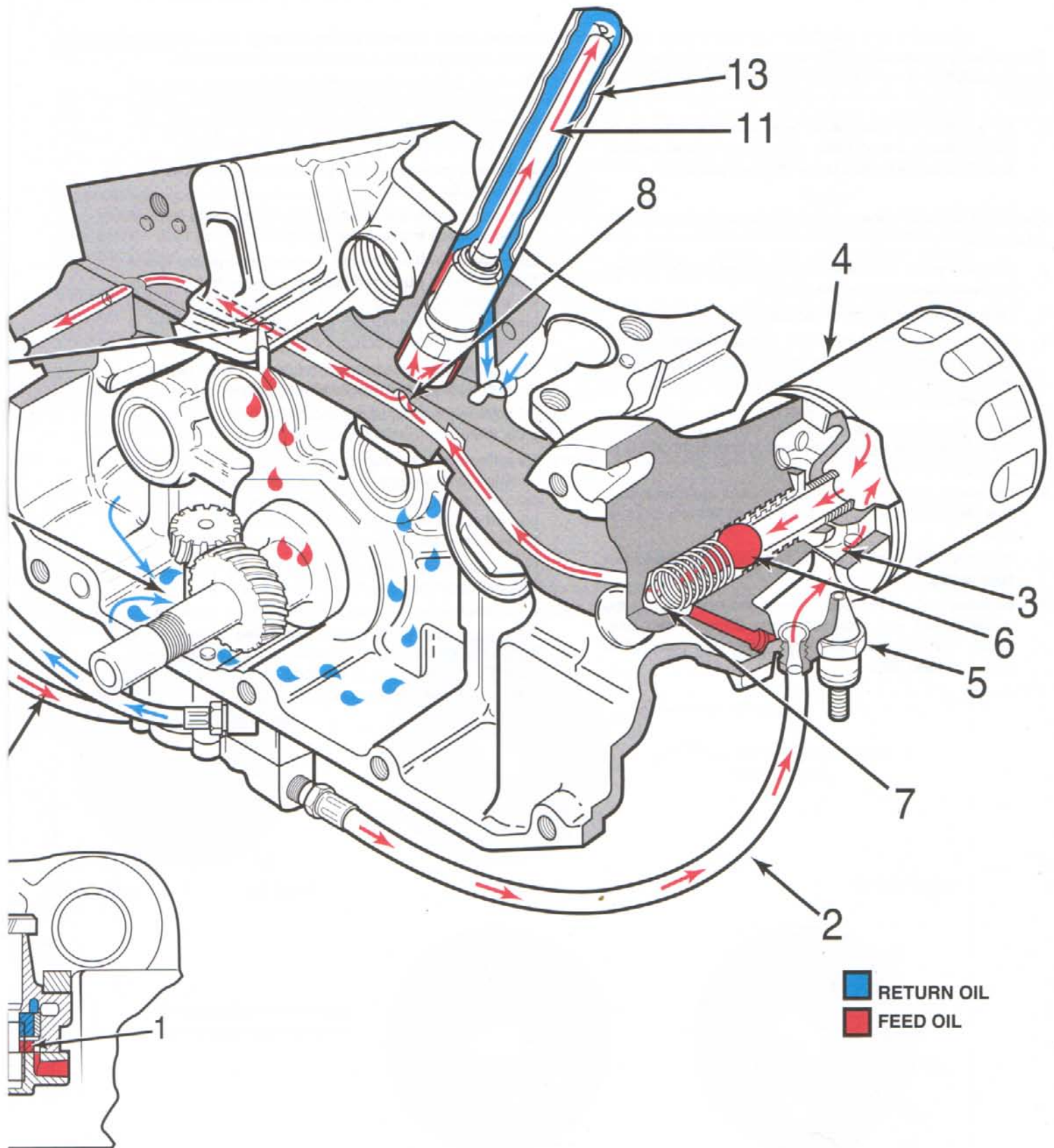


Figure 3-53. Principle of Gerotor Operation

INTERNAL ENCO



LINE PASSAGES



REMOVAL/DISASSEMBLY

NOTE

Oil pump can be removed with engine in frame and without removing gearcase cover.

1. Drain oil tank. See 1.6 ENGINE LUBRICATION SYSTEM.
2. See Figure 3-54. Disconnect feed hose (3).
3. Remove clamp (6) from filter hose. Detach oil filter hose connection (5).

NOTE

Loosen nut on oil filter hose connection (5) and then remove pressurized hose.

4. Carefully remove mounting screws and washers (1). Pump will drop with screws removed. Discard mounting gasket.
5. Remove clamp and detach return hose connection (4).

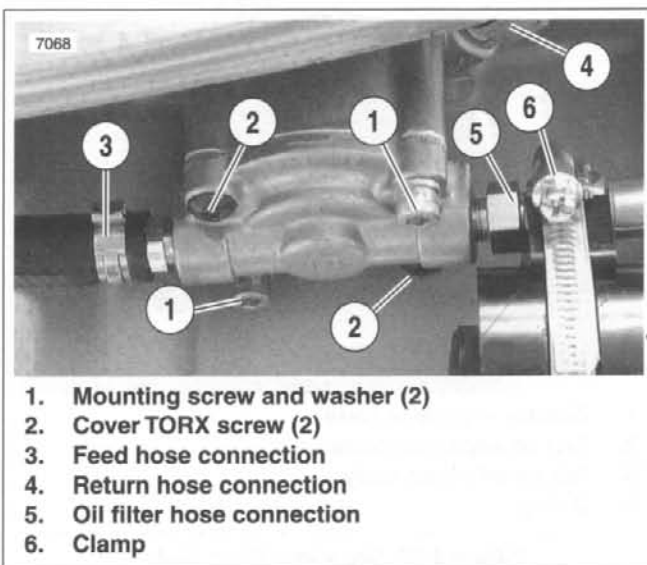


Figure 3-54. Oil Pump Hardware

6. See Figure 3-55. Remove cover TORX screws (2). Lift cover (6) off body (12). Remove and discard O-ring (14).
7. Slide both pieces of gerotor feed set (7), separator plate (8) and both pieces of gerotor scavenge set (9) off gear shaft (11).
8. Remove and discard retaining ring (16). Remove thrust washer (15) and gear shaft (11).

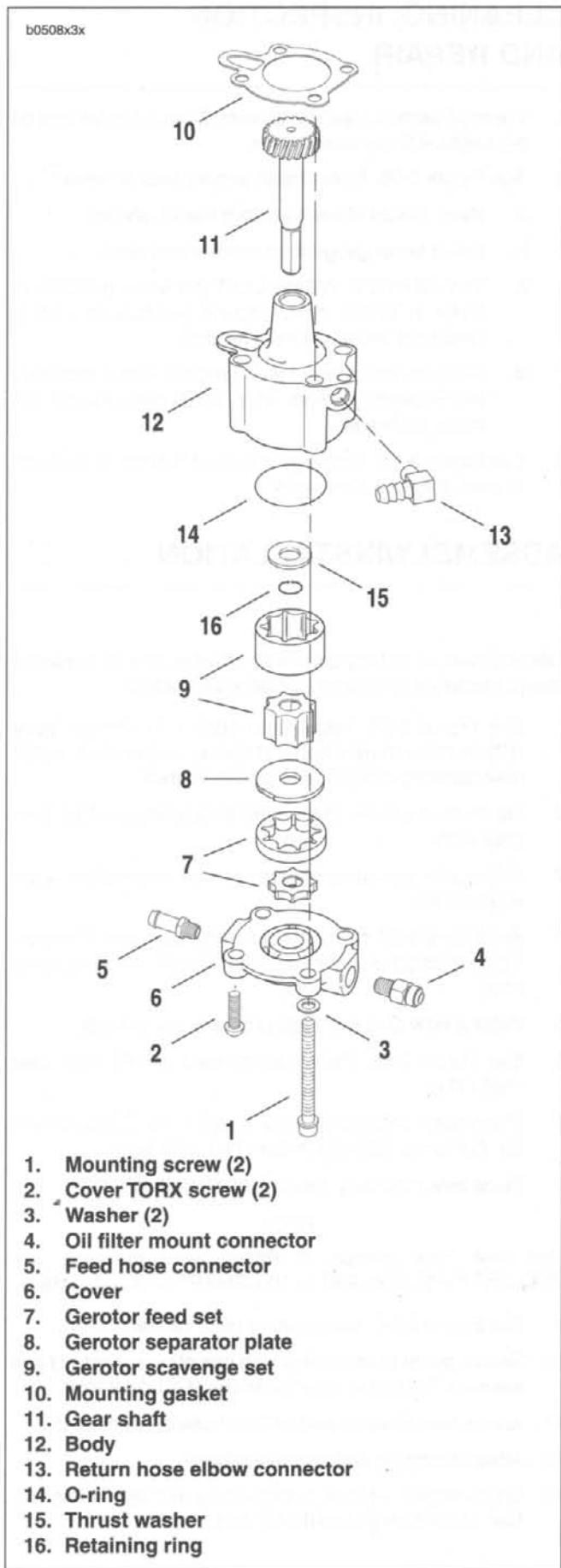


Figure 3-55. Oil Pump

CLEANING, INSPECTION AND REPAIR

1. Clean all parts in cleaning solvent. Blow out holes and oil passages with compressed air.
2. See Figure 3-56. Inspect both gerotor sets for wear.
 - a. Mesh pieces of each set together as shown.
 - b. Use a feeler gauge to determine clearance.
 - c. The **SERVICE WEAR LIMIT** between gerotors is 0.004 in. (0.102 mm). Replace gerotors as a set if clearance exceeds this dimension.
 - d. Measure thickness of feed gerotors with a micrometer. Replace gerotors as a set if they are not the same thickness.
3. See Figure 3-55. Check gear shaft (11) teeth for damage or wear. Replace if necessary.

ASSEMBLY/INSTALLATION

NOTE

Liberalily coat all moving parts with clean engine oil to ensure easy assembly and smooth operation at start-up.

1. See Figure 3-55. Install gear shaft (11) through body (12). Position thrust washer (15) over end of shaft. Install **new** retaining ring (16) into groove in shaft.
2. Insert inner gerotor of the gerotor scavenge set (9) over gear shaft.
3. Place outer gerotor over inner gerotor to complete scavenge set (9).
4. See Figure 3-57. Install gerotor separator plate (1) by lining up slots (2) on perimeter with tabs (3) inside oil pump body.
5. Install a **new** O-ring (4) into groove in pump body.
6. See Figure 3-55. Place gerotor feed set (7) over gear shaft (11).
7. Place cover onto pump body. Install cover TORX screws (2). Tighten to 125-150 **in-lbs** (14.1-16.9 Nm).
8. Place **new** mounting gasket (10) in position.

NOTE

*Use **new** hose clamps. If fittings were removed, use **TEFLON**[®] PIPE SEALANT or **HYLOMAR**[®] on fitting threads.*

9. See Figure 3-54. Attach return hose connection (4).
10. Secure pump to crankcase with mounting screws (1) and washers. Tighten to 125-150 **in-lbs** (14.1-16.9 Nm).
11. Attach feed hose (3) and oil filter hose connection (5).
12. Attach clamp (6) and canister to hose.
13. Check engine oil level. Add oil to correct level if needed. See 1.6 ENGINE LUBRICATION SYSTEM.

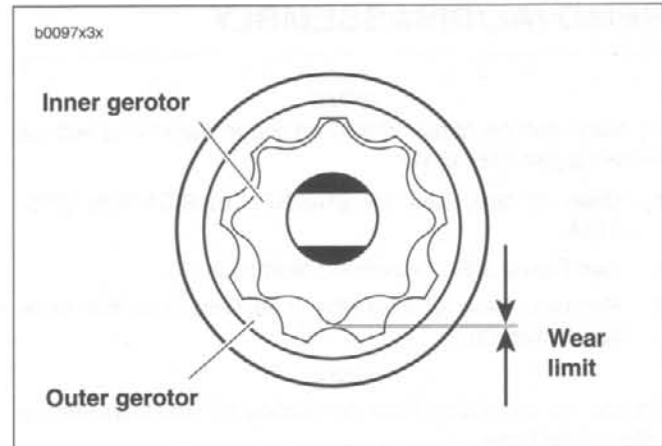


Figure 3-56. Gerotor Wear Limits

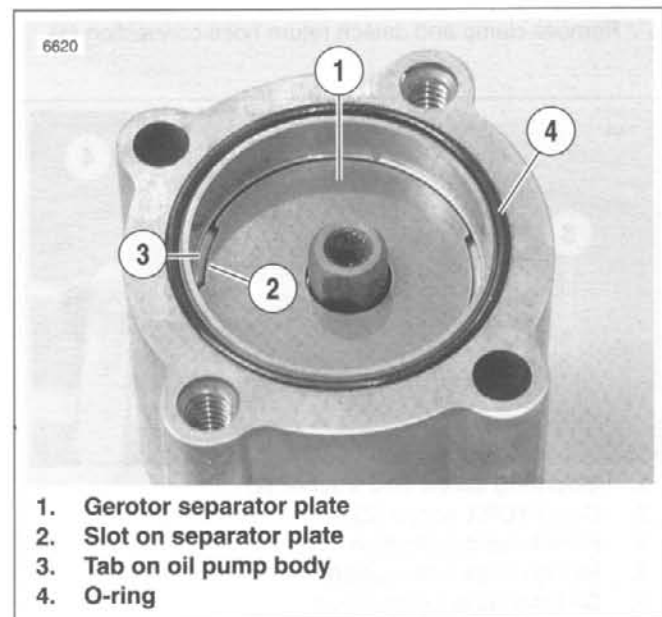


Figure 3-57. Separator Plate Slots

GENERAL

See Figure 3-58. Oil is pressure-fed from the oil pump to the filter mount (4) via a hose (5). Oil travels through the filter mount into the filter via outer filter holes.

Adequate oil pressure activates the oil pressure indicator switch (6) in the filter mount, which turns off the oil pressure indicator lamp.

The check ball (2) in the filter adapter (1) "opens" at 4-6 psi (28-41 kN/m²) oil pressure. Filtered oil leaves the filter, flowing past the check ball.

DISASSEMBLY

1. Drain oil tank and remove filter. See 1.6 ENGINE LUBRICATION SYSTEM.
2. Remove filter adapter (1) from filter mount (4). Remove check ball (2) and spring (3).
3. Detach indicator lamp wire (7) from oil pressure indicator switch (6). Remove switch using OIL PRESSURE SENDING UNIT WRENCH (Part No. HD-41675).

CLEANING/INSPECTION

Thoroughly clean all parts in cleaning solvent. Blow out holes and passages using compressed air.

ASSEMBLY

NOTE

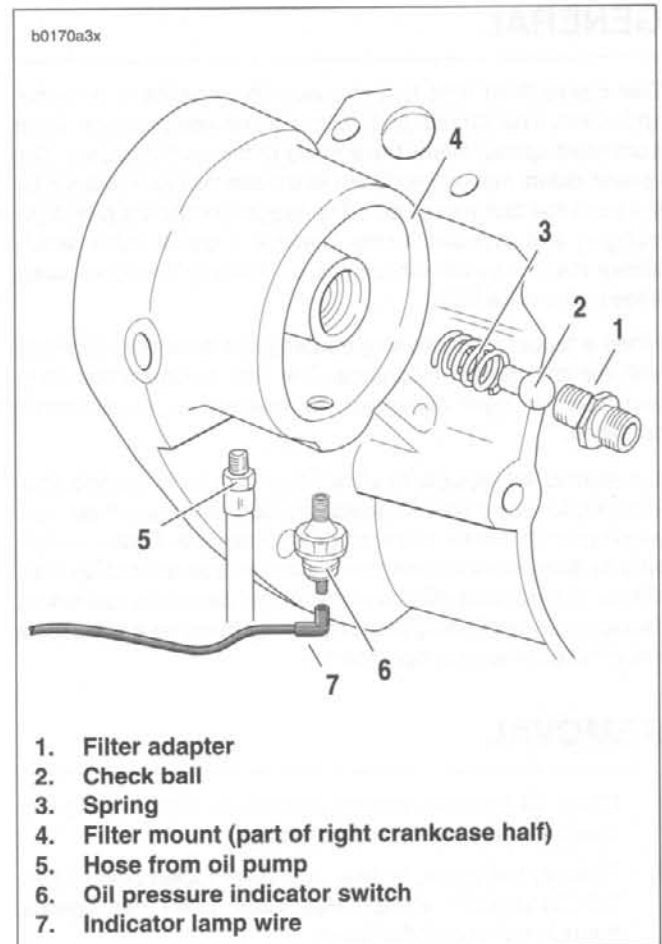
Use *TEFLON PIPE SEALANT* or *HYLOMAR* on all fittings installed to oil filter mount.

1. Install oil pressure indicator switch (6) using OIL PRESSURE SENDING UNIT WRENCH (Part No. HD-41675). Tighten to 4-6 ft-lbs (5.4-8.1 Nm).

NOTE

The filter adapter (1) has identical ends; either end may be installed into the filter mount (4).

2. Apply **LOCTITE THREADLOCKER 243** (blue) to the threads on that end of the filter adapter (1) which is installed into filter mount (4). Do not apply **LOCTITE** to adapter threads on filter element side.



1. Filter adapter
2. Check ball
3. Spring
4. Filter mount (part of right crankcase half)
5. Hose from oil pump
6. Oil pressure indicator switch
7. Indicator lamp wire

Figure 3-58. Oil Filter Mount

3. Install filter mount components.
 - a. Place spring (3) and check ball (2) into threaded hole at center of mount (4).
 - b. Push threaded end of filter adapter (with **LOCTITE**) (1) against check ball to compress spring.
 - c. Screw adapter into threaded hole. Tighten to 8-12 ft-lbs (10.8-16.3 Nm).
4. Attach indicator lamp wire (7).
5. Install a **new** filter and fill oil tank with proper oil. See 1.6 ENGINE LUBRICATION SYSTEM.

GENERAL

See Figure 3-59. The tappet assembly consists of a tappet and roller. The tappet and roller, under compression force from valve spring, follow the surface of the revolving cam. The up-and-down motion produced is transmitted to the valve by the push rod and rocker arm. The tappet contains a piston (or plunger) and cylinder; it also contains a check valve, which allows the unit to fill with engine oil, thereby reducing clearance in the valve train.

When a tappet is functioning properly, the assembly operates with minimal tappet clearance. The unit automatically compensates for heat expansion to maintain a no-clearance condition.

It is normal for tappets to click when engine is started after standing for some time. Tappets have a definite leakdown rate which permits the oil in the tappets to escape. This is necessary to allow units to compensate for various expansion conditions of parts and still maintain correct clearance operation. Tappets are functioning properly if they become quiet after a few minutes of engine operation.

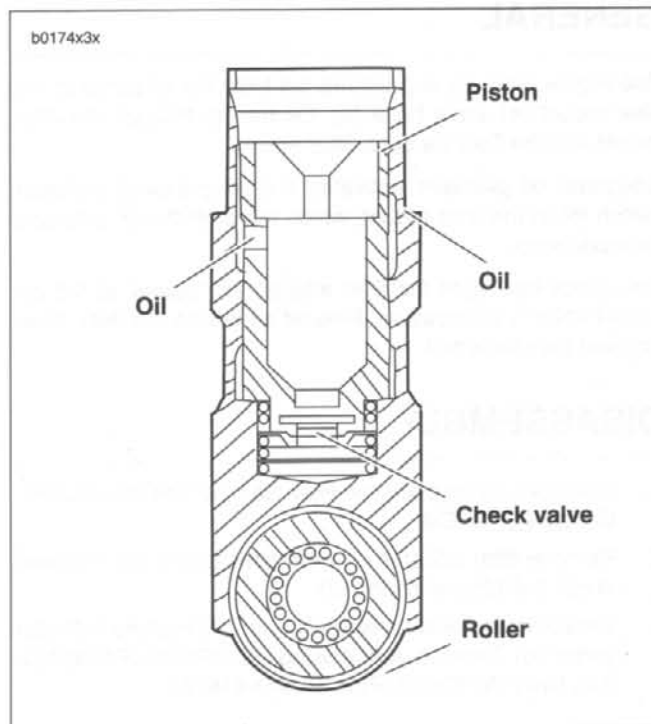


Figure 3-59. Tappet Assembly

REMOVAL

1. Clean all dirt from around crankcase. Blow loose particles from area with compressed air.
2. Remove the upper, middle, and lower rocker covers. See 3.5 CYLINDER HEAD. Pull each push rod upward through top of cylinder head.
3. See Figure 3-61. Remove both push rod covers (7).
 - a. Remove screw (11) and washer (13).
 - b. Lift retainer (9) and seal (8) upward a few inches on push rod cover (7).
 - c. Push upward on push rod cover while pulling bottom of cover clear of crankcase. Remove cover.
4. Remove both valve tappets (6).
 - a. Remove screw (5), washer (14) and plate (4).
 - b. Pull and discard O-rings (3) from ends of pins (2). Grasp pins (2) and pull from crankcase. Use a pliers if necessary.
 - c. Remove tappet from crankcase bore using a thin-bladed screwdriver. Mark the location and orientation (front/back) of each tappet.

CLEANING/INSPECTION

1. Clean all parts, except roller/tappet assembly, thoroughly in solvent. Blow dry with compressed air.

NOTE

Inside and outside micrometers used for measuring tappets and tappet guides must be calibrated to ensure accurate readings.

2. Inspect valve tappets for excessive clearance in guide. Accurately measure tappet bore inner diameter with a gauge.
 - a. Clearance should be within 0.0008-0.0020 in. (0.0203-0.0508 mm).
 - b. Fit a **new** tappet and/or replace crankcases if clearance exceeds SERVICE WEAR LIMIT of 0.0030 in. (0.076 mm).
3. Check tappet roller freeplay.
 - a. Roller clearance on pin should be within 0.0006-0.0010 in. (0.0152-0.0254 mm).
 - b. Replace tappets if clearance exceeds SERVICE WEAR LIMIT of 0.0015 in. (0.0381 mm).
4. Check tappet roller end clearance.
 - a. End clearance should be within 0.008-0.022 in. (0.203-0.559 mm).
 - b. Replace tappets if clearance exceeds SERVICE WEAR LIMIT of 0.026 in. (0.660 mm).
5. Soak tappets in clean engine oil. Keep covered until assembly.

INSTALLATION

1. See Figure 3-60. Rotate engine so that both tappets, from the cylinder being serviced, will be installed on the base circle (1) of the cam.

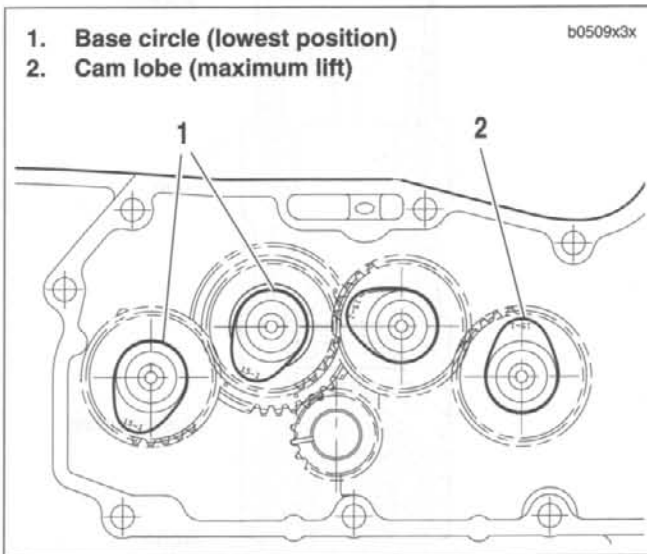
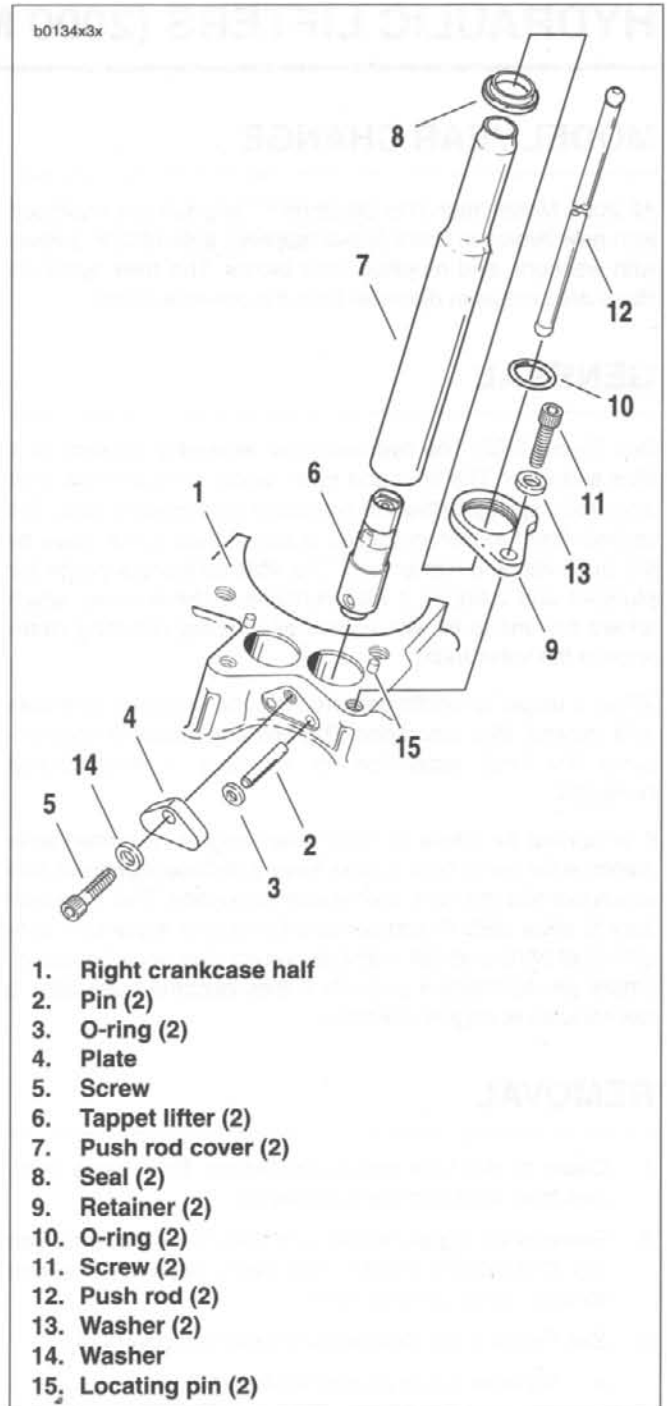


Figure 3-60. Base Circle

2. Apply a liberal amount of engine oil to each tappet assembly (especially the roller needles) for smooth initial operation.
3. See Figure 3-61. Insert tappet (6) into bore in crankcase (1). Rotate tappet so that flats at upper end of tappet face the front and rear of the engine. If the tappet is installed incorrectly, pins (2) cannot be inserted.
4. Secure tappets in place.
 - a. Insert pins (2) in the holes in crankcase.
 - b. Place **new** O-rings (3) over ends of pins.
 - c. Install plate (4) using screw (5) with washer (14). Tighten to 80-110 **in-lbs** (9.0-12.4 Nm).
5. Install push rod covers.
 - a. Slide **new** seal (8) and retainer (9) over top of push rod cover (7).
 - b. Position **new** O-ring (10) at top of push rod cover.
 - c. Hold cover at an angle and insert top through hole in cylinder head. Push up on cover while aligning bottom of cover with tappet bore in crankcase.
 - d. Lower retainer (9) with seal (8) onto crankcase, aligning locating pin (15) with hole in retainer.
 - e. Insert screw (11) with washer (13) through hole in retainer (9). Thread screw (11) into tapped hole in crankcase. Tighten to 15-18 **ft-lbs** (20.3-24.4 Nm).
6. Install push rods and rocker covers. See INSTALLATION.



1. Right crankcase half
2. Pin (2)
3. O-ring (2)
4. Plate
5. Screw
6. Tappet lifter (2)
7. Push rod cover (2)
8. Seal (2)
9. Retainer (2)
10. O-ring (2)
11. Screw (2)
12. Push rod (2)
13. Washer (2)
14. Washer
15. Locating pin (2)

Figure 3-61. Valve Tappet Service

MODEL YEAR CHANGE

All 2000 Model Year Thunderstorm™ engines are equipped with **new** hydraulic lifters (valve tappets), anti-rotation screws with washers, and modified lifter blocks. The **new** hydraulic lifters are smaller in diameter than the previous lifters.

GENERAL

See Figure 3-62. The hydraulic lifter assembly consists of a lifter and roller. The lifter and roller, under compression force from valve spring, follow the surface of the revolving cam. The up-and-down motion produced is transmitted to the valve by the push rod and rocker arm. The lifter contains a piston (or plunger) and cylinder; it also contains a check valve, which allows the unit to fill with engine oil, thereby reducing clearance in the valve train.

When a tappet is functioning properly, the assembly operates with minimal lifter clearance. The unit automatically compensates for heat expansion to maintain a no-clearance condition.

It is normal for lifters to click when engine is started after standing for some time. Lifters have a definite leakdown rate which permits the oil in the tappets to escape. This is necessary to allow units to compensate for various expansion conditions of parts and still maintain correct clearance operation. Lifters are functioning properly if they become quiet after a few minutes of engine operation.

REMOVAL

1. Clean all dirt from around crankcase. Blow loose particles from area with compressed air.
2. Remove the upper, middle, and lower rocker covers. See 3.5 CYLINDER HEAD. Pull each push rod upward through top of cylinder head.
3. See Figure 3-64. Remove both push rod covers (4).
 - a. Remove screw (8) and washer (10).
 - b. Lift retainer (6) and seal (7) upward a few inches on push rod cover (4).
 - c. Push upward on push rod cover while pulling bottom of cover clear of crankcase. Remove cover.
4. Remove both hydraulic lifters (3).
 - a. Remove two anti-rotation screws with washers (2).
 - b. Remove lifters (3) from crankcase bore using a thin-bladed screwdriver. Mark the location and orientation (front/back) of each tappet.

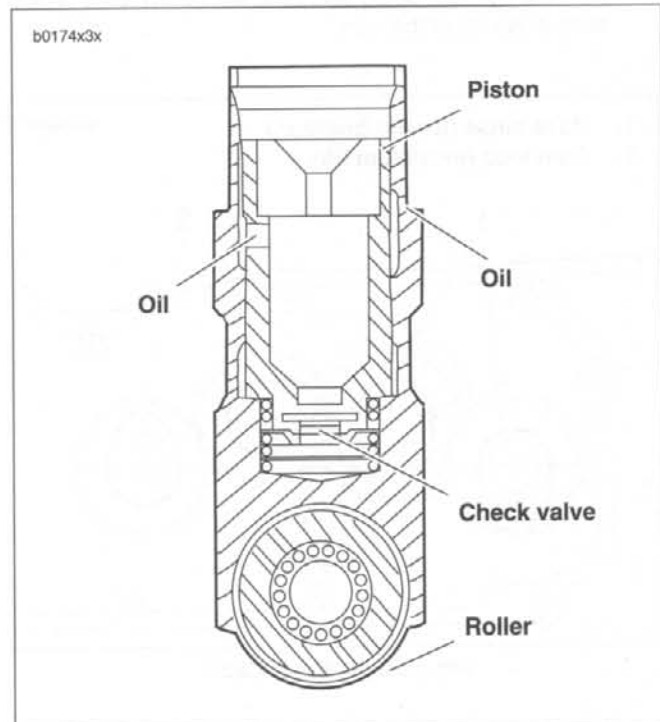


Figure 3-62. Lifter Assembly (Typical)

CLEANING/INSPECTION

1. Clean all parts, except roller/lifter assembly, thoroughly in solvent. Blow dry with compressed air.

NOTE

Inside and outside micrometers used for measuring lifters and lifter guides must be calibrated to ensure accurate readings.

2. Inspect hydraulic lifters for excessive clearance in guide. Accurately measure lifter bore inner diameter with a gauge.
 - a. Clearance should be within 0.0008-0.0020 in. (0.0203-0.0508 mm).
 - b. Fit a **new** lifter and/or replace crankcases if clearance exceeds SERVICE WEAR LIMIT of 0.0030 in. (0.076 mm).
3. Check lifter roller freeplay.
 - a. Roller clearance on pin should be within 0.0006-0.0010 in. (0.0152-0.0254 mm).
 - b. Replace lifters if clearance exceeds SERVICE WEAR LIMIT of 0.0015 in. (0.0381 mm).
4. Check lifter roller end clearance.
 - a. End clearance should be within 0.008-0.022 in. (0.203-0.559 mm).
 - b. Replace tappets if clearance exceeds SERVICE WEAR LIMIT of 0.026 in. (0.660 mm).
5. Soak lifters in clean engine oil. Keep covered until assembly.

INSTALLATION

1. See Figure 3-63. Rotate engine so that both lifters, from the cylinder being serviced, will be installed on the base circle (1) of the cam.

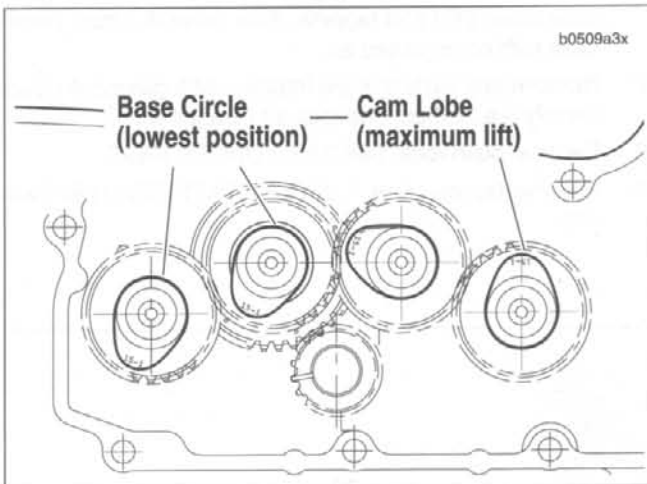
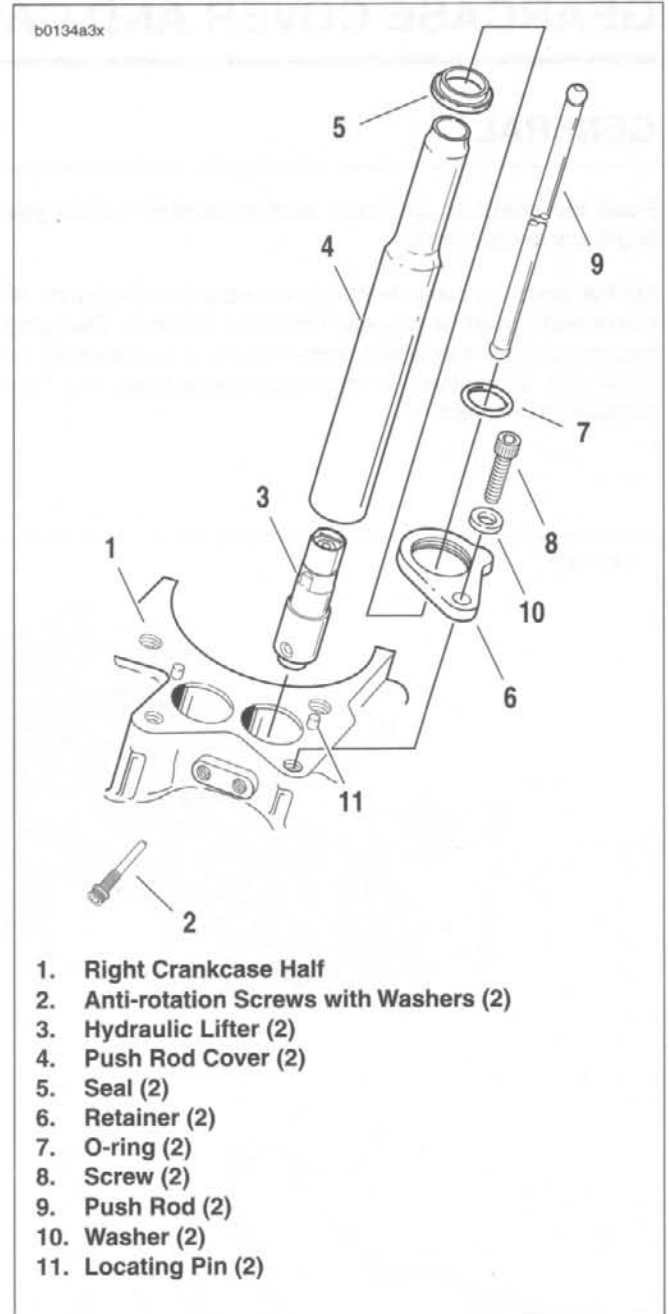


Figure 3-63. Base Circle

2. Apply a liberal amount of engine oil to each lifter assembly (especially the roller needles) for smooth initial operation.
3. See Figure 3-64. Insert lifter (3) into bore in crankcase (1) with lifter oil hole facing towards the oil trough. Rotate lifter so that flats at upper end of lifter faces the front and rear of the engine. If the lifter is installed incorrectly, anti-rotation screws (2) cannot be inserted.
4. Secure lifters in place.
 - a. Insert anti-rotation screws with washers (2) in the threaded holes in crankcase.
 - b. Tighten anti-rotation screws to 80-110 in-lbs (9.0-12.4 Nm)
5. Install push rod covers.
 - a. Slide **new** seal (5) and retainer (6) over top of push rod cover (4).
 - b. Position **new** O-ring (7) at top of push rod cover.
 - c. Hold cover at an angle and insert top through hole in cylinder head. Push up on cover while aligning bottom of cover with lifter bore in crankcase.
 - d. Lower retainer (6) with seal (5) onto crankcase, aligning locating pin (11) with hole in retainer.
 - e. Insert screw (8) with washer (10) through hole in retainer (6). Thread screw (8) into tapped hole in crankcase. Tighten to 15-18 ft-lbs (20.3-24.4 Nm).
6. Install push rods and rocker covers. See 3.5 CYLINDER HEAD.



1. Right Crankcase Half
2. Anti-rotation Screws with Washers (2)
3. Hydraulic Lifter (2)
4. Push Rod Cover (2)
5. Seal (2)
6. Retainer (2)
7. O-ring (2)
8. Screw (2)
9. Push Rod (2)
10. Washer (2)
11. Locating Pin (2)

Figure 3-64. Hydraulic Lifter Service

GEARCASE COVER AND CAM GEARS (1999 MODELS) 3.17

GENERAL

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

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

REMOVAL/DISASSEMBLY

1. See Figure 3-65. Thoroughly clean area around gearcase cover (17) and tappets. Blow loose dirt from crankcase with compressed air.
2. Remove any parts that will interfere with gearcase disassembly (i.e., exhaust header, air cleaner, etc.).
3. Remove push rods. See 3.5 CYLINDER HEAD.
4. Remove tappets. See 3.15 VALVE TAPPETS (1999 models).

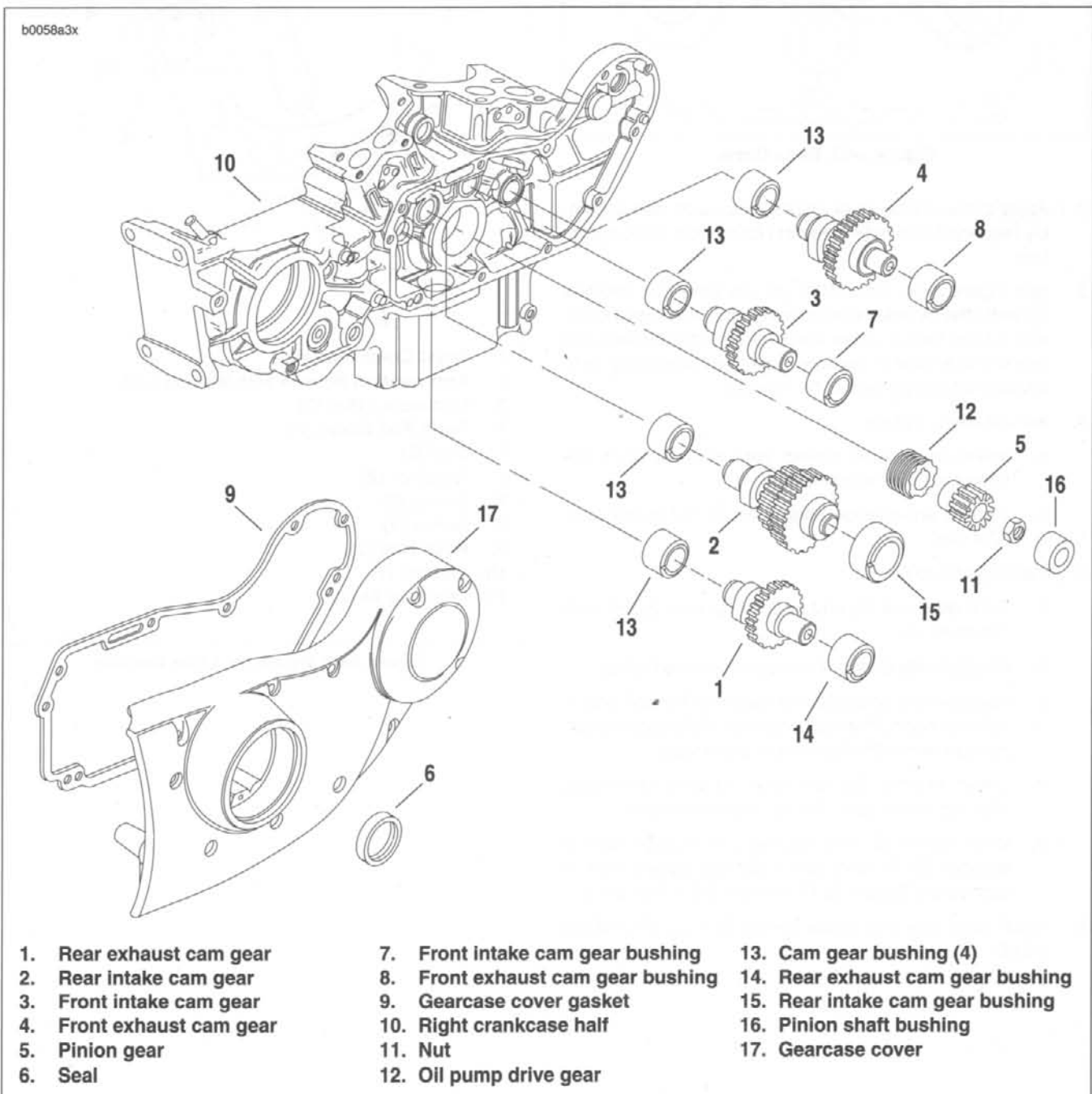


Figure 3-65. Gearcase and Valve Train Components

5. Check for minimum cam gear end play. Record readings.
6. Remove cam position sensor from gearcase cover. See 4.29 CAM POSITION SENSOR AND ROTOR.
7. Place a pan under gearcase to collect oil. Remove cover screws. Carefully remove gearcase cover. Discard old gasket (9).

NOTE

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

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

NOTE

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

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

CLEANING, INSPECTION AND REPAIR

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

Cam and Pinion Gear Identification, Inspection, and Selection

See Figure 3-66. Cam lobes are stamped with the number "15" followed by a number (1, 2, 3 or 4). The number "15" indicates model year application; the number identifies the cam location/function:

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

Use only "15" cams on 1998 models.

See Figure 3-67. Measure the gear diameter with a micrometer over 0.108 in. (2.743 mm) diameter gauge pins on opposite sides of the gear. The pins are of the proper size to fit between the contacting surfaces of the gear teeth. Gear diameter should be measured in at least two places 90° apart. Use GAUGE PIN SET (Part No. HD-38361) when measuring pinion and cam gear sizes.

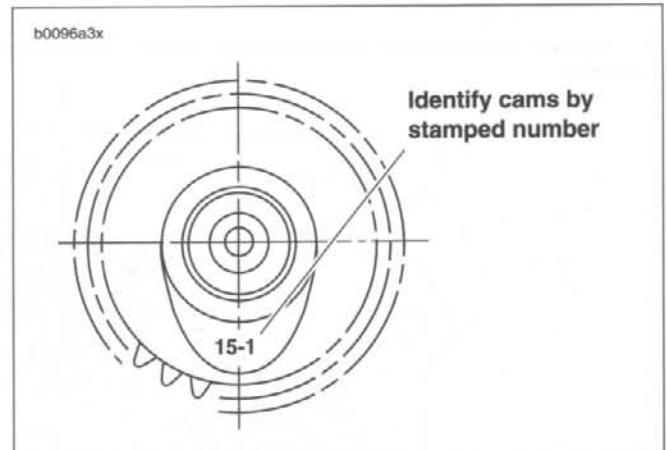


Figure 3-66. Cam Identification

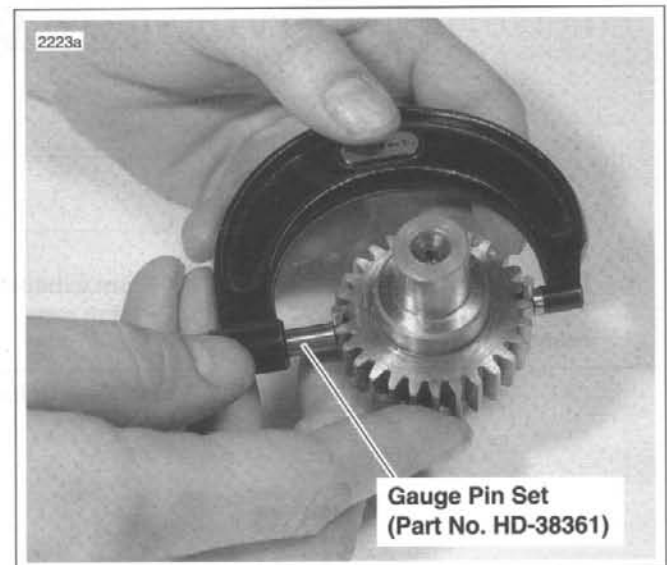


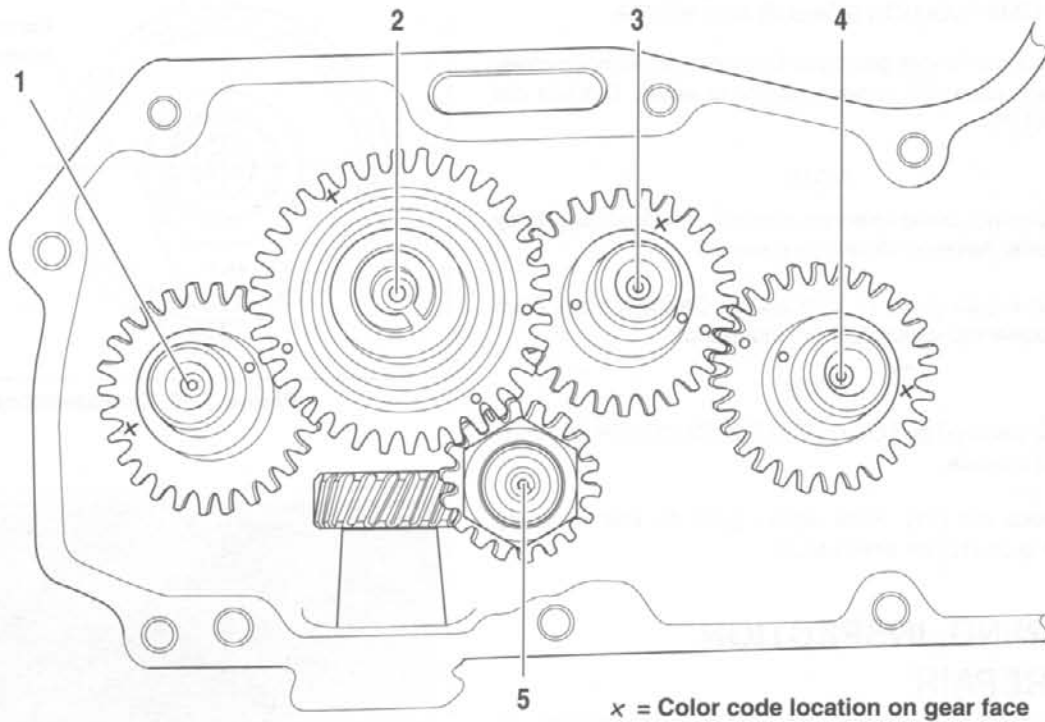
Figure 3-67. Measuring Gear Size

Cam and pinion gears are individually selected for each specific gear cover through sophisticated computer-aided measuring techniques in a controlled environment. Each gear is assigned an individual color code based on its diameter (measured with gauge pins). When cam and/or pinion gears are replaced, always use the same color code as found on gears being replaced to ensure that the gear operation remains as quiet as possible. For location of cam and pinion gear color codes, see Figure 3-68.

NOTE

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

See Table 3-10. Compare the previously measured diameter of each gear with the specifications (listed in inches) shown in the table to determine amount of wear on gear teeth.



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

Figure 3-68. Cam and Pinion Gear Color Code Location and Timing Mark Indexing

NOTE

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

Table 3-10. Cam and Pinion Gear Color Code and Diameter

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

Bushing Inspection and Removal

- See Figure 3-65. Bushings (7, 8, 13, 14, 15 and 16) are press fit in gearcase cover (17) and crankcase. Inspect each bushing against its corresponding cam gear shaft or pinion gear shaft. See Table 3-11.

Table 3-11. Gear Shaft Specifications

GEAR SHAFT	CORRECT CLEARANCE	SERVICE WEAR LIMIT
Cam	0.0007-0.0022 in. (0.0178-0.0559 mm)	0.003 in. (0.076 mm)
Pinion	0.0023-0.0043 in. (0.0584-0.1092 mm)	0.0050 in. (0.1270 mm)

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

Bushing Installation

NOTE

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

CAM GEAR BUSHINGS IN RIGHT CRANKCASE HALF

- See Figure 3-71. Each cam gear bushing (1), to be installed in right crankcase half (2), must be positioned in crankcase bore with its oiling slot at exact top of bore (12 o'clock position).
- Using an arbor press, install each bushing in its crankcase bore so that bushing shoulder contacts crankcase boss.
- After you install a **new** bushing in right crankcase half, ream the bushing to correct size. See BUSHING REAMING on page 3-48.

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

- See Figure 3-65. Using an arbor press, install each bushing (7, 8 and 14) in its gearcase cover (17) bore so that bushing shoulder contacts cover boss. Orient each bushing so the oiling slot is at the 9 o'clock position within the gearcase cover bore.
- After you install a **new** bushing in gearcase cover, line-ream the bushing to correct size. See BUSHING REAMING on page 3-48.

REAR INTAKE CAM GEAR BUSHING IN GEARCASE COVER.

- See Figure 3-65. Rear intake cam gear bushing (15) must be installed in its gearcase cover (17) bore using an arbor press. You will need to orient the bushing in a specific position of rotation within the cover bore, and will need to drill a lubrication hole in the bushing, according to the following procedures.



Figure 3-69. Removing Bushing

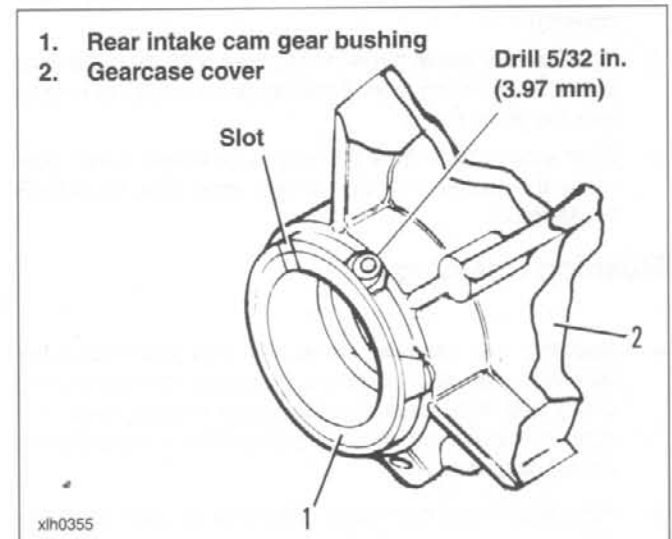


Figure 3-70. Rear Intake Cam Gear Bushing Installed in Gearcase Cover

- See Figure 3-70. Position bushing (1) over bore of gearcase cover (2) with chamfered edge downward and slot upward. Align slot in bushing with slot in gearcase cover boss. Press bushing into cover bore until bushing is flush with cover boss.
- Drill a 5/32 in. (3.97 mm) diameter hole through bushing using existing hole in gearcase cover as a guide.
- After you install a **new** bushing in gearcase cover, line-ream the bushing to the correct size. See BUSHING REAMING on page 3-48.

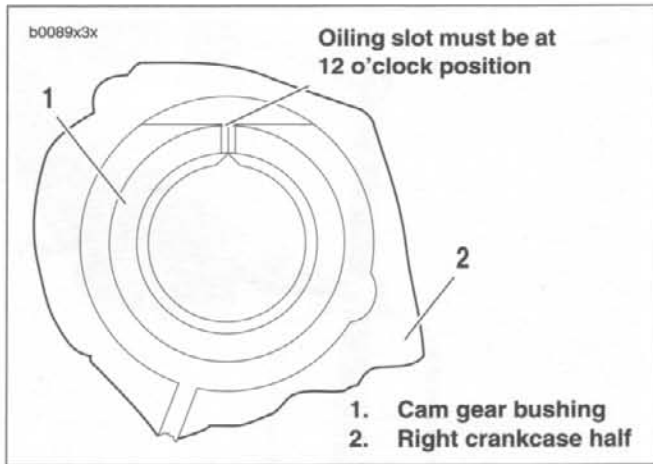


Figure 3-71. Cam Gear Bushing Installed in Crankcase

PINION SHAFT BUSHING IN GEARCASE COVER

1. See Figure 3-65. Using an arbor press, install pinion shaft bushing (16) in its gearcase cover (17) so that bushing is flush with cover boss. There is no need to orient this particular bushing in any specific position of rotation within the gearcase cover bore.
2. Although the original pinion shaft bushing is not "pinned," the replacement bushing must be secured, from possible rotation within the cover bore, by installation of a dowel pin. See Figure 3-72. Drill a No. 31 hole, 0.281 in. (7.137 mm) deep, at top side of boss (side toward top of gearcase cover), centering the drill bit on the cover bore circle (hole is drilled half in bushing OD and half in cover bore ID).
3. Drive a **new** dowel pin no more than 0.20 in. (5.08 mm) below the bushing face. Carefully peen edges of hole to lock the pin in place.
4. After you install a **new** bushing in gearcase cover, line-ream the bushing to the correct size. See BUSHING REAMING.

Bushing Reaming

NOTE

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

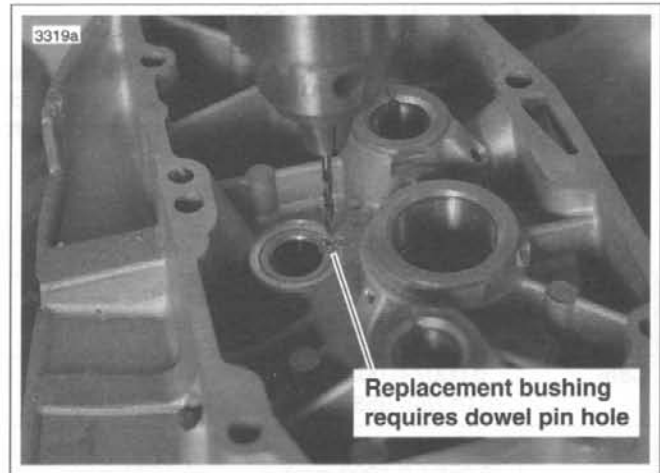


Figure 3-72. Drilling Dowel Pin Hole

CAM GEAR BUSHINGS IN RIGHT CRANKCASE HALF

1. Separate two halves of crankcase, if not already accomplished. Place right crankcase half on flat surface with gearcase side upward. Bushing to be reamed must be oriented as shown in Figure 3-71.
2. See Figure 3-73. Position CAMSHAFT BUSHING REAMER PILOT (Part No. HD-38871) onto gearcase side of crankcase half; upper right and lower left indexing holes in pilot must be placed over dowels in crankcase half. Insert two bolts (supplied with pilot) through two remaining holes in pilot, and into threaded holes of crankcase half. Tighten bolts securely.
3. Insert the 11/16 in. diameter reamer through pilot hole and into bushing while turning reamer clockwise. Continue turning reamer clockwise through bushing until smooth shank of reamer passes through hole in pilot.
4. Detach reamer from handle. Pull reamer out opposite side of crankcase half.
5. Thoroughly clean right crankcase half, removing all metal chips/shavings. Blow out all oil passages using compressed air.

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

NOTE

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

1. See Figure 3-65. Bushings (7, 8 and 14) to be reamed must be installed in gearcase cover (17) as described in BUSHING INSTALLATION on page 3-47. Attach gearcase cover to right crankcase half (10), which has been disassembled from left crankcase half, securing with a minimum of three mounting screws.

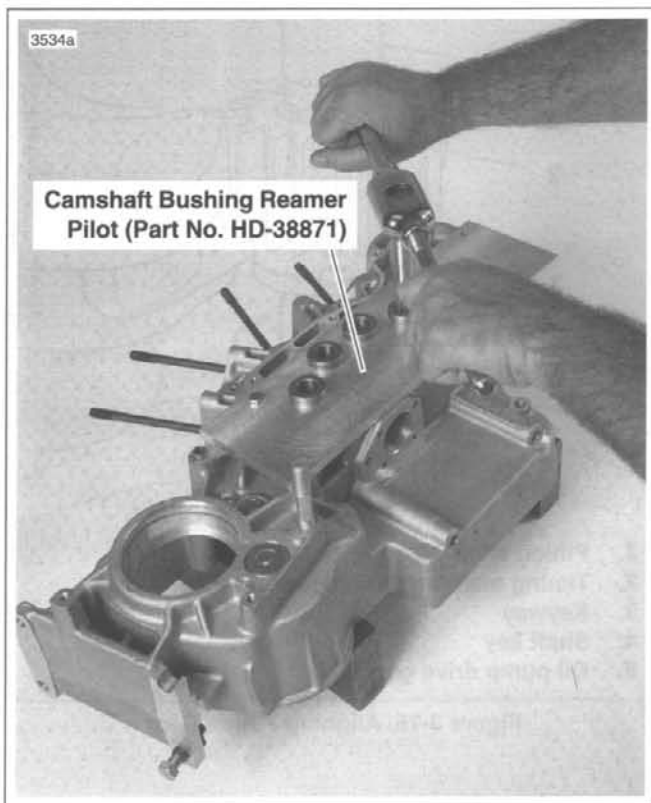


Figure 3-73. Reaming Cam Gear Bushing in Right Crankcase Half

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

REAR INTAKE CAM GEAR BUSHING IN GEARCASE COVER

NOTE

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

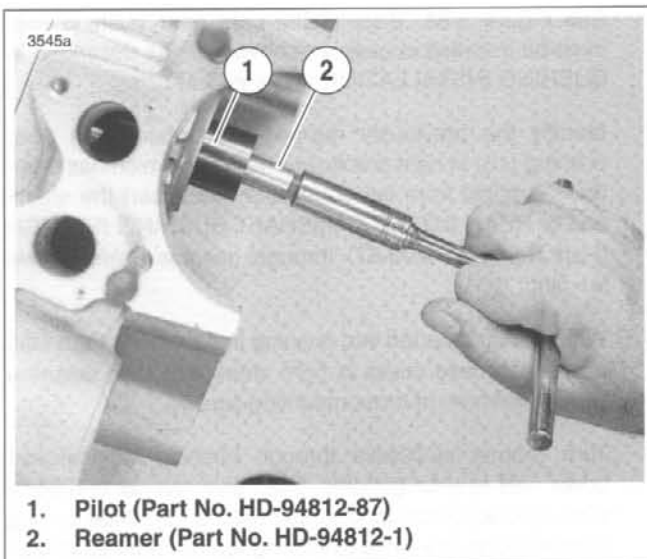
1. See Figure 3-65. Rear intake cam gear bushing (15) must be installed in gearcase cover (17) as described in BUSHING INSTALLATION on page 3-47.
2. Identify the previously reamed rear intake cam gear bushing (13) in right crankcase half (10), which has been disassembled from left crankcase half. Insert the shank end of REAR INTAKE CAMSHAFT BUSHING REAMER (Part No. HD-94803-67) through gearcase side of this bushing.
3. With reamer inserted into bushing in right crankcase half, attach gearcase cover to right crankcase half, securing with a minimum of three mounting screws.
4. Turn reamer clockwise through bushing in gearcase cover until reamer bottoms. Then give reamer one complete clockwise turn to size the bushing. Continue turning reamer clockwise while extracting reamer from bushing.
5. Separate gearcase cover from right crankcase half. Inspect bushing for proper cam gear shaft fit. Repeat line reaming operation if necessary.
6. Thoroughly clean gearcase cover, removing all metal chips/shavings. Blow out all oil passages using compressed air.

PINION SHAFT BUSHING IN GEARCASE COVER

NOTE

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

1. See Figure 3-65. Pinion shaft bushing (16) must be installed in gearcase cover (17) as described in BUSHING INSTALLATION on page 3-47. Attach gearcase cover to right crankcase half (10), which has been disassembled from left crankcase half, securing with a minimum of three mounting screws.
2. See Figure 3-74. Install PINION SHAFT BUSHING REAMER PILOT (Part No. HD-94812-87) into right crankcase roller race. Insert PINION SHAFT BUSHING REAMER (Part No. HD-94812-1) through the pilot.
3. Turn reamer clockwise through bushing in gearcase cover until reamer bottoms. Then give reamer one complete clockwise turn to size the bushing. Continue turning reamer clockwise while extracting reamer from bushing.
4. Separate gearcase cover from right crankcase half. Inspect bushing for proper pinion shaft fit. Repeat line reaming operation if necessary.
5. Remove pilot from right crankcase roller race. Thoroughly clean gearcase cover, removing all metal chips/shavings. Blow out all oil passages using compressed air.



1. Pilot (Part No. HD-94812-87)
2. Reamer (Part No. HD-94812-1)

Figure 3-74. Line Reaming Pinion Shaft Bushing

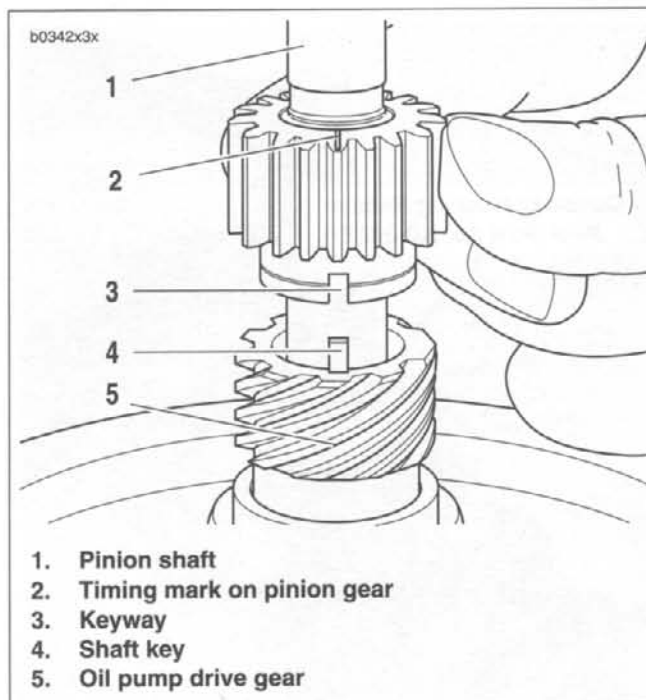
ASSEMBLY/INSTALLATION

1. See Figure 3-75. Install oil pump drive gear (5) and pinion gear on pinion shaft.
 - a. Slide oil pump gear drive gear (5) over pinion shaft (1). Drive gear must align with shaft key (4).
 - b. Align keyway (3) in ID of pinion gear with shaft key (4).
 - c. Slide pinion gear over shaft key (4) and against oil pump drive gear (5).
2. See Figure 3-65. Install nut (11).
 - a. Clean threads on pinion shaft and nut.
 - b. Apply several drops of LOCTITE THREADLOCKER 262 (red) to threads of nut.
 - c. See Figure 3-76. Install CRANKSHAFT LOCKING TOOL (Part No. HD-41506) over pinion shaft.
 - d. Tighten nut to 35-45 ft-lbs (47.5-61.0 Nm).
3. Liberally apply engine oil to bushings, shafts, and gears. Install all cam gears into bushings of right crankcase half, properly aligning timing marks of cam gears and pinion gear. See Figure 3-68.

NOTE

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

4. See Figure 3-65. Install a **new** seal (6) and **new** dry gearcover gasket (9) on gearcase cover (17).



1. Pinion shaft
2. Timing mark on pinion gear
3. Keyway
4. Shaft key
5. Oil pump drive gear

Figure 3-75. Aligning Pinion Gear

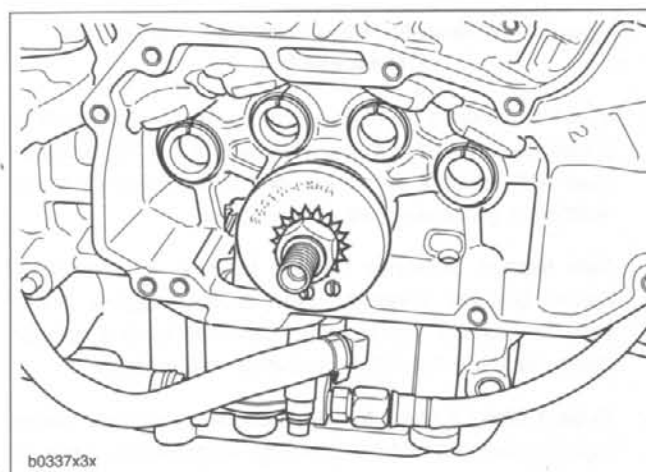


Figure 3-76. Crankshaft Locking Tool

5. Install gearcase cover over all gears and onto right crankcase half (10). Secure cover to crankcase half with 11 socket head screws. Tighten screws evenly to 80-110 **in-lbs** (9.0-12.4 Nm). Use torque sequence shown in Figure 3-77.
6. See Figure 3-78. Check cam gear end play for each cam gear as follows:
 - a. Turn engine over until lobe of cam gear being checked is pointing toward its respective tappet guide hole.
 - b. Gently pry the cam gear toward the gearcase cover using a flat blade screwdriver.
 - c. Measure gap between bushing (in crankcase half) and cam gear shaft thrust face (shoulder) using a feeler gauge. This is cam gear end play.
 - d. Compare cam gear end play measurements with the SERVICE WEAR LIMITS. Make repairs as required if end play does not meet specifications.
7. Install valve tappets and push rods. See 3.15 VALVE TAPPETS (1999 models).
8. Install cam position sensor in gearcase cover. See 4.29 CAM POSITION SENSOR AND ROTOR.
9. Install any components removed to gain access to gearcase (i.e. exhaust system components, air cleaner, etc.).
10. Check engine timing. See 1.23 IGNITION TIMING

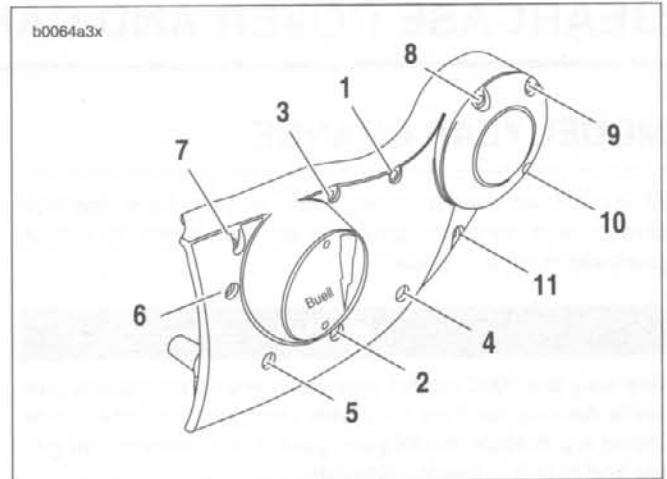


Figure 3-77. Gearcase Cover Mounting Screw Torque Sequence

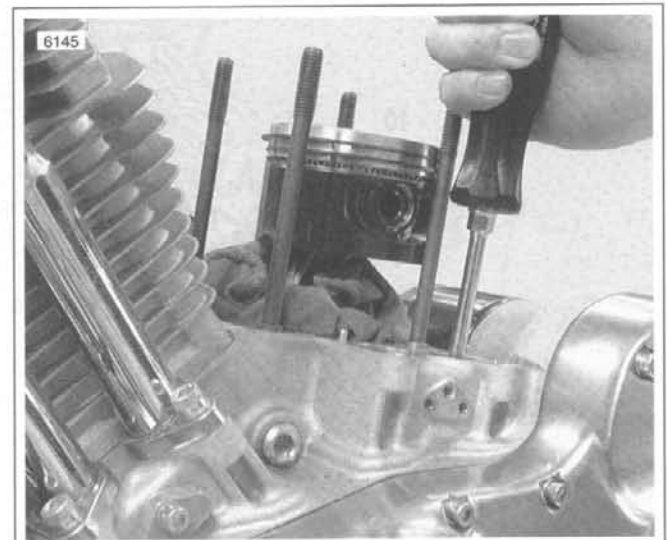


Figure 3-78. Checking Cam Gear End Play

GEARCASE COVER AND CAM GEARS (2000 MODELS) 3.18

MODEL YEAR CHANGE

All 2000 Model Year Thunderstorm™ engines have new high contact ratio drive and pinion gears and a new gearcase, gearcase cover and gasket.

CAUTION

Use only the 2000 model year gearcase cover gasket (see parts catalog for Part No.) with the new gearcase cover. Using a previous model year gasket will obstruct oil galley and result in engine damage.

GENERAL

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

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

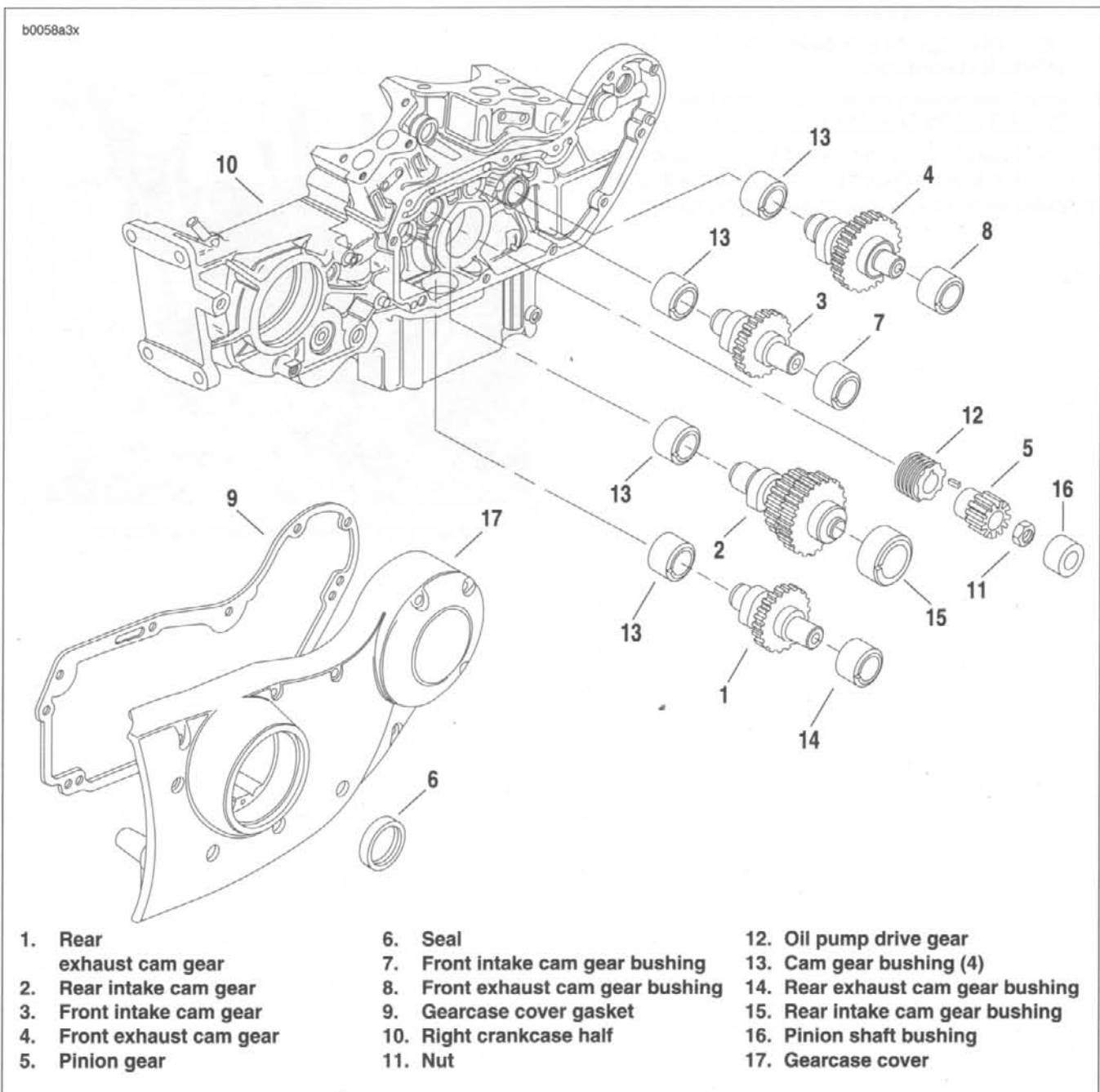


Figure 3-79. Gearcase and Valve Train Components

REMOVAL/DISASSEMBLY

1. See Figure 3-79. Thoroughly clean area around gearcase cover (17) and tappets. Blow loose dirt from crankcase with compressed air.
2. Remove any parts that will interfere with gearcase disassembly (i.e., exhaust header, air cleaner, etc.).
3. Remove push rods. See 3.5 CYLINDER HEAD.
4. Remove hydraulic lifters. See 3.16 HYDRAULIC LIFTERS (2000 models).
5. Check for minimum cam gear end play. Record readings.
6. Remove cam position sensor from gearcase cover. See 4.29 CAM POSITION SENSOR AND ROTOR.
7. Place a pan under gearcase to collect oil. Remove cover screws. Carefully remove gearcase cover. Discard old gasket (9).

NOTE

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

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

NOTE

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

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

CLEANING AND INSPECTION

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

Cam and Pinion Gear Identification, Inspection, and Selection

See Figure 3-80. Cam lobes are stamped with the number "15" followed by a number (1, 2, 3 or 4). The number "15" indicates model year application; the number identifies the cam location/function:

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

Use only "15" cams on 1998 models.

See Figure 3-81. Measure the gear diameter with a micrometer over 0.108 in. (2.743 mm) diameter gauge pins on opposite sides of the gear. The pins are of the proper size to fit between the contacting surfaces of the gear teeth. Gear diameter should be measured in at least two places 90° apart. Use GAUGE PIN SET (Part No. HD-38361) when measuring pinion and cam gear sizes.

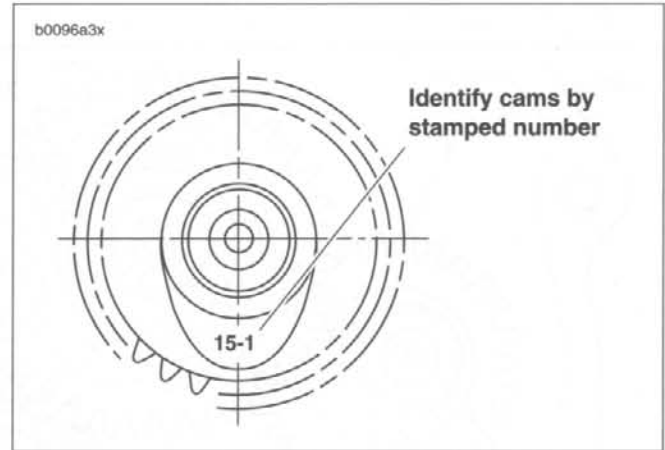


Figure 3-80. Cam Identification

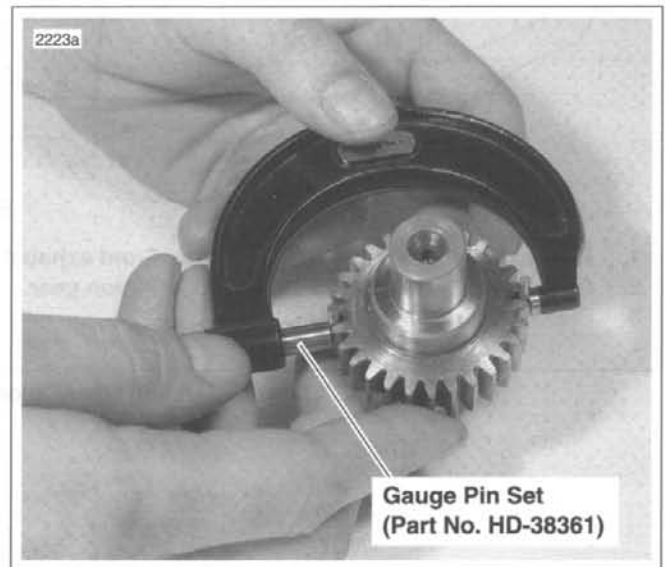


Figure 3-81. Measuring Gear Size

Cam and pinion gears are individually selected for each specific gear cover through sophisticated computer-aided measuring techniques in a controlled environment. Each gear is assigned an individual color code based on its diameter (measured with gauge pins). When cam and/or pinion gears are replaced, always use the same color code as found on gears being replaced to ensure that the gear operation remains as quiet as possible. For location of cam and pinion gear color codes, see Figure 3-82.

NOTE

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

See Table 3-12. Compare the previously measured diameter of each gear with the specifications (listed in inches) shown in the table to determine amount of wear on gear teeth.

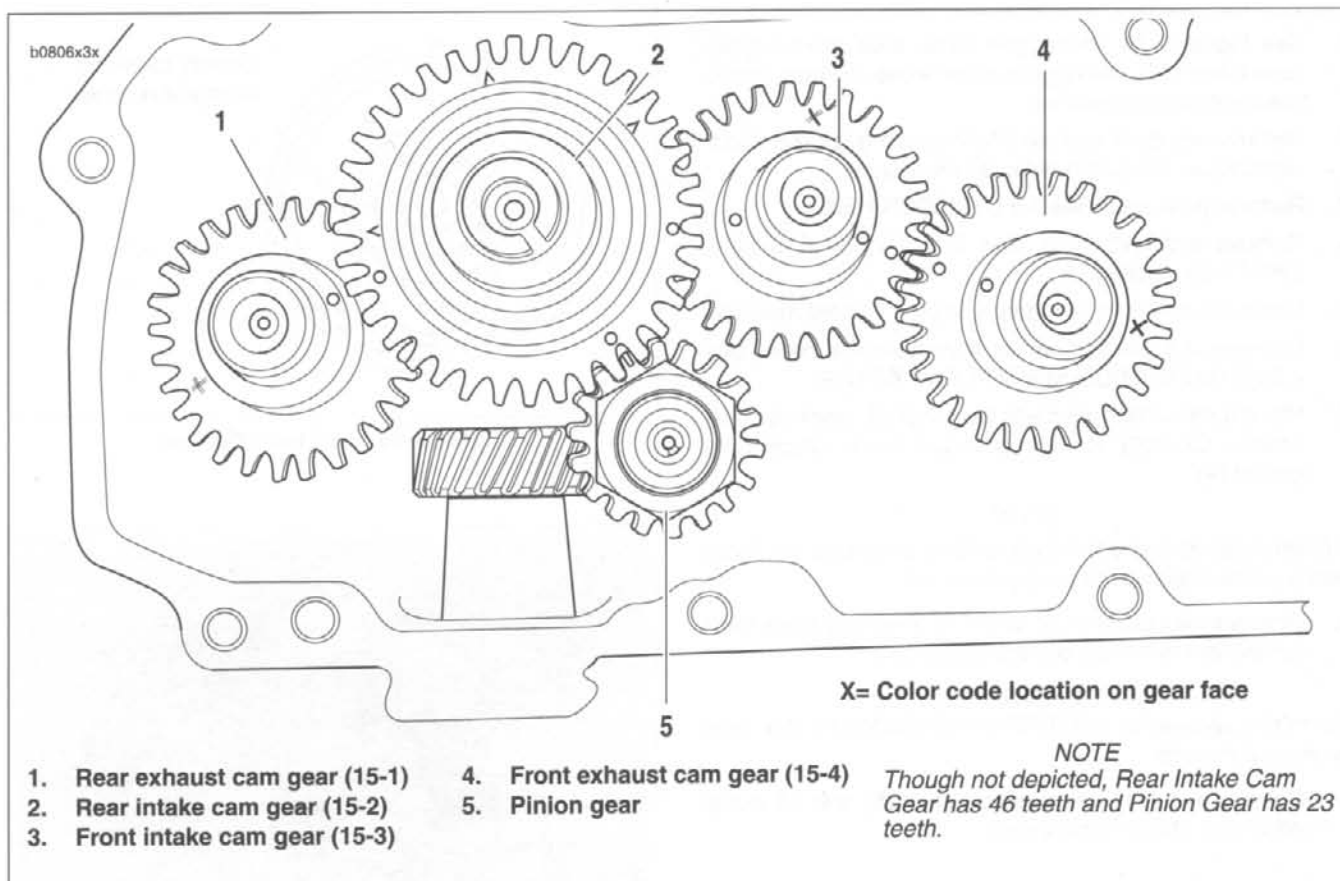


Figure 3-82. Cam and Pinion Gear Color Code Location and Timing Mark Indexing

NOTE

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

Table 3-12. Cam and Pinion Gear Color Code and Diameter

GEAR NO. & POSITION	1	2 INBOARD	2 OUT-BOARD	3	4	5
COLOR CODE (1 paint dot)	Rear Exhaust	Rear Intake	Rear Intake	Front Intake	Front Exhaust	Pinion
RED	1.9015-1.9019 (48.298-48.308)	1.9025-1.9029 (48.323-48.333)	2.4031-2.4035 (61.038-61.049)	1.9015-1.9019 (48.298-48.308)	1.9025-1.9029 (48.323-48.333)	
WHITE	1.9020-1.9024 (48.310-48.321)	1.9020-1.9024 (48.310-48.321)	2.4036-2.4040 (61.051-61.061)	1.9020-1.9024 (48.310-48.321)	1.9020-1.9024 (48.310-48.321)	
GREEN	1.9025-1.9029 (48.323-48.333)	1.9015-1.9019 (48.298-48.308)	2.4041-2.4045 (61.064-61.074)	1.9025-1.9029 (48.323-48.333)	1.9015-1.9019 (48.298-48.308)	

Bushing Inspection and Removal

- See Figure 3-79. Bushings (7, 8, 13, 14, 15 and 16) are press fit in gearcase cover (17) and crankcase. Inspect each bushing against its corresponding cam gear shaft or pinion gear shaft. See Table 3-13.

Table 3-13. Gear Shaft Specifications

GEAR SHAFT	CORRECT CLEARANCE	SERVICE WEAR LIMIT
Cam	0.0007-0.0022 in. (0.0178-0.0559 mm)	0.003 in. (0.076 mm)
Pinion	0.0023-0.0043 in. (0.0584-0.1092 mm)	0.0050 in. (0.1270 mm)

- See Figure 3-83. Use a BUSHING AND BEARING PULLER (Part No. HD-95760-69A) to remove bushings from gearcase cover and crankcase.

Bushing Installation

NOTE

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

CAM GEAR BUSHINGS IN RIGHT CRANKCASE HALF

- See Figure 3-85. Each cam gear bushing (1), to be installed in right crankcase half (2), must be positioned in crankcase bore with its oiling slot at exact top of bore (12 o'clock position).
- Using an arbor press, install each bushing in its crankcase bore so that bushing shoulder contacts crankcase boss.
- After you install a **new** bushing in right crankcase half, ream the bushing to correct size. See BUSHING REAMING.

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

- See Figure 3-79. Using an arbor press, install each bushing (7, 8 and 14) in its gearcase cover (17) bore so that bushing shoulder contacts cover boss. Orient each bushing so the oiling slot is at the 9 o'clock position within the gearcase cover bore.
- After you install a **new** bushing in gearcase cover, line-ream the bushing to correct size. See BUSHING REAMING.

REAR INTAKE CAM GEAR BUSHING IN GEARCASE COVER.

- See Figure 3-79. Rear intake cam gear bushing (15) must be installed in its gearcase cover (17) bore using an arbor press. You will need to orient the bushing in a specific position of rotation within the cover bore, and will need to drill a lubrication hole in the bushing, according to the following procedures.

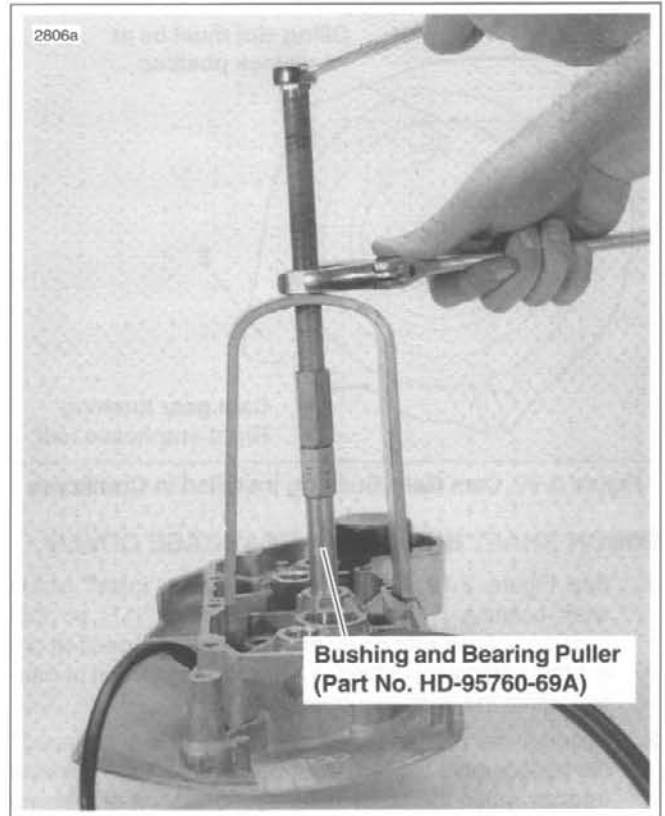


Figure 3-83. Removing Bushing

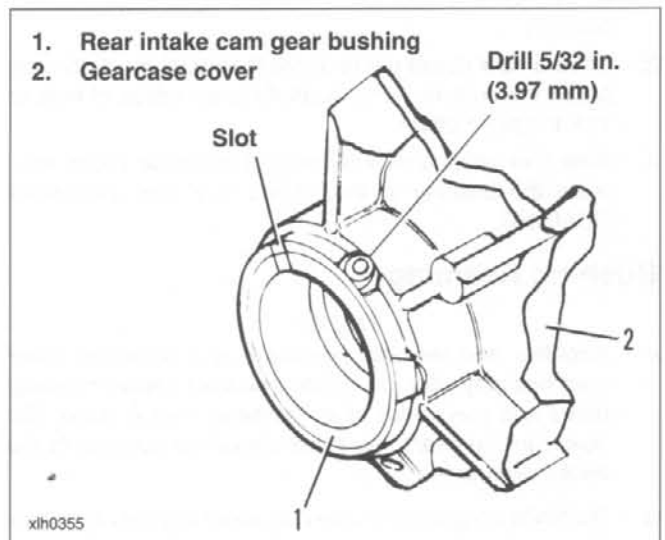


Figure 3-84. Rear Intake Cam Gear Bushing Installed in Gearcase Cover

- See Figure 3-84. Position bushing (1) over bore of gearcase cover (2) with chamfered edge downward and slot upward. Align slot in bushing with slot in gearcase cover boss. Press bushing into cover bore until bushing is flush with cover boss.
- Drill a 5/32 in. (3.97 mm) diameter hole through bushing using existing hole in gearcase cover as a guide.
- After you install a **new** bushing in gearcase cover, line-ream the bushing to the correct size. See BUSHING REAMING.

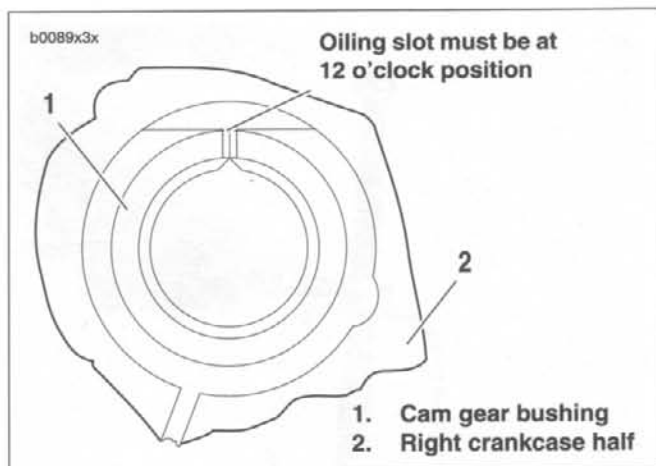


Figure 3-85. Cam Gear Bushing Installed in Crankcase

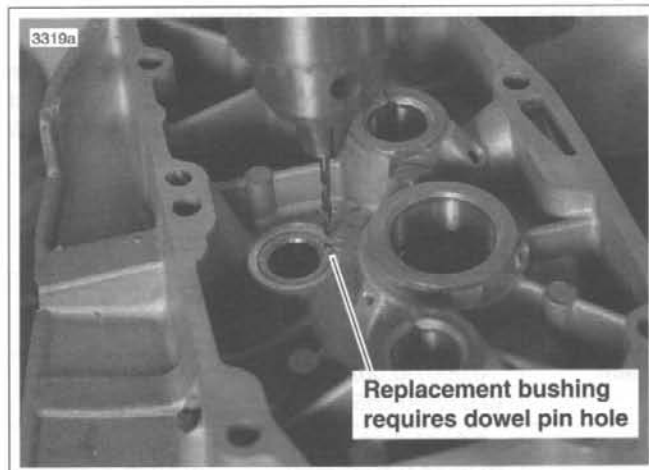


Figure 3-86. Drilling Dowel Pin Hole

PINION SHAFT BUSHING IN GEARCASE COVER

1. See Figure 3-79. Using an arbor press, install pinion shaft bushing (16) in its gearcase cover (17) so that bushing is flush with cover boss. There is no need to orient this particular bushing in any specific position of rotation within the gearcase cover bore.
2. Although the original pinion shaft bushing is not "pinned," the replacement bushing must be secured, from possible rotation within the cover bore, by installation of a dowel pin. See Figure 3-86. Drill a No. 31 hole, 0.281 in. (7.137 mm) deep, at top side of boss (side toward top of gearcase cover), centering the drill bit on the cover bore circle (hole is drilled half in bushing OD and half in cover bore ID).
3. Drive a **new** dowel pin no more than 0.20 in. (5.08 mm) below the bushing face. Carefully peen edges of hole to lock the pin in place.
4. After you install a **new** bushing in gearcase cover, line-ream the bushing to the correct size. See BUSHING REAMING.

Bushing Reaming

NOTE

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

CAM GEAR BUSHINGS IN RIGHT CRANKCASE HALF

1. Separate two halves of crankcase, if not already accomplished. Place right crankcase half on flat surface with gearcase side upward. Bushing to be reamed must be oriented as shown in Figure 3-85.
2. See Figure 3-87. Position CAMSHAFT BUSHING REAMER PILOT (Part No. HD-38871) onto gearcase side of crankcase half; upper right and lower left indexing holes in pilot must be placed over dowels in crankcase half. Insert two bolts (supplied with pilot) through two remaining holes in pilot, and into threaded holes of crankcase half. Tighten bolts securely.
3. Insert the 11/16 in. diameter reamer through pilot hole and into bushing while turning reamer clockwise. Continue turning reamer clockwise through bushing until smooth shank of reamer passes through hole in pilot.
4. Detach reamer from handle. Pull reamer out opposite side of crankcase half.
5. Thoroughly clean right crankcase half, removing all metal chips/shavings. Blow out all oil passages using compressed air.

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

NOTE

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

1. See Figure 3-79. Bushings (7, 8 and 14) to be reamed must be installed in gearcase cover (17) as described in BUSHING INSTALLATION. Attach gearcase cover to right crankcase half (10), which has been disassembled from left crankcase half, securing with a minimum of three mounting screws.

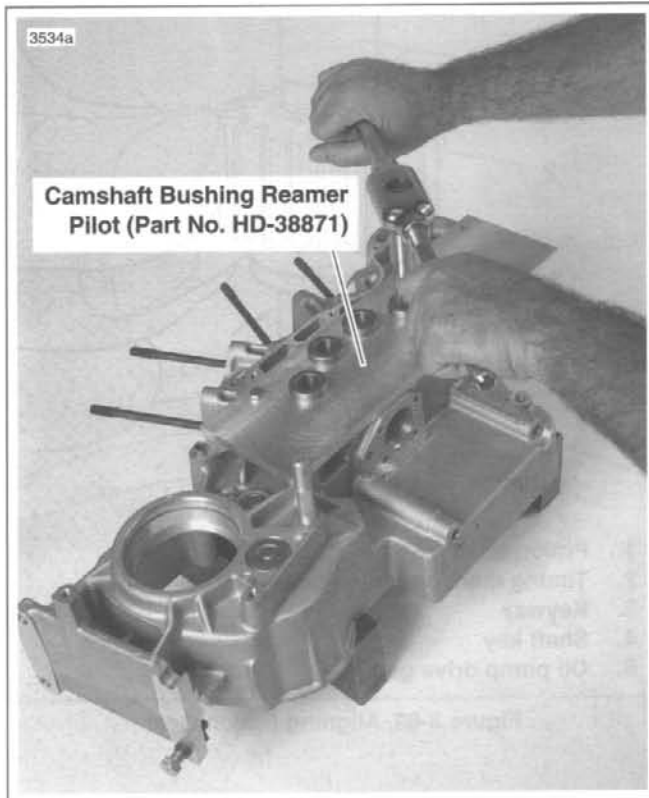


Figure 3-87. Reaming Cam Gear Bushing in Right Crankcase Half

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

REAR INTAKE CAM GEAR BUSHING IN GEARCASE COVER

NOTE

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

1. See Figure 3-79. Rear intake cam gear bushing (15) must be installed in gearcase cover (17) as described in BUSHING INSTALLATION.
2. Identify the previously reamed rear intake cam gear bushing (13) in right crankcase half (10), which has been disassembled from left crankcase half. Insert the shank end of REAR INTAKE CAMSHAFT BUSHING REAMER (Part No. HD-94803-67) through gearcase side of this bushing.
3. With reamer inserted into bushing in right crankcase half, attach gearcase cover to right crankcase half, securing with a minimum of three mounting screws.
4. Turn reamer clockwise through bushing in gearcase cover until reamer bottoms. Then give reamer one complete clockwise turn to size the bushing. Continue turning reamer clockwise while extracting reamer from bushing.
5. Separate gearcase cover from right crankcase half. Inspect bushing for proper cam gear shaft fit. Repeat line reaming operation if necessary.
6. Thoroughly clean gearcase cover, removing all metal chips/shavings. Blow out all oil passages using compressed air.

PINION SHAFT BUSHING IN GEARCASE COVER

NOTE

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

1. See Figure 3-79. Pinion shaft bushing (16) must be installed in gearcase cover (17) as described in BUSHING INSTALLATION. Attach gearcase cover to right crankcase half (10), which has been disassembled from left crankcase half, securing with a minimum of three mounting screws.
2. See Figure 3-88. Install PINION SHAFT BUSHING REAMER PILOT (Part No. HD-94812-87) into right crankcase roller race. Insert PINION SHAFT BUSHING REAMER (Part No. HD-94812-1) through the pilot.
3. Turn reamer clockwise through bushing in gearcase cover until reamer bottoms. Then give reamer one complete clockwise turn to size the bushing. Continue turning reamer clockwise while extracting reamer from bushing.
4. Separate gearcase cover from right crankcase half. Inspect bushing for proper pinion shaft fit. Repeat line reaming operation if necessary.
5. Remove pilot from right crankcase roller race. Thoroughly clean gearcase cover, removing all metal chips/shavings. Blow out all oil passages using compressed air.

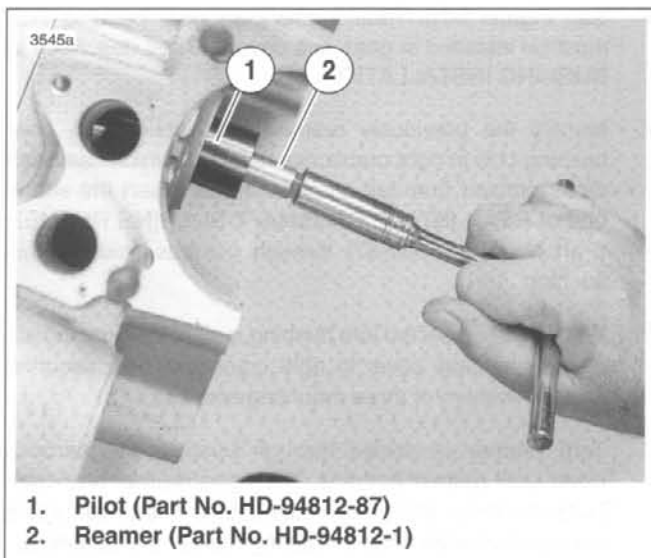


Figure 3-88. Line Reaming Pinion Shaft Bushing

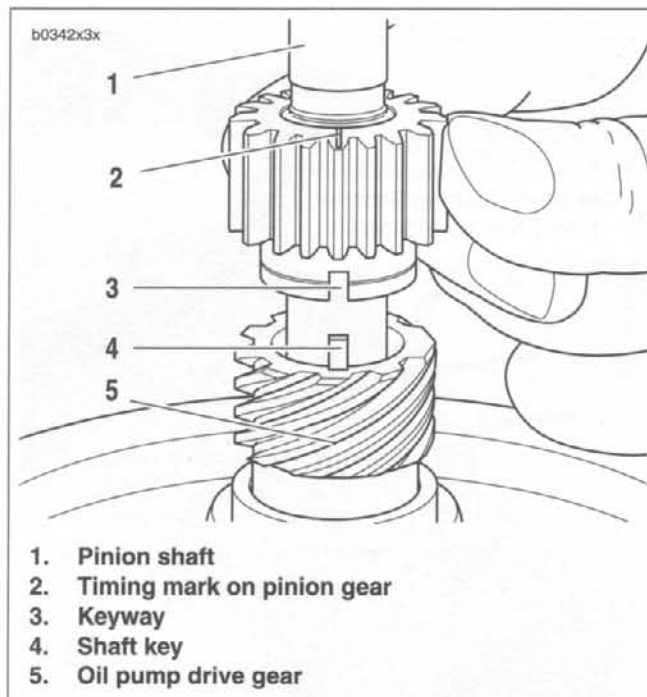


Figure 3-89. Aligning Pinion Gear

ASSEMBLY/INSTALLATION

1. See Figure 3-89. Install oil pump drive gear (5) and pinion gear on pinion shaft.
 - a. Slide oil pump gear drive gear (5) over pinion shaft (1). Drive gear must align with shaft key (4).
 - b. Align keyway (3) in ID of pinion gear with shaft key (4).
 - c. Slide pinion gear over shaft key (4) and against oil pump drive gear (5).
2. See Figure 3-79. Install nut (11).
 - a. Clean threads on pinion shaft and nut.
 - b. See Figure 3-90. Install CRANKSHAFT LOCKING TOOL (Part No. HD-43984) to gearcase with "Side A" facing out, over pinion shaft, with two screws.
 - c. Apply several drops of LOCTITE THREADLOCKER 262 (red) to threads of nut.
 - d. Install nut to pinion shaft. Tighten nut to 35-45 ft-lbs (47.5-61.0 Nm).
3. Liberally apply engine oil to bushings, shafts, and gears. Install all cam gears into bushings of right crankcase half, properly aligning timing marks of cam gears and pinion gear. See Figure 3-82.

NOTE

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

CAUTION

Use only the 2000 model year gearcase cover gasket (see parts catalog for Part No.) with the new gearcase cover. Using previous gasket will obstruct oil galley and result in engine damage.

4. See Figure 3-79. Install a **new** seal (6) and **new** dry gearcover gasket (9) on gearcase cover (17).

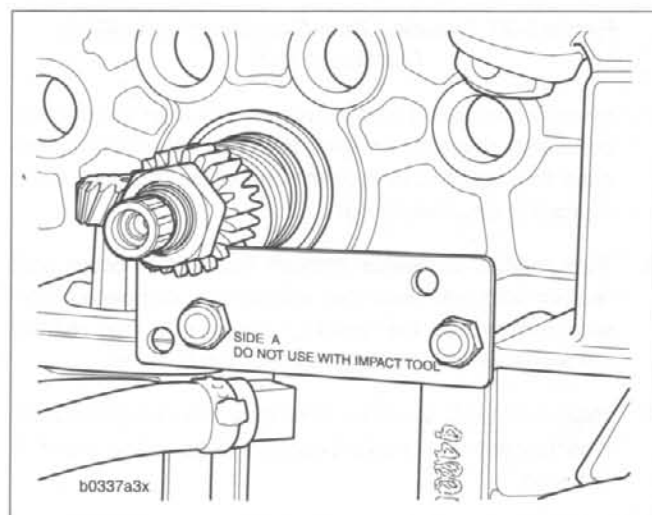


Figure 3-90. Crankshaft Locking Tool (HD-43984)

5. Install gearcase cover over all gears and onto right crankcase half (10). Secure cover to crankcase half with 11 socket head screws. Tighten screws evenly to 80-110 **in-lbs** (9.0-12.4 Nm). Use torque sequence shown in Figure 3-91.
6. See Figure 3-92. Check cam gear end play for each cam gear as follows:
 - a. Turn engine over until lobe of cam gear being checked is pointing toward its respective tappet guide hole.
 - b. Gently pry the cam gear toward the gearcase cover using a flat blade screwdriver.
 - c. Measure gap between bushing (in crankcase half) and cam gear shaft thrust face (shoulder) using a feeler gauge. This is cam gear end play.
 - d. Compare cam gear end play measurements with the SERVICE WEAR LIMITS. Make repairs as required if end play does not meet specifications.
7. Install hydraulic lifters and push rods. See 3.16 HYDRAULIC LIFTERS (2000 models).
8. Install cam position sensor in gearcase cover. See 4.29 CAM POSITION SENSOR AND ROTOR.
9. Install any components removed to gain access to gearcase (i.e. exhaust system components, air cleaner, etc.).

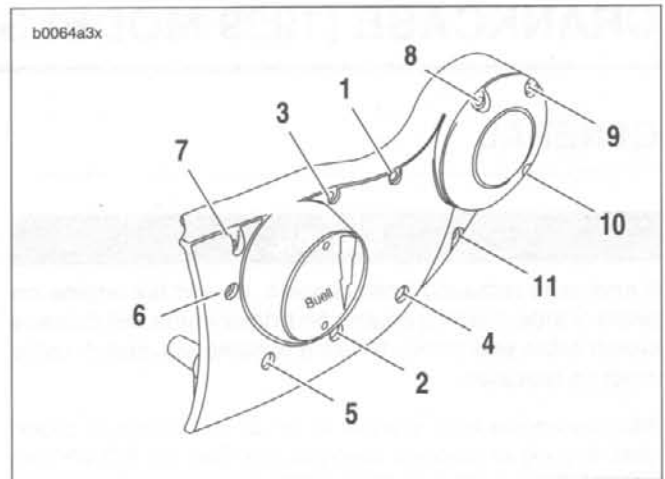


Figure 3-91. Gearcase Cover Mounting Screw Torque Sequence

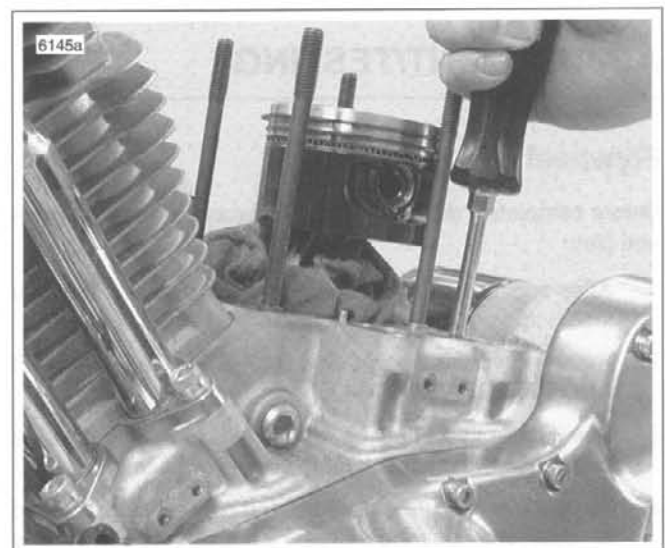


Figure 3-92. Checking Cam Gear End Play

GENERAL

CAUTION

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

Remove engine from chassis to repair rod bearings, pinion shaft bearing or sprocket shaft bearing. See 3.3 STRIPPING MOTORCYCLE FOR ENGINE REPAIR.

It is recommended procedure to overhaul engine if removed. This includes inspecting and repairing cylinder heads, cylinders, gearcase and transmission.

ADJUSTMENT/TESTING

Flywheel End Play

Before completely disassembling crankcases, check flywheel end play.

1. After engine has been removed from chassis, securely fasten it to a stand or workbench.
2. Remove gearcase cover. See 3.17 GEARCASE COVER AND CAM GEARS (1999 models).
3. See Figure 3-93. Attach a dial indicator to gear side crankcase with indicator stem on end of gearshaft.
4. To obtain an accurate flywheel end play reading, preload sprocket shaft bearings. Create a suitable tool by welding two handles to an old engine sprocket nut. Install the nut and sprocket. Tighten to 190-210 ft-lbs (257.6-284.7 Nm).
5. Check flywheel end play.
 - a. Rotate and **push** on sprocket shaft while reading dial indicator.
 - b. Then rotate and **pull** on sprocket shaft while reading dial indicator.
 - c. Replace bearing inner spacer (item 6, Figure 3-96.) if difference (end play) in indicator readings is not 0.001-0.005 in. (0.025-0.127 mm). Choose spacer from Table 3-14.

NOTE

Use a thinner spacer for less end play; use a thicker spacer for more end play.

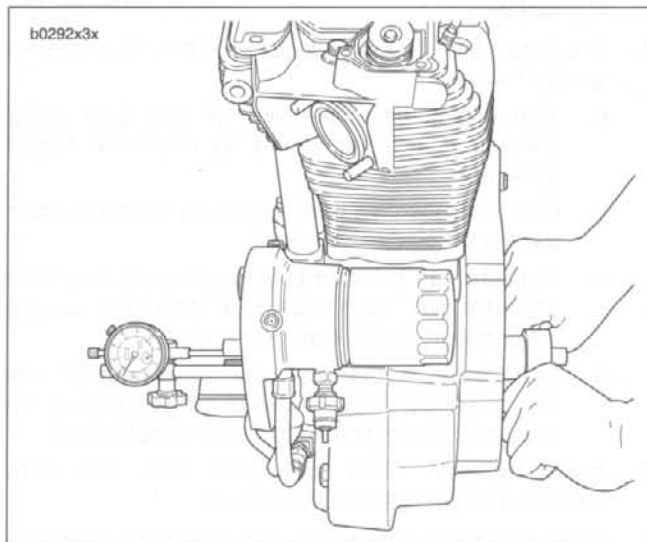


Figure 3-93. Checking Flywheel End Play

Table 3-14. Flywheel End Play Spacers

PART NUMBER	THICKNESS	
	IN.	MM
9155	0.0975-0.0985	2.4765-2.5019
9142	0.0995 - 0.1005	2.5273-2.5527
9143	0.1015-0.1025	2.5781-2.6035
9144	0.1035 - 0.1045	2.6289-2.6543
9145	0.1055 - 0.1065	2.6797-2.7051
9146	0.1075 - 0.1085	2.7305-2.7559
9147	0.1095 - 0.1105	2.7813-2.8067
9148	0.1115 - 0.1125	2.8321-2.8575
9149	0.1135 - 0.1145	2.8829-2.9083

DISASSEMBLY

Crankcase Halves

1. Remove cylinder heads. See 3.5 CYLINDER HEAD.

CAUTION

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

2. Remove cylinders and pistons. See 3.6 CYLINDER AND PISTON.
3. Remove oil pump. See 3.13 OIL PUMP.

4. Remove gearcase components. See 3.17 GEARCASE COVER AND CAM GEARS (1999 models).
5. Remove primary cover and primary drive/clutch components. See PRIMARY CHAIN/DRIVE under 6.5 PRIMARY DRIVE/CLUTCH.
6. Remove starter motor. See 5.7 STARTER.
7. Remove transmission. See 6.7 TRANSMISSION CASE.
8. See Figure 3-94. Remove screws and rear engine mount bolt securing crankcase halves together.
9. Position crankcase on work bench, gearcase side up. Tap crankcase with plastic mallet to loosen top half and separate the halves.

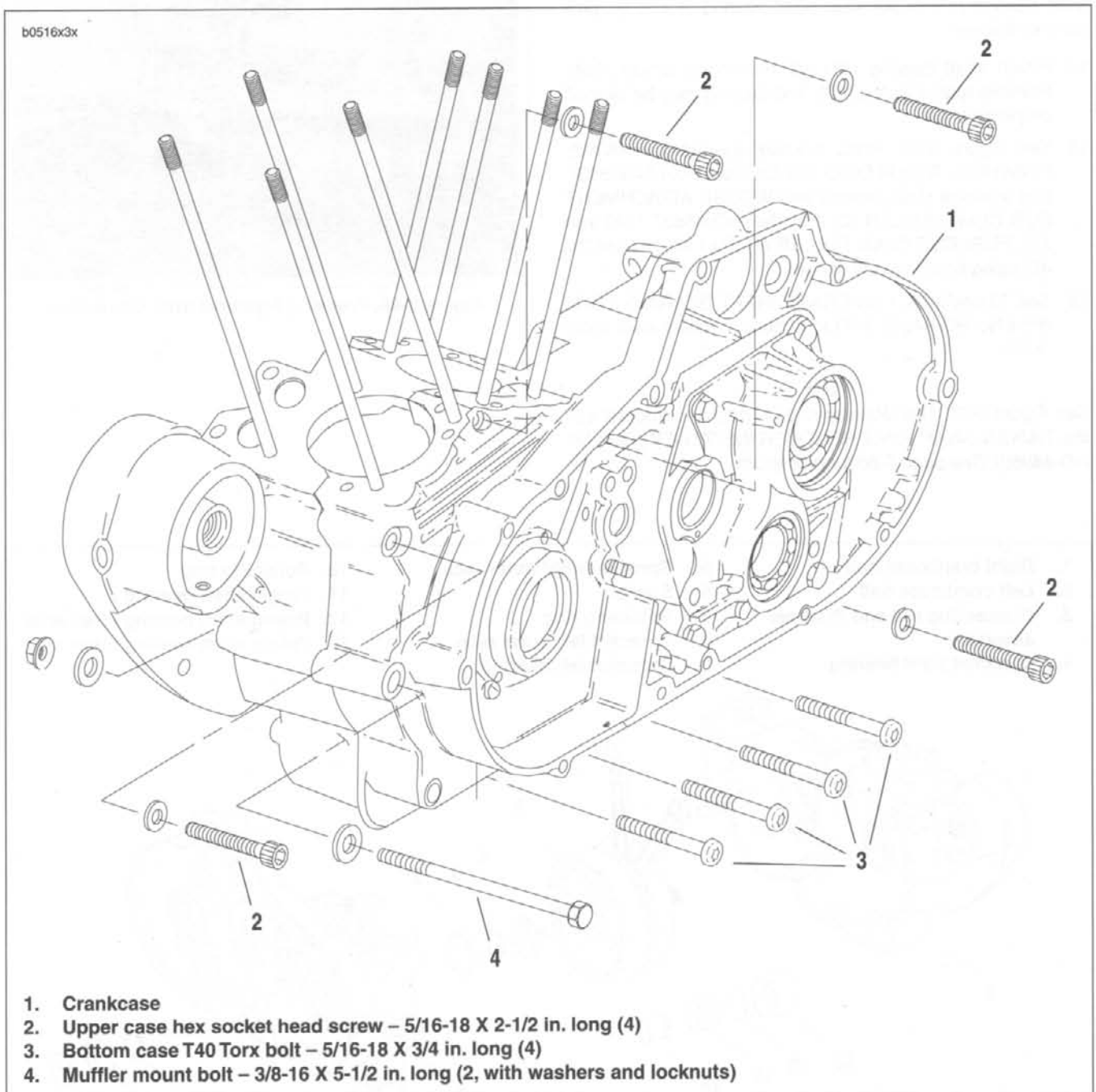


Figure 3-94. Crankcase Hardware

WARNING

The next step requires using a press. Wear eye protection and make certain set-up is stable. The pressure involved could cause parts to "fly out" with considerable force. Inadequate safety precautions could result in death or serious injury.

10. See Figure 3-95. Mount the left crankcase half and flywheel assembly on a press table, supporting crankcase on parallel bars. Press on end of sprocket shaft with arbor press until flywheel assembly is free from crankcase half. Do not drive flywheel assembly from crankcase half as flywheels may be knocked out of alignment.

NOTE

See Figure 3-96. If it is necessary to remove either the pinion shaft bearing (11) or sprocket shaft bearing (4 and 9), proceed as follows:

11. Pinion shaft bearing (11) will remain on pinion shaft. Remove retaining ring (10), and bearing may be slipped off pinion shaft.
12. See Figure 3-97. Place flywheel assembly in ROWE FLYWHEEL REBUILDING JIG (3) (Part No. HD-34813). Pull sprocket shaft bearing with WEDGE ATTACHMENT FOR CLAW PULLER (2) (Part No. HD-95637-46A) and ALL PURPOSE CLAW PULLER (1) (Part No. HD-95635-46) using bolts in place of jaws.
13. See Figure 3-98. Use CRANKSHAFT BEARING TOOL (Part No. HD-94547-101) to remove sprocket shaft outer races.

NOTE

See Figure 3-96. The retaining ring (7) may be removed with the TIMKEN SNAP RING REMOVER/INSTALLER (Part No. HD-44069). See page 3-80 for procedure.

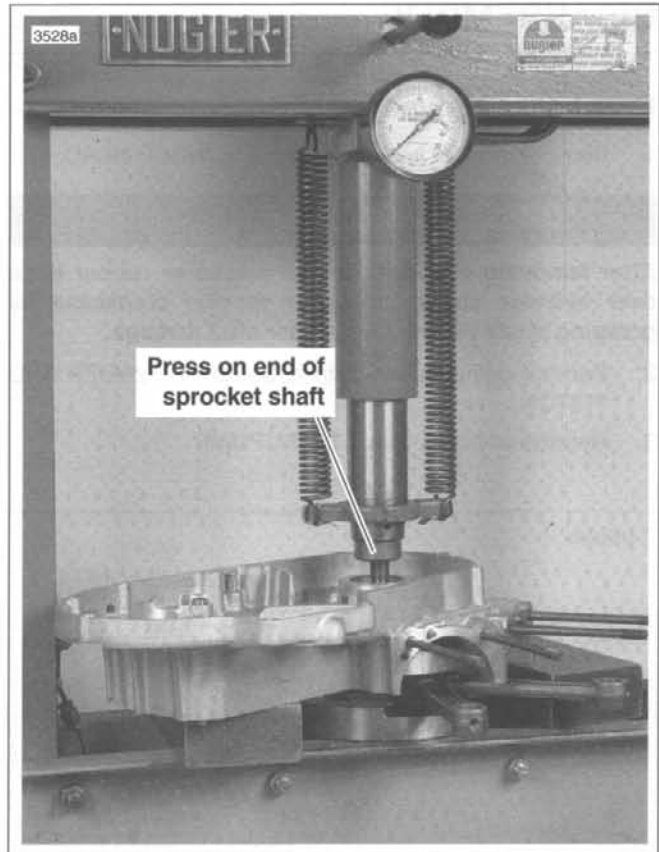


Figure 3-95. Pressing Flywheel from Crankcase

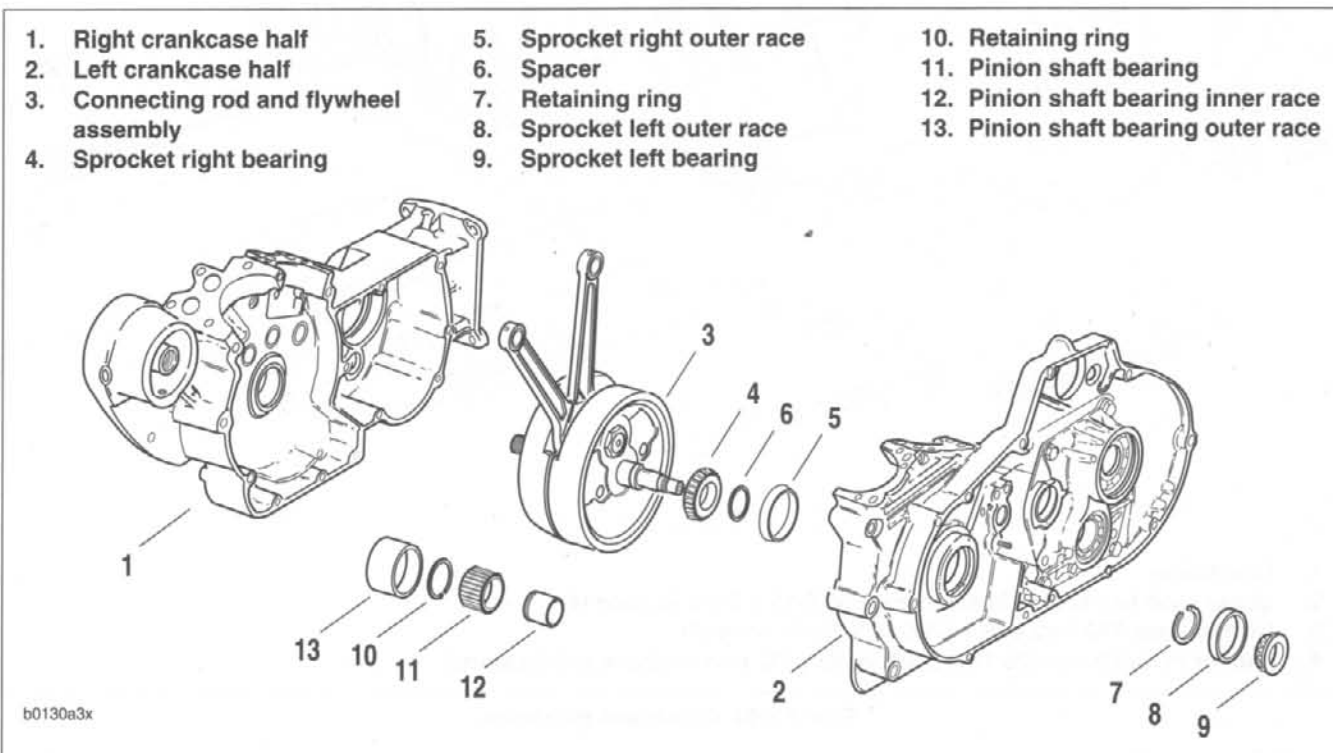


Figure 3-96. Crankcase and Flywheel Assembly

Flywheels

1. See Figure 3-99. Place flywheel assembly in rebuilding jig. Remove crank pin nut (1). Strike left flywheel with soft metal mallet at about 90° from crank pin hole on wheel periphery to loosen. Lift left flywheel (2) off crank pin.
2. Hold down crank pin bearing assembly (4) with a short length of pipe or tubing so connecting rods (3) may be slipped off bearings, then remove bearing assembly. Secure bearings (4) together in set until they are washed and refitted to crank pin.
3. Remove crank pin nut (8), then tap crank pin (6) out of flywheel and remove key (7).

CLEANING/INSPECTION

1. Wash all parts in solvent and blow dry with compressed air.
2. Examine crank pin for wear, grooving and pitting. If the surface is at all worn, replace with **new** crank pin.
3. Examine flywheel washers. If either washer is worn or grooved, it should be replaced. See REPLACING FLYWHEEL WASHERS below.
4. Examine connecting rod lower races.
 - a. If they appear slightly grooved or shouldered where edge of bearing rollers ride, they may be lapped out. Install an oversize crank pin and **new** bearing.
 - b. If they appear badly worn, grooved or pitted, install **new** rods. However, the preferred solution is installing an assembly with **new** bearings, crank pin and rods.
5. Inspect bearing for wear, pitting and heat discoloration. Replace as required.
6. Inspect crank pin, crank pin roller and connecting rods for correct freeplay.

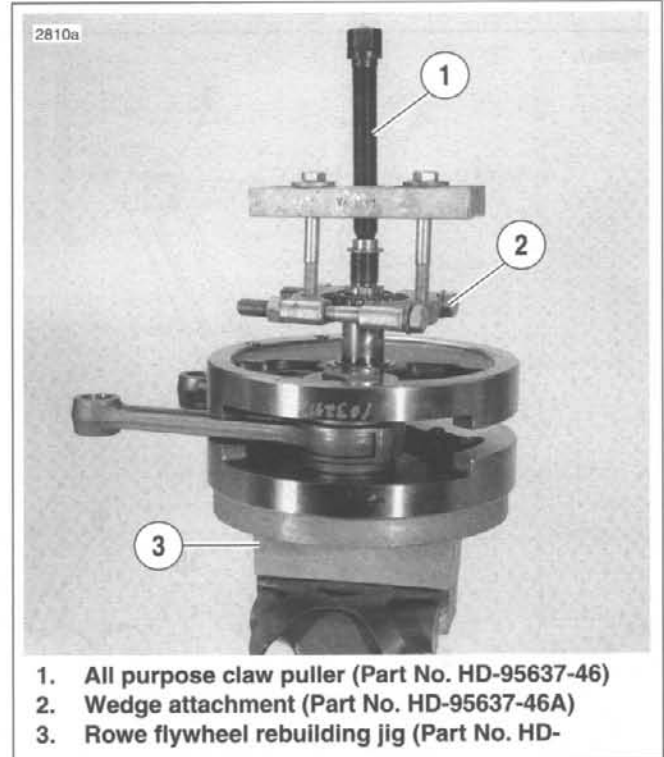


Figure 3-97. Removing Sprocket Shaft Roller Bearing



Figure 3-98. Sprocket Shaft Outer Race Removal

b0059x3x

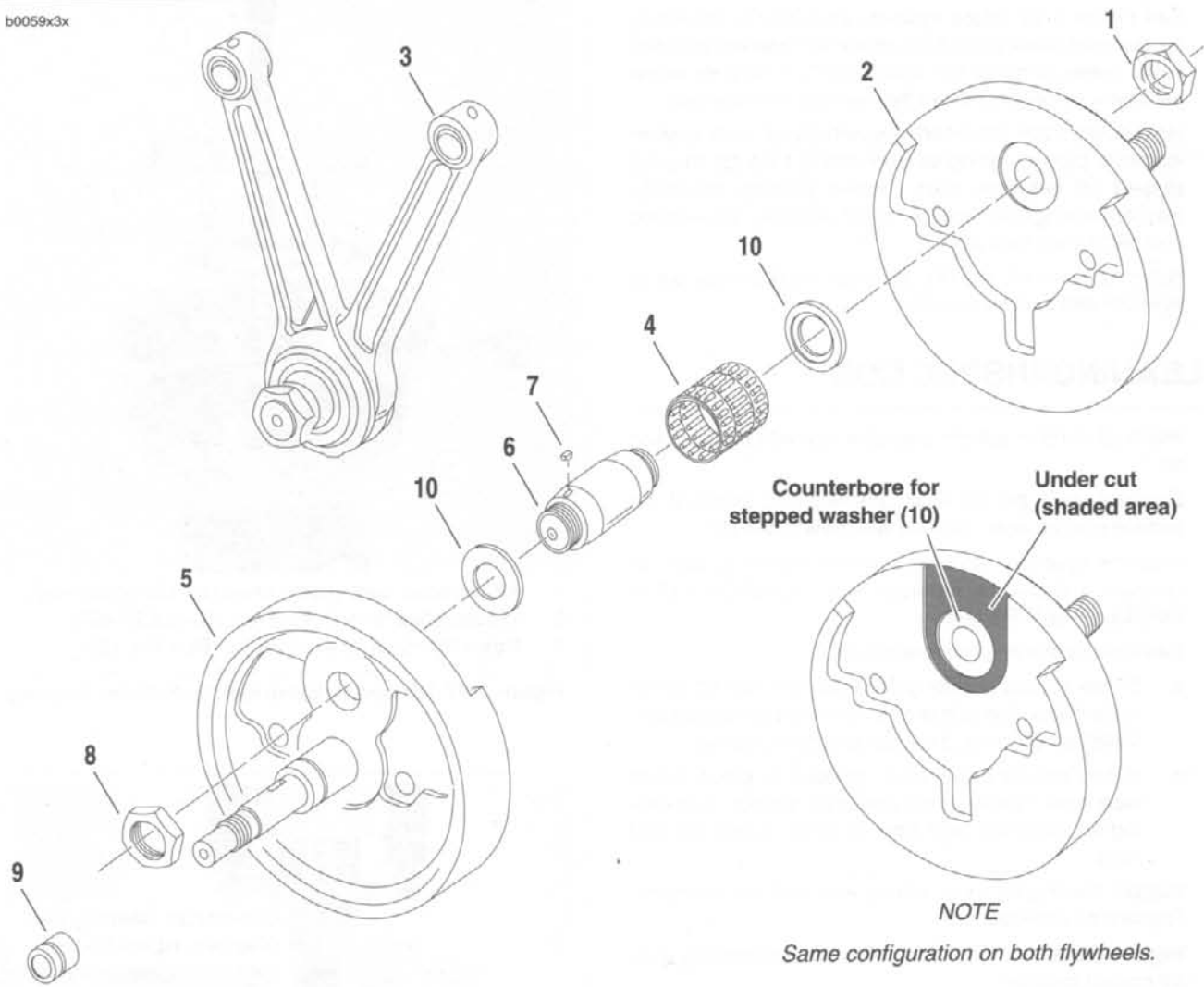


Figure 3-99. 1999 Flywheel and Connecting Rod Assembly

Replacing Flywheel Washers

Replace worn flywheel washers as follows:

1. See Figure 3-100. The stepped flywheel washer is a close fit in flywheel recess. Washers are originally secured by punching flywheel metal tight against the washer at several points. It is usually necessary to drill a 1/8 in. (3.2 mm) or smaller hole at the outer edge of the washer to permit prying with a pointed tool.

NOTE

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

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

CAUTION

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

3. Carefully tap **new** washers into place. Use a punch topeen flywheel metal over washer edge to retain washer.

Lapping Connecting Rod Races

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

1. Clean lapping arbor before using.
2. See Figure 3-101. Clamp lapping arbor into lathe chuck. Carefully load lap with #220 grit grinding compound, mixed with oil. Adjust lathe to turn at approximately 150-200 RPM.
3. Carefully slide connecting rod over lap. Adjust lap to a dragging, but free, fit in rod race.

NOTE

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

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

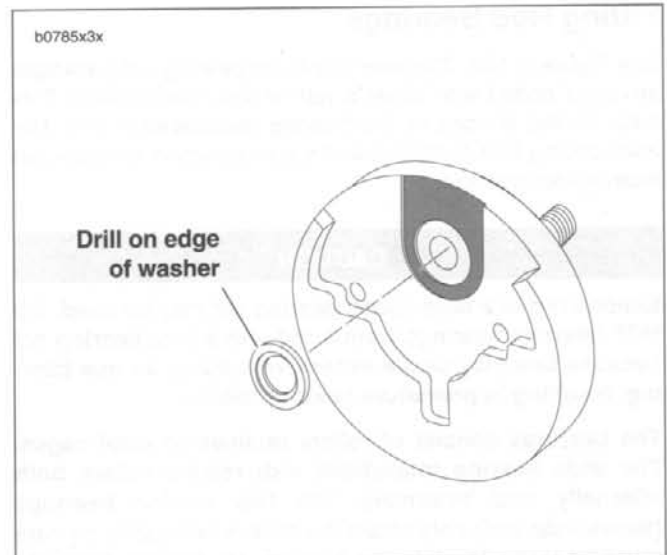


Figure 3-100. Flywheel Washer



Figure 3-101. Lapping Connecting Rod Races

Fitting Rod Bearings

See Figure 3-102. The **new** crank pin bearing set packages are color coded with either a red or blue identification. This color coding is used by the bearing manufacturer only. The color coding **DOES NOT** indicate size selection for crank pin bearing replacement.

CAUTION

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

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

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

1. See Figure 3-103. Measure inside diameter (ID) of lapped connecting rod races. Use a dial bore gauge that has 0.0001 in. (0.0025 mm) graduations.
 - a. Measure and record the ID at four places as shown.
 - b. If any race ID exceeds SERVICE WEAR LIMIT of 1.6270 in. (41.3258 mm), replace races or connecting rod set.
 - c. If race ID measurements are less than 1.6270 in. (41.3258 mm), continue procedure as follows:
2. Compare the measurements recorded in Step 1 with the ranges given in Table 3-15. If the four measurements taken in each race differ, use the smallest measurements.

NOTE

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

3. Inspect parts to determine fitment. See Table 3-15.
 - a. For example purposes, suppose the front connecting rod race ID is 1.6255 in. (41.2877 mm). This race ID requires a 0.0010 in. (0.0254 mm) oversize crank pin.
 - b. For example purposes, suppose the rear connecting rod race ID is 1.6250 in. (41.2750 mm). This race ID requires the standard sized crank pin.
 - c. Therefore, the rear connecting rod races must be lapped to accommodate the oversized crank pin. Front and rear races must have the same ID within 0.0002 in. (0.0051 mm).

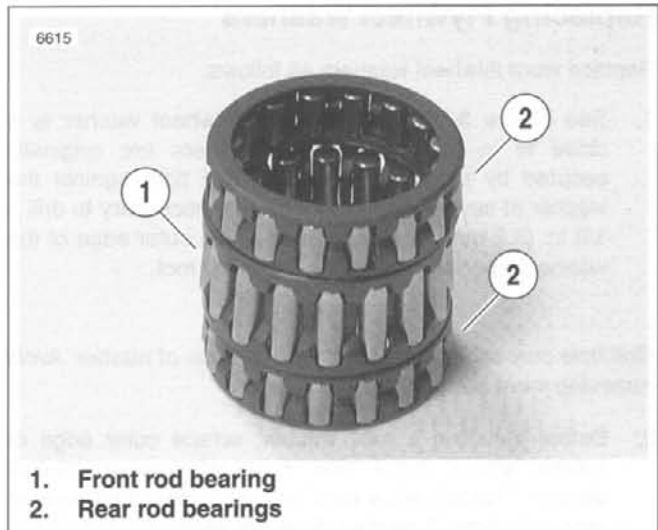


Figure 3-102. Crank Pin Bearing Set

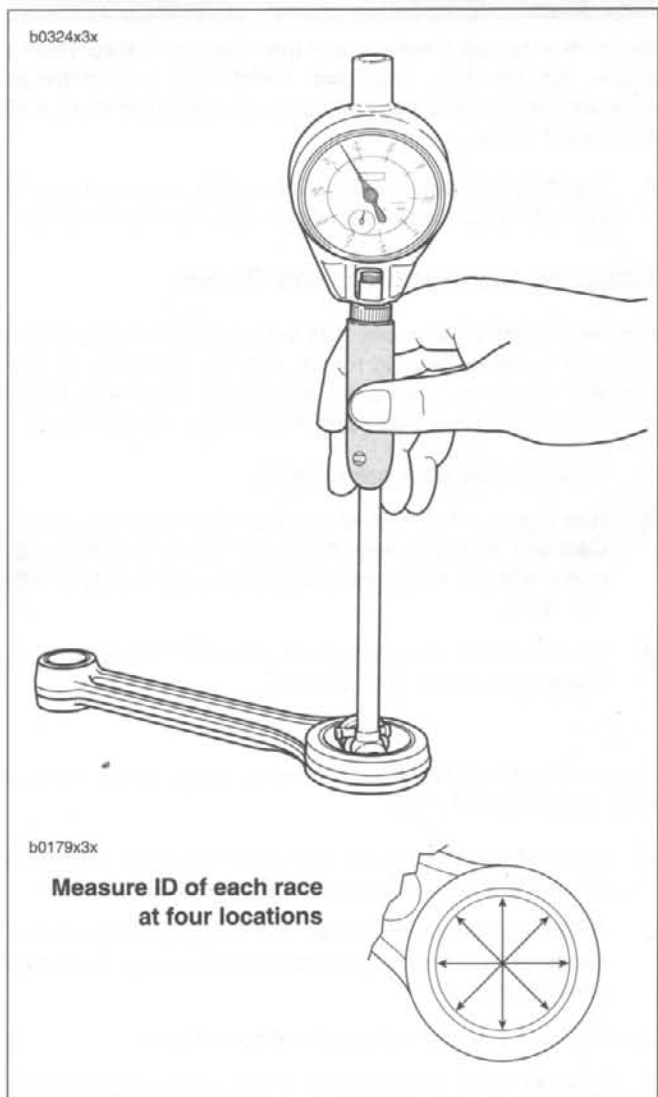


Figure 3-103. Measuring Connecting Rod Race Inside Diameter

NOTE

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

4. See Figure 3-104. Two oversize (OS) crank pins are available. Identify OS crank pins by the blue or red paint dot on the ends of the pins. Standard size crank pins will not be marked.
 - a. A blue dot indicates 0.0010 in. (0.0254 mm) OS.
 - b. A red dot indicates 0.0020 in. (0.0508 mm) OS.

CAUTION

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

5. Before assembling the flywheel assembly, recheck connecting rods specifications. See Table 3-16.
 - a. Check difference in ID of two rear races.
 - b. Check difference in ID between front and rear races.
 - c. Check each race for roundness. Difference between largest and smallest ID measurement in any race must not exceed 0.00025 in. (0.00635 mm).

Fitting Sprocket Bearings

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

Fitting Pinion Bearings

See Figure 3-96. A pressed-in bushing in the right crankcase half is the outer race (13). The inner race (12) is pressed on the pinion shaft.

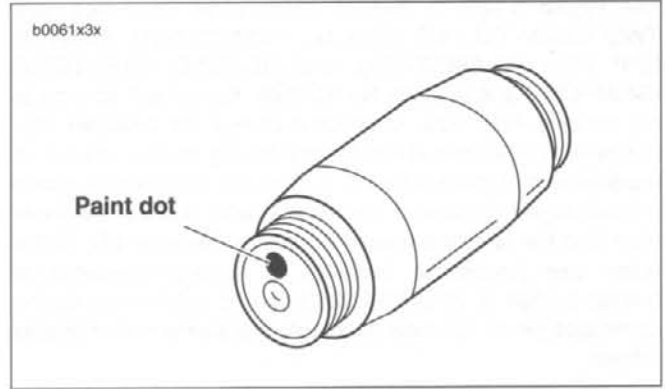


Figure 3-104. Oversize Crank Pin Identification

Table 3-15. Race Diameter and Crank Pin Size

CONNECTING ROD RACE ID REQUIRED	CRANK PIN REQUIRED	PAINT DOT
1.6245-1.6250 in. (41.2623-41.2750 mm)	Standard	none
1.6255-1.6260 in. (41.2887-41.3004 mm)	0.0010 in. oversize (0.0254 mm)	blue
1.6265-1.6270 in. (41.3131-41.3258 mm)	0.0020 in. oversize (0.0508 mm)	red
Greater than 1.6270 in. (41.3258 mm)	Replace races or connecting rod set.	

Table 3-16. Connecting Rod Specifications

CONNECTING ROD	SPECIFICATION
Rear	Difference in ID of two rear races must not exceed 0.0001 in. (0.0025 mm).
Front and rear	Difference in ID of races in front and rear connecting rods must not exceed 0.0002 in. (0.0051 mm).
Front and rear	Races must be round within 0.00025 in. (0.00635 mm).

See Figure 3-105. To remove pinion shaft inner race, use TWO CLAW PULLER (Part No. HD-97292-61), CENTER CAP (Part HD-95652-43A), and BEARING SEPARATOR (SNAP-ON TOOLS Stock No. CJ950). Apply heat to race to aid removal. Four sizes of pinion bearings are available. Pinion bearing selection at the factory, during engine rebuild, or replacement of crankcase set or flywheel assembly is based on the largest measured outside diameter (OD) of the inner race and the smallest measured inside diameter (ID) of the outer race (crankcase bushing). A running clearance of 0.0002-0.0008 in. (0.0051-0.0203 mm) is established during crankcase set or flywheel assembly replacement and engine rebuild.

See Figure 3-106. Installed inner races are identified at the factory as shown.

See Figure 3-107. Outer races are identified at the factory as shown.

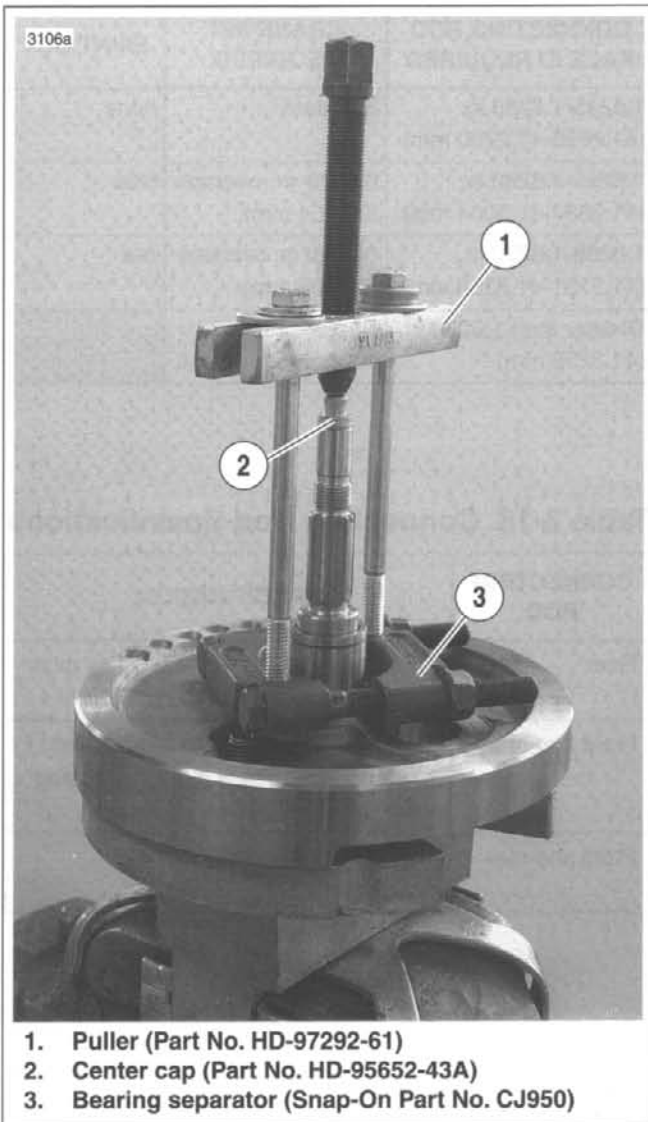


Figure 3-105. Pulling Pinion Shaft Inner Race

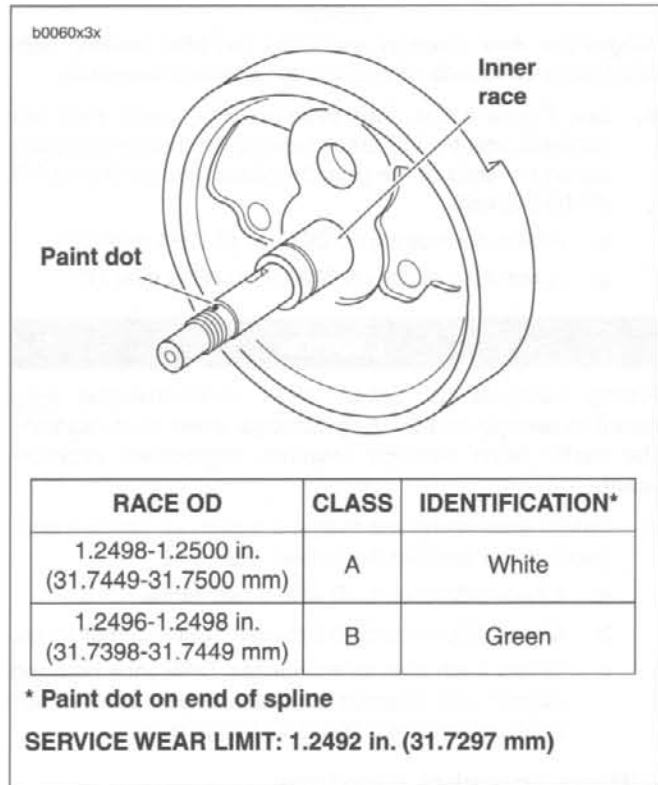


Figure 3-106. Factory Inner Race Sizes

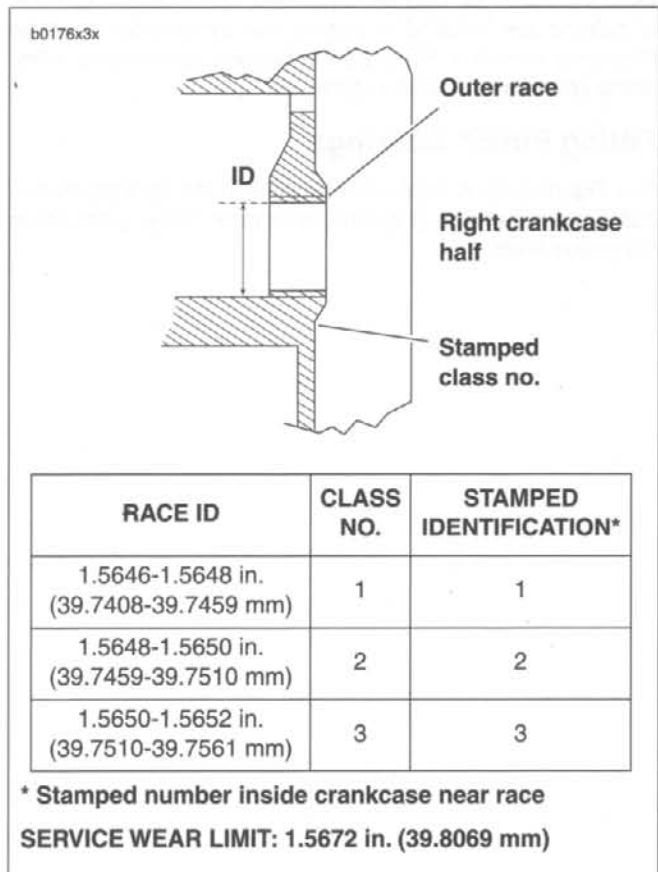


Figure 3-107. Factory Outer Race Sizes

NOTE

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

See Figure 3-108. Pinion bearings are identified as shown.

BEARING SELECTION

Select bearings using the identification information given for inner and outer races and bearings. See Table 3-17.

NOTE

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

1. Use a dial bore gauge to measure and record ID of outer race. Take four measurements on ID where bearing rollers ride.
 - a. If the largest measurement is larger than 1.5672 in. (39.8069 mm) or the required lapping to remove wear marks would enlarge bore beyond 1.5672 in., continue at Step 5.
 - b. If largest measurement is 1.5672 in. (39.8069 mm) or less, cover the cam bearings with masking tape to prevent debris from entering bearings. Assemble crankcase halves.

NOTE

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

2. See LAPPING ENGINE MAIN BEARING RACES. Lap race until all wear marks are removed.
3. Measure and record ID of race at four places.
4. Check measurements against these specifications:
 - Largest ID measured:** 1.5672 in. (39.8069 mm) or less
 - Roundness of ID:** within 0.0002 in. (0.0051 mm)
 - Taper:** within 0.0002 in. (0.0051)
 - a. If lapping increased bore ID to larger than 1.5672 in. (39.8069 mm), go to Step 5.
 - b. If roundness or taper do not meet specifications, continue lapping until specifications are met.
 - c. If all specifications are met, continue at Step 7 to remove and size inner race.

5. Press the outer race from the right crankcase. Press **new** outer race into crankcase flush with inside edge of cast-in insert.

See Figure 3-109. Dimensions are shown for fabrication of tools used in pressing the outer race into or out of crankcase.

6. The **new** outer race must be lapped slightly to true and align with left case bearing and to meet the following specifications. See LAPPING ENGINE MAIN BEARING RACES.

ID: 1.5646 - 1.5652 in. (39.7408 - 39.7561 mm)

Roundness: within 0.0002 in. (0.0051 mm)

Taper: within 0.0002 in. (0.0051 mm)

Surface finish: 16 RMS

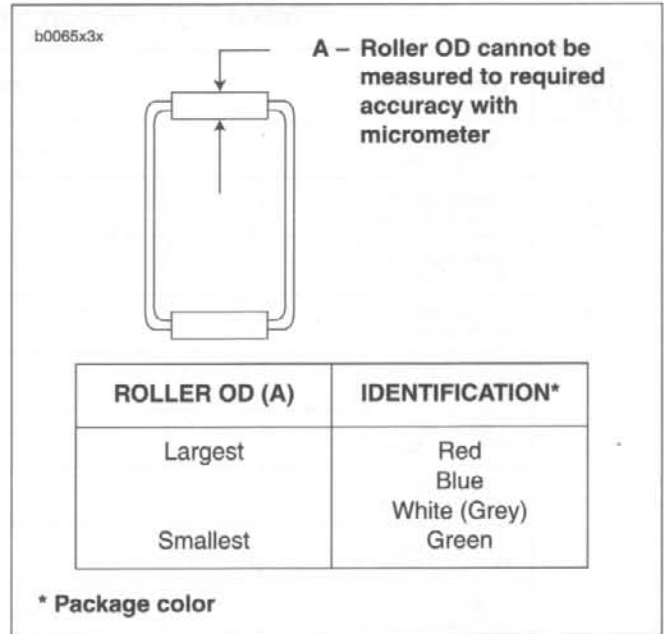


Figure 3-108. Bearing Identification

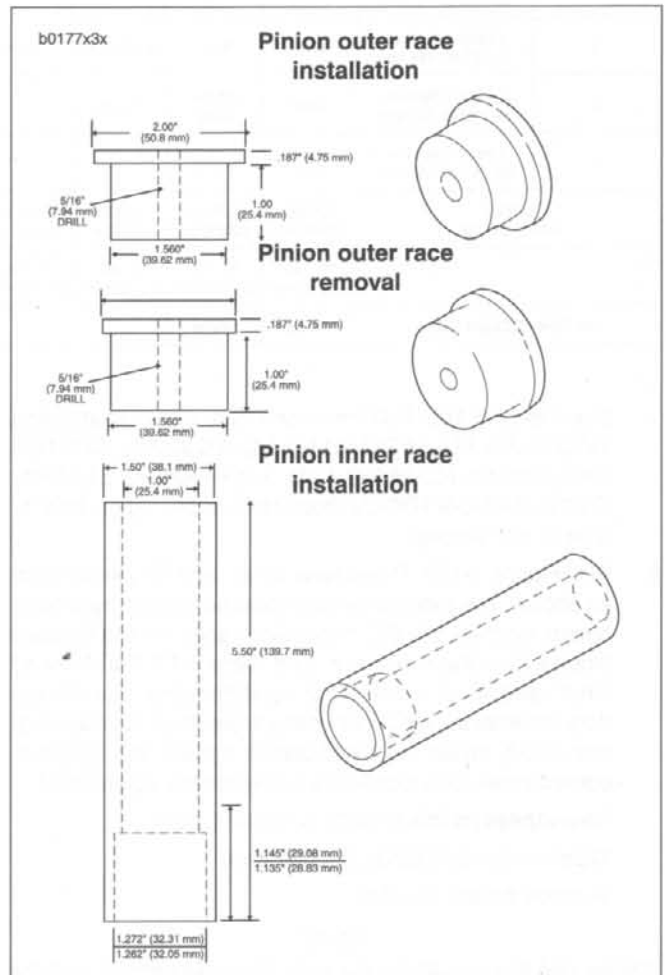


Figure 3-109. Pinion Shaft Bearing Tools

Table 3-17. Pinion Shaft Bearing Selection

FACTORY STAMPED NUMBER	OUTER RACE ID	BEARING SIZE AS IDENTIFIED BY COLOR CODING													
	over 1.5672 in. 39.807 mm	Service Wear Limit Exceeded – Replace Outer Race and Resize													
	1.5670-1.5672 in. 39.802-39.807 mm												Red		
	1.5668-1.5670 in. 39.797-39.802 mm											Red	Blue		
	1.5666-1.5668 in. 39.792-39.797 mm											Red	Blue	White-Gray	
	1.5664-1.5666 in. 39.787-39.792 mm											Red	Blue	White-Gray	Green
	1.5662-1.5664 in. 39.781-39.787 mm											Red	Blue	White-Gray	Green
	1.5660-1.5662 in. 39.776-39.781 mm											Red	Blue	White-Gray	Green
	1.5658-1.5660 in. 39.771-39.776 mm											Red	Blue	White-Gray	Green
	1.5656-1.5658 in. 39.766-39.771 mm											Red	Blue	White-Gray	Green
	1.5654-1.5656 in. 39.761-39.766 mm											Red	Blue	White-Gray	Green
	1.5652-1.5654 in. 39.756-39.761 mm											Red	Blue	White-Gray	Green
3	1.5650-1.5652 in. 39.751-39.756 mm	Red	Blue	White-Gray	Green										
2	1.5648-1.5650 in. 39.746-39.751 mm	Blue	White-Gray	Green											
1	1.5646-1.5648 in. 39.741-39.746 mm	White-Gray	Green												
INNER RACE OD (In)		1.2496-1.2498 in.	1.2498-1.2500 in.	1.2500-1.2502 in.	1.2502-1.2504 in.	1.2504-4.2506 in.	1.2506-1.2508 in.	1.2508-1.2510 in.	1.2510-1.2512 in.	1.2512-1.2514 in.	1.2514-1.2516 in.	1.2516-1.2518 in.			
		31.740 31.745 mm	31.745 31.750 mm	31.750- 31.755 mm	31.755- 31.760 mm	31.760- 31.765 mm	31.765- 31.770 mm	31.770- 31.775 mm	31.775- 31.780 mm	31.780- 31.786 mm	31.786- 31.791 mm	3.791- 31.796 mm			
FACTORY COLOR CODE		Green	White												

7. See Figure 3-105. Pull inner race from pinion shaft using TWO CLAW PULLER (Part No. HD-97292-61), CENTER CAP (Part No. HD-95652-43A), and BEARING SEPARATOR (SNAP-ON TOOLS Stock No. CJ950). Apply heat to race to aid removal.
8. See Figure 3-110. Press **new** inner race on pinion shaft as shown. The **new** inner race must be ground by a competent machinist to OD dimension range for the finished lapped ID of the outer race. See Table 3-17. The finished inner race must meet these specifications. For necessary dimensions for constructing a press-on tool see Figure 3-109. When the tool bottoms against the flywheel, correct inner race location is automatically established.
 - Roundness:** within 0.0002 in. (0.0051 mm)
 - Taper:** within 0.0002 in. (0.0051 mm)
 - Surface finish:** 16 RMS

NOTE

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

9. The following example illustrates how to determine the required inner race OD.
 - a. See Table 3-17. For example purposes, suppose the smallest outer race ID measurement is 1.5651 in. (39.754 mm). This requires an inner race OD range of 1.2496-1.2504 in. (31.740 - 31.760 mm).

NOTE

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

- b. Grind inner race. Measure OD at four places. Check that specifications in Step 8 are met.
- c. For example purposes, suppose the largest inner race OD measurement after grinding is 1.2499 in. (31.747 mm) OD.
- d. With a 1.5651 in. (39.754 mm) ID outer race and a 1.2499 in. (31.747 mm) OD inner race, a blue bearing is required.

Lapping Engine Main Bearing Races

1. Secure right and left crankcase halves with three crankcase stud bolts (top center and bottom left and right). The sprocket shaft bearing outer races and large spacer must be installed in left crankcase.
2. See Figure 3-111. Obtain CRANKCASE MAIN BEARING LAPPING TOOL (Part No. HD-96710-40B). Assemble CRANKCASE MAIN BEARING LAP (Part No. HD-96718-87) to lapping handle. Assemble guide sleeve to sprocket shaft bearing bushing. Sleeves, for use with tapered bearing, are assembled to case with bearings and small spacer collar. Finger-tighten the sleeve parts.
3. Insert lap shaft with arbor assembled through pinion bearing bushing and into guide sleeve. Tighten arbor expansion collars using a length of 0.156 in. (3.962 mm) rod as spanner until arbor begins to drag. Do not adjust arbor snug in bushing or bushing will "bell," a condition where hole is larger at ends than it is in the center.
4. Withdraw arbor far enough to coat lightly with 220 grit lapping compound. Do not apply a heavy coat. Reposition lap in bushing and turn handle at moderate hand speed. Work lap back and forth in bushing, as it is revolved, to avoid grooving and tapering.
5. At frequent intervals, remove lap from crankcase, wash and inspect bushing. Lapping is completed when entire bushing surface has a dull, satin finish rather than a glossy, smooth appearance. If necessary, flush off lap in cleaning solvent, air dry and apply fresh, light coat of fine lapping compound.

ASSEMBLY

Flywheels

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

1. Carefully clean all flywheel components using a non-petroleum-based solvent, such as LOCTITE CLEANING SOLVENT or electrical contact cleaner. Thoroughly dry all components.
2. See Figure 3-99. Apply two drops of LOCTITE 620 RETAINING COMPOUND to the crank pin threads, and apply no more than two drops to the nut bearing faces.

CAUTION

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

3. Assemble crank pin (6) to gear-side flywheel (5) making sure that key (7) is in proper position. Tighten gear-side crank pin nut to 150-185 ft-lbs (203.4-250.8 Nm).
4. Place gear-side flywheel assembly in rebuilding jig with crank pin pointing up. Wipe crank pin taper clean.

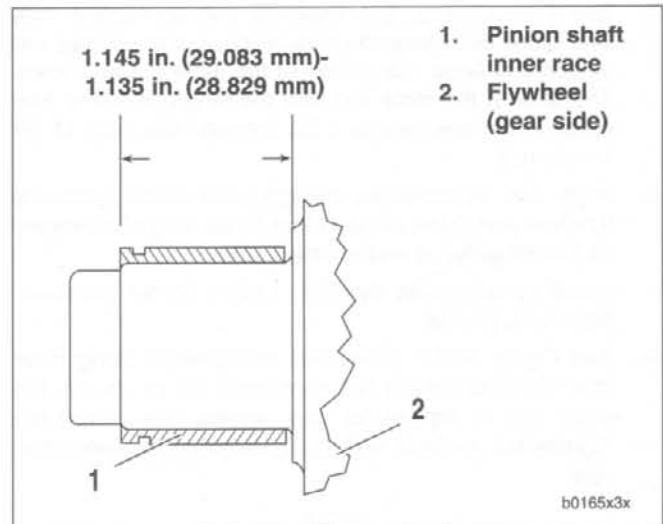


Figure 3-110. Inner Race Location

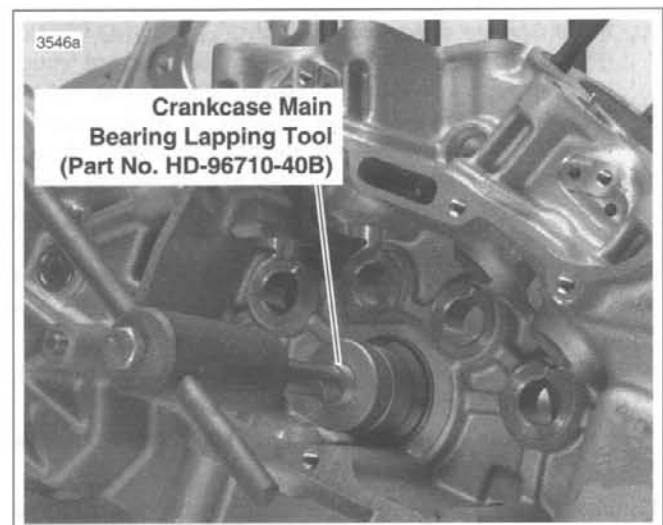


Figure 3-111. Lapping Pinion Shaft Main Bearing

5. See Figure 3-112. Slip bearings and connecting rods over crank pin. Assemble angular boss of the female rod adjacent to large radius side of the male rod as shown. The side of the male rod with the larger radius is narrower in the area where it fits between the forks of the female rod.
6. Verify that oil passages through pinion shaft, gear-side flywheel and crank pin are clear by blowing compressed air into oil galley at end of pinion shaft.
7. Install sprocket-side flywheel. Lightly tighten sprocket-side crank pin nut.
8. See Figure 3-113. Hold steel straightedge along outer face of wheel rims at 90° from crank pin as shown. Tap outer rim of top wheel until wheels are concentric. Tighten nut, recheck with straightedge at frequent intervals.

NOTE

Use soft metal hammer to realign wheels.

9. Tighten sprocket-side crank pin nut to 150-185 ft-lbs (203.4-250.8 Nm).
10. Install flywheel assembly in FLYWHEEL TRUING STAND (Part No. HD-96650-80). Adjust so centers are snug. Wheels must turn freely; however, shafts must not be loose in centers. If flywheel assembly is either loose or too tight, indicators will not indicate accurately. Adjust indicators to take reading as near to flywheels as possible. Pointers should read at about the middle of the scales.
 - a. Turn flywheels slowly and observe the movement of indicator pointers. Movement toward flywheels indicate high points of shafts.
 - b. Find highest point of each shaft. Use chalk to mark flywheel rims at those points.
 - c. Remove flywheel from stand. Make corrections as follows:
11. See Figure 3-114. Flywheel may be out of true three ways (a, b and c) or a combination of two of the three ways.

- a. When wheels are both out of true as indicated in A, tighten C-clamp on rims or wheels opposite crank pin. Lightly tap the rim at the crank pin with lead or copper mallet.
- b. When wheels are both out of true as indicated in B, drive a hardwood wedge between the wheels opposite the crank pin. Lightly tap the rims near the crank pin with a lead or copper mallet.
- c. When wheels are out of true as indicated in C, strike the rim of the wheel a firm blow at about 90° from crank pin on high side.
- d. When wheels are out of true in a combination of any of the conditions shown, correct C first, tapping rim of offending wheel only. Then correct condition A or B.

NOTE

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

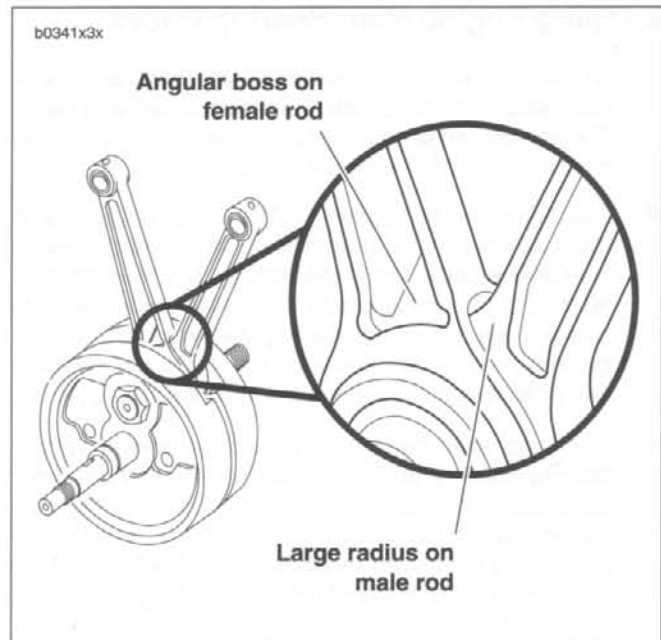


Figure 3-112. Installing Connecting Rods

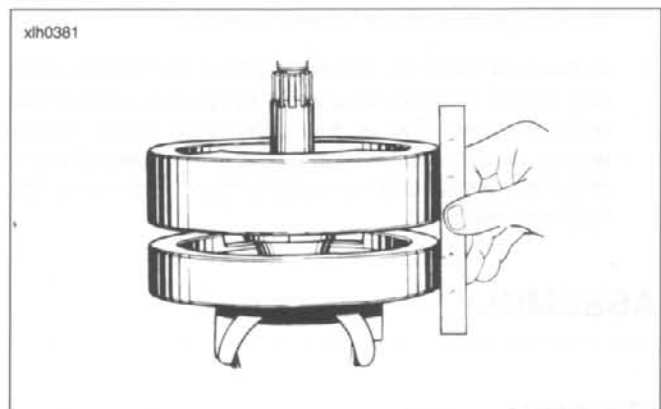


Figure 3-113. Squaring Flywheel Faces

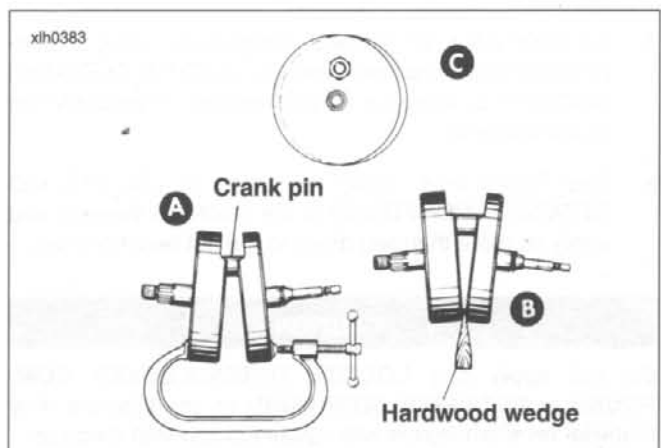


Figure 3-114. Correcting Flywheel Alignment

12. Readjust centers, revolve wheels and take reading from indicator. Repeat truing operation until indicated shaft runout does not exceed 0.001 in. (0.025 mm).

NOTE

Each graduation on indicator is 0.002 in. (0.051 mm).

13. If it is impossible to true wheels, check for:
- Cracked flywheel.
 - Damaged or enlarged tapered hole.
 - Sprocket or pinion shaft worn out-of-round at surface where indicator reading is being taken.
14. See Figure 3-115. When wheels are true, check connecting rod side play with thickness gauge as shown. If it is greater than tolerance shown in SERVICE WEAR LIMITS draw up crank pin nuts until within tolerance. Insufficient play between rods and flywheel face is caused by one of the following conditions:
- Flywheels and crank pin assembled with oil on tapers and nut over-tightened. Disassemble, clean and reassemble.
 - New** flywheel washers installed and not fully seated. Disassemble, inspect, replace deepest seating flywheel or crank pin. As last resort, grind down width of forked rod.
 - Taper holes enlarged as a result of having been taken apart several times. Replace deepest seating wheel.
 - Cracked flywheel at tapered hole. Replace flywheel.
15. After rod side play is checked and adjusted, check that crank pin nut is tightened to specified torque. Recheck wheel trueness on truing device. Correct any runout as above.

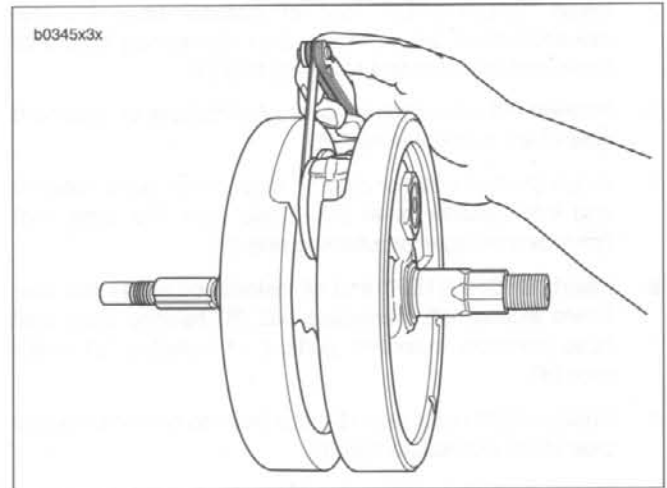
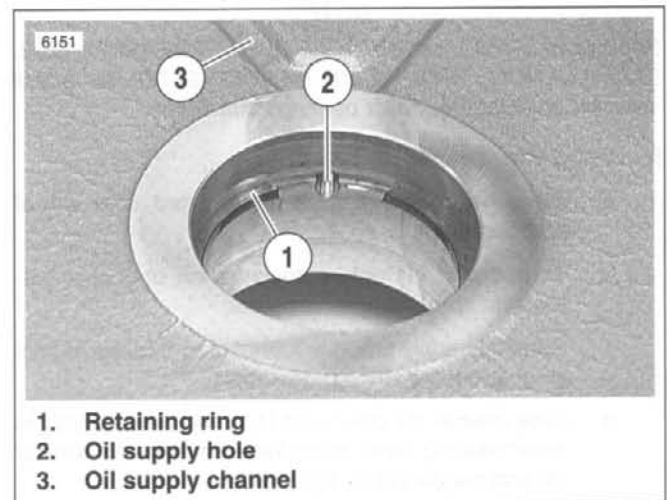


Figure 3-115. Checking Connecting Rod Side Play



- Retaining ring
- Oil supply hole
- Oil supply channel

Figure 3-116. Retaining Ring

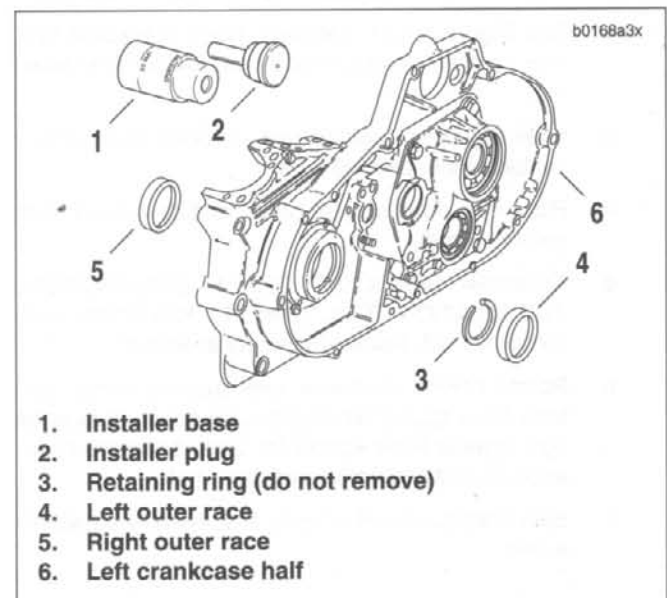
Crankcase Halves

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

- See Figure 3-117. The original retaining ring (1) is left in place to avoid damaging the bearing bore of the left crankcase half. Verify that gap in retaining ring (1) is aligned with oil supply hole (2) in left crankcase half bearing bore.

NOTE

See Figure 3-117. Use **SPROCKET SHAFT BEARING OUTER RACE INSTALLATION TOOL (1, 2)** (Part No. HD-39458) to install left and right outer races (4, 5) of sprocket shaft tapered roller bearings into left crankcase half (6). Always install left outer race (4) prior to installing right outer race (5) because the installer base (1) is usable only when you follow this sequence of race installation.



- Installer base
- Installer plug
- Retaining ring (do not remove)
- Left outer race
- Right outer race
- Left crankcase half

Figure 3-117. Installing Sprocket Shaft Bear Outer Races

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

NOTE

See Figure 3-118. Use *SPROCKET SHAFT BEARING/SEAL INSTALLATION TOOL* (Part No. HD-42579) to install sprocket shaft tapered roller bearings and seal.

8. Install inner bearing (6).
 - a. Place **new** bearing, small end upward, over end of sprocket shaft.
 - b. Thread pilot (1) onto sprocket shaft until pilot bottoms on sprocket shaft shoulder.
 - c. Sparingly apply graphite lubricant to threads of pilot shaft to ensure smooth operation.
 - d. Slide sleeve (5) over pilot (1) until sleeve contacts inner bearing race. Install Nice bearing (4), washer (3) and handle (2) on top of sleeve.
 - e. Rotate handle clockwise until bearing (6) contacts flywheel shoulder. Remove tool from sprocket shaft.
9. See Figure 3-96. Install spacer (6) and outer bearing (9).
 - a. See Figure 3-119. Carefully place crankcase half over sprocket shaft so that it rests flat on inner bearing.
 - b. Slide **new** inner spacer over sprocket shaft until it contacts inner bearing race.
 - c. Place **new** outer bearing, small end downward, over sprocket shaft.
 - d. Assemble *SPROCKET SHAFT BEARING/SEAL INSTALLATION TOOL* (Part No. HD-42579) onto sprocket shaft. Follow procedure in Step 8.
 - e. Rotate handle clockwise until bearing firmly contacts inner spacer. Inner and outer bearings must be tight against inner spacer for correct bearing clearance. Remove tool from sprocket shaft.
 - f. Spin crankcase half to verify that flywheel assembly is free.

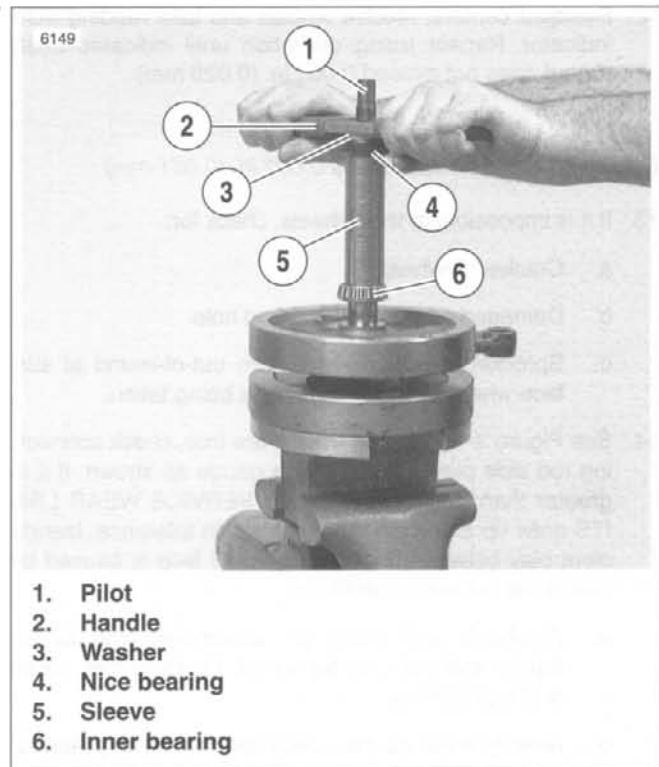


Figure 3-118. Inner Bearing Installation

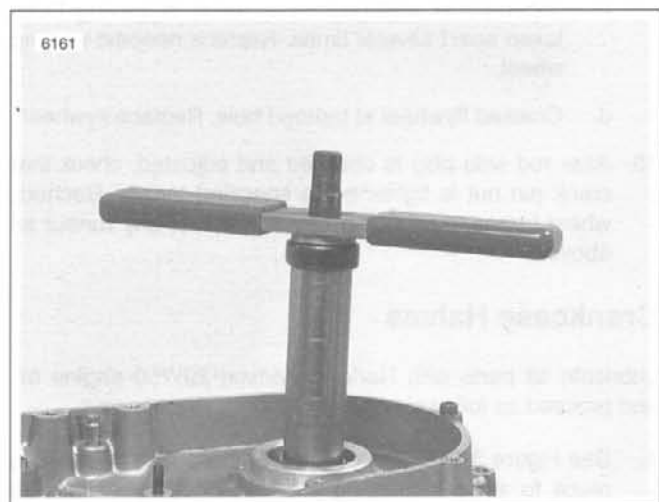


Figure 3-119. Installing Flywheel Spacer and Outer Bearing

10. See Figure 3-120. Install **new** spacer in seal ID. With the open (lipped) side facing outward, center seal/spacer assembly over bearing bore.

CAUTION

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

11. See Figure 3-121. Install bearing seal and spacer.
 - a. Center seal/spacer driver (2) over seal, so that the sleeve (smaller OD) seats between seal wall and garter spring.
 - b. Assemble SPROCKET SHAFT BEARING/SEAL INSTALLATION TOOL (1) (Part No. HD-42579) and SPROCKET SHAFT SEAL/SPACER INSTALLER (Part No. HD-42774) onto sprocket shaft. Follow procedure in Step 8.
 - c. Rotate handle clockwise until the spacer makes contact with the bearing. Remove tool from sprocket shaft.
12. See Figure 3-122. Install pinion shaft bearing.
 - a. Lubricate pinion shaft bearing with engine oil.
 - b. Slip bearing on pinion shaft.
 - c. Install **new** retaining ring in groove of pinion shaft bearing inner race.
13. Assemble crankcase halves together.
 - a. Apply a thin coat of DOW CORNING SILASTIC or 3-M 800 sealant to crankcase joint faces.
 - b. Slide pinion shaft through outer race in right crankcase.
 - c. Attach crankcase halves using hardware shown in Figure 3-94.
 - d. Tighten the 1/4-in. fasteners to 70-110 in-lbs (7.9-12.4 Nm)
 - e. Tighten the 5/16-in. fasteners to 15-19 ft-lbs (20.3-25.8 Nm).

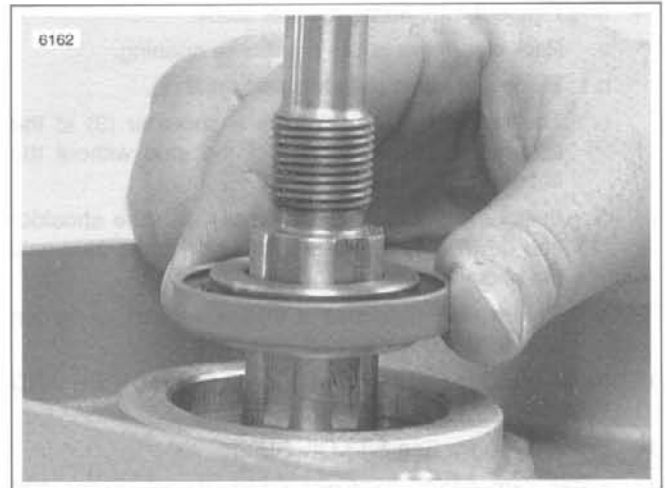
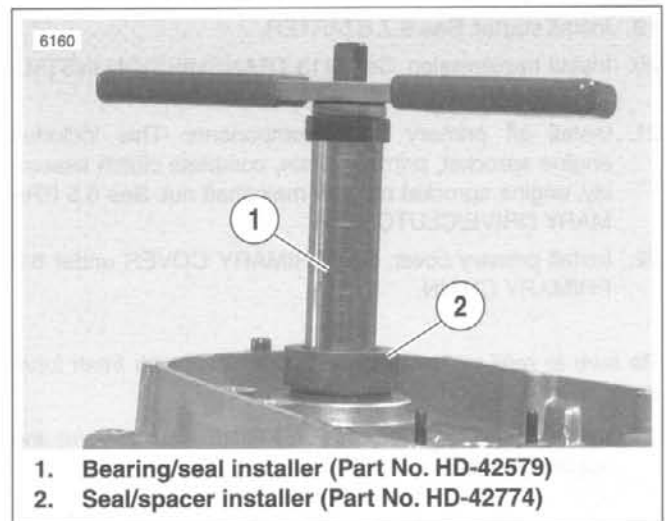


Figure 3-120. Install Spacer in Seal



1. Bearing/seal installer (Part No. HD-42579)
2. Seal/spacer installer (Part No. HD-42774)

Figure 3-121. Install Bearing Seal/Spacer

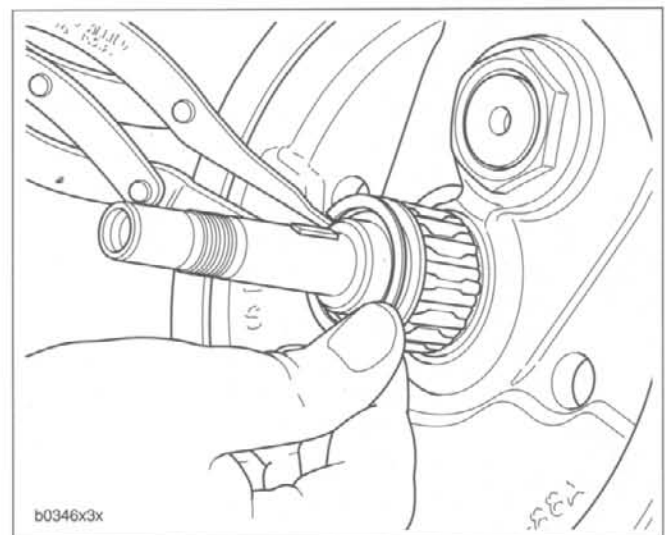


Figure 3-122. Pinion Shaft Bearing

14. See Figure 3-123. Install cylinder studs.
 - a. Pack clean towels into crankcase opening.
 - b. Place a steel ball into a head screw (1).
 - c. The cylinder studs (2) have a shoulder (3) at the lower end. Place the end of the stud without the shoulder into the head screw.
 - d. Install the stud in the crankcase with the shoulder end down. Use an air gun (4) to drive the stud until the shoulder reaches the crankcase.
 - e. Remove air gun. Use a torque wrench to tighten stud to 10-20 ft-lbs (13.6-27.1 Nm).
15. Install pistons and cylinders. See 3.6 CYLINDER AND PISTON.
16. Install oil pump. See 3.13 OIL PUMP.
17. Install cam gears, gearcase cover, tappet guides and tappets. See 3.17 GEARCASE COVER AND CAM GEARS (1999 models).
18. Install cylinder heads. See 3.5 CYLINDER HEAD.
19. Install starter. See 5.7 STARTER.
20. Install transmission. See 6.13 TRANSMISSION INSTALLATION AND SHIFTER PAWL ADJUSTMENT.
21. Install all primary drive components. This includes engine sprocket, primary chain, complete clutch assembly, engine sprocket nut and mainshaft nut. See 6.5 PRIMARY DRIVE/CLUTCH.
22. Install primary cover. See PRIMARY COVER under 6.2 PRIMARY CHAIN.

NOTE

Be sure to refill transmission to proper level with fresh lubricant. See 1.12 CLUTCH.

23. See 3.4 INSTALLING THE ENGINE and perform the applicable steps.

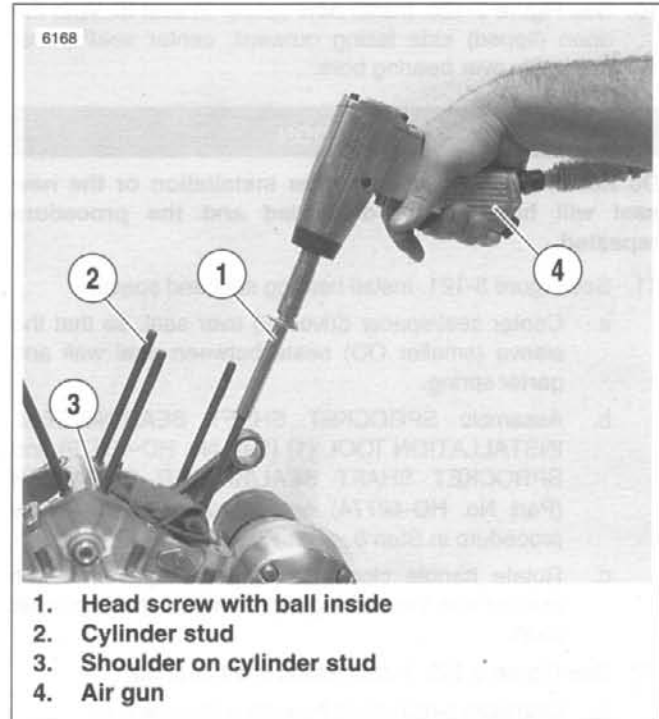


Figure 3-123. Cylinder Studs

MODEL YEAR CHANGE

All 2000 Model Year Buell Thunderstorm™ engines have a new straight, pressed-in crankpin and low-inertia flywheel. The new flywheel is serviced as an assembly (is not disassembled).

GENERAL

CAUTION

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

Remove engine from chassis to repair rod bearings, pinion shaft bearing or sprocket shaft bearing. See 3.3 STRIPPING MOTORCYCLE FOR ENGINE REPAIR.

It is recommended procedure to overhaul engine if removed. This includes inspecting and repairing cylinder heads, cylinders, gearcase and transmission.

ADJUSTMENT/TESTING

Flywheel End Play

Before completely disassembling crankcases, check flywheel end play.

1. After engine has been removed from chassis, securely fasten it to a stand or workbench.
2. Remove gearcase cover. See 3.18 GEARCASE COVER AND CAM GEARS (2000 models).
3. See Figure 3-124. Attach a dial indicator to gear side crankcase with indicator stem on end of gearshaft.
4. To obtain an accurate flywheel end play reading, preload sprocket shaft bearings. Create a suitable tool by welding two handles to an old engine sprocket nut. Install the nut and sprocket. Tighten to 190-210 ft-lbs (257.6-284.7 Nm).
5. Check flywheel end play.
 - a. Rotate and **push** on sprocket shaft while reading dial indicator.
 - b. Then rotate and **pull** on sprocket shaft while reading dial indicator.
 - c. Replace bearing inner shim (See Figure 3-127.) if difference (end play) in indicator readings is not 0.001-0.005 in. (0.025-0.127 mm). Choose shim from Table 3-18.

NOTE

Use a thinner shim for less end play; use a thicker shim for more end play.

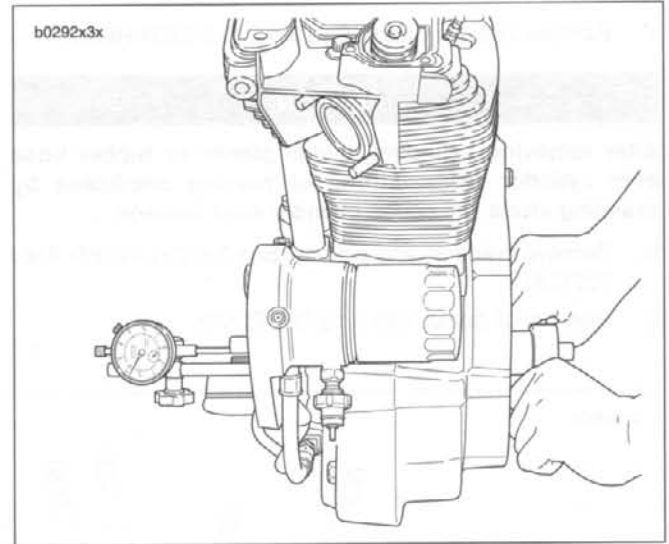


Figure 3-124. Checking Flywheel End Play

Table 3-18. Flywheel End Play Shims

PART NUMBER	THICKNESS	
	IN.	MM
9155	0.0975-0.0985	2.4765-2.5019
9142	0.0995 - 0.1005	2.5273-2.5527
9143	0.1015-0.1025	2.5781-2.6035
9144	0.1035 - 0.1045	2.6289-2.6543
9145	0.1055 - 0.1065	2.6797-2.7051
9146	0.1075 - 0.1085	2.7305-2.7559
9147	0.1095 - 0.1105	2.7813-2.8067
9148	0.1115 - 0.1125	2.8321-2.8575
9149	0.1135 - 0.1145	2.8829-2.9083

Table 3-19. Gearshaft Bearings

PART NUMBER	COLOR
24647-87	Blue
24650-87	Red
24659-87	White/Grey
24660-87	Green

DISASSEMBLY

Crankcase Halves

1. Remove cylinder heads. See 3.5 CYLINDER HEAD.

CAUTION

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

2. Remove cylinders and pistons. See 3.6 CYLINDER AND PISTON.
3. Remove oil pump. See 3.13 OIL PUMP.

4. Remove gearcase components. See 3.18 GEARCASE COVER AND CAM GEARS (2000 models).
5. Remove primary cover and primary drive/clutch components. See PRIMARY CHAIN/DRIVE under 6.5 PRIMARY DRIVE/CLUTCH.
6. Remove starter motor. See 5.7 STARTER.
7. Remove transmission. See 6.7 TRANSMISSION CASE.
8. See Figure 3-125. Remove screws and rear engine mount bolt securing crankcase halves together.
9. Position crankcase on work bench, gearcase side up. Tap crankcase with plastic mallet to loosen top half and separate the halves.

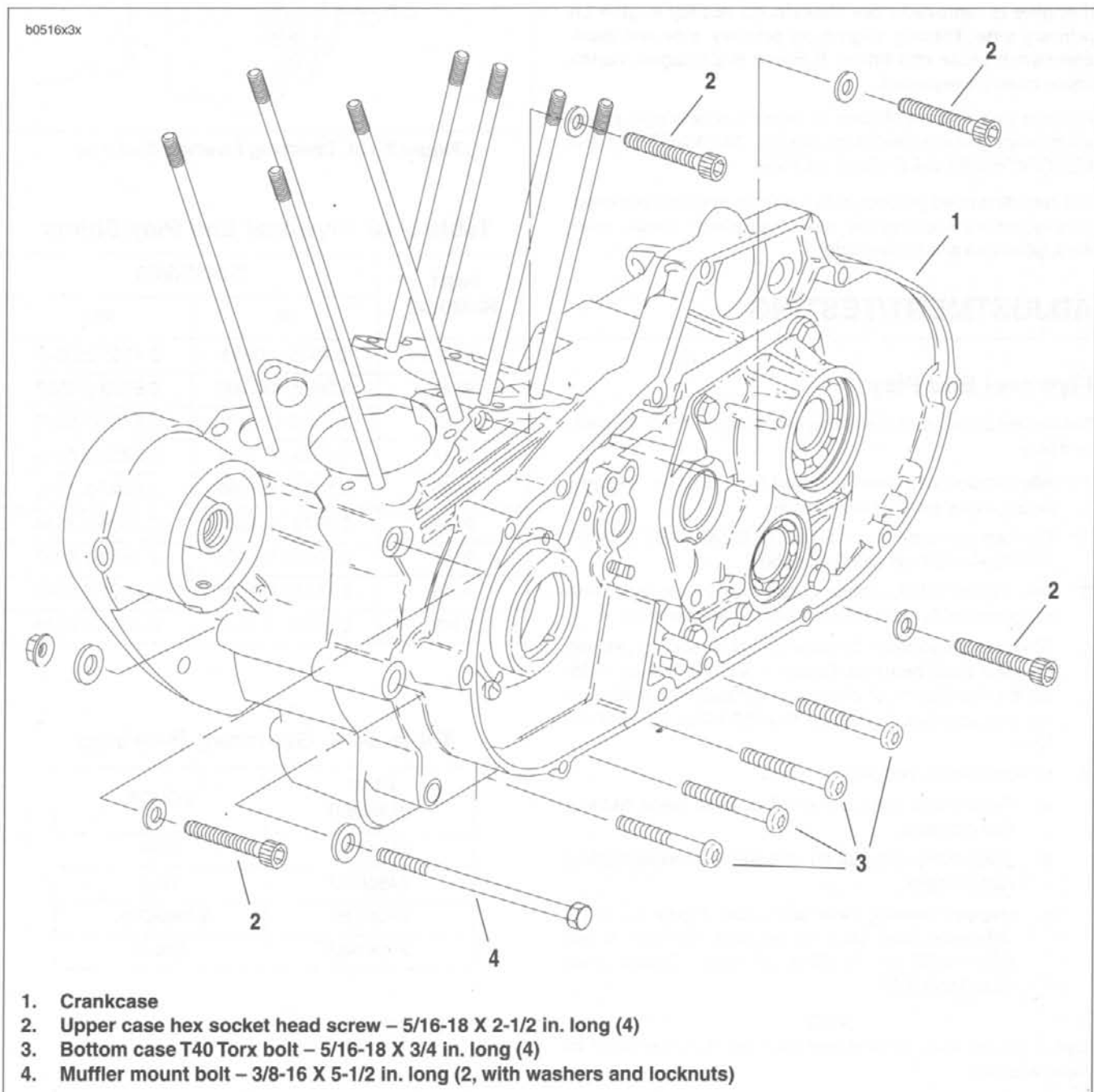


Figure 3-125. Crankcase Hardware (Typical)

WARNING

The next step requires using a press. Wear eye protection and make certain set-up is stable. The pressure involved could cause parts to "fly out" with considerable force. Inadequate safety precautions could result in death or serious injury.

10. See Figure 3-126. Mount the left crankcase half and flywheel assembly on a press table, supporting crankcase on parallel bars. Press on end of sprocket shaft with arbor press until flywheel assembly is free from crankcase half. Do not drive flywheel assembly from crankcase half as flywheels may be knocked out of alignment.

NOTE

See Figure 3-126. If it is necessary to remove either the pinion shaft bearing (11) or sprocket shaft bearing (4 and 9), proceed as follows:

11. Gearshaft bearing will remain on flywheel pinion shaft. Remove retaining ring, and bearing may be slipped off pinion shaft.
12. See Figure 3-128. Place flywheel assembly in FLYWHEEL FIXTURE (Part No. HD-44385). Pull sprocket shaft bearing with SPROCKET SHAFT INNER TIMKIN BEARING REMOVER (Part No. HD-44404) and ALL PURPOSE CLAW PULLER (Part No. HD-95635-46) using bolts in place of jaws. Insert a penny (or suitable coin) between shaft and claw puller to avoid damaging shaft.
13. See Figure 3-129. Use CRANKSHAFT BEARING TOOL (Part No. HD-94547-101) to remove sprocket shaft outer races.

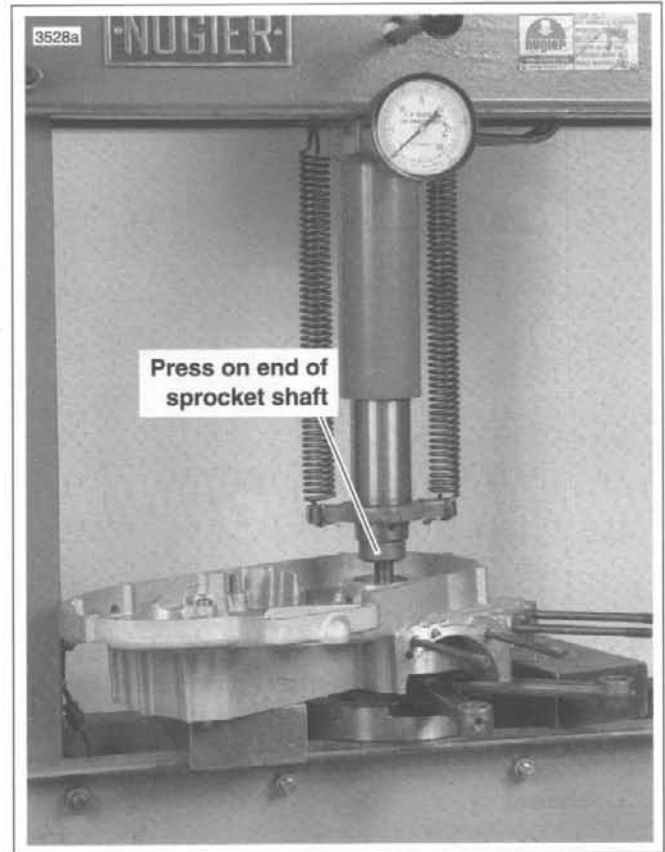


Figure 3-126. Pressing Flywheel from Crankcase

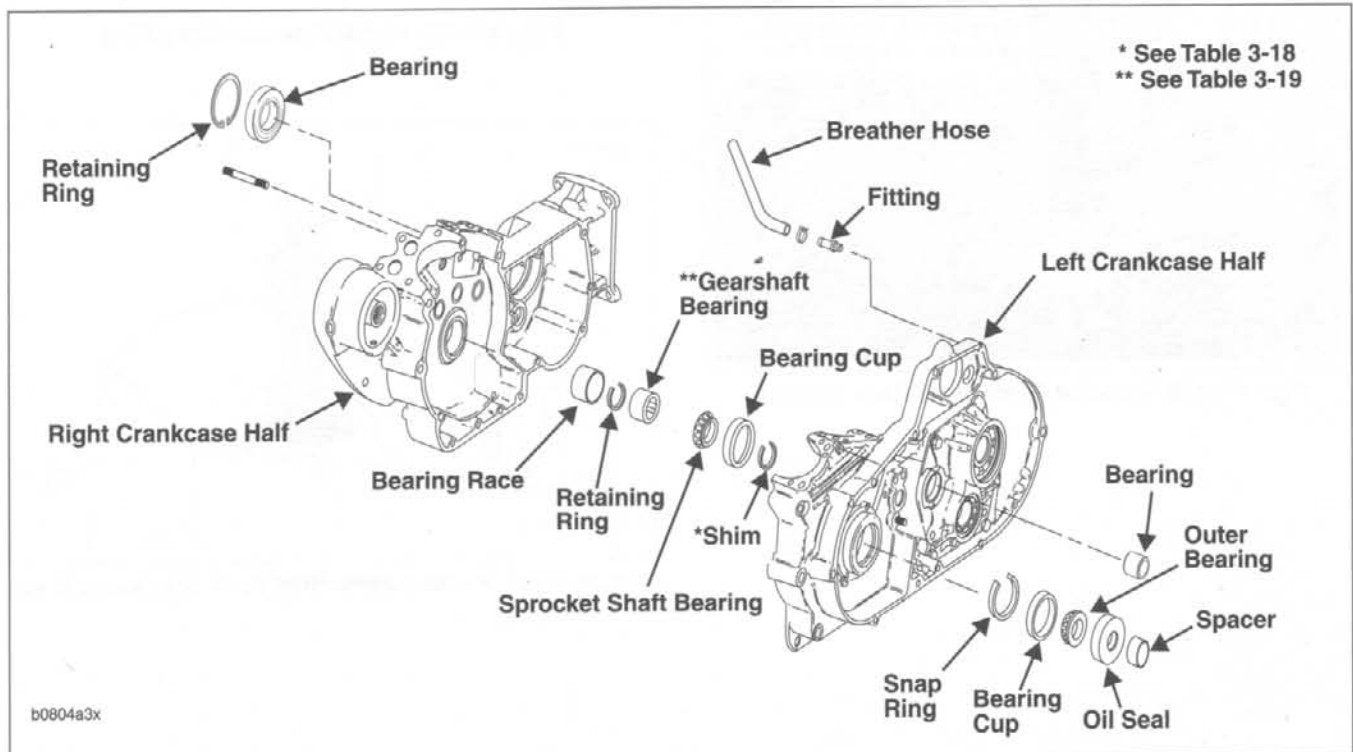
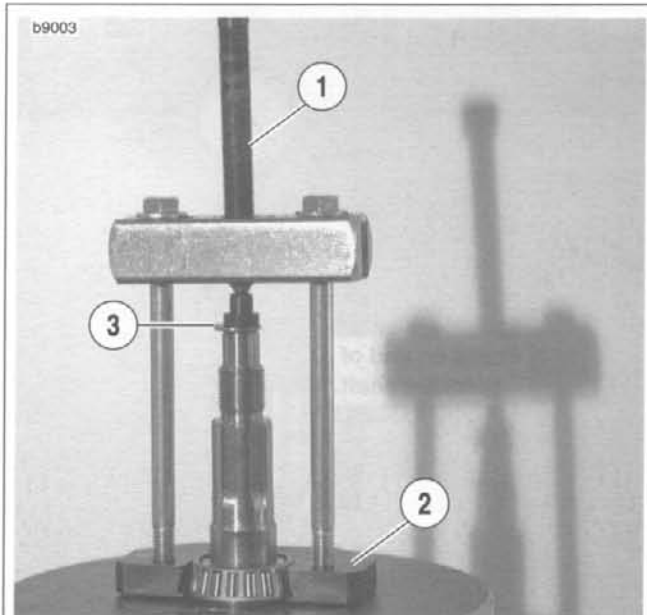


Figure 3-127. Crankcase Assembly



1. All purpose claw puller (Part No. HD-95637-46)
2. Sprocket Shaft Inner Timken Bearing Remover (Part No. HD-44404)
3. Penny (or suitable coin)
4. Flywheel Fixture (Part No. HD-44385) (Not Shown)

Figure 3-128. Removing Sprocket Shaft Inner Timken Bearing (Typical)

14. Remove crankcase retaining ring from crankcase bore.
 - a. Place the crankcase half on a flat surface with the outboard side facing up.
 - b. Obtain the two TIMKEN SNAP RING REMOVER/INSTALLER (HD-44069).
 - c. See Figure 3-130. With the gap in the retaining ring being the 12 o'clock position, place the two claws so that the slotted sides engage the inside edge of the retaining ring at the 10 and 2 o'clock positions.
 - d. Using a 9/64 inch allen head bit, tighten the screws to fix the position of the claws on the retaining ring.
 - e. See Figure 3-131. Inserting the tips of a large retaining ring pliers (Snap-On PR-56A) into one hole in each claw, compress the retaining ring and remove it from the crankcase bore.
 - f. Loosen allen head screws and remove claws from retaining ring.

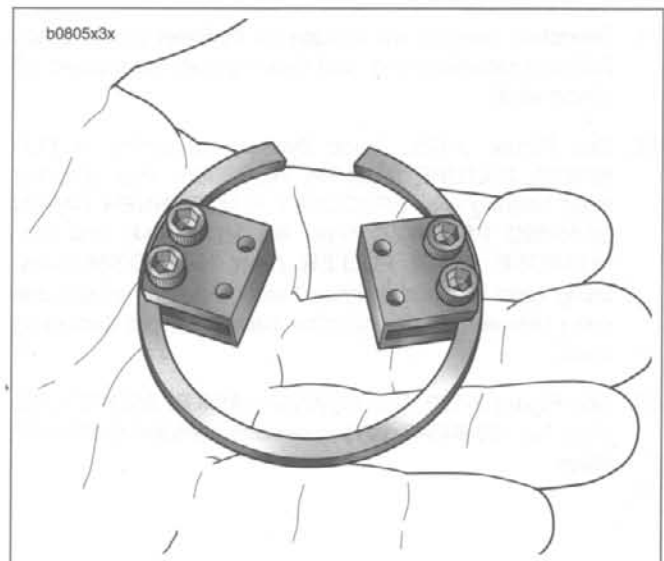


Figure 3-130. Install Claws on Snap Ring

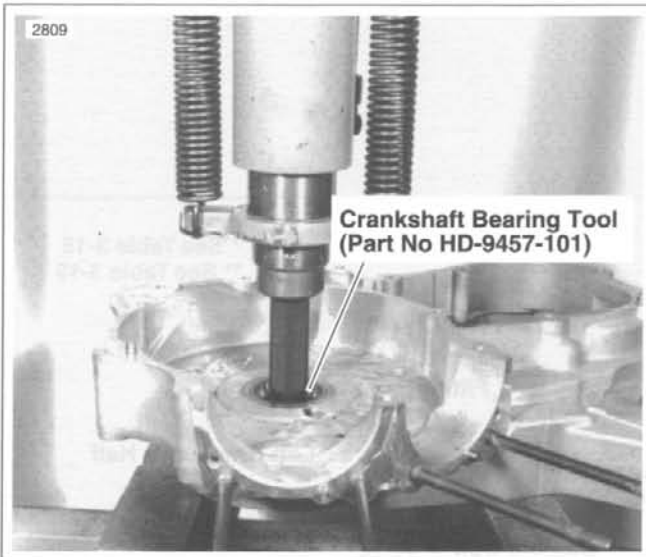


Figure 3-129. Sprocket Shaft Outer Race Removal

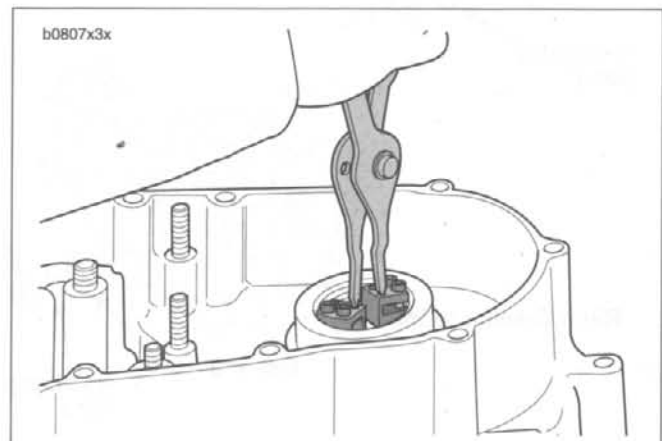


Figure 3-131. Remove Snap-Ring From Crankcase Bore

Flywheel/Connecting Rod Assembly

NOTE

If the flywheel or connecting rods need to be replaced, then they must be replaced together as one assembly. Return the flywheel/connecting rod assembly to the factory for service or replacement.

CLEANING AND INSPECTION

Wash all parts in solvent and blow dry with compressed air.

Flywheel/Connecting Rod Assembly

1. Replace the flywheel/connecting rod assembly if any of the following conditions are noted:
 - Connecting rods are bent or twisted.
 - Connecting rods do not fall under their own weight or are in a bind.
 - The crankshaft (roller) bearing inner race is bur-nelled, burnt, scored, blued or damaged.
2. Inspect connecting rods for correct free play.
 - a. Holding the shank of each rod just above the bearing bore, pull up and down on the connecting rods. Any discernible up and down movement indicates excessive lower bearing clearance. Replace the flywheel/connecting rod assembly.
3. See Figure 3-132. Check connecting rod side play.
 - a. Insert a feeler gauge between the thrust washer and the outboard side of the connecting rod.
 - a. Replace the assembly if the rod side play exceeds 0.030 inch (0.762 mm).

Fitting Sprocket Bearings

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

Fitting Pinion Bearings

See Figure 3-127. A pressed-in bushing in the right crankcase half is the outer race. The inner race is pressed on the pinion shaft.

See Figure 3-135. To remove pinion shaft inner race, use TWO CLAW PULLER (Part No. HD-97292-61), CENTER CAP (Part No. HD-95652-43A), and BEARING SEPARATOR (SNAP-ON TOOLS Stock No. CJ950). Apply heat to race to aid removal. Four sizes of pinion bearings are available. Pinion bearing selection at the factory, during engine rebuild, or replacement of crankcase set or flywheel assembly is based on the largest measured outside diameter (OD) of the inner race and the smallest measured inside diameter (ID) of the outer race (crankcase bushing). A running clearance of 0.0002-0.0008 in. (0.0051-0.0203 mm) is established during crankcase set or flywheel assembly replacement and engine rebuild.

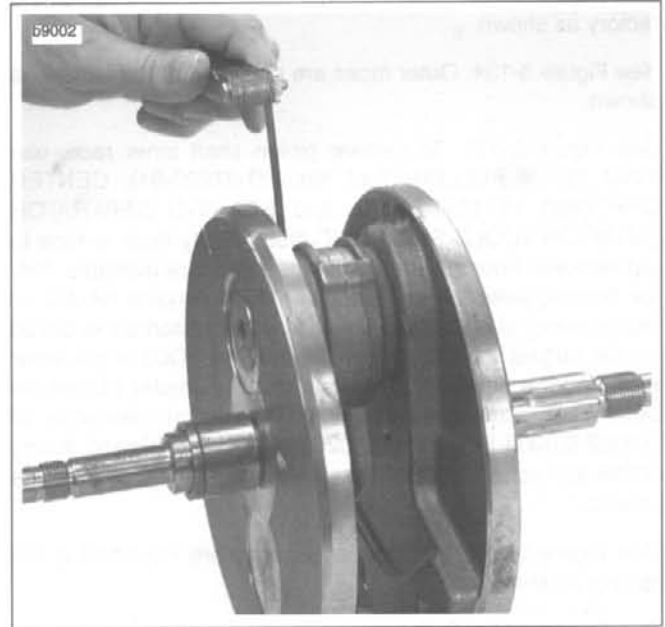


Figure 3-132. Checking Connecting Rod Side Play

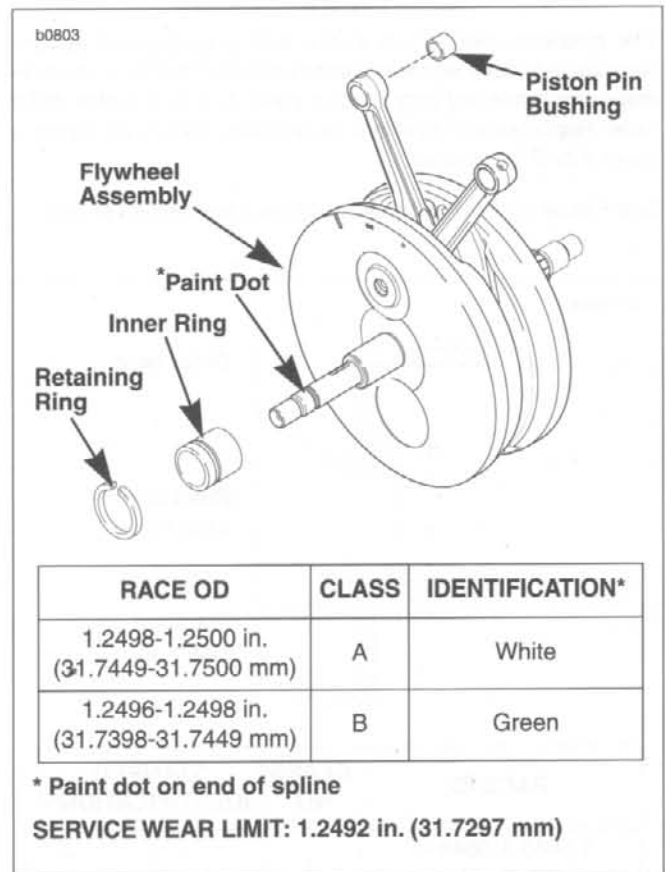


Figure 3-133. Low Inertia Flywheel and Connecting Rod Assembly/Factory Inner Race Sizes

See Figure 3-133. Installed inner races are identified at the factory as shown.

See Figure 3-134. Outer races are identified at the factory as shown.

See Figure 3-135. To remove pinion shaft inner race, use TWO CLAW PULLER (Part No. HD-97292-61), CENTER CAP (Part HD-95652-43A), and BEARING SEPARATOR (SNAP-ON TOOLS Stock No. CJ950). Apply heat to race to aid removal. Four sizes of pinion bearings are available. Pinion bearing selection at the factory, during engine rebuild, or replacement of crankcase set or flywheel assembly is based on the largest measured outside diameter (OD) of the inner race and the smallest measured inside diameter (ID) of the outer race (crankcase bushing). A running clearance of 0.0002-0.0008 in. (0.0051-0.0203 mm) is established during crankcase set or flywheel assembly replacement and engine rebuild.

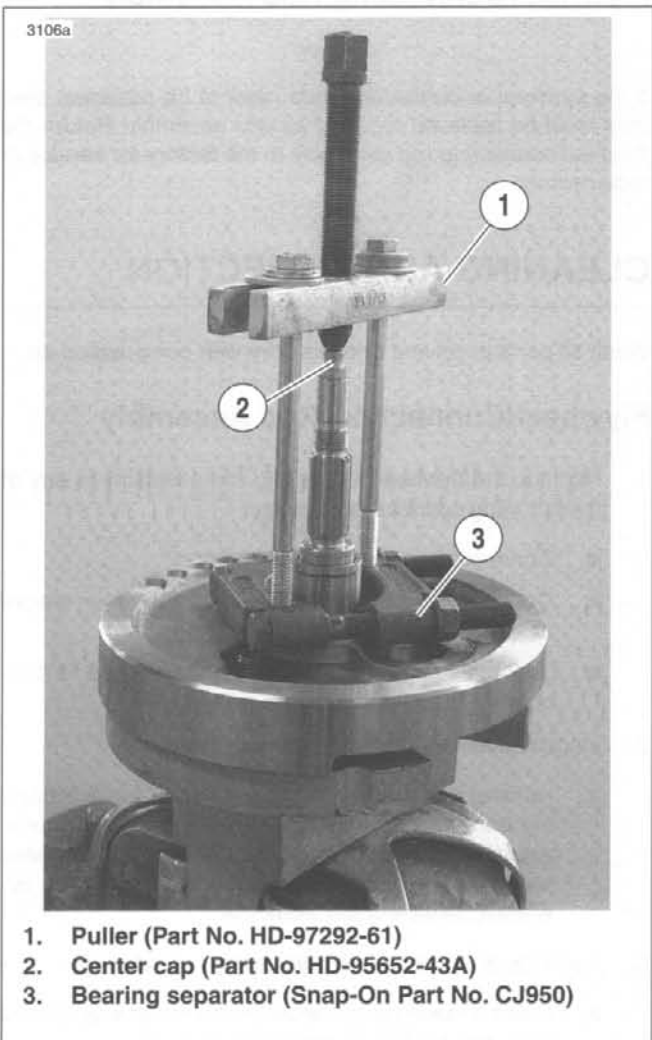
See Figure 3-133. Installed inner races are identified at the factory as shown.

See Figure 3-134. Outer races are identified at the factory as shown.

NOTE

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

See Figure 3-137. Pinion bearings are identified as shown.



1. Puller (Part No. HD-97292-61)
2. Center cap (Part No. HD-95652-43A)
3. Bearing separator (Snap-On Part No. CJ950)

Figure 3-135. Pulling Pinion Shaft Inner Race (Typical)

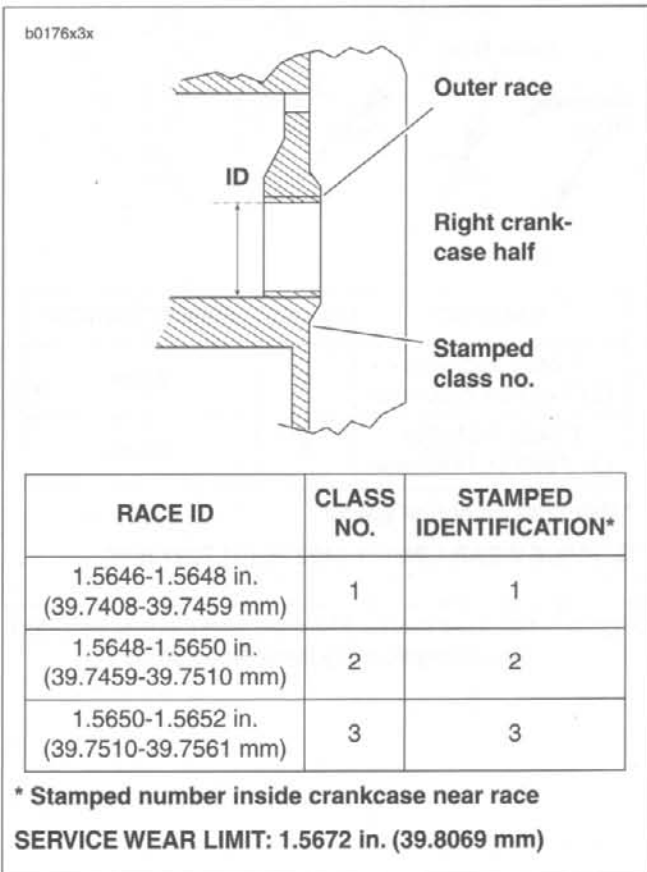


Figure 3-134. Factory Outer Race Sizes

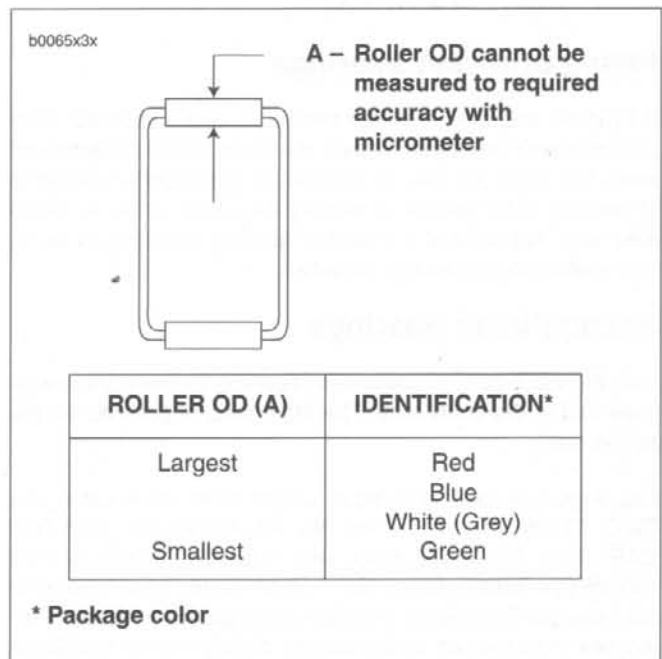


Figure 3-136. Bearing Identification

BEARING SELECTION

Select bearings using the identification information given for inner and outer races and bearings. See Table 3-19. and Table 3-20.

NOTE

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

1. Use a dial bore gauge to measure and record ID of outer race. Take four measurements on ID where bearing rollers ride.
 - a. If the largest measurement is larger than 1.5672 in. (39.8069 mm) or the required lapping to remove wear marks would enlarge bore beyond 1.5672 in., continue at Step 5.
 - b. If largest measurement is 1.5672 in. (39.8069 mm) or less, cover the cam bearings with masking tape to prevent debris from entering bearings. Assemble crankcase halves.

NOTE

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

2. See LAPPING ENGINE MAIN BEARING RACES. Lap race until all wear marks are removed.
3. Measure and record ID of race at four places.
4. Check measurements against these specifications:

Largest ID measured: 1.5672 in. (39.8069 mm) or less

Roundness of ID: within 0.0002 in. (0.0051 mm)

Taper: within 0.0002 in. (0.0051)

- a. If lapping increased bore ID to larger than 1.5672 in. (39.8069 mm), go to Step 5.
 - b. If roundness or taper do not meet specifications, continue lapping until specifications are met.
 - c. If all specifications are met, continue at Step 7 to remove and size inner race.
5. Press the outer race from the right crankcase. Press **new** outer race into crankcase flush with inside edge of cast-in insert.

See Figure 3-138. Dimensions are shown for fabrication of tools used in pressing the outer race into or out of crankcase.

6. The **new** outer race must be lapped slightly to true and align with left case bearing and to meet the following specifications. See LAPPING ENGINE MAIN BEARING RACES.

ID: 1.5646 - 1.5652 in. (39.7408 - 39.7561 mm)

Roundness: within 0.0002 in. (0.0051 mm)

Taper: within 0.0002 in. (0.0051 mm)

Surface finish: 16 RMS

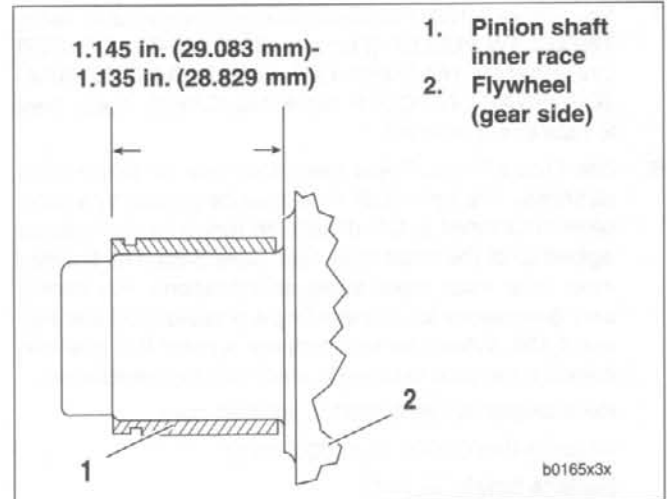


Figure 3-137. Inner Race Location

7. See Figure 3-135. Pull inner race from pinion shaft using TWO CLAW PULLER (Part No. HD-97292-61), CENTER CAP (Part No. HD-95652-43A), and BEARING SEPARATOR (SNAP-ON TOOLS Stock No. CJ950). Apply heat to race to aid removal.

8. See Figure 3-137. Press **new** inner race on pinion shaft as shown. The **new** inner race must be ground by a competent machinist to OD dimension range for the finished lapped ID of the outer race. See Table 3-20. The finished inner race must meet these specifications. For necessary dimensions for constructing a press-on tool see Figure 3-138. When the tool bottoms against the flywheel, correct inner race location is automatically established.

Roundness: within 0.0002 in. (0.0051 mm)

Taper: within 0.0002 in. (0.0051 mm)

Surface finish: 16 RMS

NOTE

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

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

- a. See Table 3-20. For example purposes, suppose the smallest outer race ID measurement is 1.5651 in. (39.754 mm). This requires an inner race OD range of 1.2496-1.2504 in. (31.740 - 31.760 mm).

NOTE

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

- b. Grind inner race. Measure OD at four places. Check that specifications in Step 8 are met.
- c. For example purposes, suppose the largest inner race OD measurement after grinding is 1.2499 in. (31.747 mm) OD.
- d. With a 1.5651 in. (39.754 mm) ID outer race and a 1.2499 in. (31.747 mm) OD inner race, a blue bearing is required.

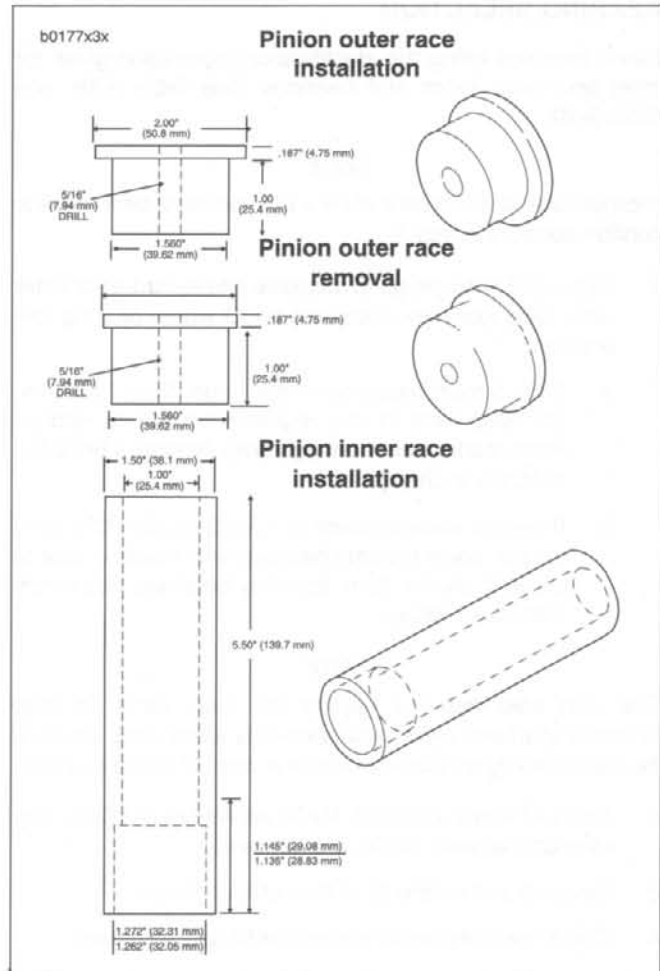


Figure 3-138. Pinion Shaft Bearing Tools

Lapping Engine Main Bearing Races

- Secure right and left crankcase halves with three crankcase stud bolts (top center and bottom left and right). The sprocket shaft bearing outer races and large spacer must be installed in left crankcase.
- See Figure 3-139. Obtain CRANKCASE MAIN BEARING LAPPING TOOL (Part No. HD-96710-40B). Assemble CRANKCASE MAIN BEARING LAP (Part No. HD-96718-87) to lapping handle. Assemble guide sleeve to sprocket shaft bearing bushing. Sleeves, for use with tapered bearing, are assembled to case with bearings and small spacer collar. Finger-tighten the sleeve parts.
- Insert lap shaft with arbor assembled through pinion bearing bushing and into guide sleeve. Tighten arbor expansion collars using a length of 0.156 in. (3.962 mm) rod as spanner until arbor begins to drag. Do not adjust arbor snug in bushing or bushing will "bell," a condition where hole is larger at ends than it is in the center.
- Withdraw arbor far enough to coat lightly with 220 grit lapping compound. Do not apply a heavy coat. Reposition lap in bushing and turn handle at moderate hand speed. Work lap back and forth in bushing, as it is revolved, to avoid grooving and tapering.

At frequent intervals, remove lap from crankcase, wash and

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

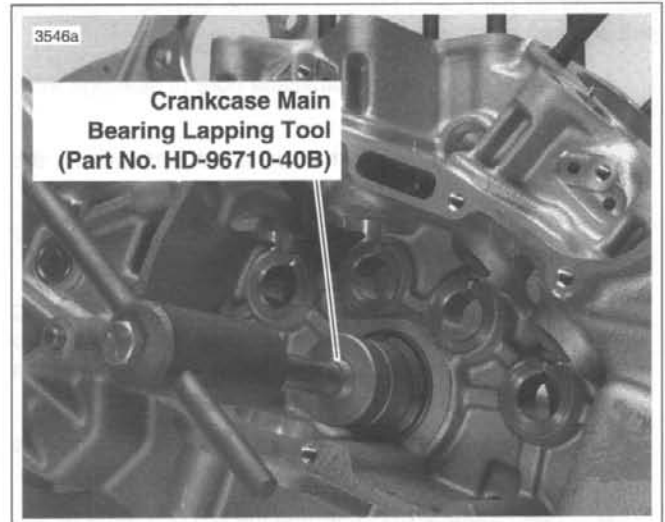


Figure 3-139. Lapping Pinion Shaft Main Bearing

Table 3-20. Pinion Shaft Bearing Selection

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

ASSEMBLY

Crankcase Halves

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

1. Install **new** snap ring to crankcase bore (if bearings were replaced).
 - a. Place the crankcase half on a flat surface with the outboard side facing up.
 - b. Obtain the two TIMKEN SNAP RING REMOVER/INSTALLER (HD-44069).
 - c. See *Figure 3-130*. With the gap in the snap ring being the 12 o'clock position, place the two claws so that the slotted sides engage the inside edge of the snap ring at the 10 and 2 o'clock positions.
 - d. Using a 9/64 inch allen head bit, tighten the screws to fix the position of the claws on the snap ring.
 - e. See *Figure 3-131*. Inserting the tips of a large retaining ring pliers (Snap-On PR-56A) into one hole in each claw, compress the snap ring and install in groove of crankcase bore.
 - f. See *Figure 3-140*. Verify that the gap in the snap ring is centered below the oil hole at the top of the ring groove. Move snap ring if not properly centered.
 - g. Loosen allen head screws and remove claws from snap ring.

NOTE

See *Figure 3-141*. Use *SPROCKET SHAFT BEARING OUTER RACE INSTALLATION TOOL* (1, 2) (Part No. HD-39458) to install left and right outer races (4, 5) of sprocket shaft tapered roller bearings into left crankcase half (6). Always install left outer race (4) prior to installing right outer race (5) because the installer base (1) is usable only when you follow this sequence of race installation.

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

NOTE

See *Figure 3-142*. Use *SPROCKET SHAFT BEARING/SEAL INSTALLATION TOOL* (Part No. HD-42579) to install sprocket shaft tapered roller bearings and seal.

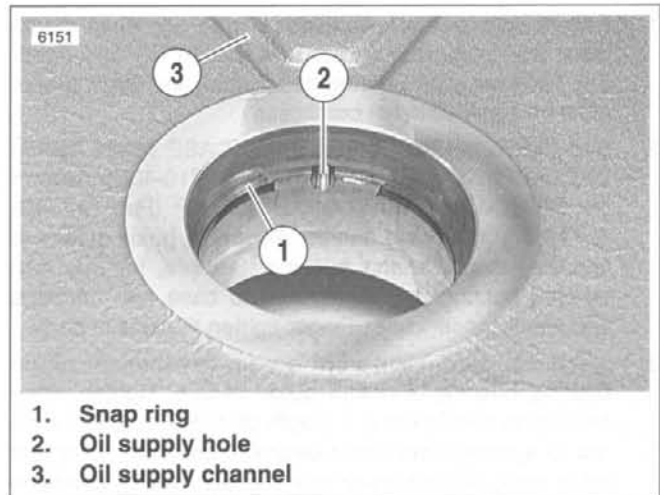


Figure 3-140. Snap Ring

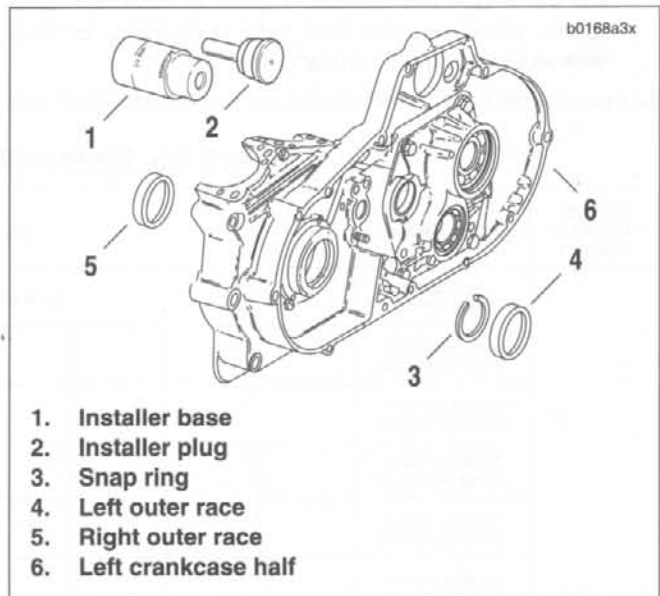


Figure 3-141. Installing Sprocket Shaft Bear Outer Races

8. Install inner bearing (6).
 - a. Place **new** bearing, small end upward, over end of sprocket shaft.
 - b. Thread pilot (1) onto sprocket shaft until pilot bottoms on sprocket shaft shoulder.
 - c. Sparingly apply graphite lubricant to threads of pilot shaft to ensure smooth operation.
 - d. Slide sleeve (5) over pilot (1) until sleeve contacts inner bearing race. Install Nice bearing (4), washer (3) and handle (2) on top of sleeve.
 - e. Rotate handle clockwise until bearing (6) contacts flywheel shoulder. Remove tool from sprocket shaft.

9. See Figure 3-127. Install shim and outer bearing.
 - a. See Figure 3-143. Carefully place crankcase half over sprocket shaft so that it rests flat on inner bearing.
 - b. Slide **new** inner spacer over sprocket shaft until it contacts inner bearing race.
 - c. Place **new** outer bearing, small end downward, over sprocket shaft.
 - d. Assemble SPROCKET SHAFT BEARING/SEAL INSTALLATION TOOL (Part No. HD-42579) onto sprocket shaft. Follow procedure in Step 8.
 - e. Rotate handle clockwise until bearing firmly contacts inner spacer. Inner and outer bearings must be tight against inner spacer for correct bearing clearance. Remove tool from sprocket shaft.
 - f. Spin crankcase half to verify that flywheel assembly is free.

- 10: See Figure 3-144. Install **new** spacer in seal ID. With the open (lipped) side facing outward, center seal/spacer assembly over bearing bore.

CAUTION

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

11. See Figure 3-145. Install bearing seal and spacer.
 - a. Center seal/spacer driver (2) over seal, so that the sleeve (smaller OD) seats between seal wall and garter spring.
 - b. Assemble SPROCKET SHAFT BEARING/SEAL INSTALLATION TOOL (1) (Part No. HD-42579) and SPROCKET SHAFT SEAL/SPACER INSTALLER (Part No. HD-42774) onto sprocket shaft. Follow procedure in Step 8.
 - c. Rotate handle clockwise until the spacer makes contact with the bearing. Remove tool from sprocket shaft.

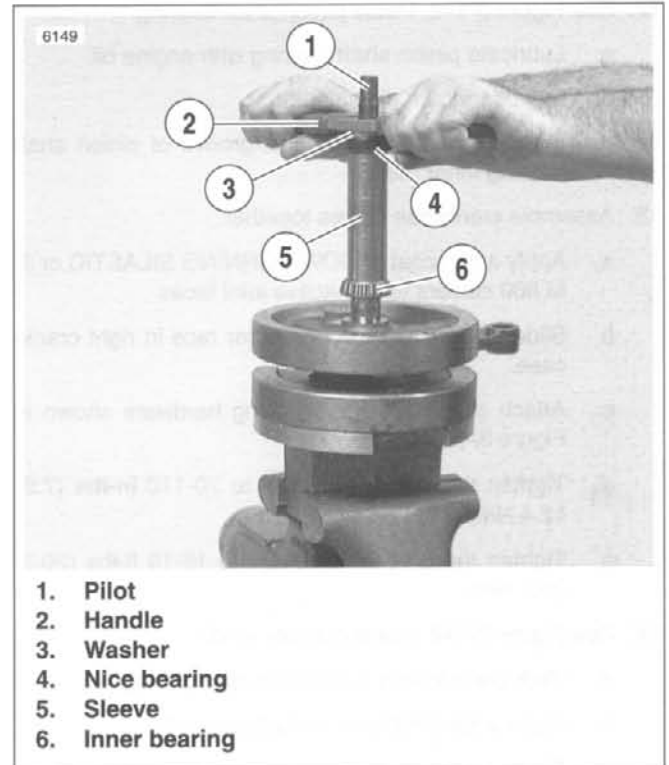


Figure 3-142. Inner Bearing Installation (Typical)

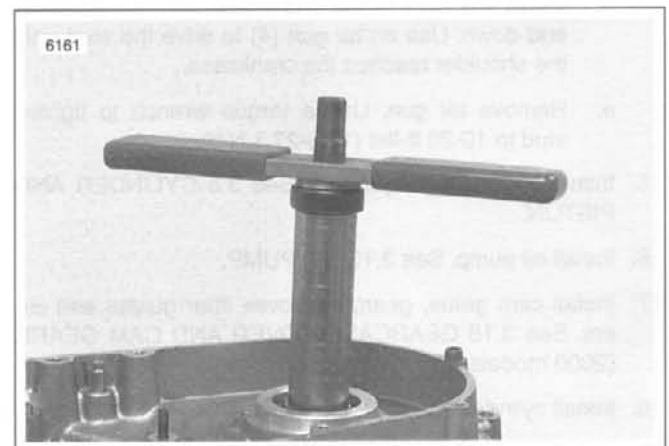


Figure 3-143. Installing Flywheel Spacer and Outer Bearing

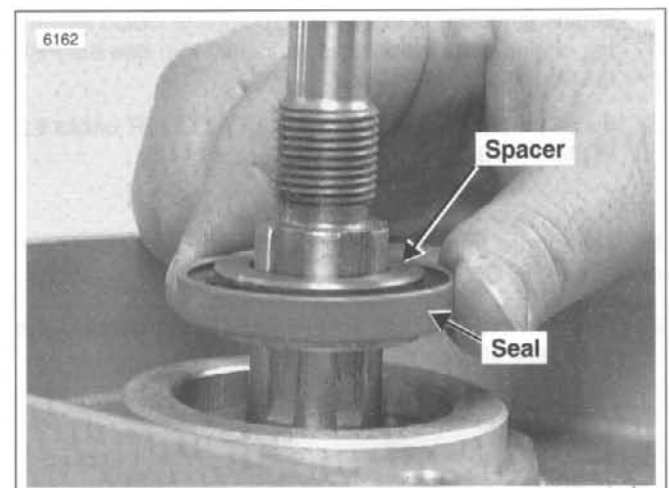


Figure 3-144. Install Spacer in Seal

12. See Figure 3-146. Install pinion shaft bearing.
 - a. Lubricate pinion shaft bearing with engine oil.
 - b. Slip bearing on pinion shaft.
 - c. Install **new** retaining ring in groove of pinion shaft bearing inner race.
13. Assemble crankcase halves together.
 - a. Apply a thin coat of DOW CORNING SILASTIC or 3-M 800 sealant to crankcase joint faces.
 - b. Slide pinion shaft through outer race in right crankcase.
 - c. Attach crankcase halves using hardware shown in Figure 3-125.
 - d. Tighten the 1/4-in. fasteners to 70-110 in-lbs (7.9-12.4 Nm)
 - e. Tighten the 5/16-in. fasteners to 15-19 ft-lbs (20.3-25.8 Nm).
14. See Figure 3-147. Install cylinder studs.
 - a. Pack clean towels into crankcase opening.
 - b. Place a steel ball into a head screw (1).
 - c. The cylinder studs (2) have a shoulder (3) at the lower end. Place the end of the stud without the shoulder into the head screw.
 - d. Install the stud in the crankcase with the shoulder end down. Use an air gun (4) to drive the stud until the shoulder reaches the crankcase.
 - e. Remove air gun. Use a torque wrench to tighten stud to 10-20 ft-lbs (13.6-27.1 Nm).
15. Install pistons and cylinders. See 3.6 CYLINDER AND PISTON.
16. Install oil pump. See 3.13 OIL PUMP.
17. Install cam gears, gearcase cover, lifter guides and lifters. See 3.18 GEARCASE COVER AND CAM GEARS (2000 models).
18. Install cylinder heads. See 3.5 CYLINDER HEAD.
19. Install starter. See 5.7 STARTER.
20. Install transmission. See 6.13 TRANSMISSION INSTALLATION AND SHIFTER PAWL ADJUSTMENT.
21. Install all primary drive components. This includes engine sprocket, primary chain, complete clutch assembly, engine sprocket nut and mainshaft nut. See 6.5 PRIMARY DRIVE/CLUTCH.
22. Install primary cover. See PRIMARY COVER under 6.2 PRIMARY CHAIN.

NOTE

Be sure to refill transmission to proper level with fresh lubricant. See 1.12 CLUTCH.

23. See 3.4 INSTALLING THE ENGINE and perform the applicable steps.

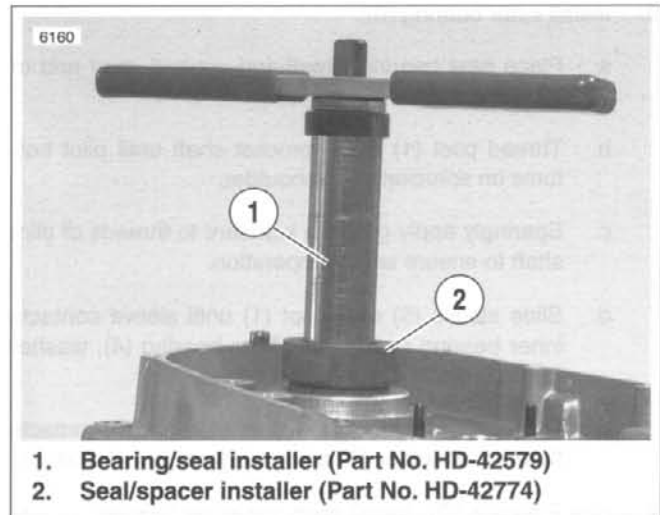


Figure 3-145. Install Bearing Seal/Spacer

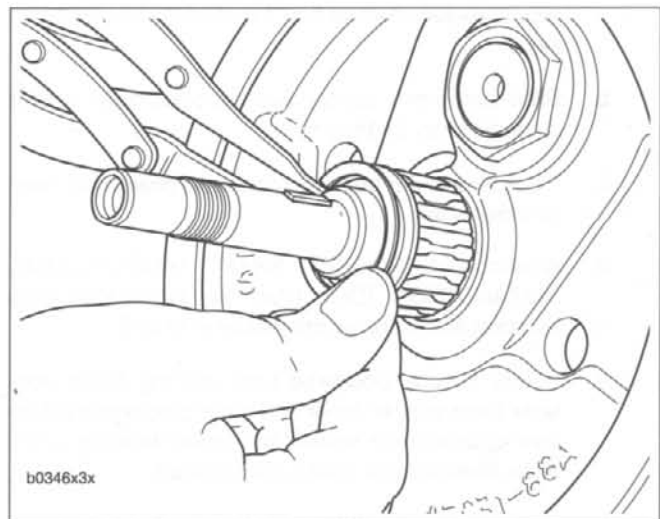


Figure 3-146. Pinion Shaft Bearing

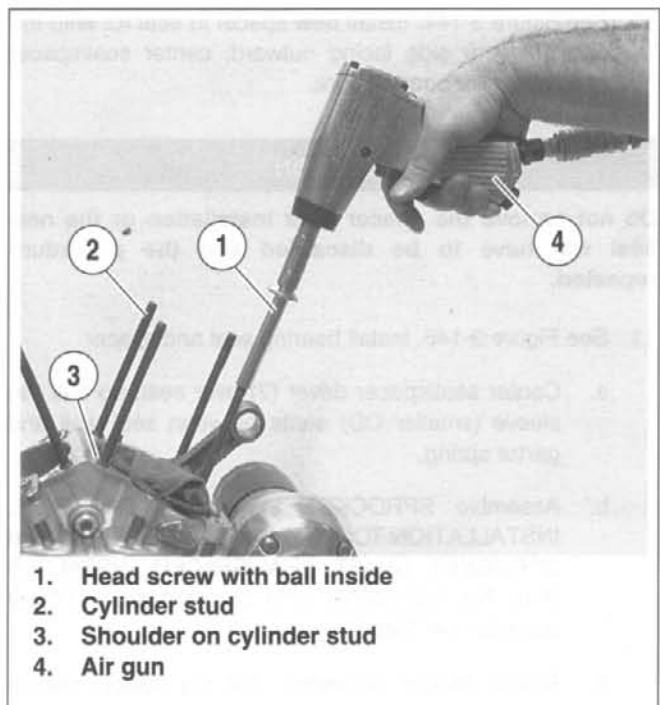


Figure 3-147. Cylinder Studs

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4.1 Dynamic Digital Fuel Injection	4-1
4.2 Diagnostic Introduction	4-3
4.3 Checking For Trouble Codes	4-4
4.4 Scanalyzer	4-6
4.5 Check Engine Lamp Diagnostics	4-9
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INTRODUCTION

The Buell Dynamic Digital Fuel Injection (DDFI) System provides microprocessor-based electronic engine management for the 1203cc Buell Thunderstorm engine. The DDFI system has the following features:

- Independently mapped spark and fuel control.
- Engine and air temperature compensated fuel delivery.
- Engine load measurement through throttle position.
- Single point spark delivery (no waste spark).
- Sequential port indirect (manifold) fuel injection.
- Open/Closed-loop air/fuel control.
- Automatic enrichment at start.
- Engine speed and position determined using a single sensor (Cam Position Sensor).
- Full diagnostic capability compatible with the SCANA-LYZER (Part No. HD-41325).
- Returnless fuel system (excess pressure relieved in tank by Fuel Pressure Regulator Valve).

The DDFI system uses six sensors to monitor the operating conditions of the engine and make decisions as to spark and fuel delivery. These sensors are:

- Throttle position (TP) sensor.
- Camshaft position (CMP) sensor.
- Engine temperature (ET) sensor.
- Intake air temperature (IAT) sensor.
- Oxygen (O₂) sensor.
- Bank Angle Sensor (BAS)

The DDFI system also analyzes how the engine performs during a ride. It then stores this information internally so it will be available for the next ride.

GENERAL

The Buell DDFI operates both as an open and closed loop system which allows it to adjust for all possible operating conditions. High lift cams make it necessary for an open loop system at idle and at wide open throttle. During open loop operation, the system utilizes programmed fuel and spark maps in the ECM which provide stable idle and ease of cold starting, and maximum power at wide open throttle (WOT).

During closed loop operation, the system relies on input from the O₂ sensor to provide for the most efficient, stoichiometric air fuel mixture (14.6:1) which results in reduced emissions, good fuel economy and power. In order for the system to enter closed loop operation, the following conditions must be met:

- O₂ Sensor at operating temperature (Engine at normal operating temperature).
- Operation above 2500 RPM with engine under load (approximately 40-60 mph in 4th or 5th gear).

By using both open and closed loop systems, engine performance is continuously tuned to compensate for changing conditions and provide maximum performance.

FOR MORE INFORMATION

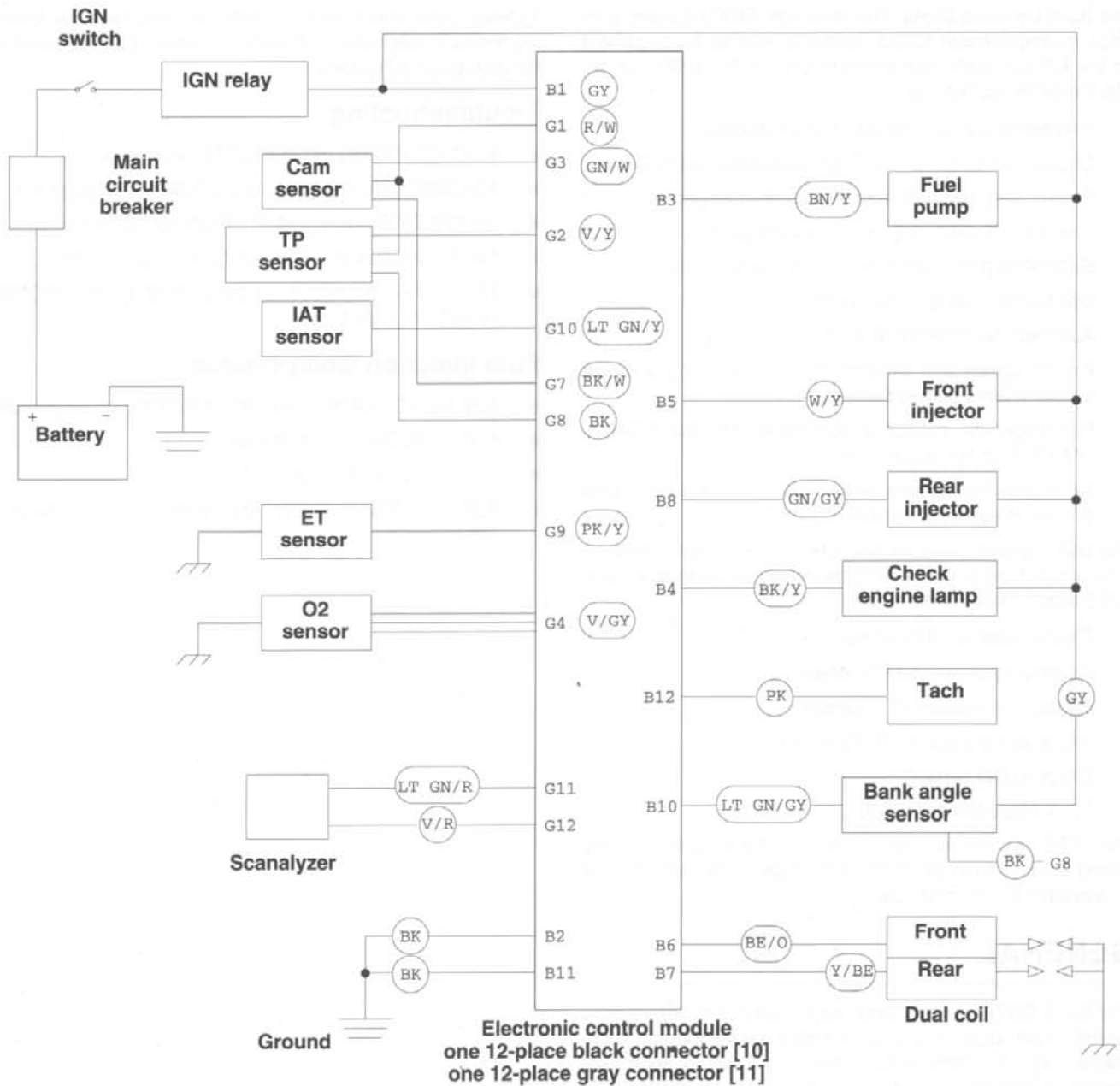
To learn more about the Buell DDFI system, read the following topics in this section. A system diagram can be found on the next page in Figure 4-1.

Troubleshooting

- 4.2 DIAGNOSTIC INTRODUCTION on page 4-3.
- 4.3 CHECKING FOR TROUBLE CODES on page 4-4.
- 4.5 CHECK ENGINE LAMP DIAGNOSTICS on page 4-9.
- 4.8 INITIAL DIAGNOSTIC CHECK on page 4-13.
- TABLE 4-5. TROUBLE CODES AND FAULT CONDITIONS on page 4-15.

Fuel Injection Components

- 4.28 ELECTRONIC CONTROL MODULE on page 4-86.
- 4.31 SENSORS on page 4-94.
- 4.37 FUEL PUMP on page 4-103.
- 4.38 THROTTLE BODY AND MANIFOLD on page 4-105.



WIRE COLOR CODES USED IN THIS DOCUMENT

LT	Light	GY	Gray	V	Violet
BK	Black	O	Orange	W	White
BE	Blue	PK	Pink	Y	Yellow
BN	Brown	R	Red		
GN	Green	TN	Tan		

Figure 4-1. Buell Dynamic Digital Fuel Injection

SYSTEM PROBLEMS

All system problems fall into at least one of three general categories.

No Start

The engine cranks over freely, but will not start. This does not include situations where the engine will not crank, such as a bad starter, dead battery, etc. This condition assumes that all obvious checks (fuel in tank, etc.) have been made.

Poor Performance

The engine starts but there are performance problems. These problems may include poor fuel economy, rough idle, engine misfire, engine hesitation, severe spark knock, etc.

Check Engine Lamp

See Figure 4-2. The check engine lamp (2) indicates the ECM has determined a fault condition exists. There may also be starting or performance problems.

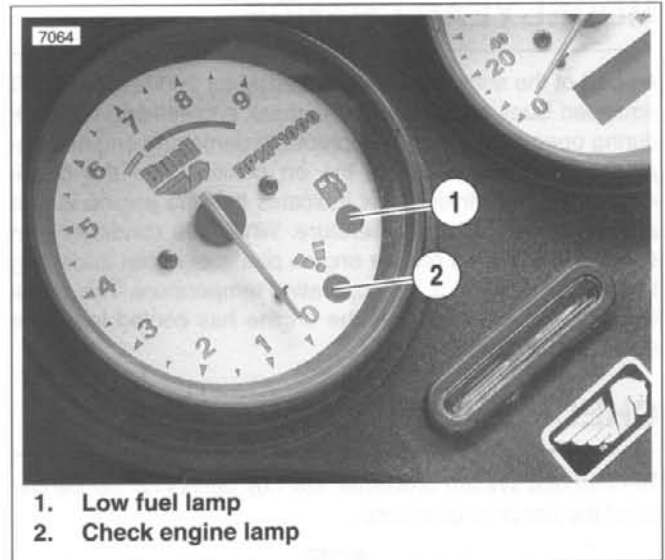


Figure 4-2. Check Engine Lamp

RESOLVING PROBLEMS

To resolve system problems, five basic steps are involved. In order of occurrence, they are:

1. Check for trouble codes by observing check engine lamp. See 4.3 CHECKING FOR TROUBLE CODES.
2. Retrieve trouble codes using SCANALYZER (Part No. HD-41325) or check engine lamp diagnostics. See 4.4 SCANALYZER, 4.5 CHECK ENGINE LAMP DIAGNOSTICS and Figure 4-3.
3. Diagnose system problems. This involves using special tools and the diagnostic flow charts in this section.
4. Correct problems through the replacement and/or repair of the affected components.
5. After repairs are performed, the work must be validated. This involves clearing the trouble codes and confirming proper vehicle operation as indicated by the behavior of the check engine lamp.

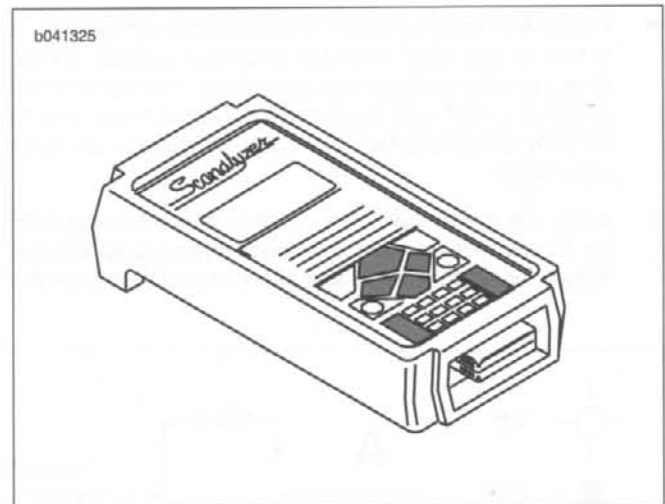


Figure 4-3. Scanalyzer

MODEL YEAR CHANGE

As part of the software in the **new** ECM for 2000 Model DDFI equipped Buell motorcycles, the check engine lamp will blink during operation to warn of potentially damaging engine temperatures. If the key is in the on position and the check engine lamp is blinking, this indicates that the engine is at a potentially damaging temperature. While this condition is in effect, the ECM will reduce engine power to assist in cooling the engine down to a safe operating temperature. The check engine lamp will blink until the engine has cooled to a safe operating temperature.

CHECK ENGINE LAMP

To diagnose system problems, start by observing the behavior of the check engine lamp.

NOTE

- See Figure 4-4. All references to "Key ON" or "Ignition Switch ON" require that the ignition key be in the IGN position and the engine stop switch be set to RUN.
 - If the check engine lamp is not illuminated at Key ON or if it fails to turn OFF after the initial four second period, then a problem exists in the lamp circuit. See 4.9 CHECK ENGINE LAMP NOT ILLUMINATED AT KEY ON or 4.10 CHECK ENGINE LAMP ON CONTINUOUSLY for more information.
1. When the ignition switch is turned ON after being OFF for 10 seconds or more, the check engine lamp will illuminate for approximately four seconds and then turn off.

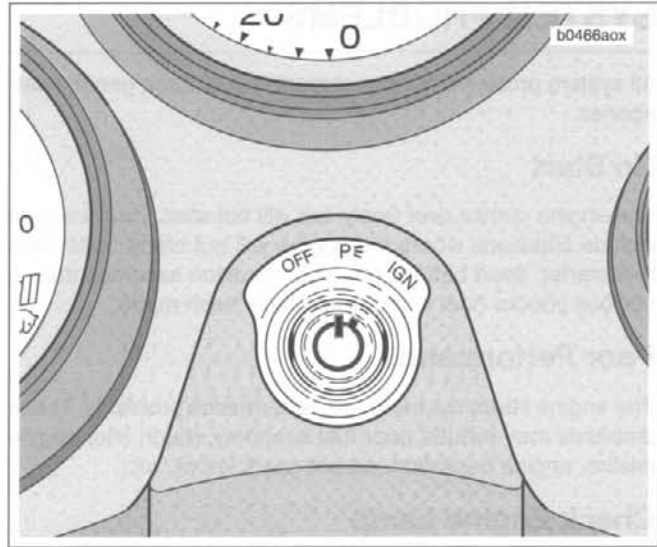


Figure 4-4. Ignition Key Switch

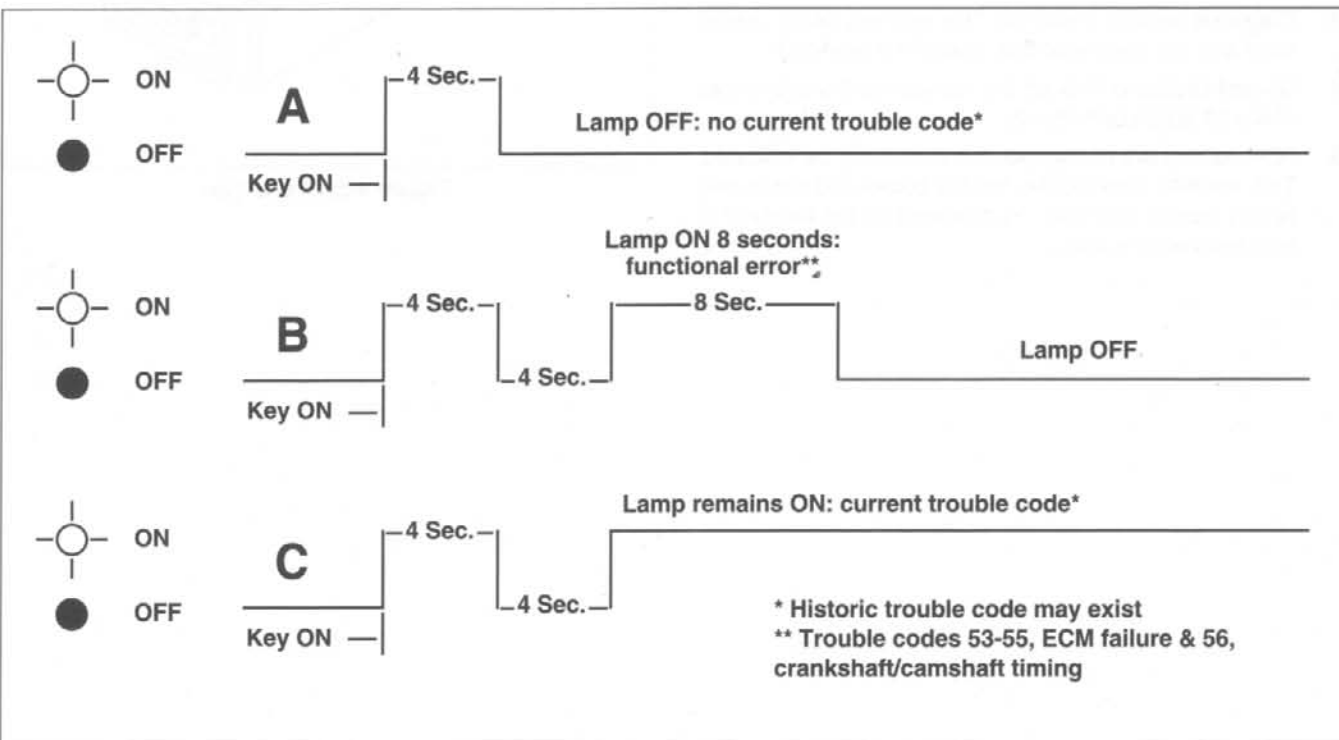


Figure 4-5. Check Engine Lamp Operation

2. See Figure 4-5. After lamp turns off after being illuminated for the first four second period, one of three situations may occur.
 - a. The lamp remains off. This indicates there are no current fault conditions or stored functional trouble codes currently detected by the ECM.
 - b. The lamp stays off for only four seconds and then comes back on for an eight second period. This indicates a functional error code is stored, but no current trouble code exists.
 - c. If the lamp remains on beyond the eight second period, then a current trouble code exists.
3. See CODE TYPES for a complete description of trouble code formats.

NOTE

Trouble codes relating to the fuel injectors or the ignition coil can only be fully diagnosed during actuation. For example, a problem with the ignition coil will be considered a current fault even after the problem is corrected, since the ECM will not know of its resolution until after the coil is exercised by vehicle start sequence. In this manner, there may sometimes be a false indication of the current trouble code.

CODE TYPES

There are three types of trouble codes: current, historic or functional. If a trouble code is stored, it can be read using either a Scanalyzer or check engine lamp diagnostics.

All trouble codes reside in the memory of the ECM until the code is cleared by use of the Scanalyzer or a total of 50 trips has elapsed. A trip consists of a start and run cycle, the run cycle lasting at least 30 seconds. After the 50 trip retention period, the trouble code is automatically erased from memory providing that no subsequent faults of the same type are detected in that period.

Current

Current trouble codes are those which presently disrupt motorcycle operation. See the appropriate flow charts for solutions.

Historic

If a particular problem happens to resolve itself, the active status problem is dropped and it becomes a historic fault rather current fault.

Historic trouble codes are stored for a length of time to assist in the diagnosis of intermittent faults. The check engine lamp will not indicate the existence of only historic trouble codes.

It is important to note that historic trouble codes may also be present whenever the system indicates the existence of a current fault. See 4.3 CHECKING FOR TROUBLE CODES if multiple trouble codes are found.

Functional

A functional trouble code indicates an internal problem with the ECM (trouble codes 52 through 55) or with the camshaft sensor/timing (trouble code 56).

RETRIEVING TROUBLE CODES

The fuel injection system provides two levels of diagnostics.

- The most sophisticated mode employs a portable diagnostic tool called a Scanalyzer. This device plugs into the motorcycle wiring harness. It facilitates the diagnosis of system problems through a direct interface with the ECM. See 4.4 SCANALYZER.
- The second mode requires using the check engine lamp. See 4.5 CHECK ENGINE LAMP DIAGNOSTICS for more information.

MULTIPLE TROUBLE CODES

The TP and CMP sensors are all connected to the same reference line (5v REF). If this line goes to ground or open, multiple trouble codes (codes 11 and 56) may be set.

Also, the ECM, fuel pump, fuel injectors, bank angle sensor and ignition coil all receive +12 volts from the ignition relay. If this line should go to ground the ignition fuse will open.

Always start with the trouble code having the lowest numerical value. See list of fault conditions on page 4-15 (Table 4-5.)

SCANALYZER DIAGNOSTICS

Data Link Connector

See Figure 4-6. Using the Scanalyzer requires access to the data link connector (1) behind the right side of steering head, near the fork lock (2). See **INSTALLATION** for instructions on reaching the data link.

Scanalyzer Cartridge

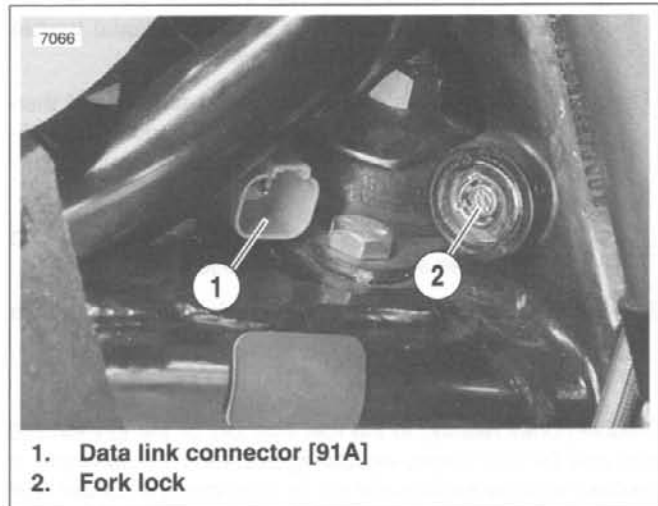
See Figure 4-7. Through a special programmable application cartridge, the Scanalyzer offers data displays and menu selections that allow for quick and easy retrieval of data. The device enables the user to perform a variety of diagnostic tests while monitoring inputs and outputs.

Sample Scanalyzer menu selections are shown in Figure 4-8.

INSTALLATION

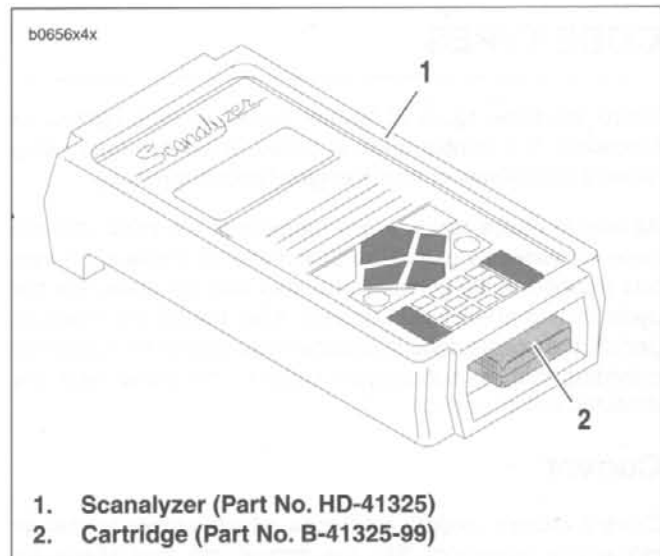
The behavior of the check engine lamp indicates the presence of trouble codes. When trouble codes are present, and a **SCANALYZER** (Part No. HD-41325) and **DIAGNOSTIC CARTRIDGE** (Part No. B-41325-99) are available, proceed as follows:

1. Turn ignition/light key switch OFF.
2. See Figure 4-6. Locate the data link connector [91A] behind right side of steering head.
3. Remove rubber protective plug from data link connector. Plug Scanalyzer into connector. If necessary, detach connector from frame.
4. Turn ignition/light key switch ON. Set engine stop switch to RUN, but do not start engine.
5. See Figure 4-7. Insert the diagnostic application cartridge (2) into the Scanalyzer (1). During the next few seconds, the Scanalyzer sequences through a series of screens that reflect a power-on self test, the system copyright, and then an attempt at communications with the ECM. Once communications is established with the ECM, the diagnostic menu appears. See Figure 4-8.
6. Continue with the instructions under **USAGE**.



1. Data link connector [91A]
2. Fork lock

**Figure 4-6. Data Link Connector
(Protective Cover Removed For Illustration Purposes)**



1. Scanalyzer (Part No. HD-41325)
2. Cartridge (Part No. B-41325-99)

Figure 4-7. Scanalyzer and Cartridge

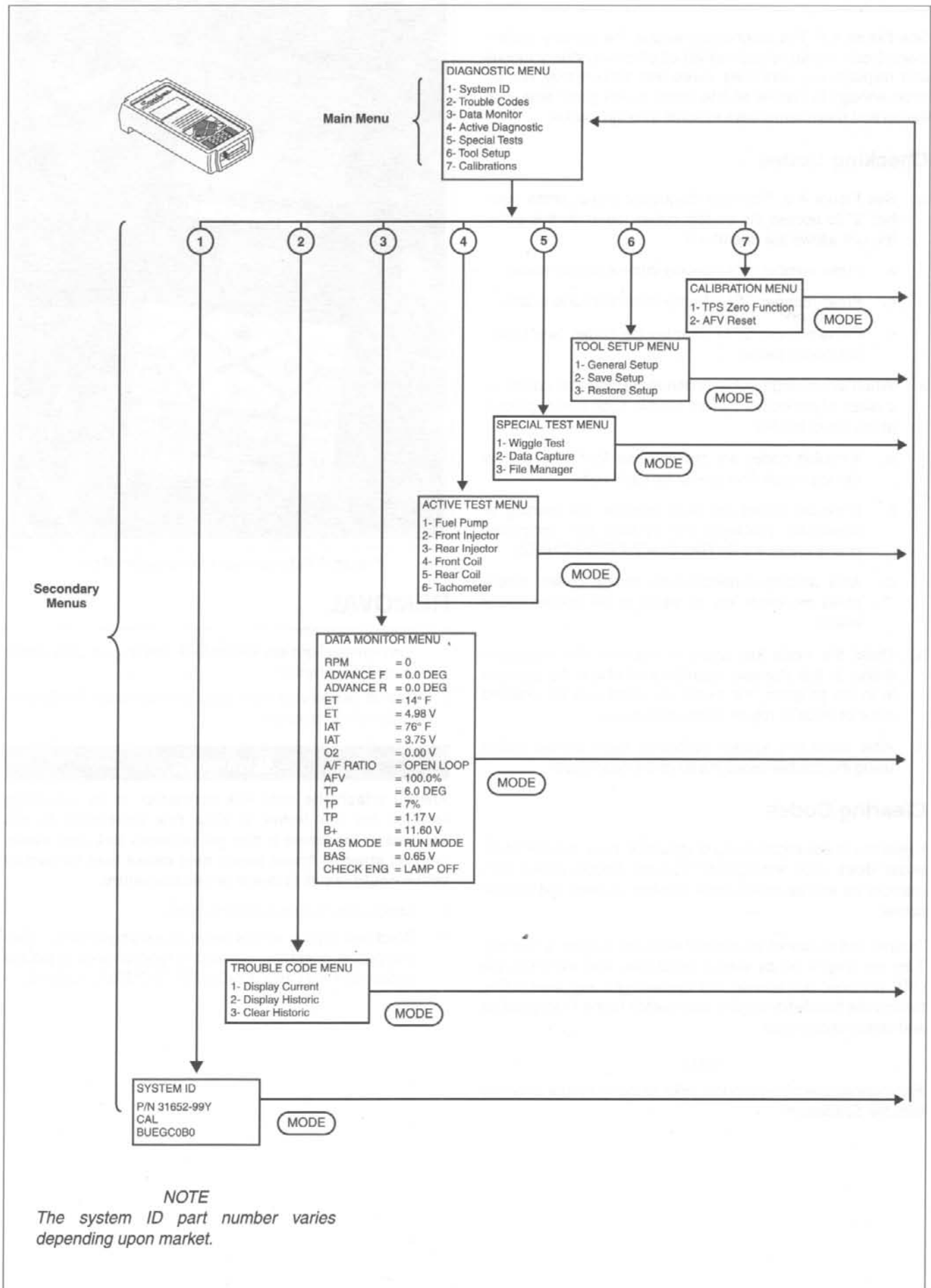


Figure 4-8. Scanalyzer Menus

USAGE

See Figure 4-8. The diagnostic menu is the primary system menu (main menu) through which all other secondary menus and displays are accessed. Since the screen may not be large enough to display all line items at any given time, use the up and down arrow keys to scroll through the list.

Checking Codes

1. See Figure 4-9. From the diagnostic menu, press number "2" to access the trouble codes menu. At this point, the unit allows the operator to:
 - a. Press number "1" to display current trouble codes.
 - b. Press number "2" to display historic trouble codes.
 - c. Press number "3" to clear trouble codes. See Clearing Codes below.
2. When examining trouble codes, write down all codes on a piece of paper. If a current trouble code exists, place it at the top of the list.
 - a. If trouble codes are present, see Table 4-5. Follow the applicable flow charts for each code.
 - b. If trouble codes are NOT present, but starting or driveability problems are evident, see symptoms charts under 4.8 INITIAL DIAGNOSTIC CHECK.
 - c. After reading current/historic trouble codes, simply press the mode key to return to the trouble codes menu.
3. Press the mode key again to return to the diagnostic menu. In this manner, regardless of where the operator is in the program, the mode key need only be pressed once or twice to return to the main menu.
4. After correcting system problems, clear trouble codes using the trouble codes menu of the scanalyzer.

Clearing Codes

Unlike the check engine lamp diagnostics, note that the Scanalyzer **does** allow the operator to clear trouble codes from memory as well as differentiate between current and historic codes.

Trouble codes cannot be cleared while the engine is running. Turn the engine off by setting handlebar stop switch to the OFF position, but leaving the ignition/light key switch ON. Return the handlebar engine stop switch to the RUN position and restart motorcycle.

NOTE

For more detailed instructions, refer to the literature provided with the Scanalyzer.



Figure 4-9. Scanalyzer Diagnostic Menu

REMOVAL

1. Turn ignition/light key switch OFF. Set engine stop switch to the OFF position.
2. Unplug Scanalyzer from data link connector. Install protective plug connector.

WARNING

Always attach the data link connector to its mounting location on the frame. If data link connector is not secured to the frame it can get between fork and frame, limiting steering travel which may cause loss of control which could result in death or serious injury.

3. Attach data link connector to frame.
4. Road test vehicle and observe check engine lamp. Confirm proper operation without the reoccurrence of trouble codes. See 4.3 CHECKING FOR TROUBLE CODES.

ACTIVATION

Use of check engine lamp diagnostics assumes that the SCANALYZER (Part No. HD-41325) is not available.

1. Detach data link connector [91A] from frame. Remove protective cover.
2. To activate the diagnostic feature of the check engine lamp, proceed as follows:
 - a. See Figure 4-10. Create diagnostic test wire from parts shown.
 - b. See Figure 4-11. Install diagnostic test wire across Terminal 1 and Terminal 2 on the data link connector [91A].
 - c. Turn the ignition/light key switch ON and wait approximately eight seconds for the check engine lamp to start flashing.
3. See Figure 4-12. All trouble codes are sent out as a series of flashes. To retrieve the first digit of the trouble code simply observe the number of times the lamp flashes.
 - a. The transmission of a trouble code is always preceded by six rapid flashes (about 3 per second).
 - b. This "intermission" is followed by a 2 second pause in which the lamp is off.
 - c. The lamp will then flash one or more times to indicate the first digit of the trouble code. The length of time the lamp is illuminated and the length of time in which it is off are each about 1 second in duration.
4. The second digit follows:
 - a. Following transmission of the first digit, there is another 2 second pause in which the lamp is off.
 - b. The lamp will then flash one or more times to indicate the second digit of the trouble code. Count the number of times the lamp flashes to retrieve the second digit.
5. If more than one trouble code is sent:
 - a. Following transmission of the second digit of the first code, there is a third 2 second pause in which the lamp is off.
 - b. After the pause comes the intermission, which is followed by transmission of the next recorded trouble code.
 - c. All subsequent codes are sent in the same manner, each separated from the next by the intermission.
6. Once all codes have been sent, the data string is repeated. When you have recorded the same trouble code twice, it is an indication that the transmission has been restarted and that all trouble codes have been retrieved.

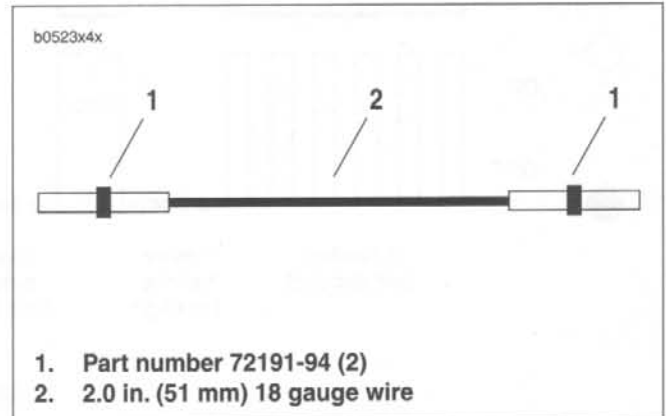


Figure 4-10. Diagnostic Test Wire

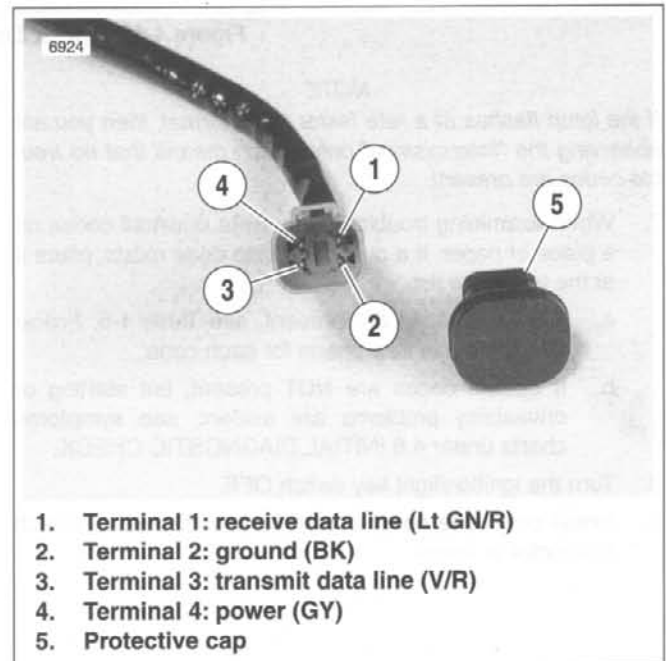


Figure 4-11. Installing Diagnostic Test Wire

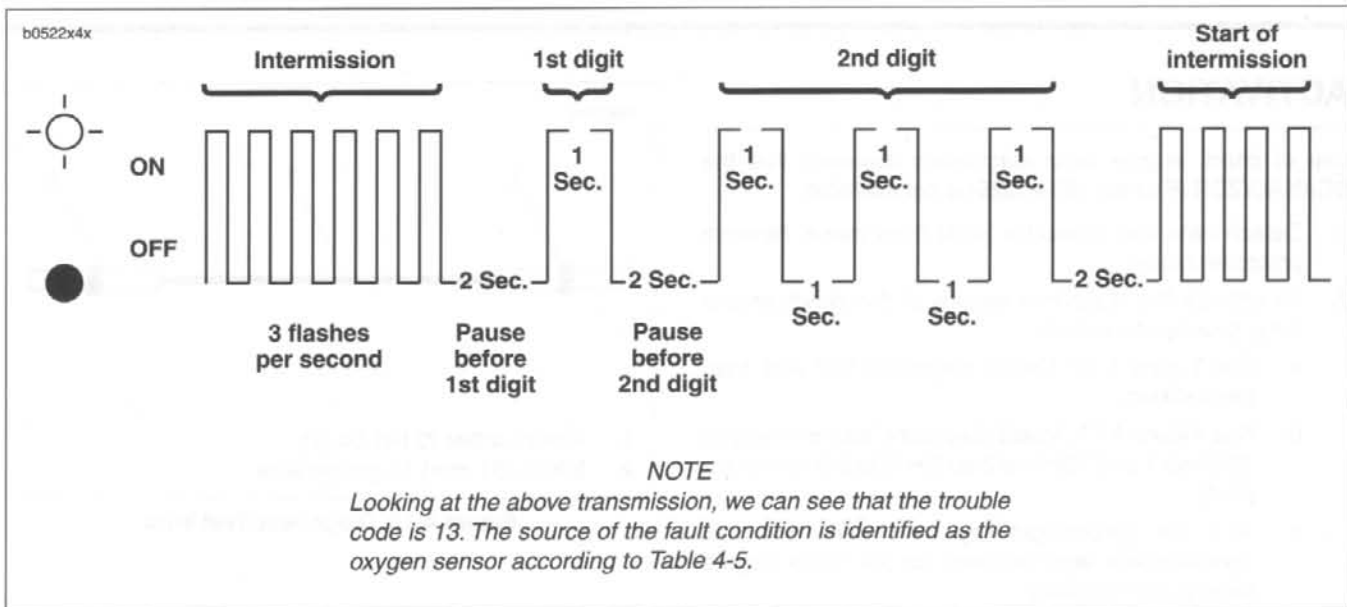


Figure 4-12. Check Engine Lamp Diagnostics

NOTE

If the lamp flashes at a rate faster than normal, then you are observing the "Intermission" only, which means that no trouble codes are present.

7. When examining trouble codes, write down all codes on a piece of paper. If a current trouble code exists, place it at the top of the list.
 - a. If trouble codes are present, see Table 4-5. Follow the applicable flow charts for each code.
 - b. If trouble codes are NOT present, but starting or driveability problems are evident, see symptoms charts under 4.8 INITIAL DIAGNOSTIC CHECK.
8. Turn the ignition/light key switch OFF.
9. Install protective cover over data link connector. Attach connector to frame.

IMPORTANT NOTE

The engine may be started and run when the trouble codes are received using a jumper wire on Pins 1 and 2 of the data link connector. However, if the jumper wire is removed with the engine running, the check engine lamp will continue to flash trouble codes. To stop check engine lamp from flashing codes, turn engine stop switch OFF.

CLEARING CODES

After correcting system problems, clear trouble codes. If the Scanalyzer is not available, perform 50 start and run cycles. To execute one run cycle:

1. Start the vehicle.
2. Let it run for at least 30 seconds.
3. Turn the engine off.

GENERAL

The BREAKOUT BOX (Part No. HD-42682) splices into the main harness. Used in conjunction with a DVOM, it allows circuit diagnosis of wiring harness and connections without having to probe with sharp objects.

INSTALLATION

1. See Figure 4-13. Detach seat. Remove two screws and washers (3) to free ECM from ECM mounting bracket.
2. Depress latches on each side of connectors [10] (black) and [11] (gray).
3. See Figure 4-14. Attach Breakout Box (1) to black connector [10].
 - a. Attach black connector from Breakout Box to corresponding black ECM connector.
 - b. Attach black connector from the wiring harness to black connector on Breakout Box.
4. Attach Breakout Box to gray connector [11].
 - a. Attach gray connector from Breakout Box to corresponding gray ECM connector.
 - b. Attach gray connector from the wiring harness to gray connector on Breakout Box.

REMOVAL

1. See Figure 4-14. Depress latches on each side of connectors [10] (black) and [11] (gray).
2. Detach Breakout Box connectors from ECM connectors.
3. Detach Breakout Box connectors from wiring harness.
4. Reattach ECM connectors to wiring harness.

⚠ WARNING

After installing seat, pull upward on front of seat to be sure it is locked in position. If seat is loose, it could shift during vehicle operation and startle the rider, causing loss of control which could result in death or serious injury.

5. Attach ECM to bracket with two screws. Reinstall seat.

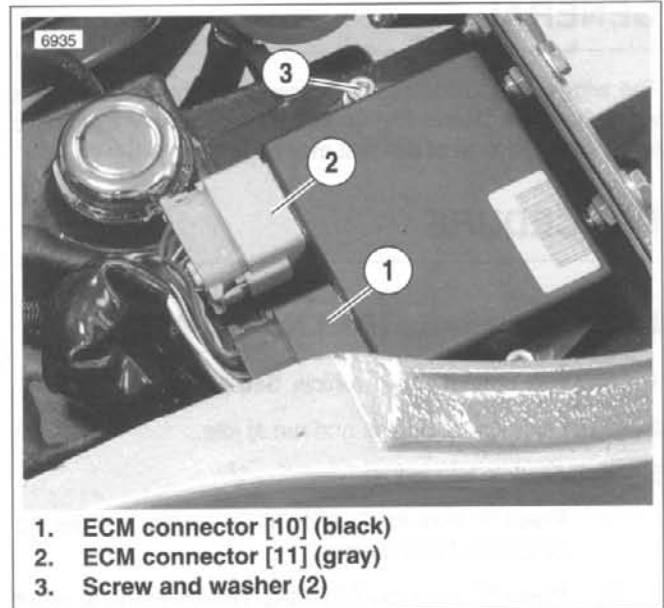


Figure 4-13. ECM Connectors

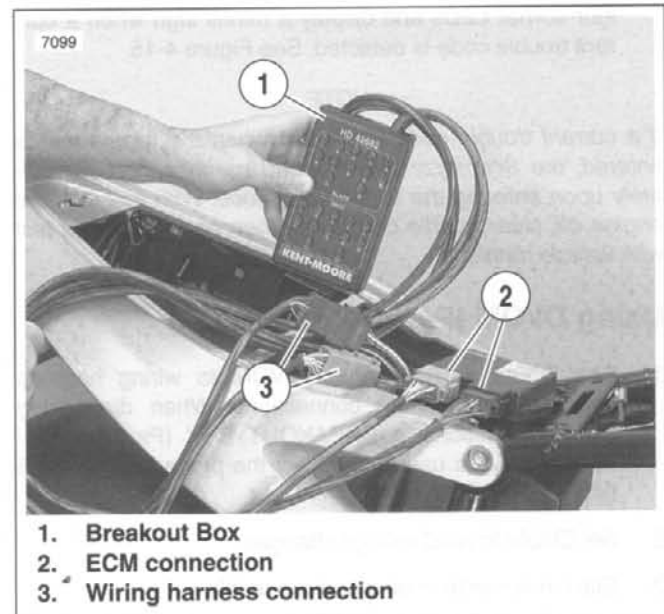


Figure 4-14. Installed Breakout Box

GENERAL

The wiggle test indicates the presence of intermittents in a wiring harness. Depending upon the availability of diagnostic tools, either version of this test may be used.

PROCEDURE

Using Scanalyzer (Part No. HD-41325)

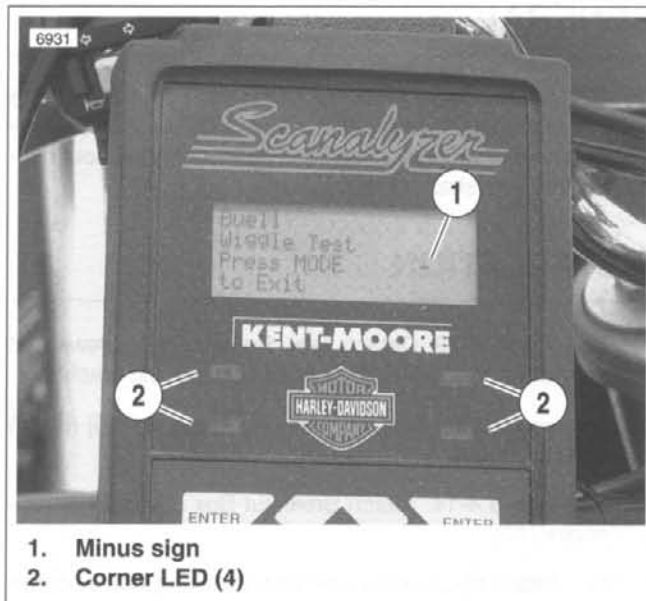
1. Connect Scanalyzer to vehicle. See 4.4 SCANALYZER.
2. Start motorcycle engine and run at idle.
3. Enter wiggle test mode.
 - a. Press "5" from the DIAGNOSTIC MENU to enter the SPECIAL TESTS menu.
 - b. Press "1" from the SPECIAL TESTS menu to enter the WIGGLE TEST.
4. Shake or wiggle harness to detect intermittents. If intermittents are present the Scanalyzer will beep, light the four corner LEDs and display a minus sign when a current trouble code is detected. See Figure 4-15.

NOTE

If a current trouble code is present when the wiggle test is entered, the Scanalyzer will respond as described immediately upon entering the wiggle test mode. With key ON and engine off, clear trouble codes and then perform wiggle test with vehicle running.

Using DVOM (Part No. HD-39978)

1. See Figure 4-16. Connect DVOM to wiring harness between the suspect connections. When diagnosing ECM connections, a BREAKOUT BOX (Part No. HD-42682) may be used to simplify the procedure. See 4.6 BREAKOUT BOX.
2. Set DVOM to read voltage changes.
3. Start motorcycle engine and run at idle.
4. Shake or wiggle harness to detect intermittents. If intermittents are present, radical voltage changes will register on the DVOM.



1. Minus sign
2. Corner LED (4)

Figure 4-15. Wiggle Test Indicators

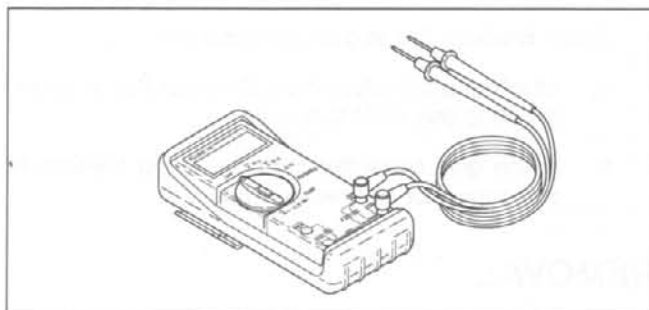


Figure 4-16. Fluke 78 Multimeter (DVOM)
(Part No. HD-39978)

GENERAL

To locate faulty circuits or other system problems, follow the diagnostic flow charts in this section. For a systematic approach, always begin with INITIAL DIAGNOSTICS. Read the general information and then work your way through the flow chart box by box.

Diagnostic Notes

If a numbered circle appears adjacent to a flow chart box, then more information is offered in the diagnostic notes. Many diagnostic notes contain supplemental information, descriptions of various diagnostic tools or references to other parts of the manual where information on the location and removal of components may be obtained.

Scanalyzer Icon

The Scanalyzer icon appears at those points in the flow chart where the Scanalyzer may be used. If a number is printed next to the icon, then refer to the Scanalyzer notes, which are similar to the diagnostic notes, but are restricted to information on the use of the Scanalyzer. All Scanalyzer notes may be found at the end of the respective flow chart.

Circuit Diagram/Wire Harness Connector Table

When working through a flow chart, refer to the illustrations, the associated circuit diagram and the wire harness connector table as necessary. The wire harness connector table for each circuit diagram identifies the connector number, description, type and general location.

In order to perform most diagnostic routines, a Breakout Box and a DVOM are required. See 4.6 BREAKOUT BOX.

To perform the circuit checks with any degree of efficiency, a familiarity with the various wire connectors is also necessary.

Job/Time Code Values

Dealership technicians filing warranty claims should use the job/time code values printed in **bold text** underneath the appropriate repair.

INITIAL DIAGNOSTICS

General Information

The diagnostic check is an organized approach to identifying a problem caused by an electronic control system malfunction. If no problems are found after completion of the diagnostic check, a comparison of Scanalyzer parameters may be used to help locate intermittents and out-of-specification sensors. See Table 4-1.

Diagnostic Tips

- If the Scanalyzer is not working properly, check operation on another vehicle.
- If proper Scanalyzer function is verified, check data link connector [91A] for 12 volts (Terminal 4) and proper ground (Terminal 2). See Figure 4-17.
- See Figure 4-11. If Scanalyzer reads "No Response" with the ignition key switch turned ON (engine stop switch at RUN with the engine off), check serial receive data wire for an open or short to ground between data link Terminal 1 (Lt GN/R wire) and ECM.
- Check for an open diagnostic test terminal between data link Terminal 3 (V/R wire) and ECM. With ignition key switch turned ON, transmit data line (V/R wire) should have between 11-12 volts and receive data line (Lt GN/R wire) between 5-6 volts.

IMPORTANT NOTE

The engine may be started and run when the trouble codes are received using a jumper wire on Pins 1 and 2 of the data link connector. However, if the jumper wire is removed with the engine running, the check engine lamp will continue to flash trouble codes. To stop check engine lamp from flashing codes, turn engine stop switch OFF.

Diagnostic Notes

The reference numbers below correlate with the circled numbers on the diagnostic check flow charts. See page 4-17.

1. Compare engine behavior to symptoms tables.
 - a. Starts hard. See Table 4-2.
 - b. Hesitates, stumbles, surges, misfires and/or sluggish performance. See Table 4-3.
 - c. Engine exhaust emits black smoke or fouls plugs. See Table 4-4.
2. Use HARNESS CONNECTOR TEST KIT (Part No. HD-41404), black socket probes and patch cord.
3. Connect BREAKOUT BOX (Part No. HD-42682) to ECM. See 4.6 BREAKOUT BOX.

All diagnostic codes are listed on page 4-15 in Table 4-5.

Table 4-1. Typical Scan Values

ITEM	MIN. VALUE	MAX. VALUE	HOT IDLE
RPM	500	6900	1000*
ET (temperature, °F)	3	558	varies
ET (voltage)	0.05	4.95	varies
IAT (temperature)	varies	varies	varies
IAT (voltage)	0.05	4.95	varies
TP (degrees)	0	85	6-6.5*
TP (voltage)	0.5	4.8	0.5-1.5*
INJ PW	varies	varies	varies
Advance (degrees)	0	45	5-30° (varies)
Battery (voltage)	8	16	13.5
Eng run	STOP	RUN	RUN
O2 (voltage)	0	1	0.4-0.6

*Depends on position of idle set screw

Table 4-2. Engine Starts Hard

SYMPTOM	SOLUTION
Engine temperature circuit	4.18 TROUBLE CODE 14.
Improper fuel pressure	4.13 FUEL PRESSURE TEST.
Spark plugs and/or wires	4.15 MISFIRE.
Battery discharged	See charging system troubleshooting in Section 7.
CMP sensors	4.27 TROUBLE CODE 56.
Manifold leak	Spray water around induction module seals with engine idling. If RPM changes, change seals.
Ignition coil	4.15 MISFIRE.
Leaky injectors	Test fuel injectors. See 4.38 THROTTLE BODY AND MANIFOLD.
Valve sticking	See Section 3

Table 4-3. Engine Performance Problems

SYMPTOM	SOLUTION
Engine temperature circuit	4.18 TROUBLE CODE 14.
CMP circuit	4.27 TROUBLE CODE 56.
Spark plugs and/or wires	4.15 MISFIRE.
Improper fuel pressure	4.13 FUEL PRESSURE TEST.
Improper TP sensor adjustment	Calibrate sensor. See 4.33 THROTTLE POSITION SENSOR.
Manifold leak	Spray water around induction module seals with engine idling. If RPM changes, change seals.
Throttle plates not opening fully	See Section 1.
EVAP hose disconnected from induction module (CA)	Connect.
Water or dirt in fuel system	Drain and refill with fresh fuel.

Table 4-4. Engine Exhaust Emits Black Smoke or Fouls Plugs

SYMPTOM	SOLUTION
Engine temperature circuit	4.18 TROUBLE CODE 14.
Clogged air filter	See Section 1.
Improper TP sensor adjustment	Calibrate sensor. See 4.33 THROTTLE POSITION SENSOR.
Leaky injectors	Test fuel injectors. See 4.38 THROTTLE BODY AND MANIFOLD.
Improper fuel pressure	4.13 FUEL PRESSURE TEST.

Table 4-5. Trouble Codes and Fault Conditions

CODE NO.	FAULT CONDITION	RELEVANT TOPIC	PAGE
11	Throttle position sensor	4.16 TROUBLE CODE 11	page 4-43
13	Oxygen sensor	4.17 TROUBLE CODE 13	page 4-47
14	Engine temperature sensor	4.18 TROUBLE CODE 14	page 4-52
15	Intake air temperature sensor	4.19 TROUBLE CODE 15	page 4-56
16	Battery voltage	4.20 TROUBLE CODE 16	page 4-60
23	Front fuel injector	4.21 TROUBLE CODES 23 AND 32	page 4-64
24	Front ignition coil	4.22 TROUBLE CODES 24 AND 25	page 4-68
25	Rear ignition coil	4.22 TROUBLE CODES 24 AND 25	page 4-68
32	Rear fuel injector	4.21 TROUBLE CODES 23 AND 32	page 4-64
33	Fuel pump	4.23 TROUBLE CODE 33	page 4-71
35	Tachometer	4.24 TROUBLE CODE 35	page 4-74
44	Bank angle sensor	4.25 TROUBLE CODE 44	page 4-77
52, 53, 54, 55	ECM failure	4.26 TROUBLE CODES 52, 53, 54 AND 55	page 4-81
56	Cam sync failure	4.27 TROUBLE CODE 56	page 4-82

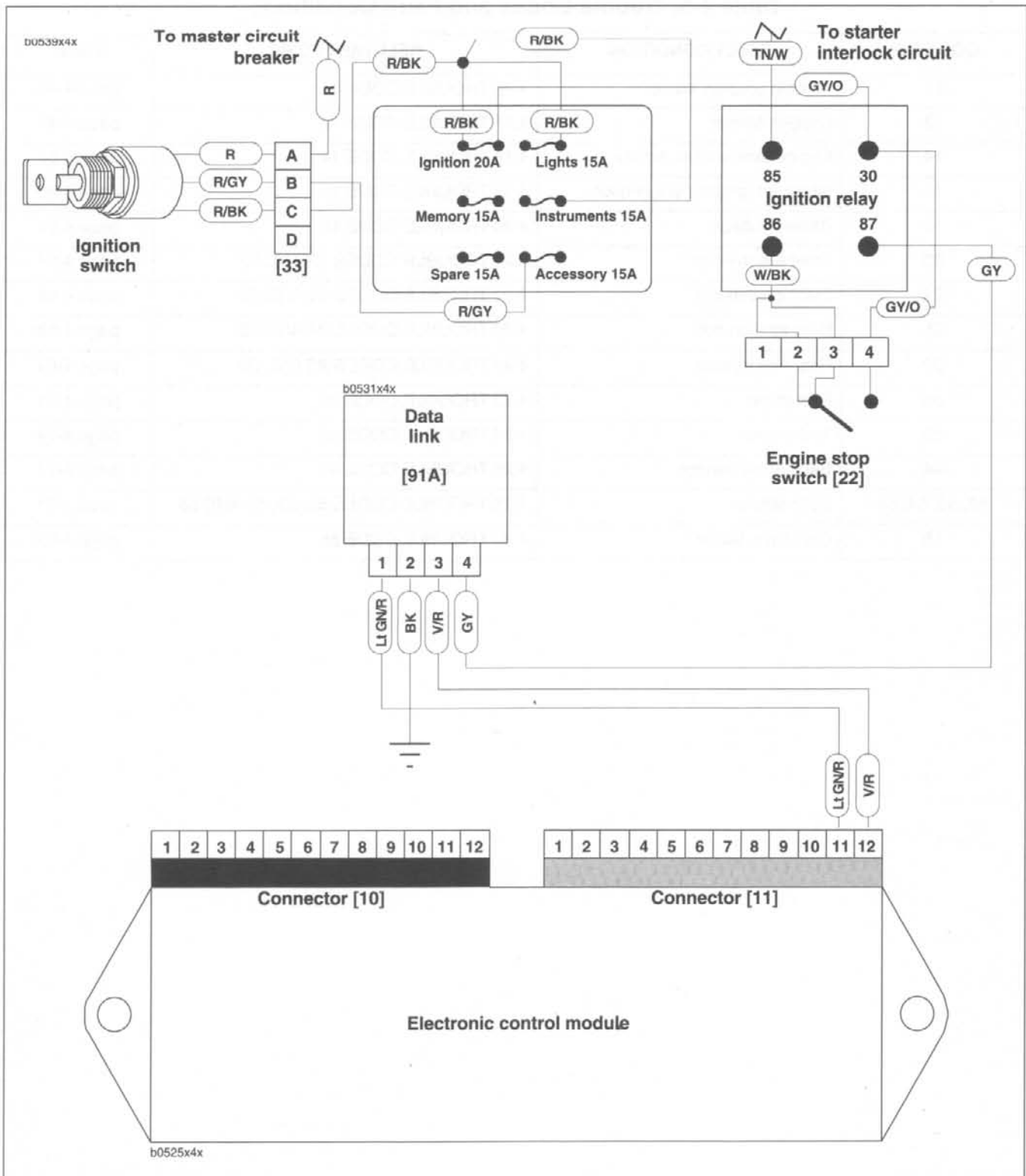
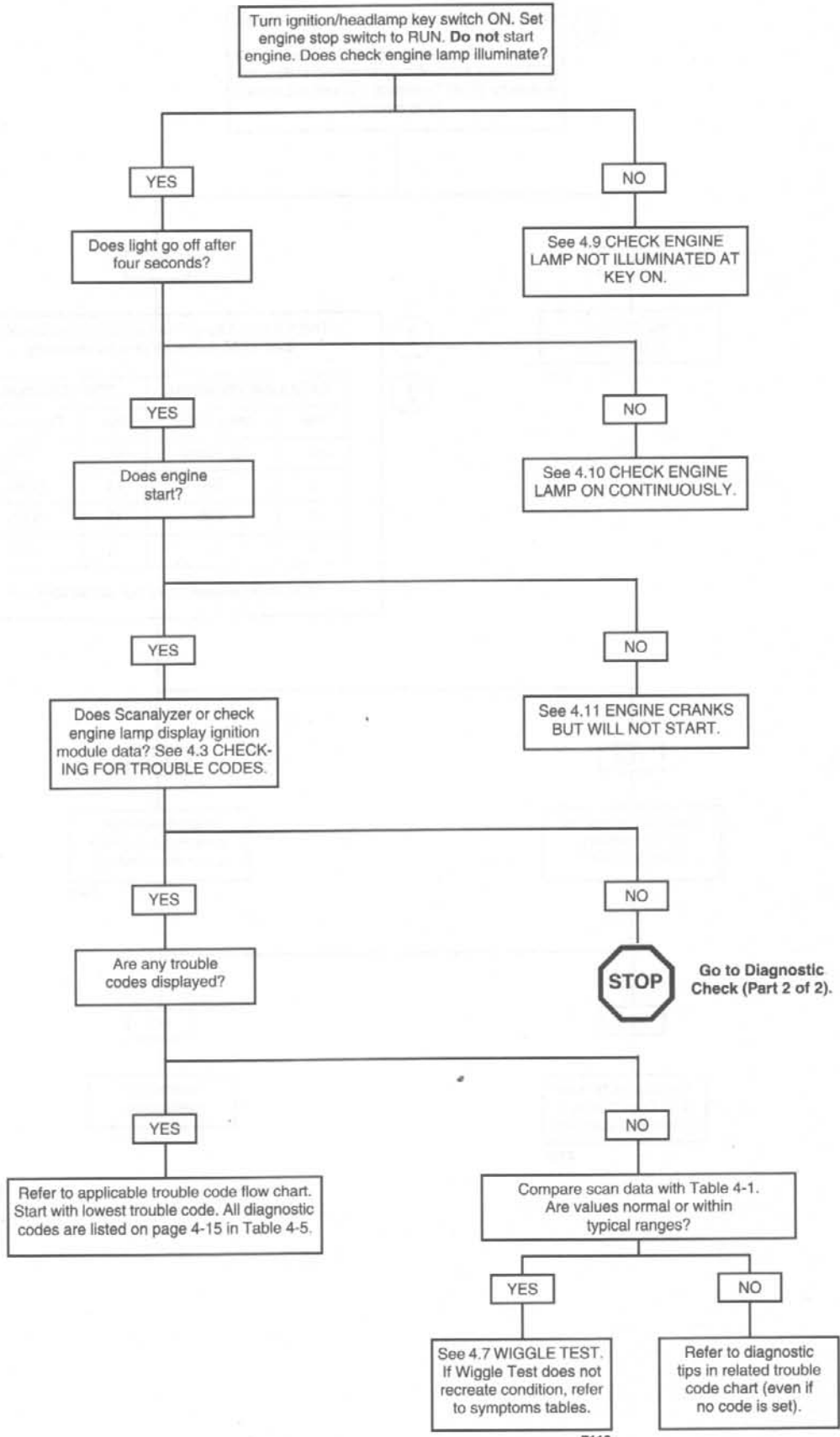


Figure 4-17. Diagnostic Check

Table 4-6. Wire Harness Connectors in Figure 4-17.

NO.	DESCRIPTION	TYPE	LOCATION
[10]	ECM (black)	12-place Deutsch	under seat
[11]	ECM (gray)	12-place Deutsch	under seat
[91A]	Data link	4-place Deutsch	behind right side of steering head

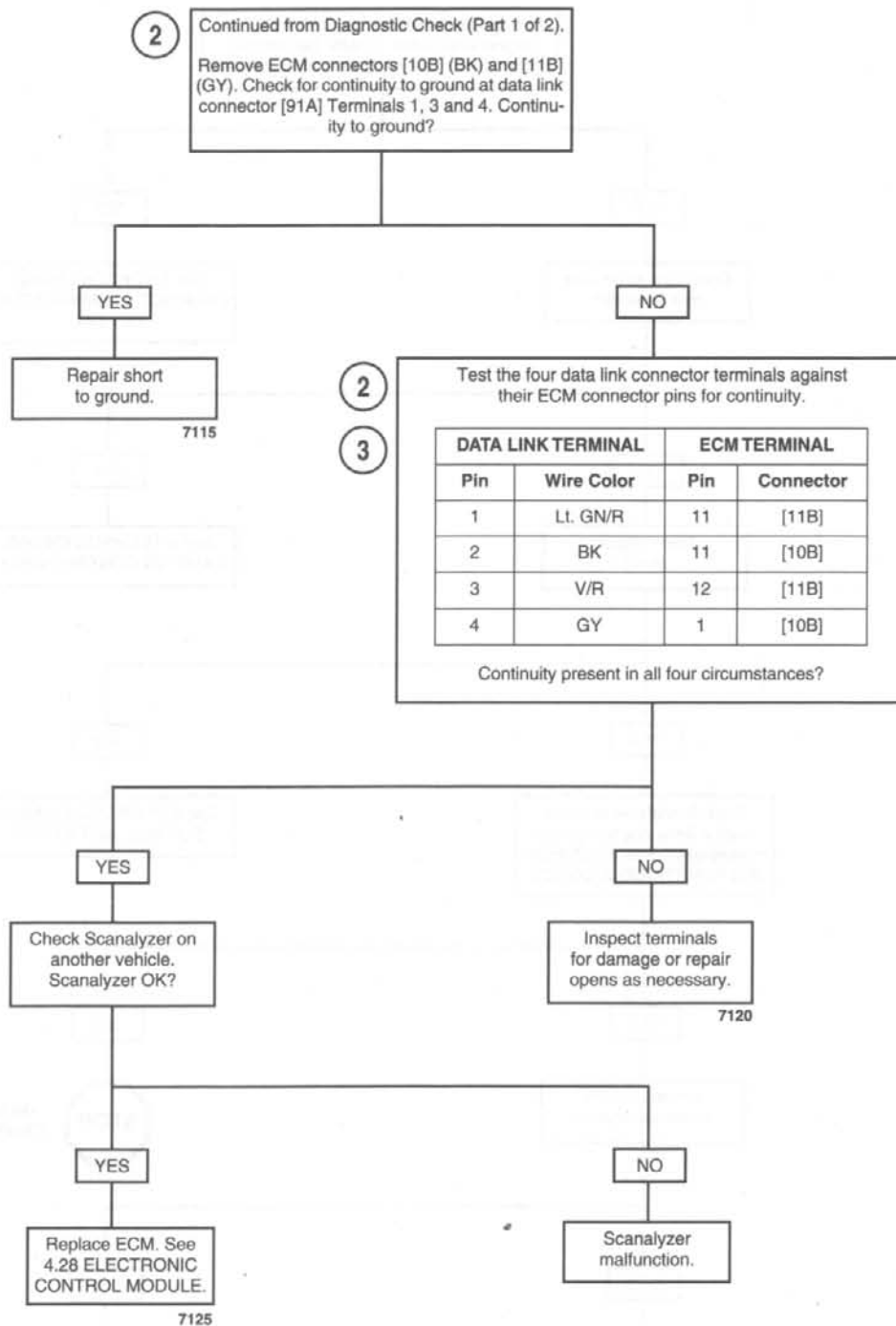
Diagnostic Check (Part 1 of 2)



7110

1

Diagnostic Check (Part 2 of 2)



CHECK ENGINE LAMP NOT ILLUMINATED AT KEY ON 4.9

GENERAL

If the engine stop switch is set to RUN with the engine off, and the ignition key switch is turned ON, the check engine lamp should illuminate for four seconds. See Figure 4-18.

Battery voltage is supplied to the lamp bulb. The lamp bulb is grounded by the ECM through the BK/Y wire. A lack of power to the ECM will cause the check engine lamp to be inoperative and also create a no start situation.

DIAGNOSTICS

Diagnostic Tips

Check for the following conditions:

- Check for open in BK/Y wire.
- Check for blown instrument fuse.

Diagnostic Notes

The reference numbers below correlate with the circled numbers on the Test 4.9 flow chart.

1. Use HARNESS CONNECTOR TEST KIT (Part No. HD-41404), black pin probe and patch cord.
2. See Figure 4-19. Inspect connector [10] (black) for contamination or corrosion. If connection is good, replace ECM. See 4.28 ELECTRONIC CONTROL MODULE.
3. Check continuity between instrument connector [39] Pin 8 and ECM connector [10] (black), Pin 4.
 - a. Gain access to tachometer cover by removing wind-screen.
 - b. Remove tachometer cover and pull check engine lamp from back of tachometer. See Figure 4-20. Remove check engine bulb from bulb socket.
 - c. If continuity is present, check for short to battery on the BK/Y wire between connectors [39] and [10].
 - d. If no continuity, check for damaged/open wires in the check engine lamp circuit.

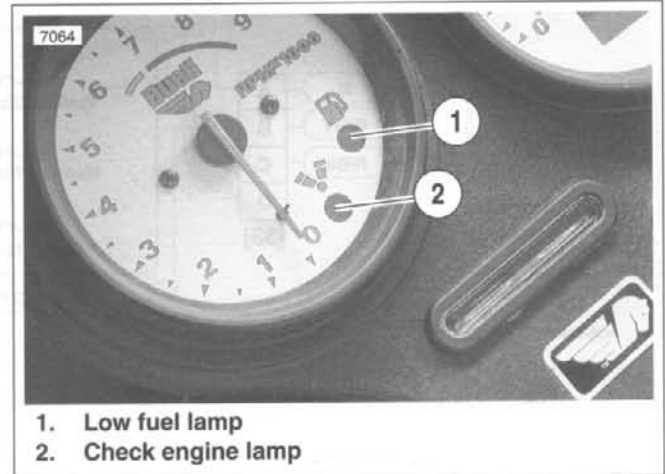


Figure 4-18. Check Engine Lamp

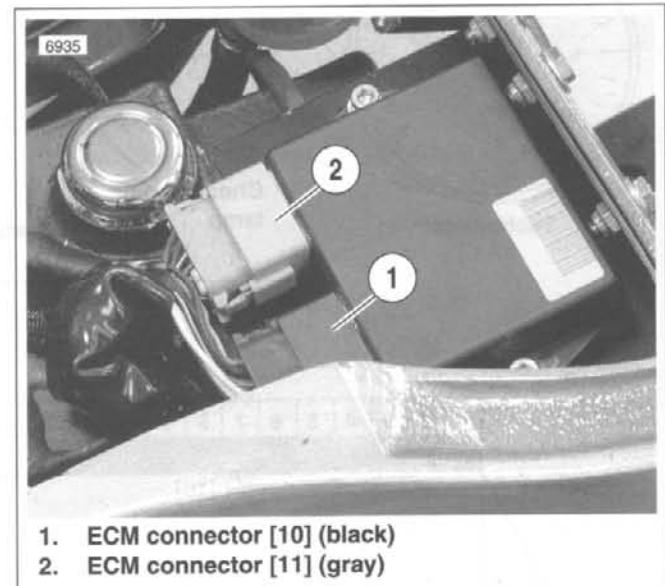


Figure 4-19. Electronic Control Module

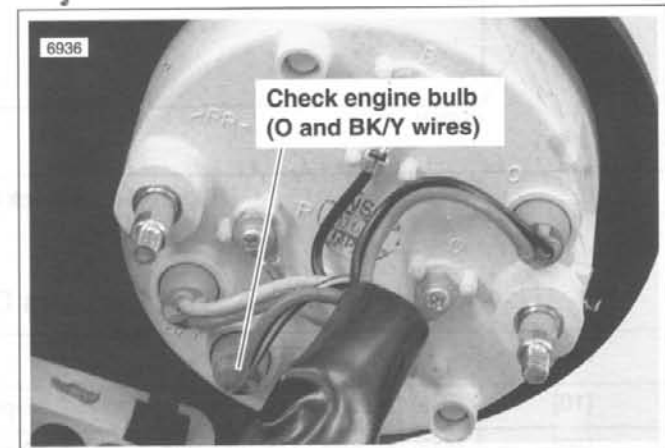


Figure 4-20. Check Engine Lamp Bulb

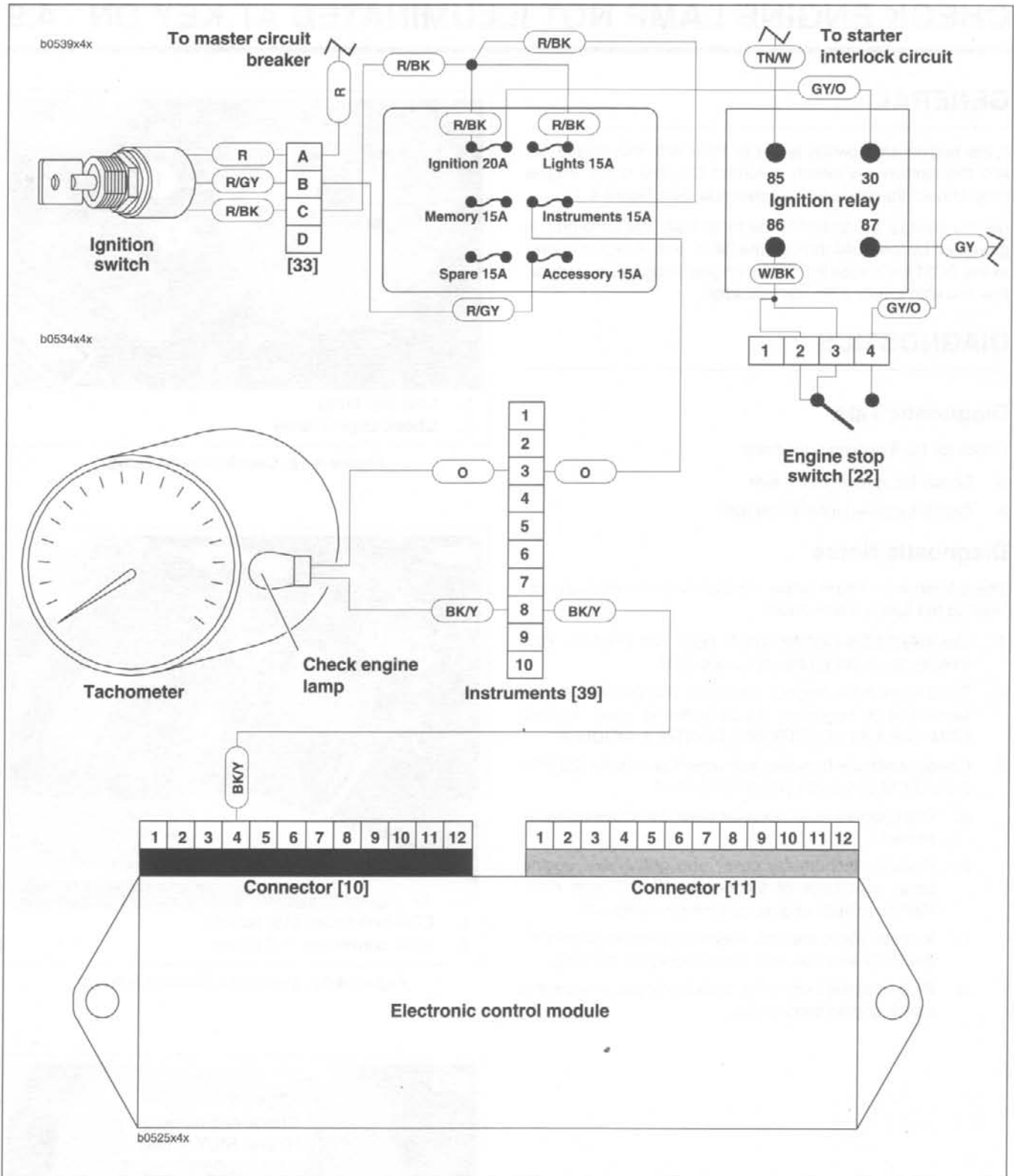
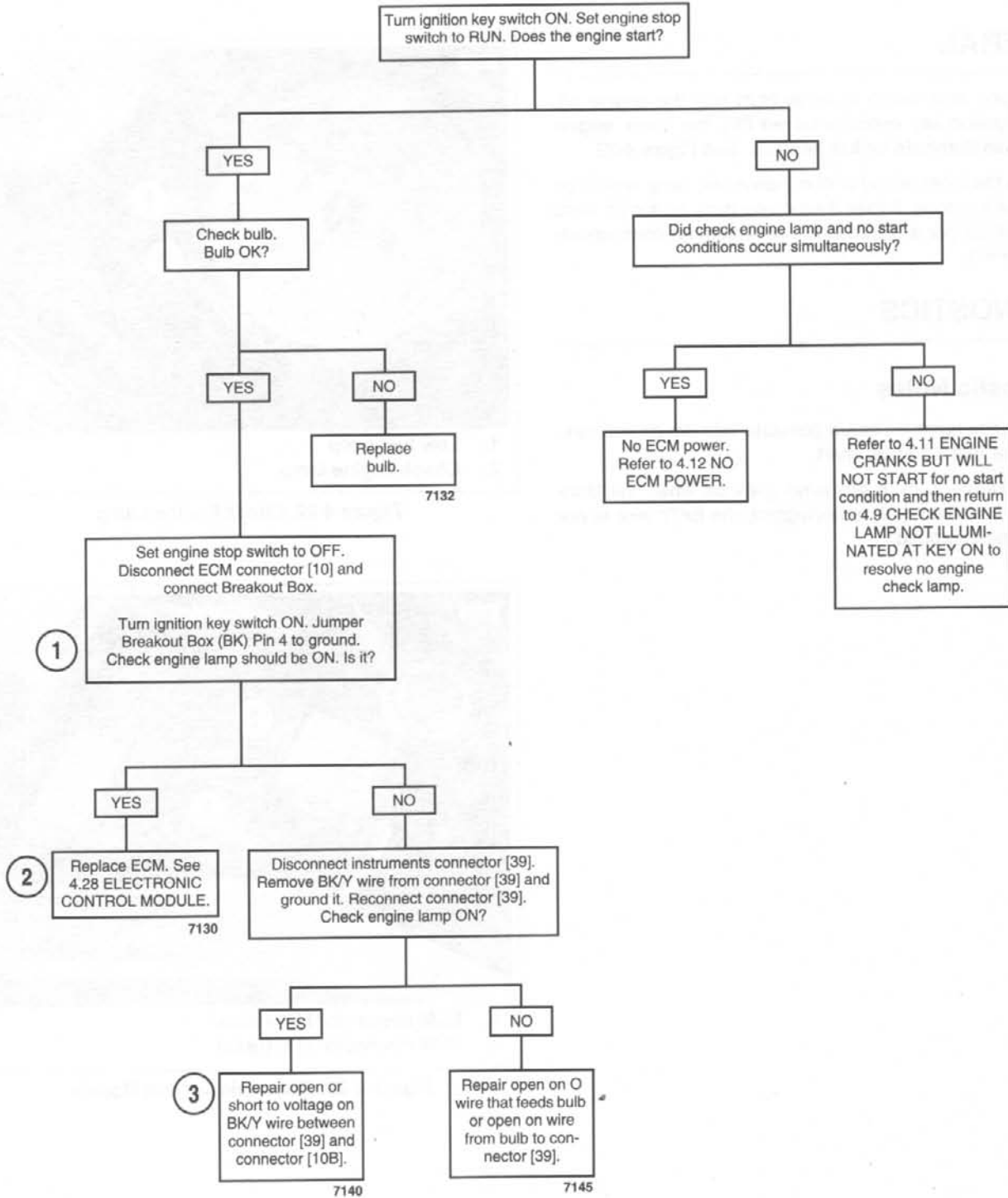


Figure 4-21. Check Engine Lamp Circuit

Table 4-7. Wire Harness Connectors in Figure 4-21.

NO.	DESCRIPTION	TYPE	LOCATION
[10]	ECM (black)	12-place Deutsch	under seat
[39]	Main harness to instruments	10-place Multilock	under fuel cell

Test 4.9



GENERAL

If the engine stop switch is set to RUN with the engine off, and the ignition key switch is turned ON, the check engine lamp should illuminate for four seconds. See Figure 4-22.

Following the initial period of illumination, the lamp should go off for four seconds. It may then come back on for an eight second period (for a stored error) or remain on continuously (current error).

DIAGNOSTICS

Diagnostic Notes

The reference numbers below correlate with the circled numbers on the Test 4.10 flow chart.

1. See Figure 4-23. If the lamp goes off when the black ECM connector [10] is unplugged, the BK/Y wire is **not** shorted to ground.

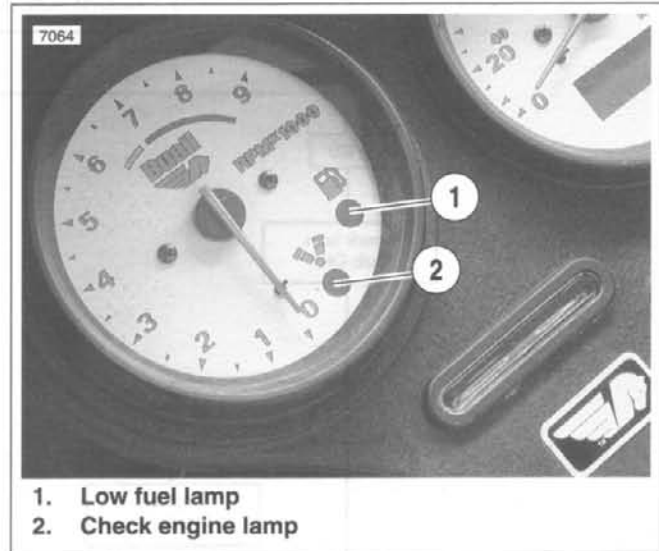


Figure 4-22. Check Engine Lamp

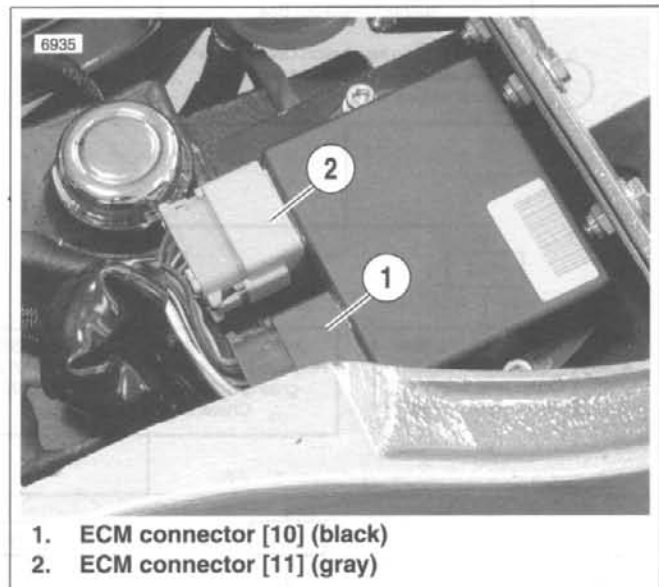


Figure 4-23. Electronic Control Module

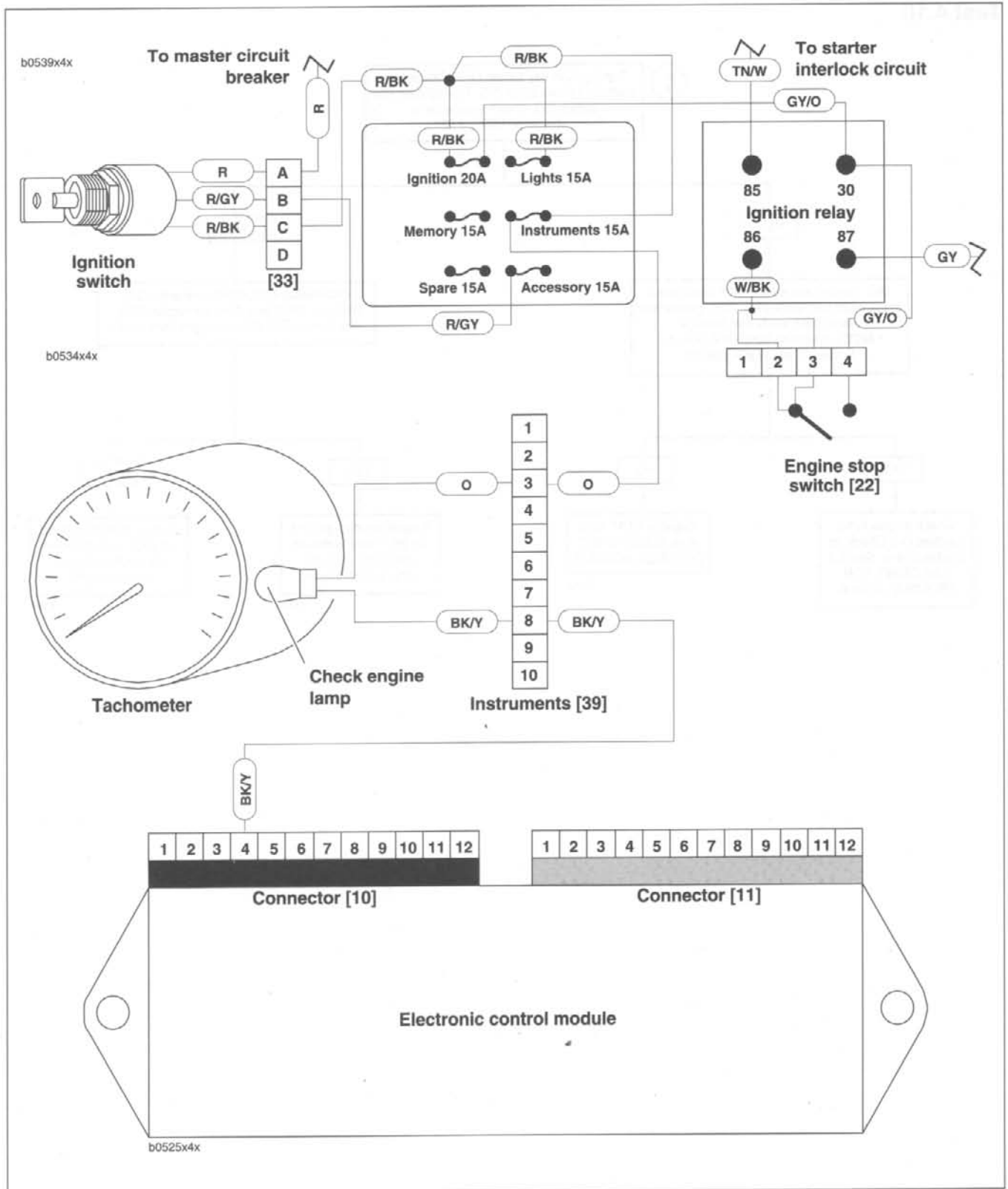
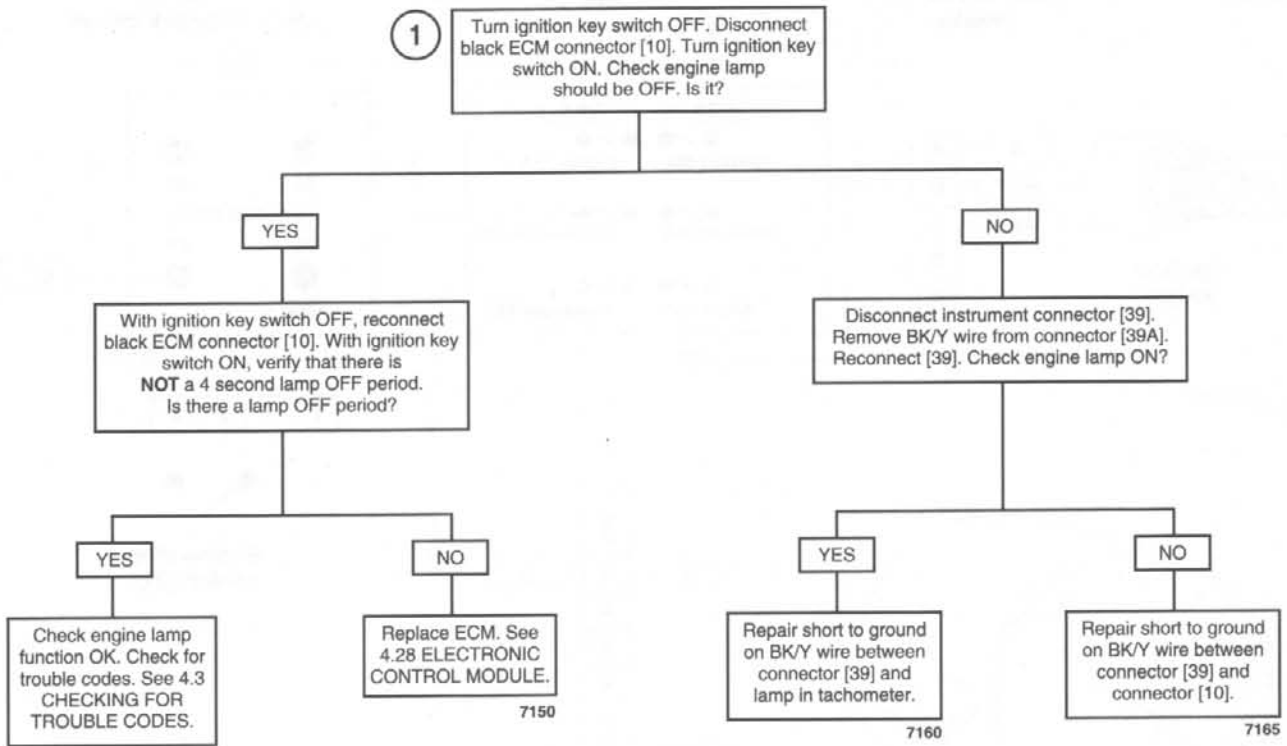


Figure 4-24. Check Engine Lamp Circuit

Table 4-8. Wire Harness Connectors in Figure 4-24.

NO.	DESCRIPTION	TYPE	LOCATION
[10]	ECM (black)	12-place Deutsch	under seat
[39]	Main harness to instruments	10-place Multilock	under fuel cell

Test 4.10



GENERAL

If the starter will not crank engine, the problem is not ignition related. See Section 5-Electric Starter.

IMPORTANT NOTE

The engine may be started and run when the trouble codes are received using a jumper wire on Pins 1 and 2 of the data link connector. However, if the jumper wire is removed with the engine running, the check engine lamp will continue to flash trouble codes. To stop check engine lamp from flashing codes, turn engine stop switch OFF.

DIAGNOSTICS

Diagnostic Notes

The reference numbers below correlate with the circled numbers on the Test 4.11 flow charts.

1. Check battery condition. Perform a voltage test and recharge if below 12.80 volts. Check battery connections and perform load test. Replace the battery if necessary.
2. Remove spark plug cable from spark plug.
 - a. Visually check condition of plug.
 - b. See Figure 4-25. Attach cable to SPARK PLUG TESTER (Part No. HD-26792). Clip tester to cylinder head bolt.
 - c. While cranking starter, look for spark. Repeat procedure on other spark plug cable.

⚠ WARNING

The gasoline in the fuel supply line downstream of the fuel pump is under high pressure (49 psi [338 kPa]). To avoid an uncontrolled discharge or spray of gasoline, always purge the system of high pressure gas before removing fuel tank. Gasoline is extremely flammable and highly explosive. Inadequate safety precautions could result in death or serious injury.

3. Purge fuel line and remove fuel tank to access fuel injectors. See 4.34 FUEL TANK. Use test lamp as shown in Figure 4-26.
4. Use HARNESS CONNECTOR TEST KIT (Part No. HD-41404) gray pin probe and patch cord.



Figure 4-25. Spark Plug Tester

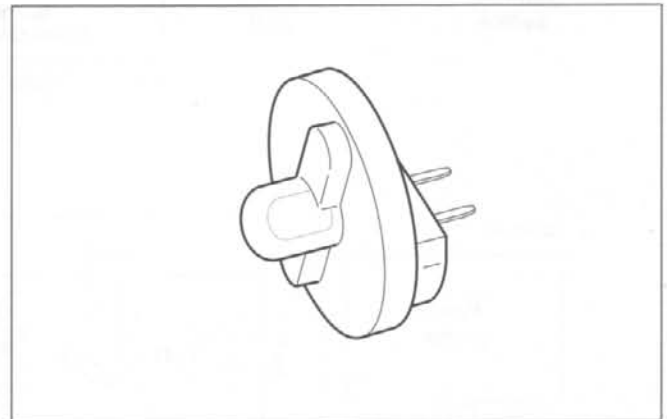


Figure 4-26. Test Lamp

5. Connect BREAKOUT BOX (Part No. HD-42682) between harness and ECM. See 4.6 BREAKOUT BOX.
6. Use HARNESS CONNECTOR TEST KIT (Part No. HD-41404) gray pin probe and patch cord.
7. Use HARNESS CONNECTOR TEST KIT (Part No. HD-41404) black pin probe and patch cord.

Table 4-9. Wire Harness Connectors in Figure 4-27.

NO.	DESCRIPTION	TYPE	LOCATION
[10]	ECM (black)	12-place Deutsch	under seat
[11]	ECM (gray)	12-place Deutsch	under seat
[14]	CMP sensor	3-place Deutsch	next to starter
[18]	Ignition coil	3-place Packard	under fuel cell, left side

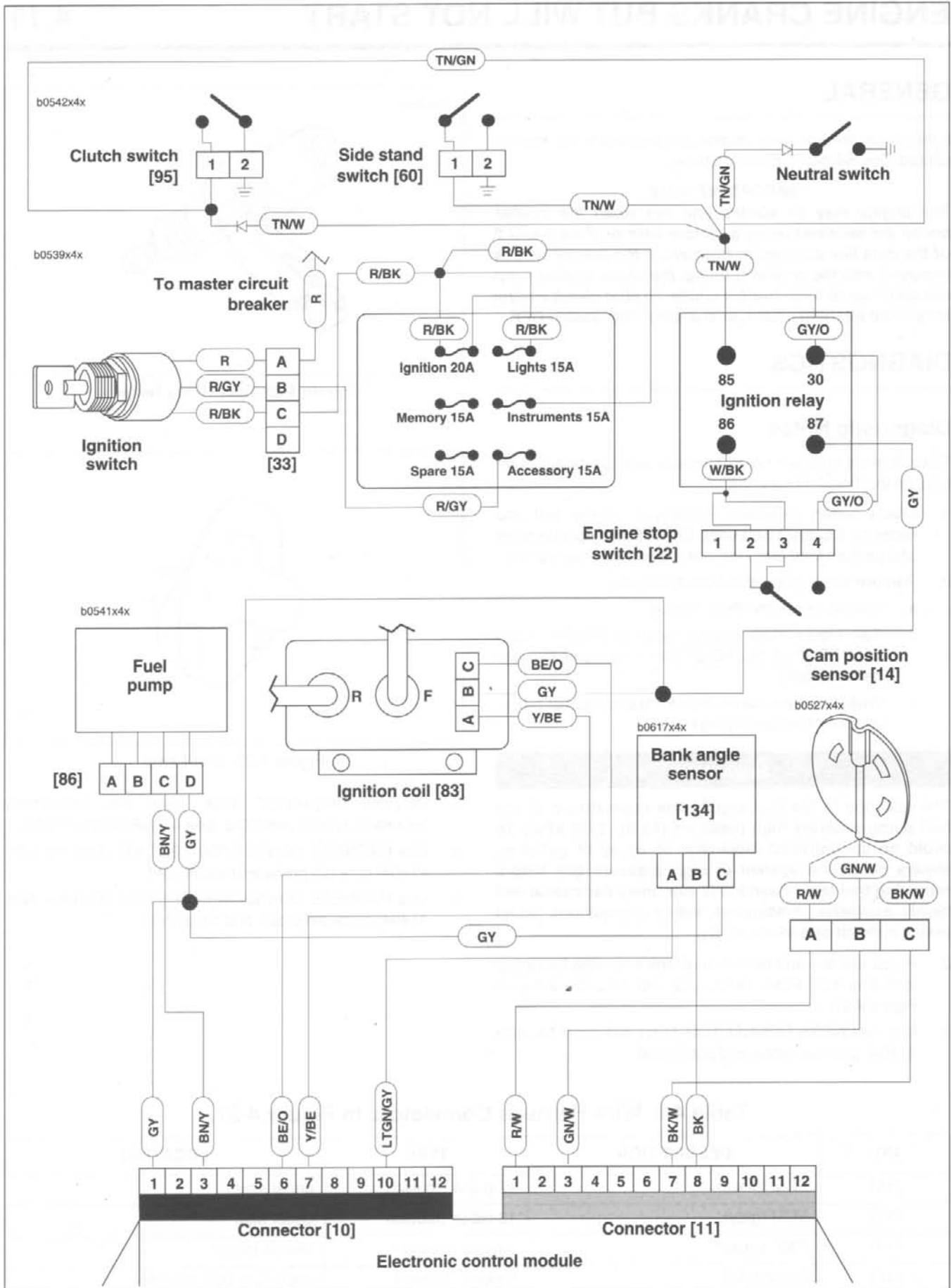
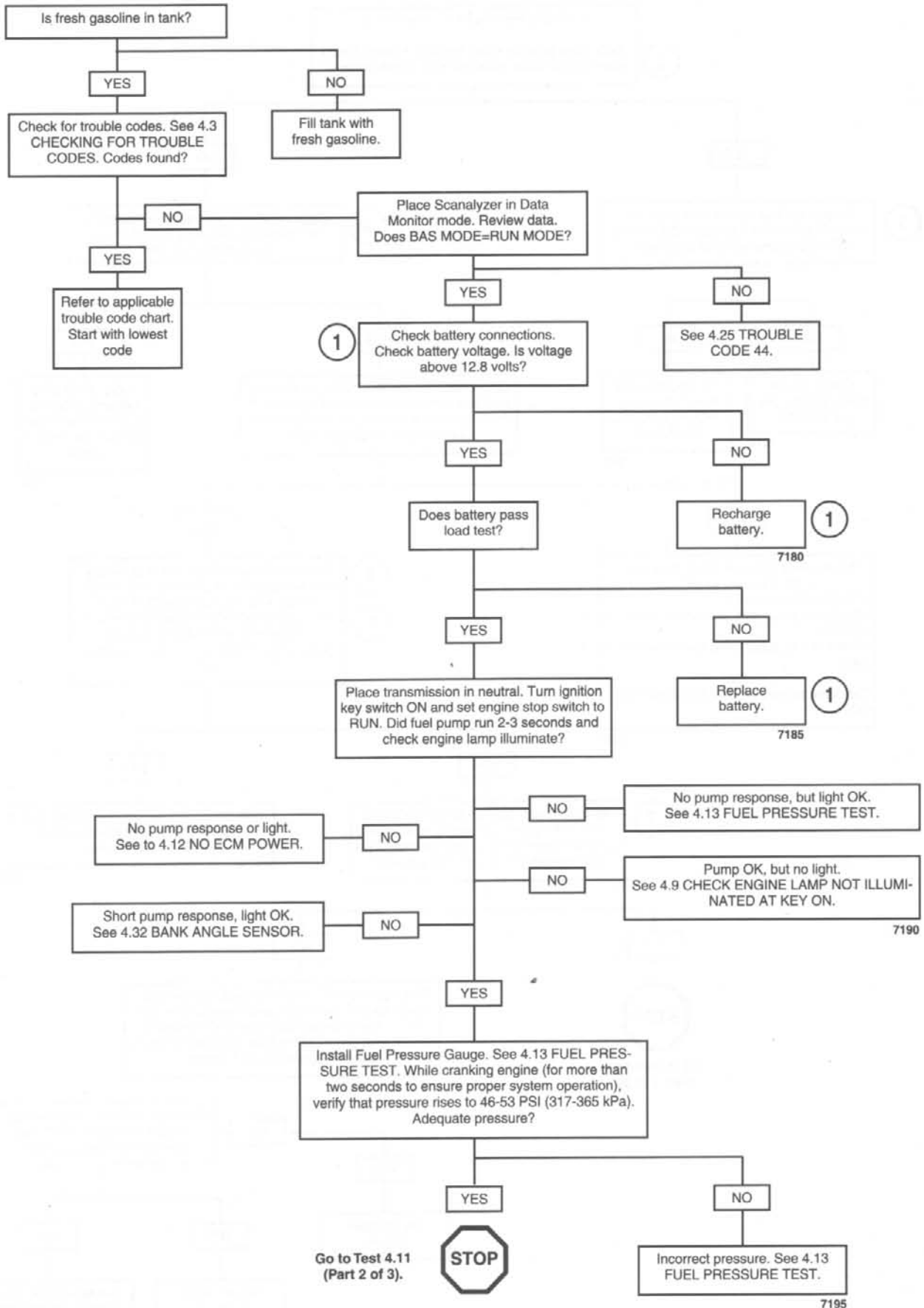
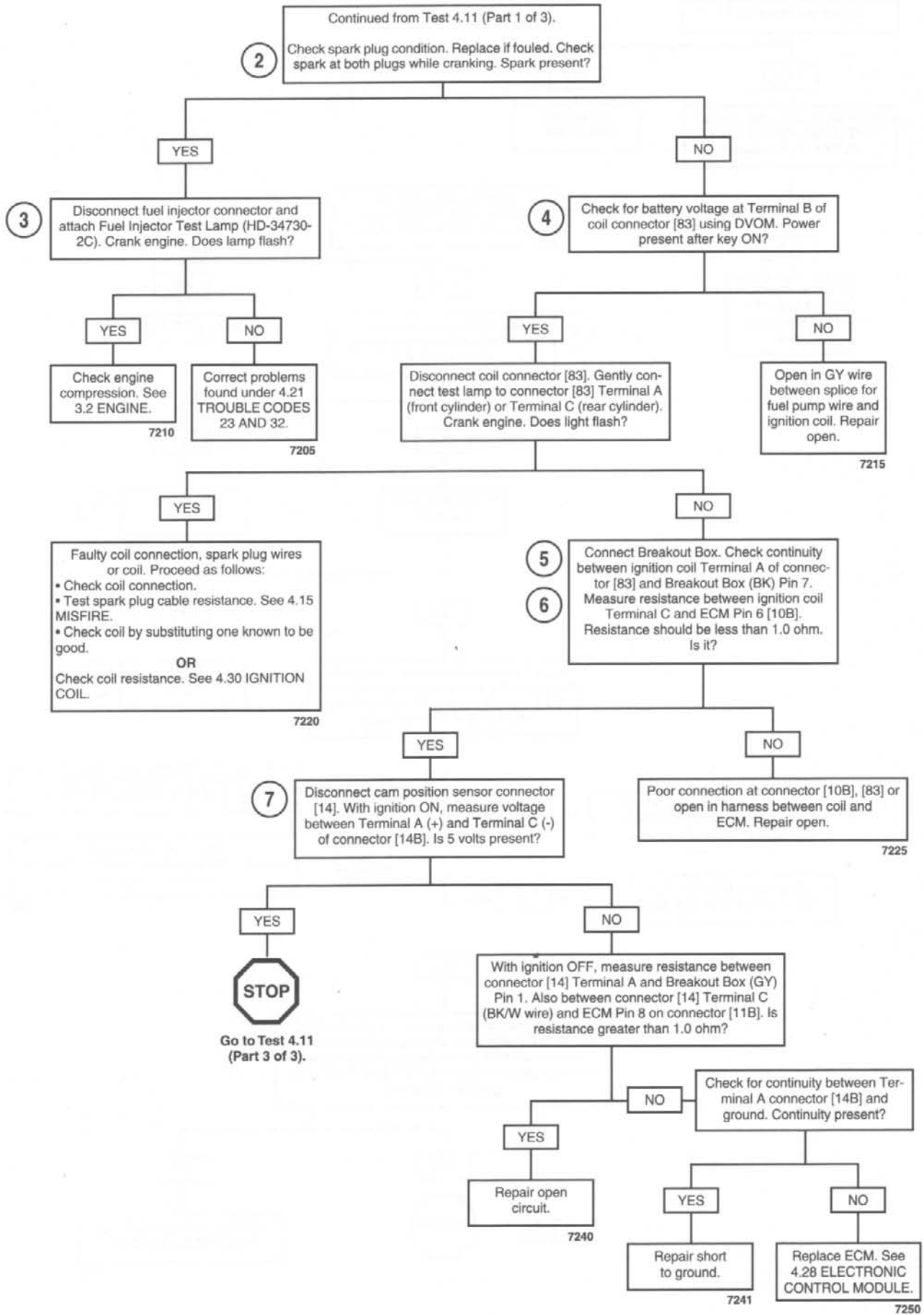


Figure 4-27. Ignition Circuit

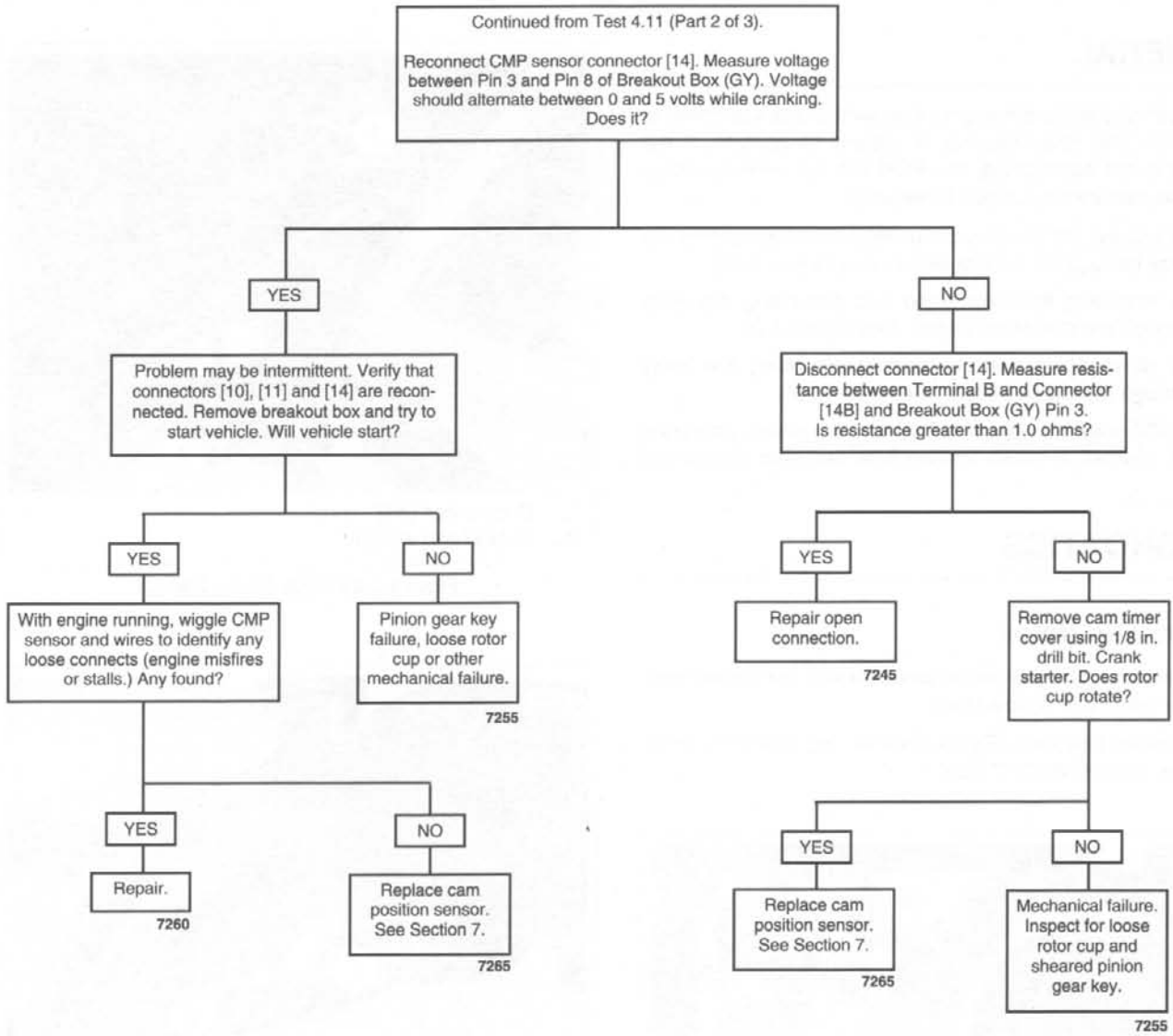
Test 4.11 (Part 1 of 3)



Test 4.11 (Part 2 of 3)



Test 4.11 (Part 3 of 3)



GENERAL

A relay controlled by the engine stop switch supplies power to the ECM. The relay requires a ground to operate. If the ground is not established, the ECM will not receive power. Grounds may be established three ways.

- By placing the motorcycle in neutral and grounding the relay through the neutral switch. See Figure 4-28.
- By retracting the side stand and grounding the relay through the side stand switch. See Figure 4-29.
- By disengaging the clutch and grounding the relay through the clutch switch. See Figure 4-30.

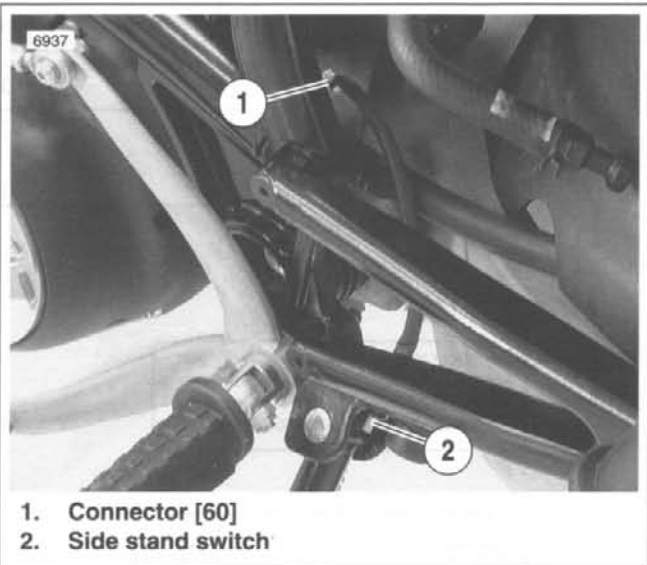
If the ECM does not appear to be receiving power, check the ground sources. A blown ignition fuse can also disable the ECM.

DIAGNOSTICS

Diagnostic Notes

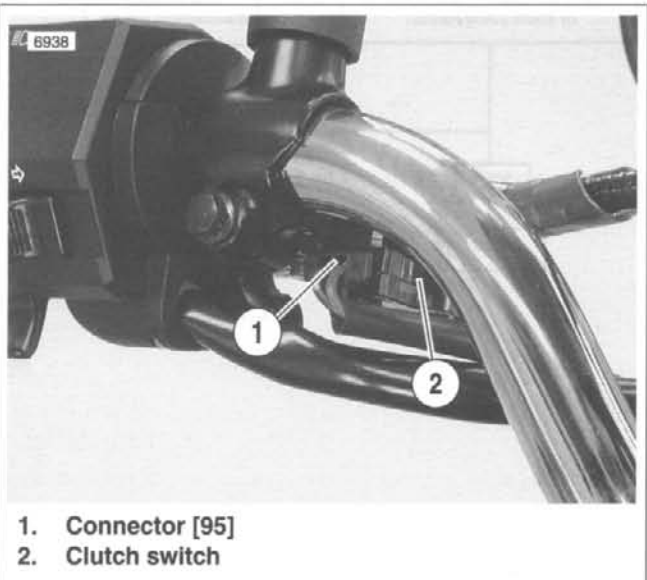
The reference numbers below correlate with the circled numbers on the Test 4.12 flow chart.

1. Connect BREAKOUT BOX (Part No. HD-42682) to ECM. See 4.6 BREAKOUT BOX.



1. Connector [60]
2. Side stand switch

Figure 4-29. Side Stand Switch



1. Connector [95]
2. Clutch switch

Figure 4-30. Clutch Switch

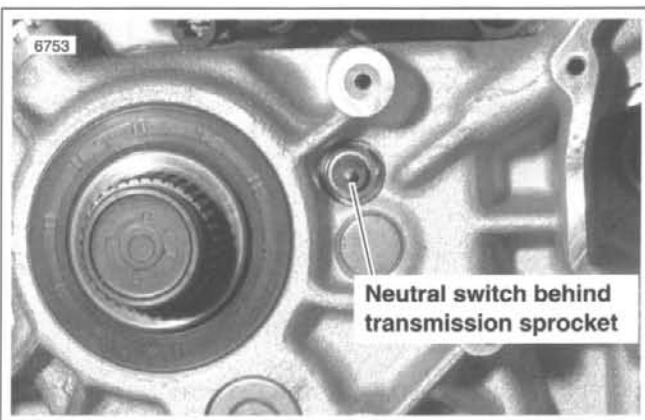


Figure 4-28. Neutral Switch

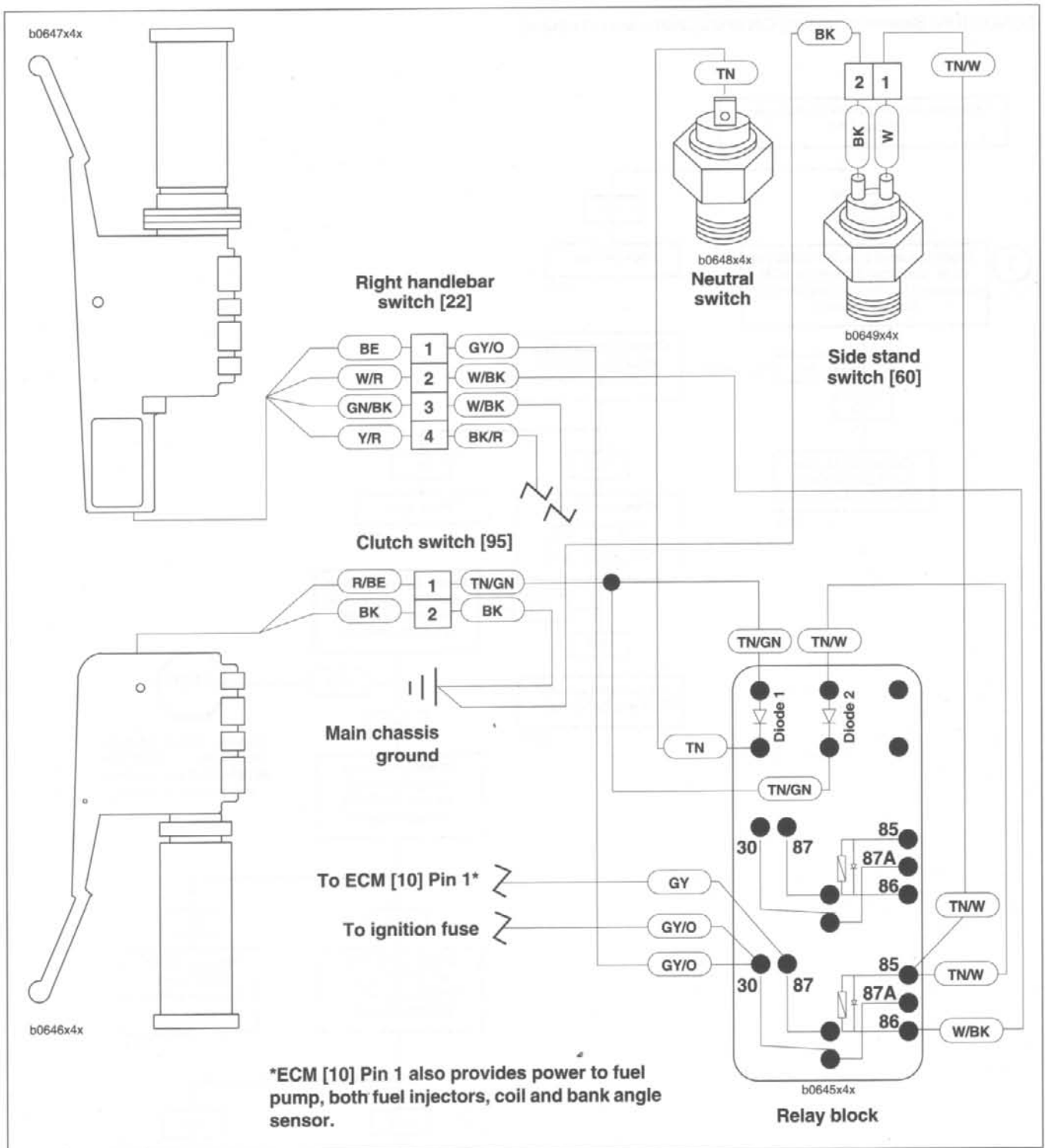


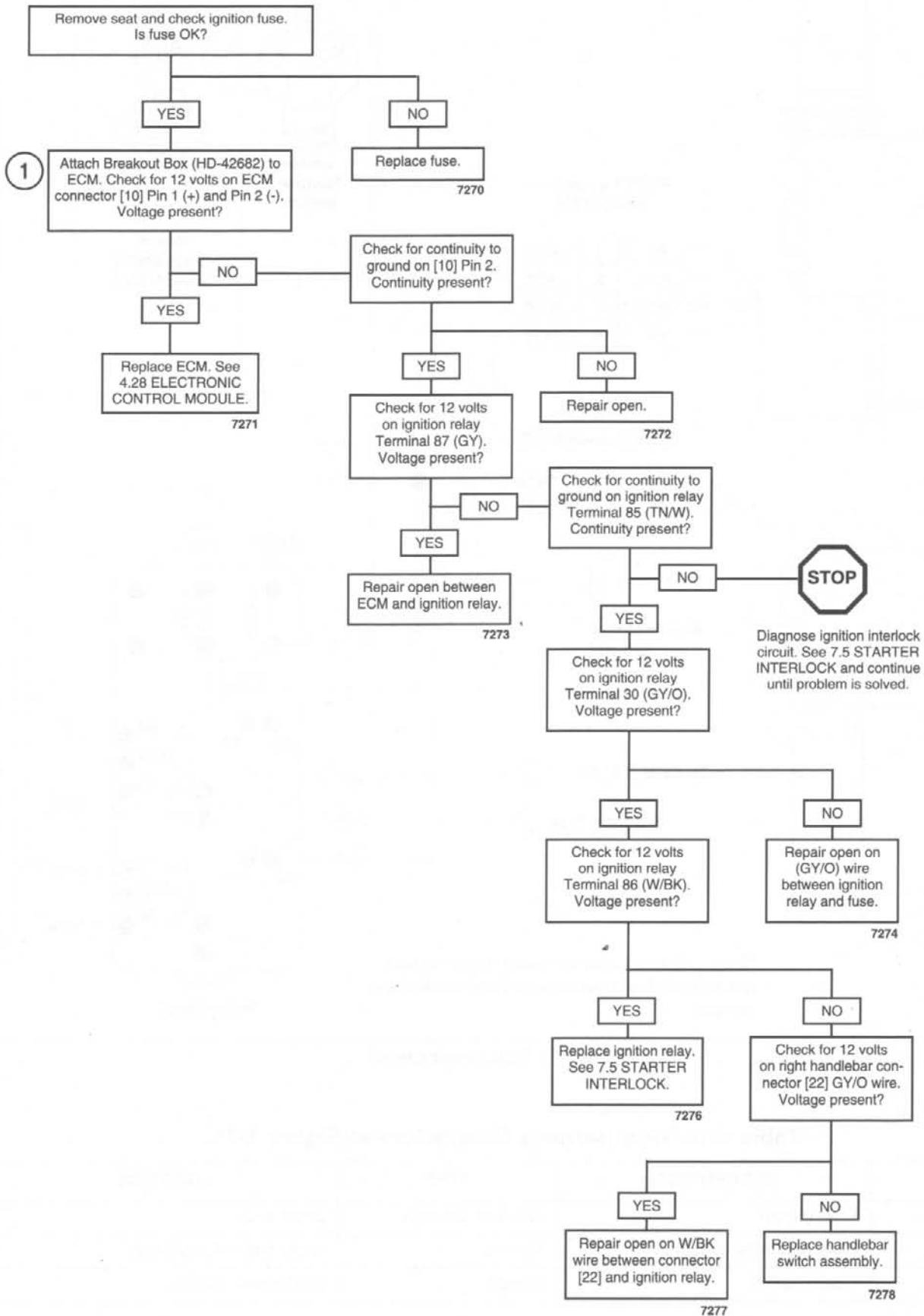
Figure 4-31. ECM Power Circuit

Table 4-10. Wire Harness Connectors in Figure 4-31.

NO.	DESCRIPTION	TYPE	LOCATION
[10]	ECM (black)	12-place Deutsch	under seat
[22]	Right handlebar switch	4-place	under fuel cell, right side
[95]	Clutch switch	2-place	clutch lever bracket

No ECM Power

CONDITION: Sidestand up, key ON and transmission in neutral



INSPECTION

WARNING

The gasoline in the fuel supply line downstream of the fuel pump is under high pressure (49 psi [338 kPa]). To avoid an uncontrolled discharge or spray of gasoline, always purge the system of high pressure gas before attaching fuel pressure gauge. Gasoline is extremely flammable and highly explosive. Inadequate safety precautions could result in death or serious injury.

1. Purge the fuel supply line of high pressure gasoline.
 - a. See Figure 4-32. Disconnect the 4-place fuel pump connector [86]. Connector is on the left side, above the rear cylinder spark plug.
 - b. With the motorcycle in neutral, start the engine and allow vehicle to run.
 - c. When the engine stalls, press the starter button for 3 seconds to remove any remaining fuel from fuel line.
2. Wrap a shop towel around the fuel supply fitting.

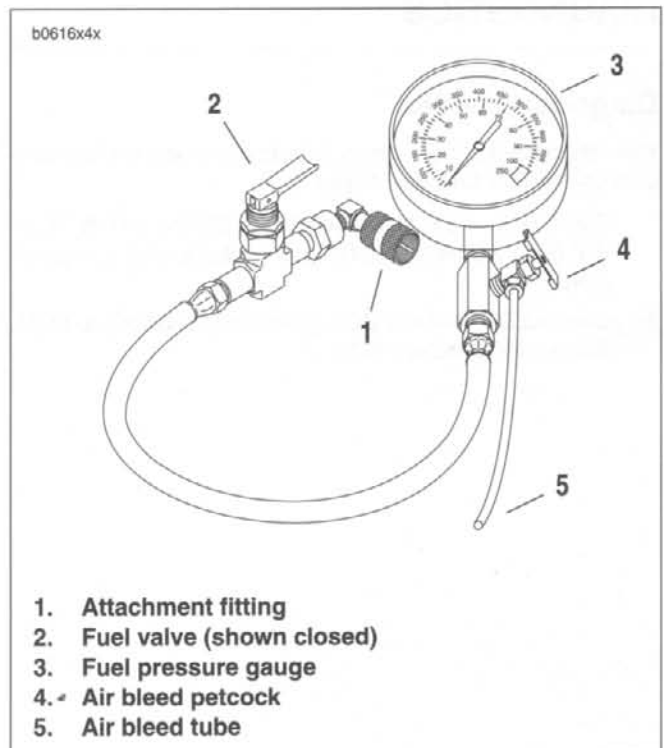
WARNING

A small amount of gasoline will drain from the valve when the gauge is installed. Thoroughly wipe up any spilt fuel immediately. Dispose of rags in a suitable manner. Gasoline is extremely flammable and highly explosive. Inadequate safety precautions could result in death or serious injury.

3. See Figure 4-33. Attach FUEL PRESSURE GAUGE (Part No. HD-41182) to Schraeder valve on fuel supply fitting.
 - a. Verify that fuel valve (2) and air bleed petcock (4) on the gauge are closed.
 - b. See Figure 4-34. Remove protective cap (3) from Schraeder valve (2).
 - c. Thread gauge into Schraeder valve.
4. See Figure 4-32. Attach fuel pump connector to main wiring harness.
5. See Figure 4-33. Pressurize the fuel system.
 - a. Start and idle engine to pressurize the fuel system.
 - b. Open fuel valve (2) on fuel pressure gauge to allow fuel to flow down the gauge hose.
 - c. Position the air bleed tube (5) in the beaker.
 - d. Open and close the air bleed petcock (4) to purge the fuel pressure gauge and hose of air. Repeat this step several times until only solid fuel (without bubbles) flows from the air bleed tube (5).
 - e. Close the air bleed petcock (4).



Figure 4-32. Fuel Pump Connector [86]



1. Attachment fitting
2. Fuel valve (shown closed)
3. Fuel pressure gauge
4. Air bleed petcock
5. Air bleed tube

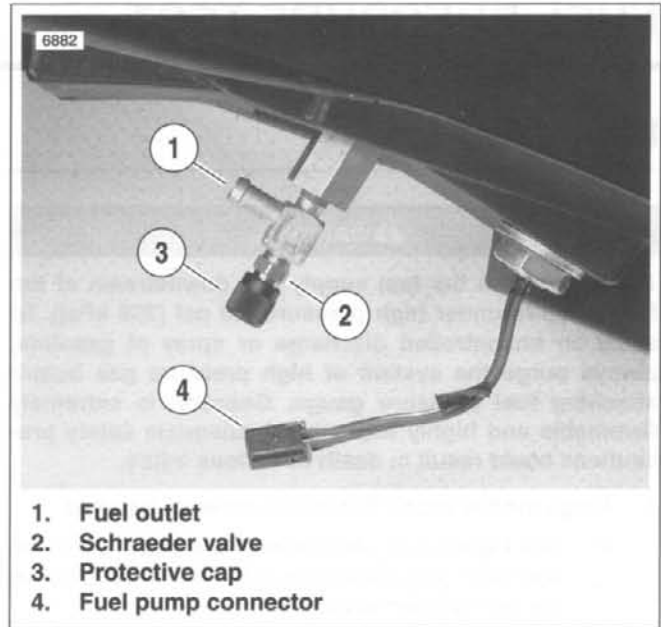
Figure 4-33. Fuel Pressure Gauge

6. Open throttle and increase engine speed to 2500-3000 RPM. Note the reading on the pressure gauge.
 - a. If pressure is 46-53 psi (317-365 kPa) then system is operating within limits.
 - b. If pressure is not within limits, see Test 4.13 (Part 1 of 2) flow chart after disconnecting pressure gauge.

⚠ WARNING

A small amount of gasoline will drain from the valve when the valve is removed. Thoroughly wipe up any spilt fuel immediately. Dispose of rags in a suitable manner. Gasoline is extremely flammable and highly explosive. Inadequate safety precautions could result in death or serious injury.

7. See Figure 4-34. Turn engine off. Detach pressure gauge from Schraeder valve.
 - a. Open the air bleed petcock to relieve fuel system pressure and purge the pressure gauge of gasoline.
 - b. Remove pressure gauge from valve.
 - c. Install protective cap on valve.



**Figure 4-34. Schraeder Valve and Cap
(Fuel Tank Removed From Chassis)**

DIAGNOSTICS

Diagnostic Notes

The reference numbers below correlate with the circled numbers on the Test 4.13 flow charts.

1. See Figure 4-35. Use HARNESS CONNECTOR TEST KIT (Part No. HD-41404), gray socket probe and patch cord.
2. Connect BREAKOUT BOX (Part No. HD-42682) to ECM. See 4.6 BREAKOUT BOX.



Figure 4-35. Harness Connector Kit

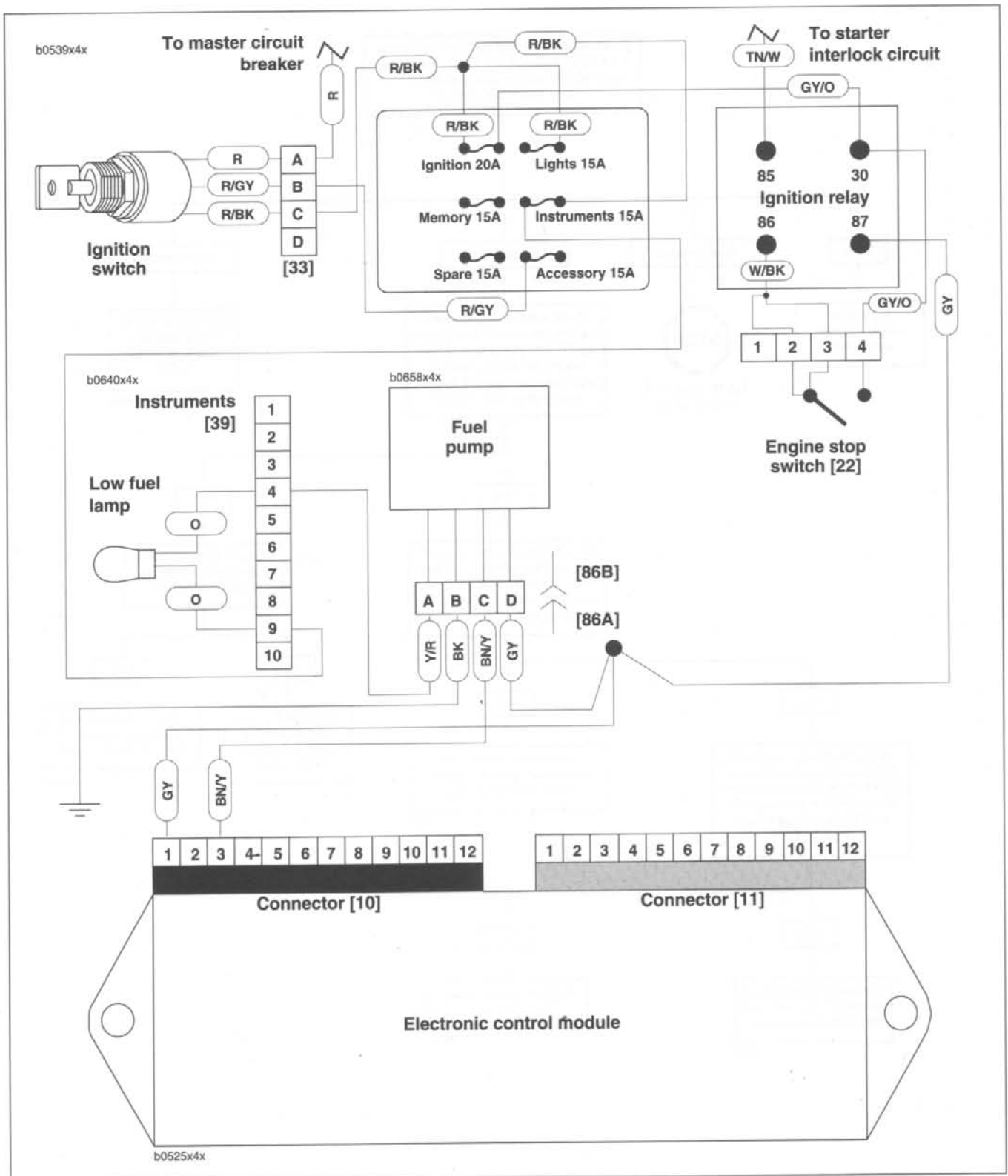
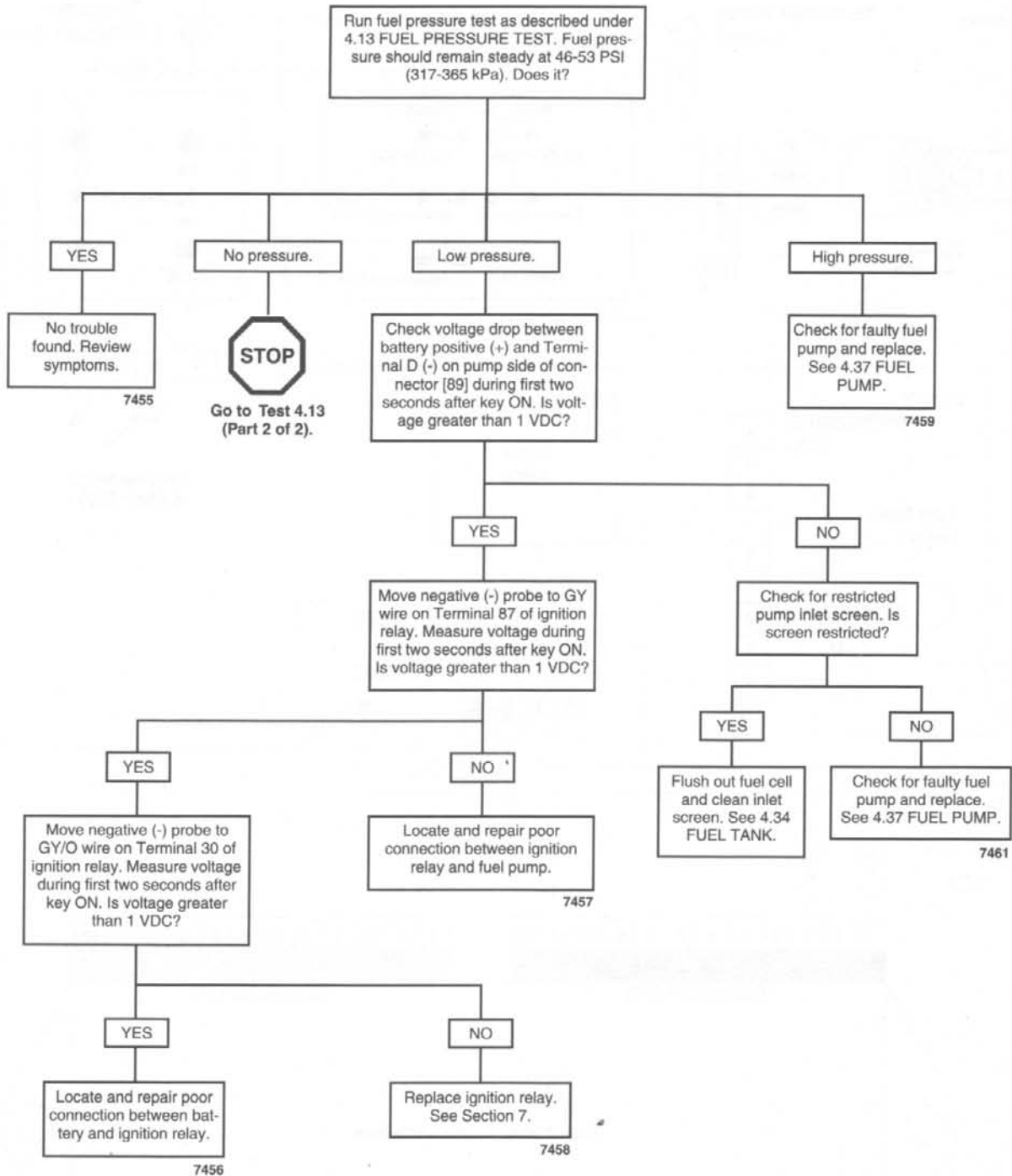


Figure 4-36. Fuel Pump Circuit

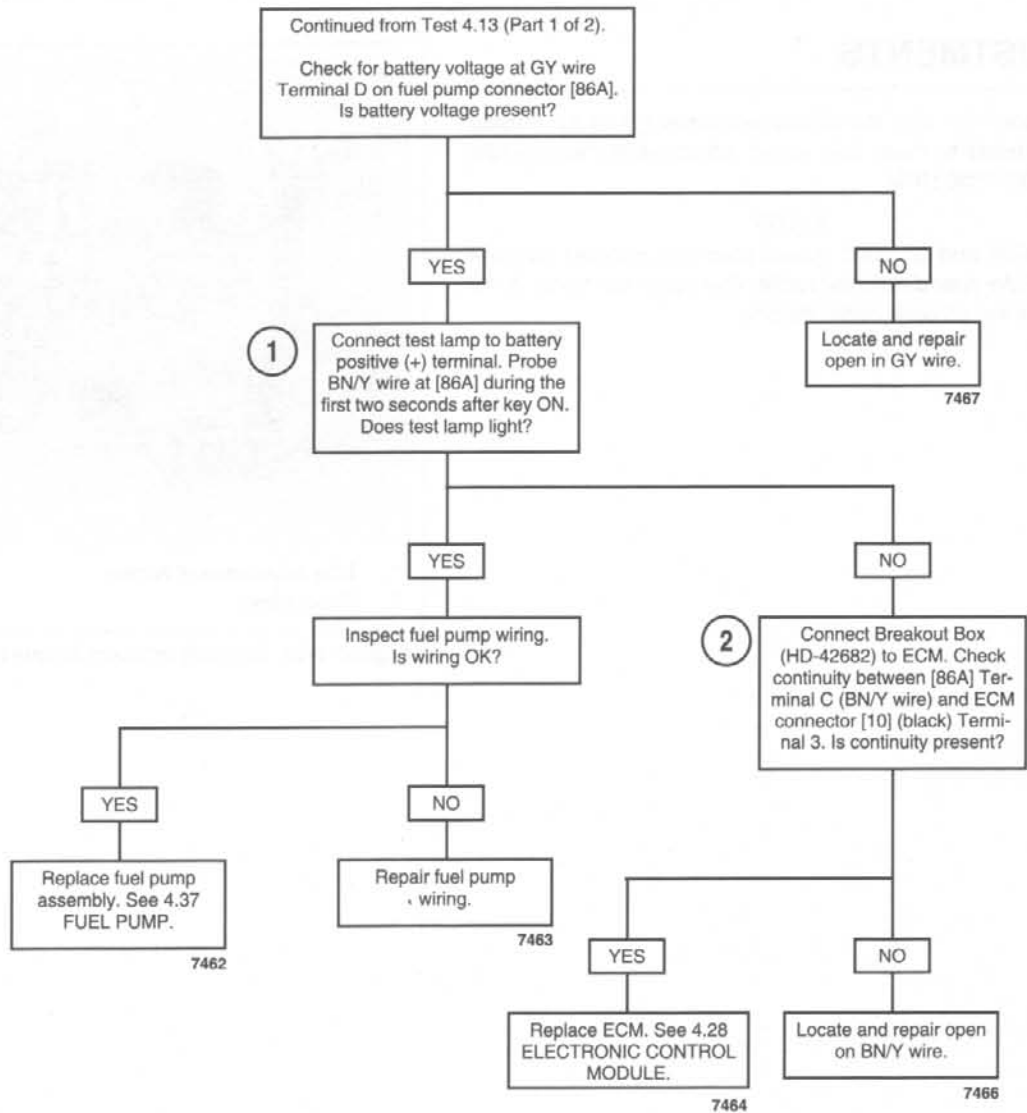
Table 4-11. Wire Harness Connectors in Figure 4-36.

NO.	DESCRIPTION	TYPE	LOCATION
[10]	ECM (black)	12-place Deutsch	under seat
[39]	Instruments	10-place Multilock	under fuel cell
[86]	Fuel pump	4-place Packard	above rear cylinder head, left side

Test 4.13 (Part 1 of 2)



Test 4.13 (Part 2 of 2)



ADJUSTMENTS

See Figure 4-37. Use the adjustment screw (1) on the throttle body manifold to make idle speed adjustments. Normal idle speed 850-1050 RPM.

NOTE

Some 1999 and all 2000 model year fuel injected vehicles have an idle speed adjuster cable. This cable functions in the same fashion as carbureted models.

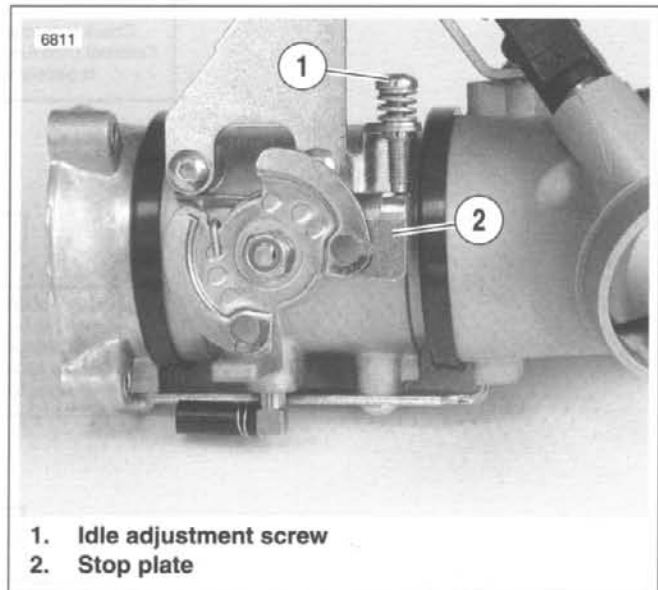


Figure 4-37. Idle Adjustment Screw (1999 Models Only)

GENERAL

Misfire At Idle or Under Load

Misfire conditions may be caused by:

- Battery condition and connections.
- Fuel system problems. See tables under 4.8 INITIAL DIAGNOSTIC CHECK.

DIAGNOSTICS

Diagnostic Notes

The reference numbers below correlate with the circled numbers on the Test 4.15 flow charts.

⚠ WARNING

Any open spark around gasoline or other combustibles could result in fire or explosion causing death or serious injury. Thoroughly wipe up an spilt fuel and dispose of rags in a suitable manner.

1. See Figure 4-38. A SPARK TESTER (Part No. HD-26792) must be used to verify adequate secondary voltage (25,000 volts) at the spark plug.
 - a. Turn ignition switch OFF.
 - b. Remove spark plug cable from spark plug. Visually check plug condition.
 - c. Attach cable to SPARK TESTER. Clip tester to cylinder head bolt.
 - d. While cranking engine, watch for spark to jump tester gap on leads.
 - e. Reinstall and repeat procedure on other spark plug cable.
2. Perform spark plug cable resistance test.
 - a. Remove spark plug cable from spark plug and ignition coil. For best results, use a needle nose pliers for removal/installation on coil. Gently grasp cable as close to terminals as possible.
 - b. Using an ohmmeter, touch probes to terminals on each end plug wire.
 - c. Compare resistance values to Table 4-12. Replace cables not meeting specifications. Reinstall and repeat procedure on other spark plug cable.



Figure 4-38. Spark Tester

Table 4-12. Spark Plug Cables

SPECIFICATION	REAR	FRONT
Length in. (mm)	19.0-19.25 (482.6-489.0)	7.25-7.50 (184.2-190.5)
Resistance-ohms	4750-11,230	1812-4375

3. If carbon tracking is evident, replace ignition coil and inspect spark plug wires. Wires must be clean and tight. Excessive wire resistance or faulty connections can cause coil damage. See 4.30 IGNITION COIL.
4. This test can also be performed by substituting a known good coil for one causing the no spark condition. The coil does not require full installation to be functional. Verify faulty coil by performing resistance test. See 4.30 IGNITION COIL.
5. Use HARNESS CONNECTOR TEST KIT (Part No. HD-41404), gray pin probe and patch cord to the coil connector [18].
6. Inspect for corrosion at battery terminals, main circuit breakers, ignition fuse terminals (GY/O and R/BK), right handlebar connector [1] and coil connector.

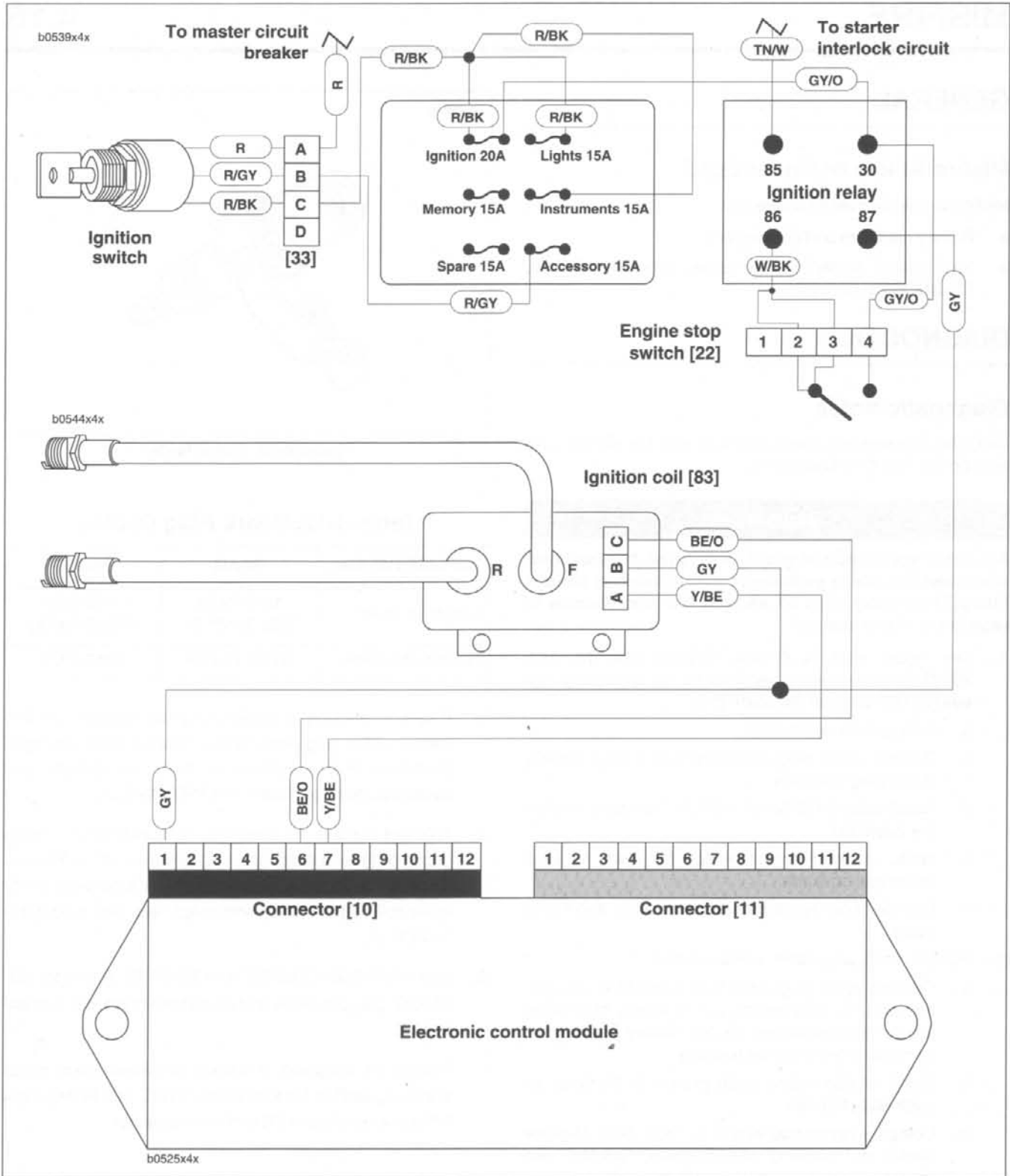
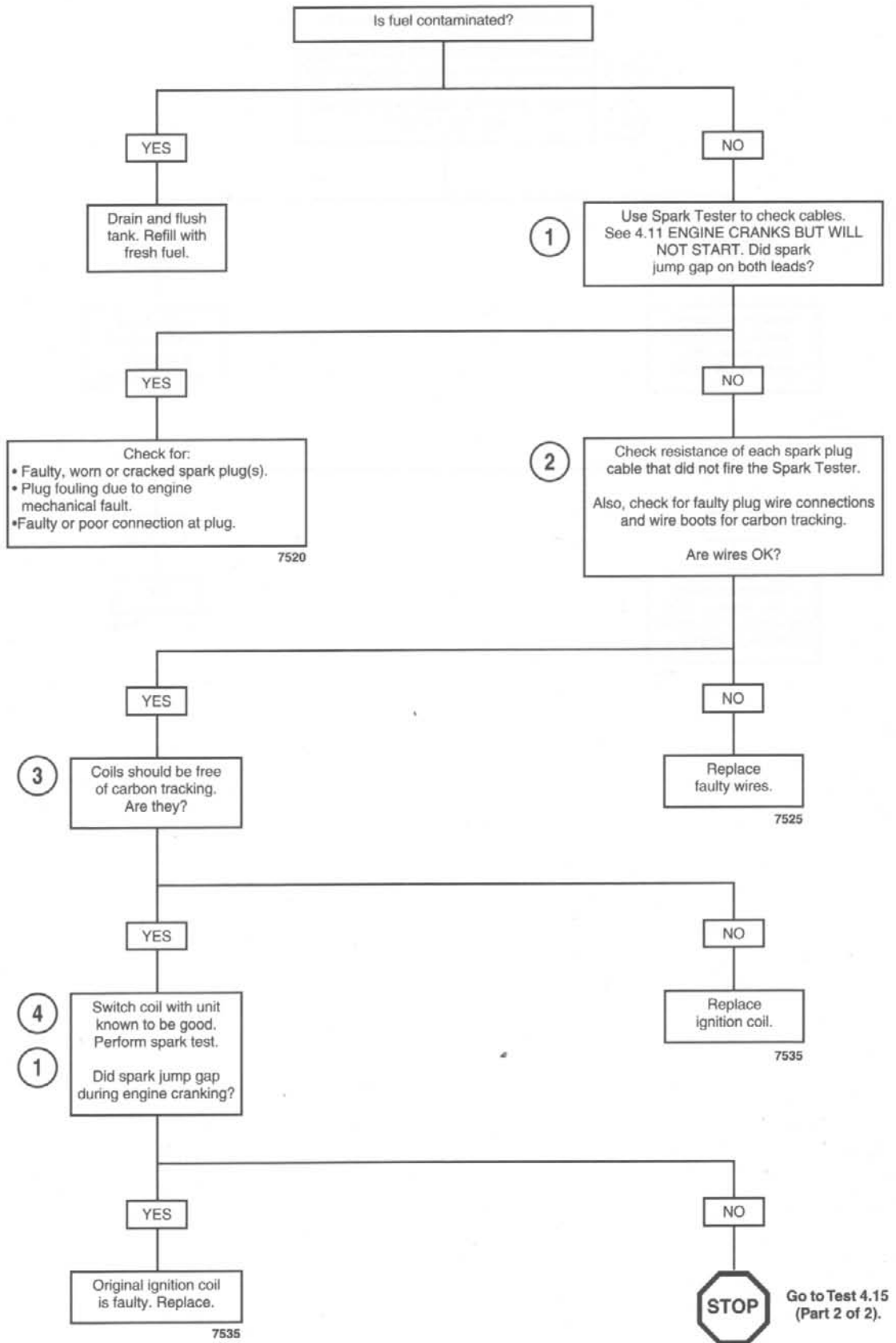


Figure 4-39. Ignition Coil Circuit

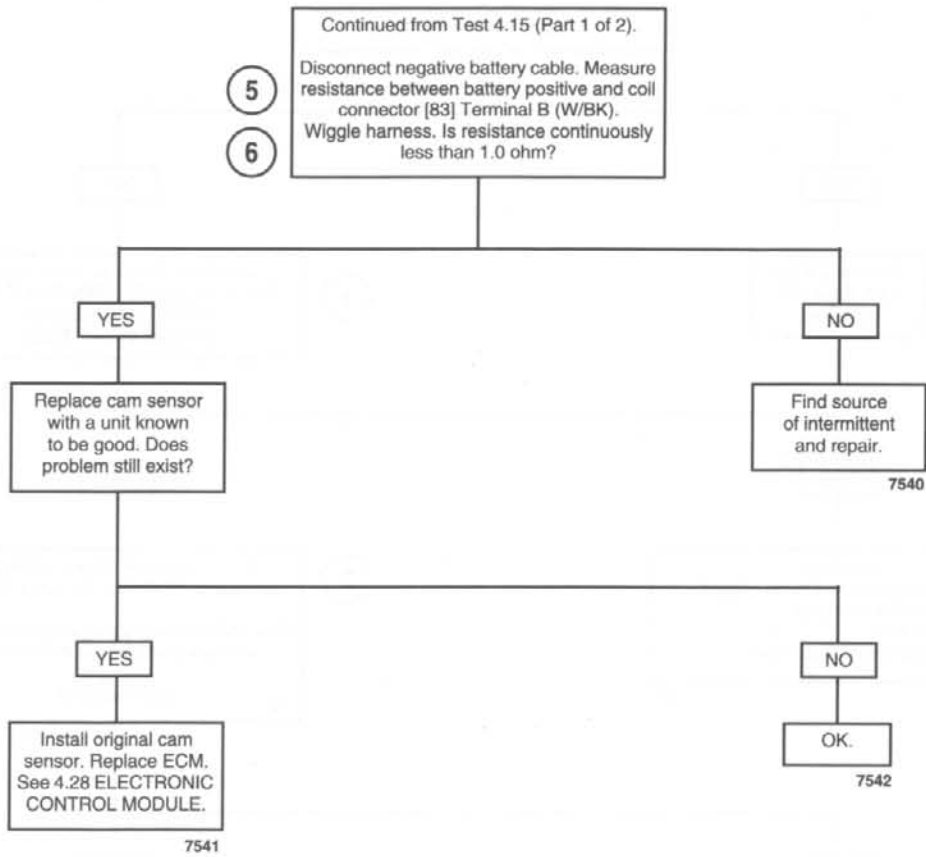
Table 4-13. Wire Harness Connectors in Figure 4-39.

NO.	DESCRIPTION	TYPE	LOCATION
[10]	ECM (black)	12-place Deutsch	under seat
[22]	Right handlebar switch	4-place	under fuel cell
[83]	Coil	3-place Packard	under fuel cell, left side

Test 4.15 (Part 1 of 2)



Test 4.15 (Part 2 of 2)



GENERAL

Throttle Position Sensor

See Figure 4-40. The throttle position sensor (TP sensor) is supplied 5.0 volts from the ECM (5v REF) and sends a signal back to the ECM (TP sensor signal) which varies according to throttle position. The output signal from the TP sensor varies from:

- 0.5-1.5 volts at idle (closed throttle).
- 3.9-4.9 volts at wide open throttle.

A Code 11 will set if the TP sensor signal voltage does not fall within the acceptable range.

NOTE

If the TP sensor is removed and/or replaced, the sensor must be calibrated using a Scanalyzer. See 4.33 THROTTLE POSITION SENSOR.

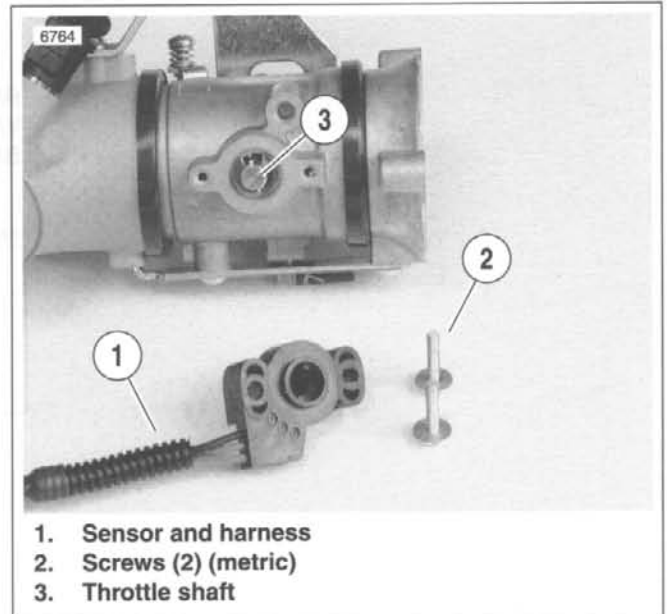


Figure 4-40. TP Sensor Assembly

DIAGNOSTICS

Diagnostic Tips

The Scanalyzer reads throttle position in degrees. TP sensor voltage should increase at a steady rate as throttle is moved from idle to wide open throttle. An open or short to ground in R/W or BK/W wires will also result in a Code 11.

Check for the following conditions:

- **Poor connection.** Inspect ECM harness connector for backed out terminals, improper mating, broken locks improperly formed or damaged terminals, poor terminal-to-wire connection and damaged harness.
- **Perform 4.7 WIGGLE TEST to locate intermittents.** If connections and harness check out OK, monitor TP sensor voltage using a Scanalyzer or DVOM while moving related connectors and wiring harness. If the failure is induced, the TP sensor display will change.
- **TP sensor scaling.** Observe the TP sensor voltage display while opening the throttle with engine stopped and ignition switch ON. Display should vary from closed throttle TP sensor voltage (when throttle is closed) to greater than 4.0 volts (when throttle is held wide open). As the throttle is **slowly** moved, the voltage should change gradually without spikes or low voltages being observed.

Scanalyzer Notes

The Scanalyzer icon appears at those points in the flow chart where the Scanalyzer can be used.

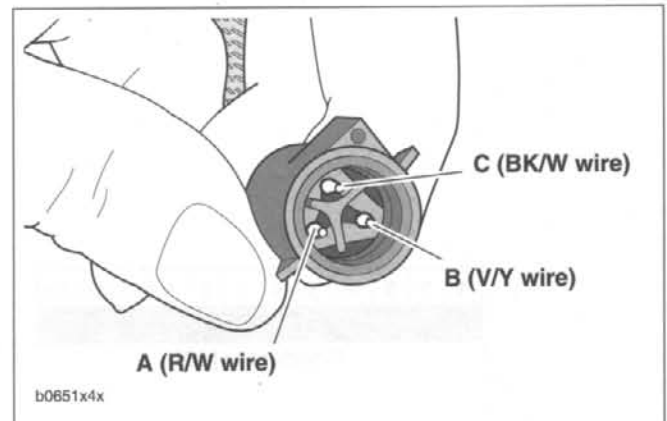


Figure 4-41. TP Sensor Terminals [88A]

Diagnostic Notes

The reference numbers below correlate with the circled numbers on the Code 11 flow charts.

1. Connect BREAKOUT BOX (Part No. HD-42682) to ECM. See 4.6 BREAKOUT BOX.
2. Use HARNESS CONNECTOR TEST KIT (Part No. HD-41404), black socket probe and patch cord.

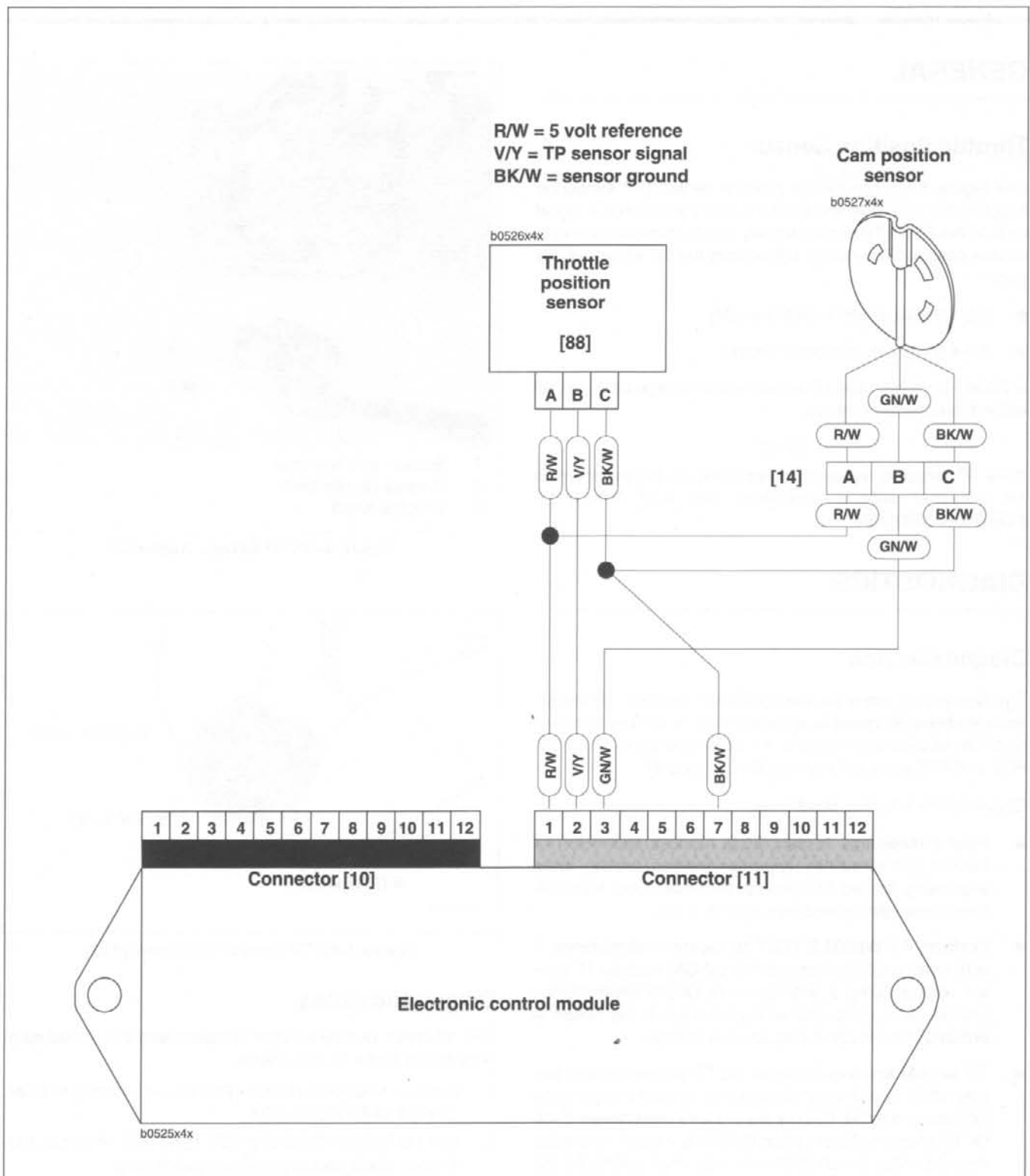
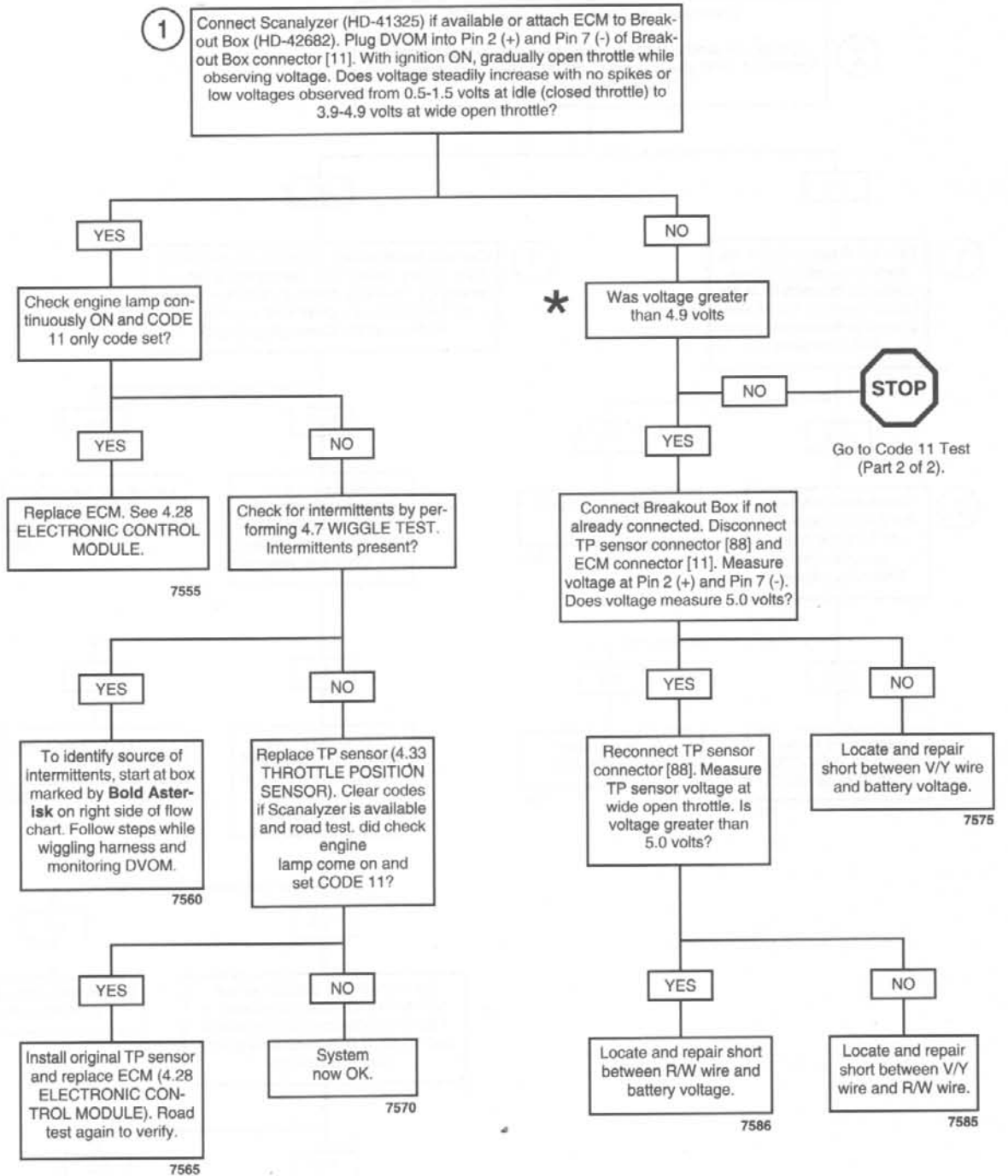


Figure 4-42. Throttle Position Sensor Circuit

Table 4-14. Wire Harness Connectors in Figure 4-42.

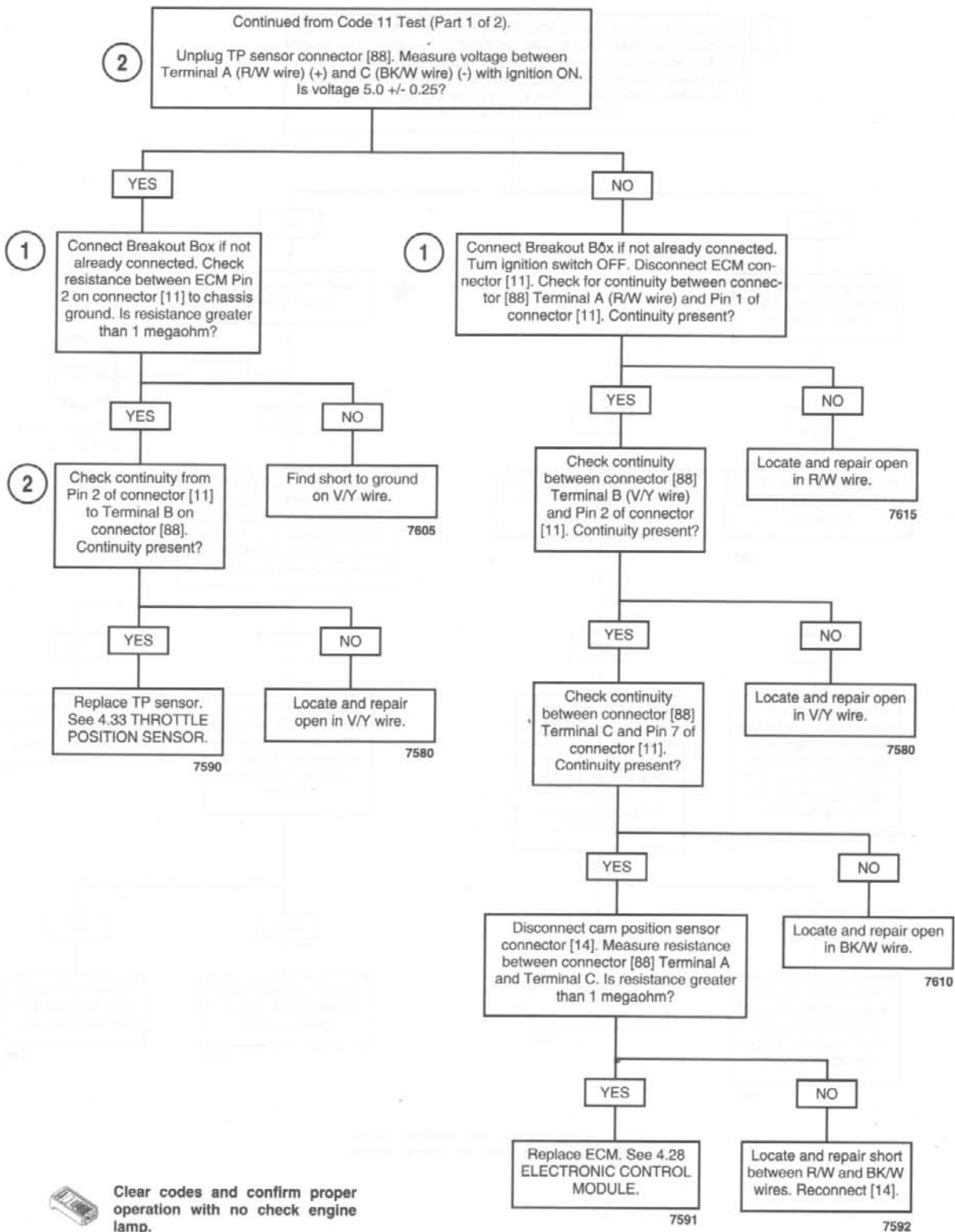
NO.	DESCRIPTION	TYPE	LOCATION
[11]	ECM (gray)	12-place Deutsch	under seat
[14]	Cam position sensor	3-place Deutsch	near starter
[88]	TP sensor	3-place Packard	behind air cleaner backplate

Code 11 Test (Part 1 of 2)



Clear codes and confirm proper operation with no check engine lamp.

Code 11 Test (Part 2 of 2)



Clear codes and confirm proper operation with no check engine lamp.

GENERAL

Oxygen (O₂) Sensor

See Figure 4-43. The oxygen (O₂) sensor provides a signal to the ECM which indicates whether or not the engine is running rich.

- A low voltage signal (<0.41 V) indicates the engine is running lean.
- A high voltage signal (>0.56 V) indicates the engine is running rich.

When the air/fuel mixture is ideal, approximately 14 parts air to 1 part fuel, the voltage will be approximately 0.48 V.

DIAGNOSTICS

Diagnostic Tips

The Scanalyzer or DVOM displays the signal from the O₂ sensor in volts. This voltage will have an average value tending towards lean, rich or ideal value depending on operating temperature of the engine, engine speed and throttle position. An open/short to voltage or short to ground in the V/GY wire will cause the engine to run rich (short to ground) or lean (short to voltage). The engine must be running at part throttle (2500 RPM) for the ECM to detect an O₂ sensor failure.

Check for the following conditions:

- **Poor connection.** Inspect the ECM harness connector [11], fuel injector connectors [84, 85] and O₂ sensor connector wiring for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wire connection and damaged harness.
- **Dirty/stuck open injectors.** The motorcycle may run lean (dirty/clogged injectors) or rich (stuck open injectors) if there is an injector problem. This could also cause poor fuel economy and performance.
- **Loose O₂ sensor.** See Figure 4-44. If the O₂ sensor is loose engine performance may be affected. This could also show up as a slow changing O₂ sensor voltage on the Scanalyzer.
- **Loose/leaking exhaust.** This can cause a poor ground connection for sensor or allow fresh air into the exhaust system. If fresh air enters exhaust system, the O₂ sensor will read a lean condition, causing the system to go rich.

Diagnostic Notes

1. Connect BREAKOUT BOX (Part No. HD-42682) to ECM. See 4.6 BREAKOUT BOX.

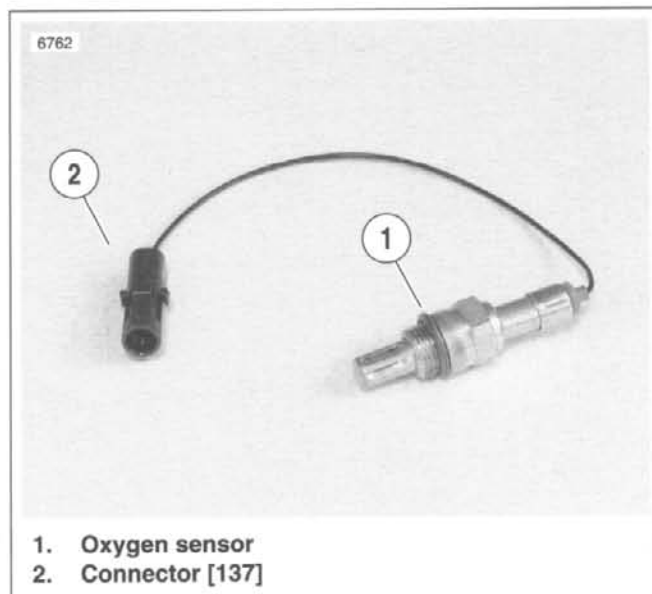


Figure 4-43. Oxygen Sensor

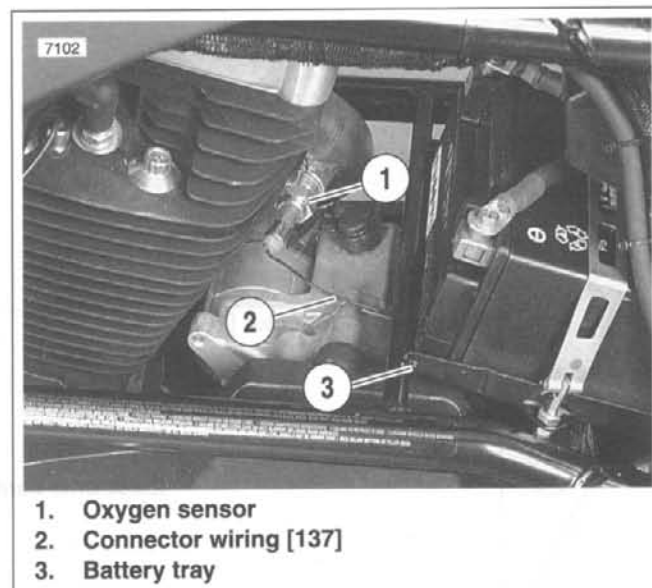


Figure 4-44. Oxygen Sensor Installed

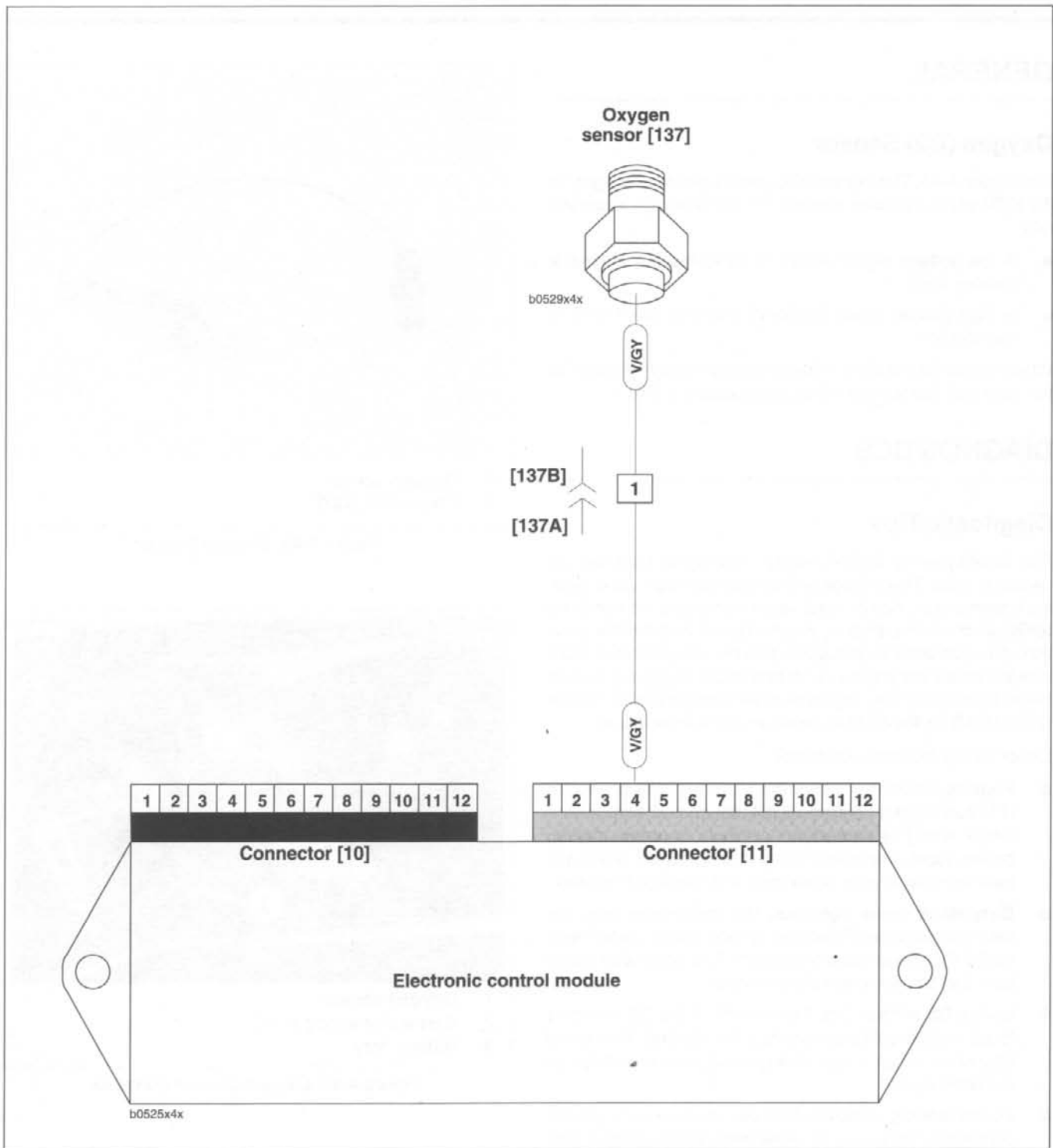
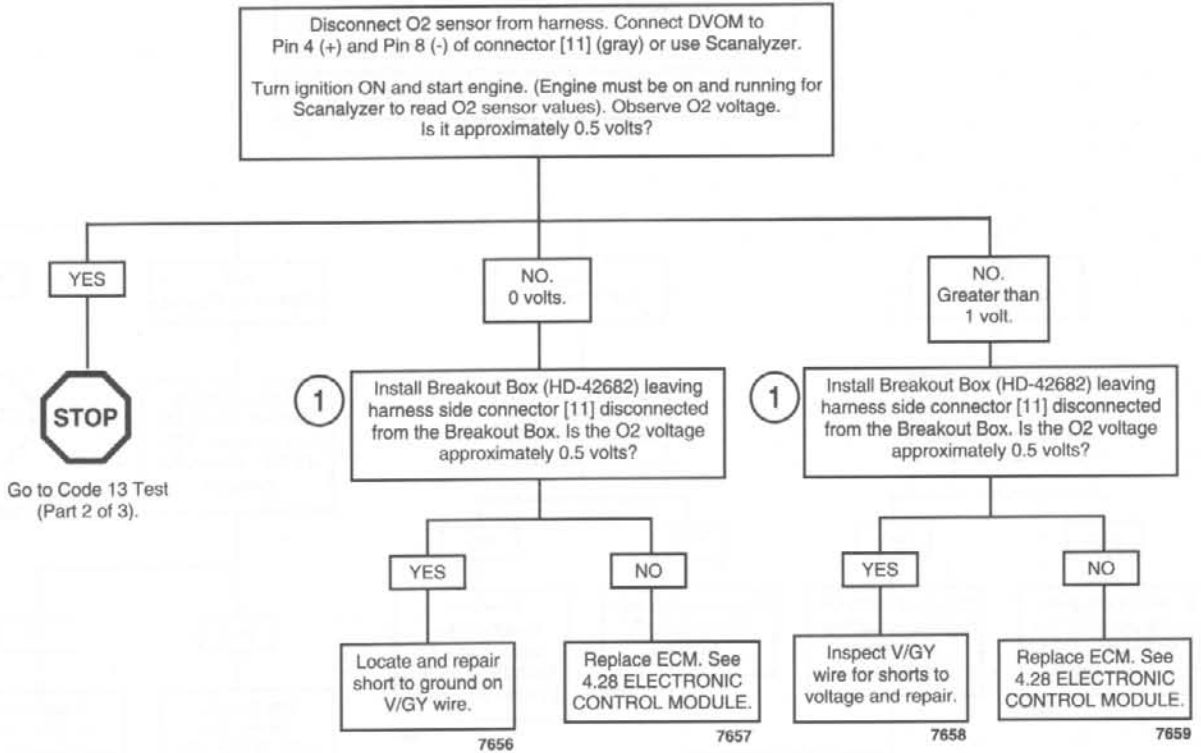


Figure 4-45. Oxygen Sensor Circuit

Table 4-15. Wire Harness Connectors in Figure 4-45.

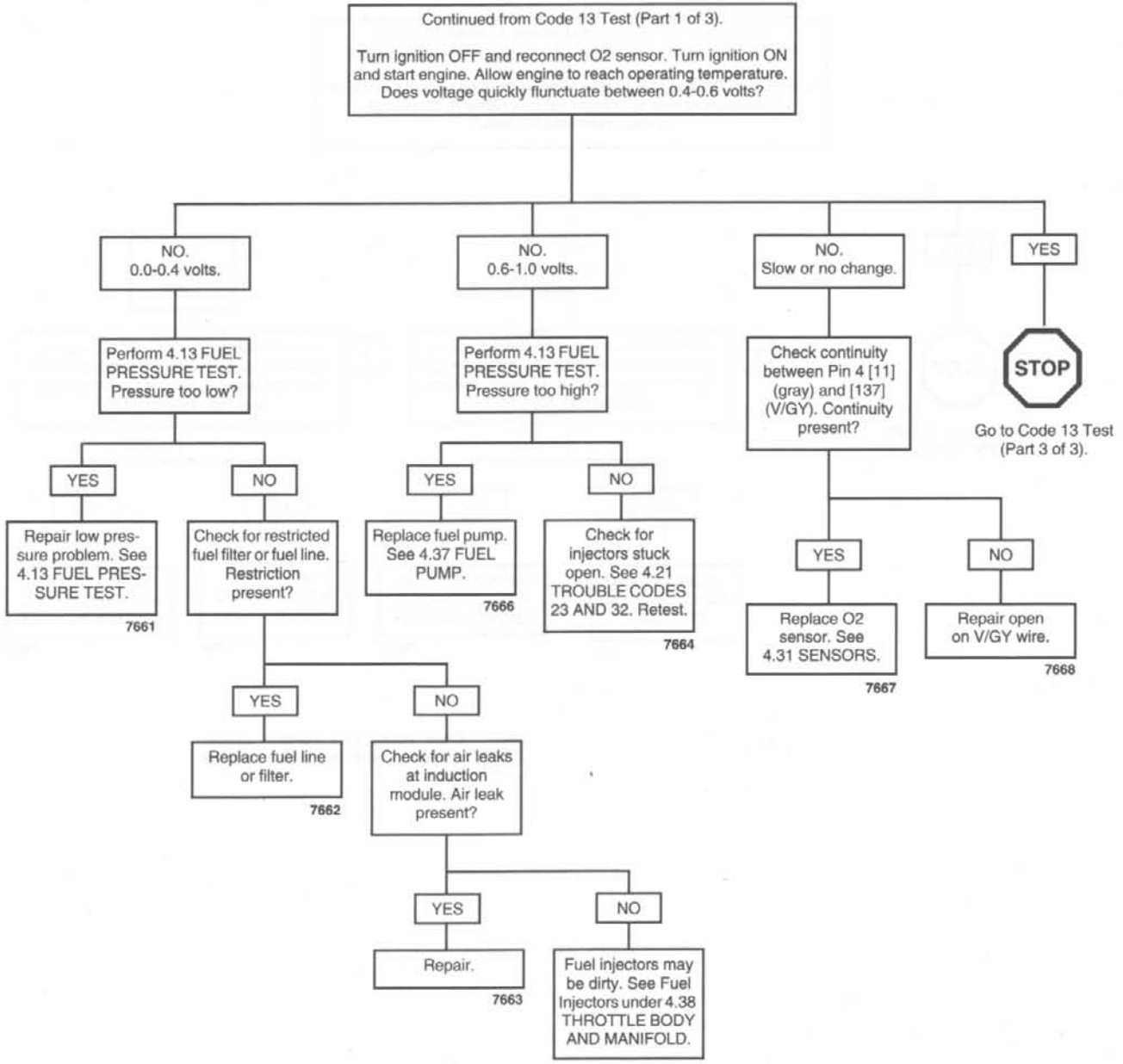
NO.	DESCRIPTION	TYPE	LOCATION
[11]	ECM (gray)	12-place Deutsch	under seat
[137]	Oxygen sensor	1-place	above starter

Code 13 Test (Part 1 of 3)



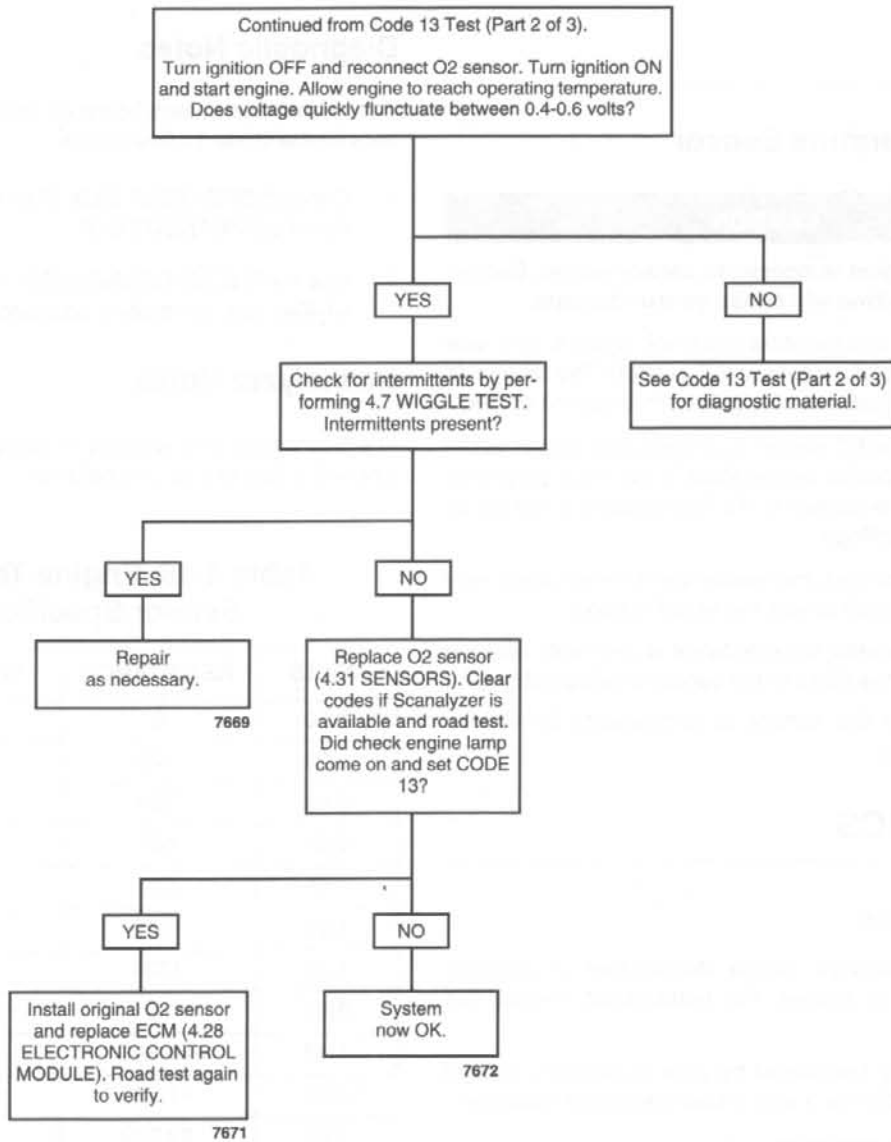
Clear codes and confirm proper operation with no check engine lamp.

Code 13 Test (Part 2 of 3)



Clear codes and confirm proper operation with no check engine lamp.

Code 13 Test (Part 3 of 3)



Clear codes and confirm proper operation with no check engine lamp.

GENERAL

Engine Temperature Sensor

CAUTION

Do not pull on engine temperature sensor wiring. Excess strain to sensor wiring will cause sensor damage.

The ECM supplies and monitors a 0-5 volt signal to one side of the engine temperature sensor (ET sensor). The other side of the ET sensor is connected to ground through the engine.

See Table 4-16. The ET sensor is a thermistor device which means that at a specific temperature it will have a specific resistance across its terminals. As this resistance varies, so does the supplied voltage.

- At high temperatures, the resistance of the sensor is very low. This effectively lowers the signal voltage.
- At low temperatures, the resistance is very high, allowing the voltage to rise close to the supplied voltage of 5 volts.

The ECM monitors this voltage to compensate for various operating conditions.

DIAGNOSTICS

Diagnostic Tips

The Scanalyzer displays engine temperature in degrees. Once the engine is started, the temperature should rise steadily.

An intermittent may be caused by poor connection, rubbed through wire insulation or a wire broken inside the insulation.

Check the following conditions:

- **Poor connection.** Inspect ECM harness connector [11] for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wire connection and damaged harness.
- **Shifted sensor.** The temperature-to-resistance values table may be used to test the ET sensor at various temperature levels in order to evaluate the possibility of a shifted (out-of-calibration) sensor which may result in driveability problems.

Diagnostic Notes

The reference numbers below correlate with the circled numbers on the Code 14 flow charts.

1. Connect BREAKOUT BOX (Part No. HD-42682) to ECM. See 4.6 BREAKOUT BOX.
2. Use HARNESS CONNECTOR TEST KIT (Part No. HD-41404), gray pin probes and patch cord.

Scanalyzer Notes

The Scanalyzer icon appears at those points in the flow chart where the Scanalyzer can be used.

Table 4-16. Engine Temperature Sensor Specifications

VOLTS	RESISTANCE	TEMP °C	TEMP °F
0.00	0	300	572
0.21	145	255	491
0.42	303	210	410
0.62	463	190	374
0.81	638	170	338
1.20	1042	150	302
1.59	1539	130	266
3.01	4991	85	185
4.43	25,647	40	104
4.63	41,295	25	77
4.83	93,759	10	50
4.88	134,200	0	32
4.93	232,414	-10	14

NOTE

All voltage and resistance values are approximate (+/- 20%). Engine temperature sensor is measured between Terminal 9 of connector [11] and system ground (Terminals 2 and 11 of connector [10]).

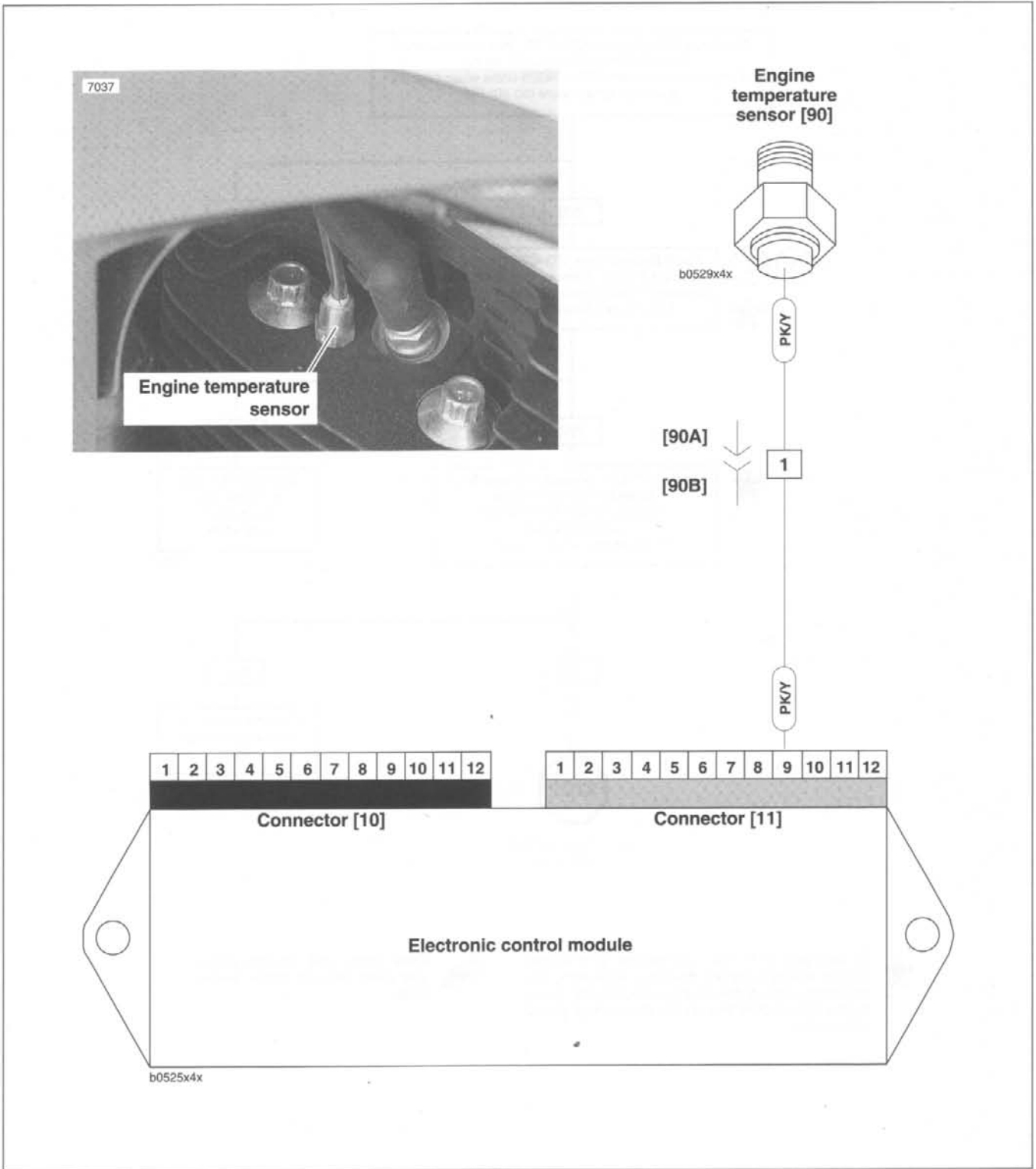
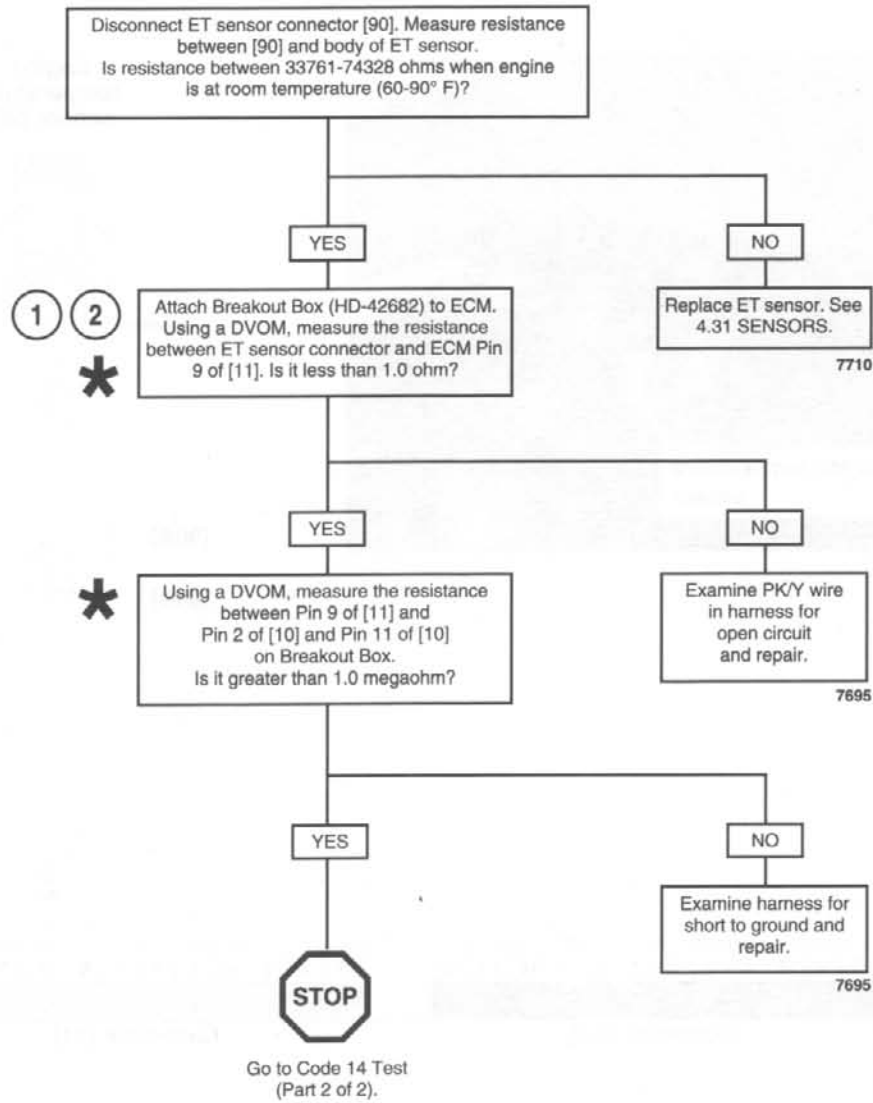


Figure 4-46. Engine Temperature Sensor Circuit

Table 4-17. Wire Harness Connectors in Figure 4-46.

NO.	DESCRIPTION	TYPE	LOCATION
[11]	ECM (gray)	12-place Deutsch	under seat
[90]	Engine temperature sensor	1-place bullet	above rear cylinder head, left side

Code 14 Test (Part 1 of 2)



***** At some point in the flow chart you may be instructed to jump directly to the box marked by an asterisk. Disregard the asterisk (but not the instruction box) if your normal progression through the chart brings you to this location.

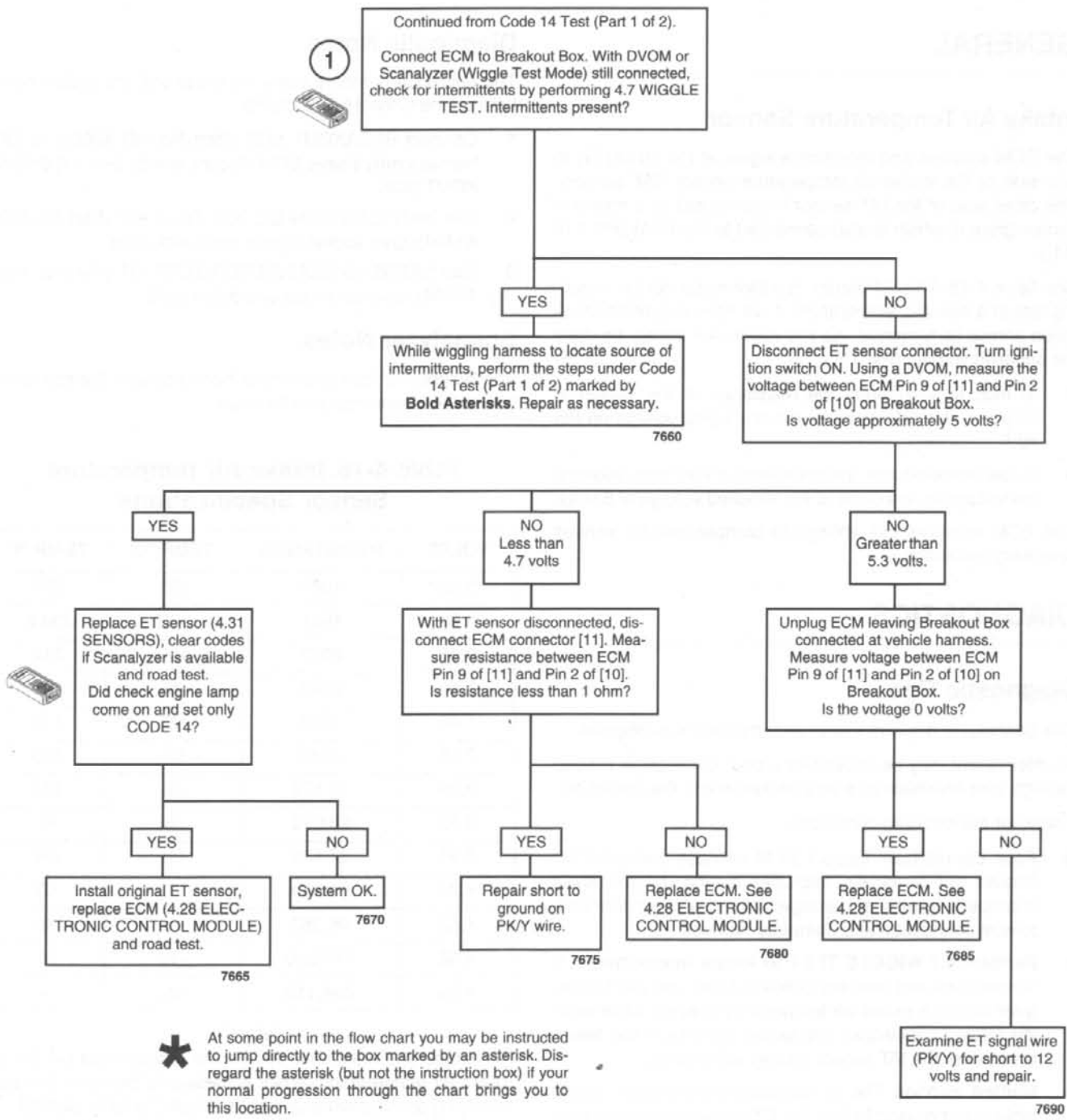


Clear codes and confirm proper operation with no check engine lamp.

Code 14 Test (Part 2 of 2)

TRUBLE CODE 12

GENERAL



***** At some point in the flow chart you may be instructed to jump directly to the box marked by an asterisk. Disregard the asterisk (but not the instruction box) if your normal progression through the chart brings you to this location.

Clear codes and confirm proper operation with no check engine lamp.

GENERAL

Intake Air Temperature Sensor

The ECM supplies and monitors a signal at Pin 10 of [11] to one side of the intake air temperature sensor (IAT sensor). The other side of the IAT sensor is connected to a common sensor ground, which is also connected to the ECM (Pin 7 of [11]).

See Table 4-18. The IAT sensor is a thermistor device, meaning that at a specific temperature, it will have a specific resistance across its terminals. As this resistance varies, so does the supplied voltage (Pin 10).

- At high temperatures, the resistance of the sensor is very low. This effectively lowers the signal voltage on Pin 10.
- At low temperatures, the resistance is very high, allowing the voltage to rise close to the supplied voltage of 5 volts.

The ECM monitors this voltage to compensate for various operating conditions.

DIAGNOSTICS

Diagnostic Tips

The Scanalyzer displays intake air temperature in degrees.

An intermittent may be caused by a poor connection, rubbed through wire insulation or a wire broken inside the insulation.

Check for the following conditions:

- **Poor connection.** Inspect ECM harness connector for backed out terminals, improper mating, broken locks improperly formed or damaged terminals, poor terminal-to-wire connection and damaged harness.
- **Perform 4.7 WIGGLE TEST to locate intermittents.** If connections and harness check out OK, use the Scanalyzer to check intake air temperature reading while moving related connectors and wiring harness. If the failure is induced, the IAT sensor display will change.
- **Shifted sensor.** The temperature-to-resistance values table may be used to test the ET sensor at various temperature levels in order to evaluate the possibility of a shifted (out-of-calibration) sensor which may result in driveability problems.

Diagnostic Notes

The reference numbers below correlate with the circled numbers on the Code 15 flow charts.

1. Connect BREAKOUT BOX (Part No. HD-42682) to EFI harness **only** (leave ECM disconnected). See 4.6 BREAKOUT BOX.
2. Use HARNESS CONNECTOR TEST KIT (Part No. HD-41404), gray socket probes and patch cord.
3. Use HARNESS CONNECTOR TEST KIT (Part No. HD-41404), gray pin probe and patch cord.

Scanalyzer Notes

The Scanalyzer icon appears at those points in the flow chart where the Scanalyzer can be used.

Table 4-18. Intake Air Temperature Sensor Specifications

VOLTS	RESISTANCE	TEMP °C	TEMP °F
0.49	1086	125	257
0.68	1561	113	234.5
0.86	2077	100	212
1.13	2920	90	194
1.40	3889	80	176
2.25	8149	60	140
3.09	16,178	40	104
3.52	23,670	30	86
3.94	37,170	20	68
4.24	55,359	10	50
4.53	96,383	0	32
4.68	146,250	-10	14
4.83	284,118	-20	-4

NOTE

All voltage and resistance values are approximate (+/- 20%). Intake air temperature sensor is measured between Terminal 10 of [11] and system ground (Terminals 2 and 11 of [10]).

Lt GN/Y = 5 volt reference and sensor signal
 BK/W = sensor ground

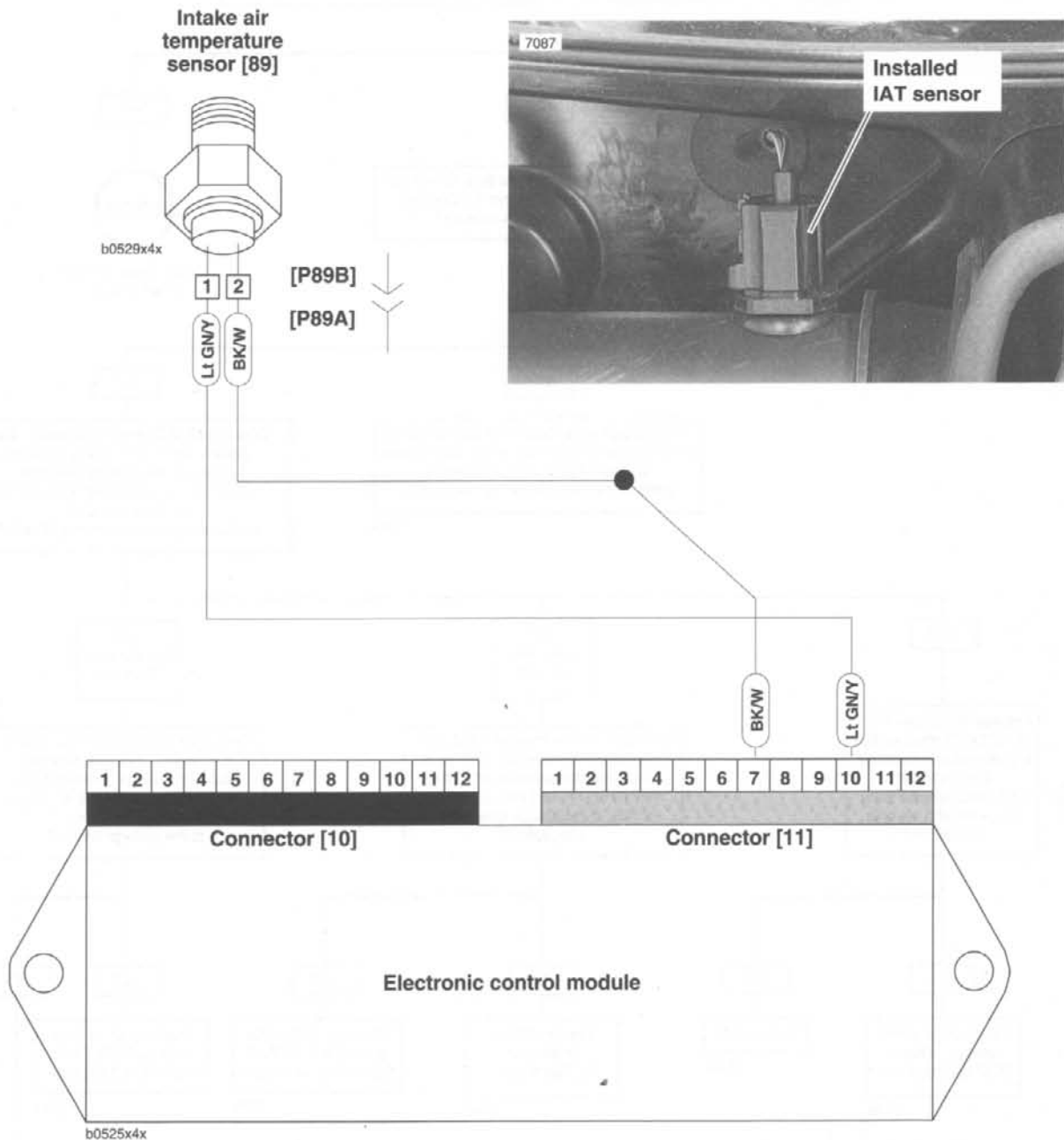
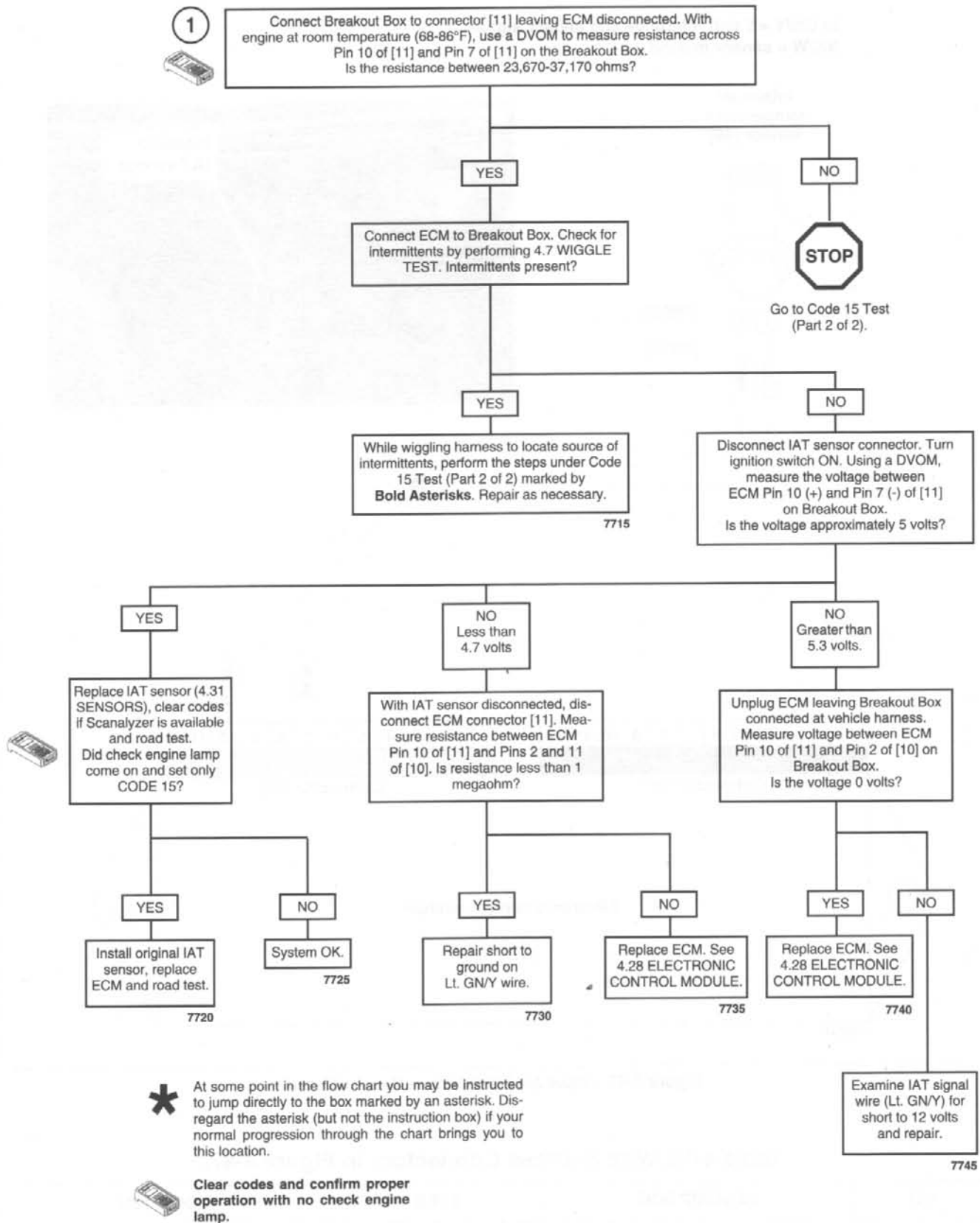


Figure 4-47. Intake Air Temperature Sensor Circuit

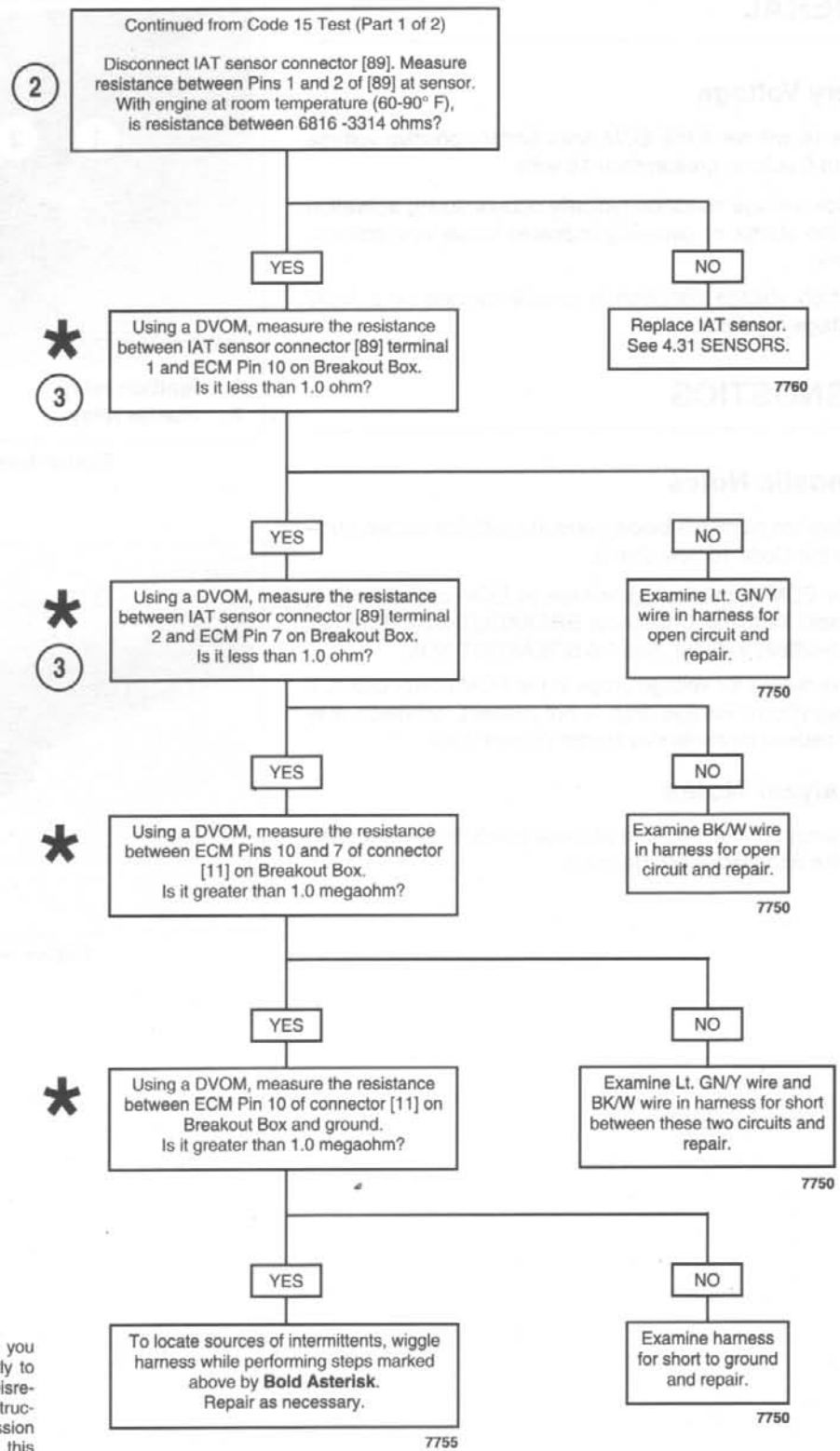
Table 4-19. Wire Harness Connectors in Figure 4-47.

NO.	DESCRIPTION	TYPE	LOCATION
[11]	ECM (gray)	12-place Deutsch	under seat
[89]	IAT sensor	2-place Deutsch	behind air cleaner backplate

Code 15 Test (Part 1 of 2)



Code 15 Test (Part 2 of 2)



At some point in the flow chart you may be instructed to jump directly to the box marked by an asterisk. Disregard the asterisk (but not the instruction box) if your normal progression through the chart brings you to this location.



Clear codes and confirm proper operation with no check engine lamp.

GENERAL

Battery Voltage

A Code 16 will set if the ECM sees battery positive voltage less than 6 volts or greater than 18 volts.

- A low voltage condition typically occurs during activation of the starter or generally indicates loose wire connections.
- A high voltage condition is usually caused by a faulty voltage regulator.

DIAGNOSTICS

Diagnostic Notes

The reference numbers below correlate with the circled numbers on the Code 16 flow charts.

1. The ECM is monitoring voltage at ECM connector [10] (black) Terminal 1. Connect BREAKOUT BOX (Part No. HD-42682) to ECM. See 4.6 BREAKOUT BOX.
2. This checks for voltage drops in the ECM power circuit. If a significant voltage drop is not present, condition may be caused by excessive starter current draw.

Scanalyzer Notes

The Scanalyzer icon appears at those points in the flow chart where the Scanalyzer can be used.

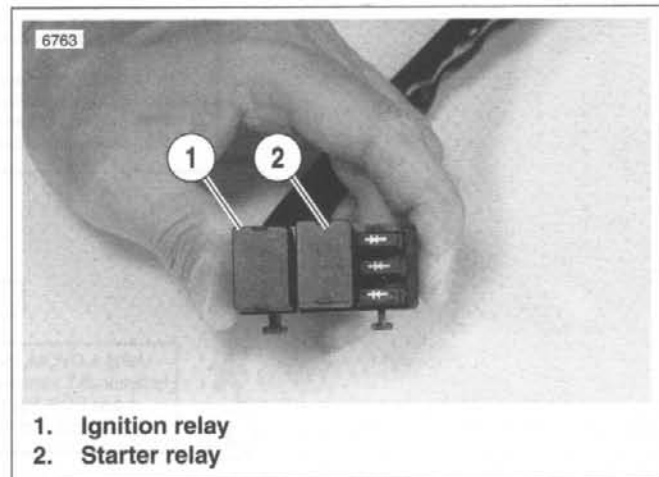


Figure 4-48. Electrical Relays

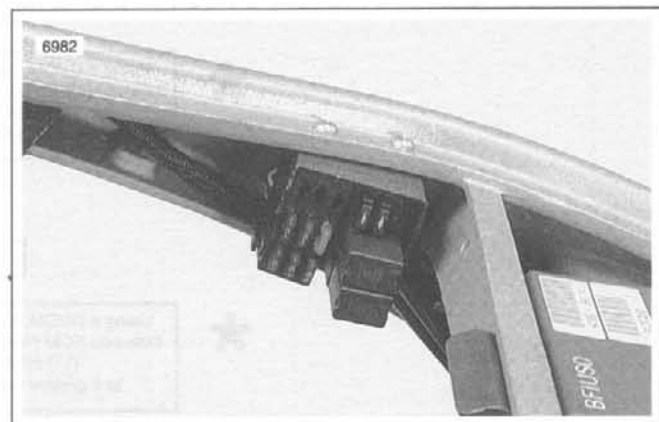


Figure 4-49. Fuse Holder

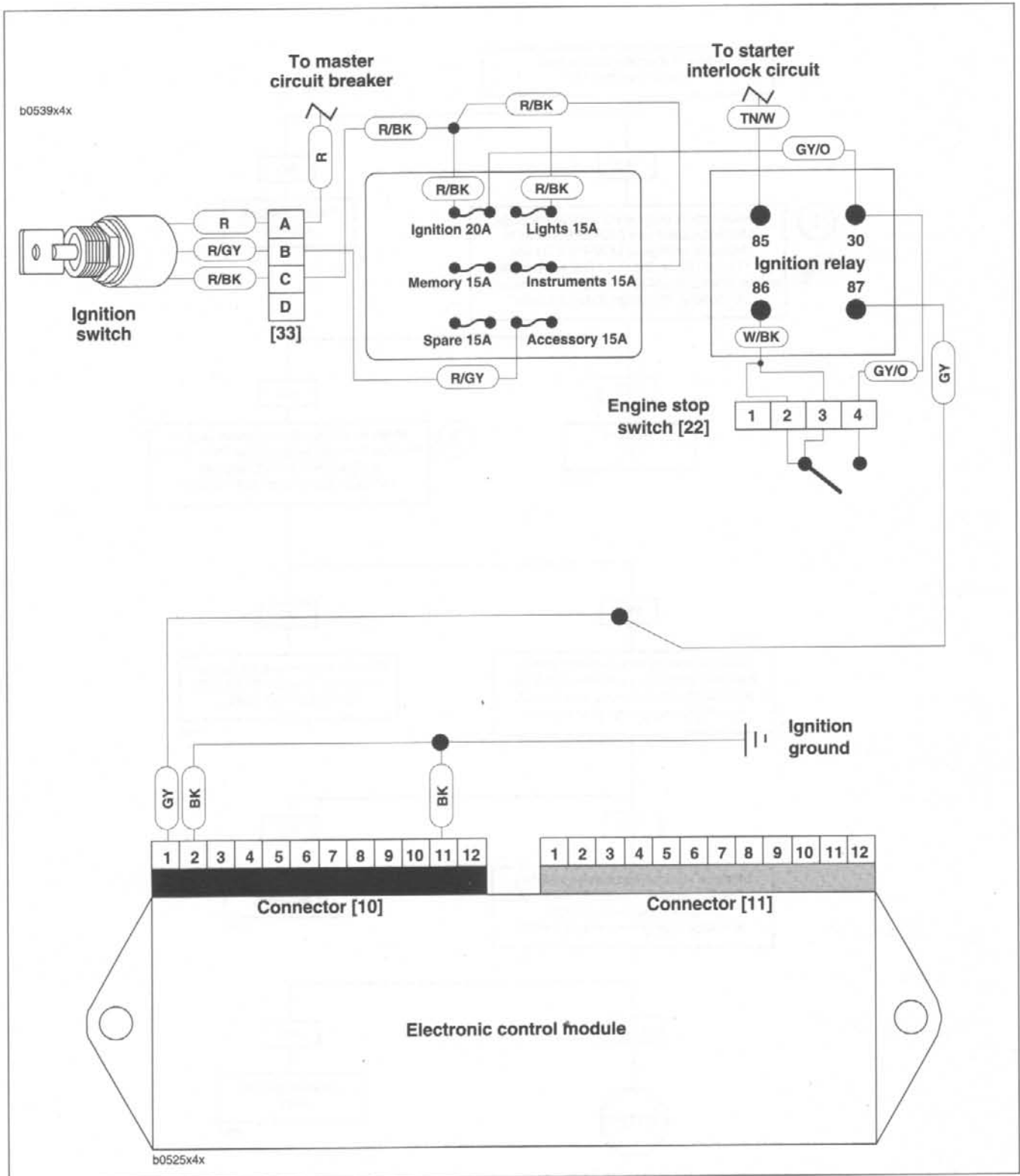
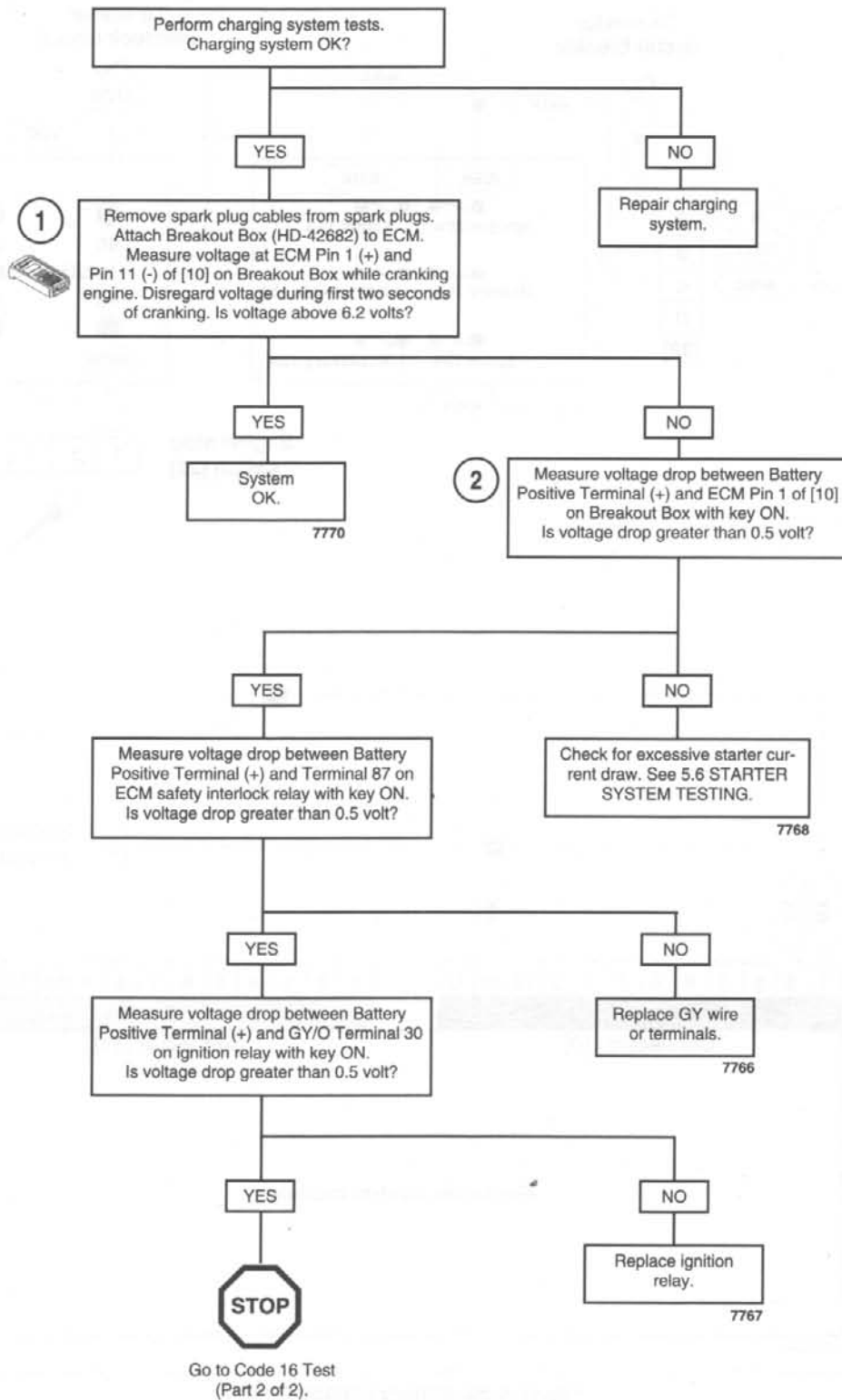


Figure 4-50. Battery Voltage Circuit

Table 4-20. Wire Harness Connectors in Figure 4-50.

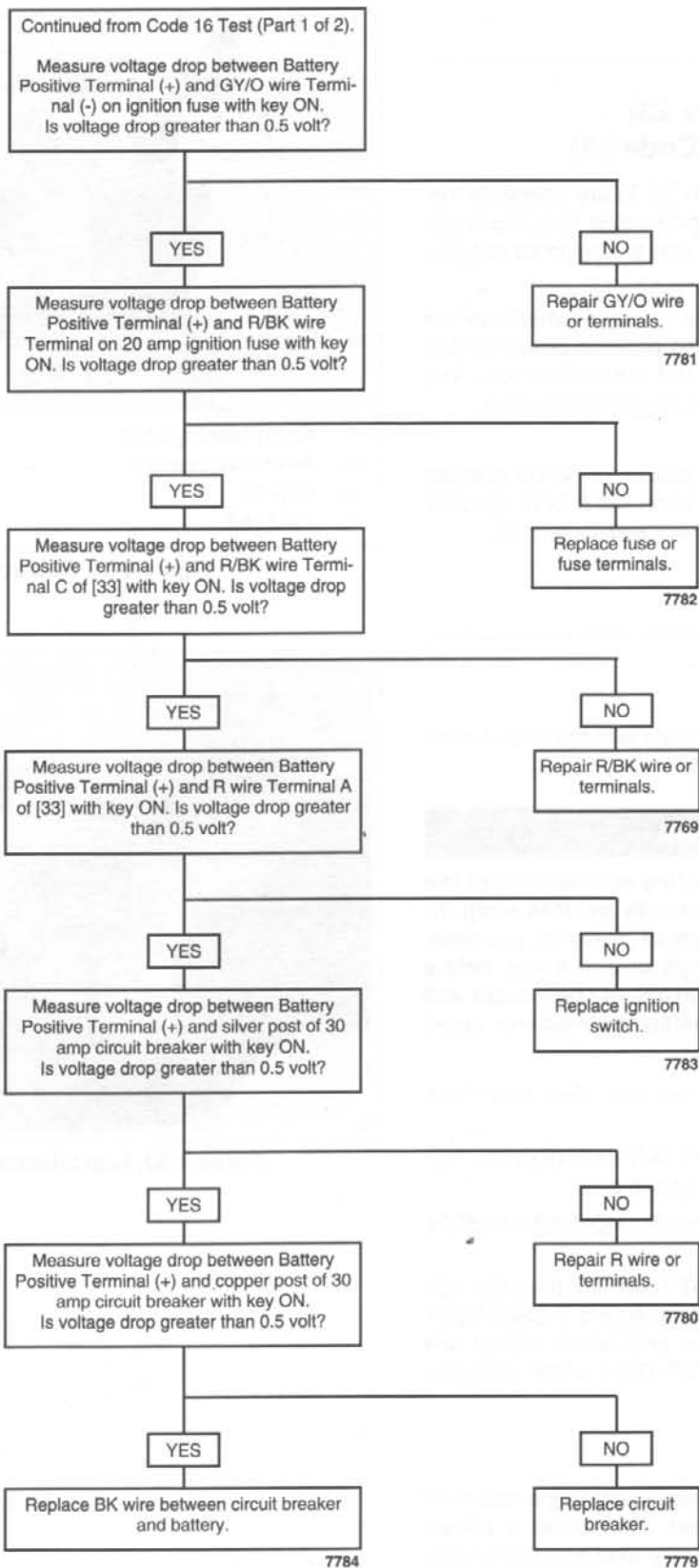
NO.	DESCRIPTION	TYPE	LOCATION
[10]	ECM (black)	12-place Deutsch	under seat

Code 16 Test (Part 1 of 2)



Clear codes and confirm proper operation with no check engine lamp.

Code 16 Test (Part 2 of 2)



Clear codes and confirm proper operation with no check engine lamp.

GENERAL

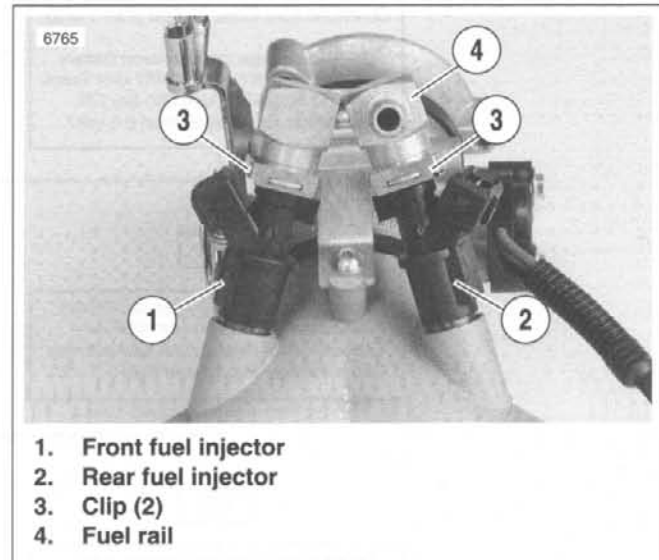
Front Fuel Injector (Code 23) And Rear Fuel Injector (Code 32)

See Figure 4-51. The fuel injectors (1, 2) are solenoids that allow pressurized fuel into the engine intake tract. The injectors are timed to the engine cycle and are triggered sequentially.

See Figure 4-52. The power for the injectors comes from the ignition relay. The ignition relay also provides power for fuel pump, ECM, bank angle sensor and the ignition coils. The ECM provides the path to ground to trigger the injectors.

NOTE

System fuse and ignition relay failures or wiring harness problems will cause 12 volt power to be lost to both injectors, ignition coils, ECM, bank angle sensor and fuel pump.



1. Front fuel injector
2. Rear fuel injector
3. Clip (2)
4. Fuel rail

Figure 4-51. Fuel Injectors

DIAGNOSTICS

Diagnostic Notes

The reference numbers below correlate with the circled numbers on the Code 23/32 flow charts.

⚠ WARNING

The gasoline in the fuel supply line downstream of the fuel pump is under high pressure (49 psi [338 kPa]). To avoid an uncontrolled discharge or spray of gasoline, always purge the system of high pressure gas before removing fuel tank. Gasoline is extremely flammable and highly explosive. Inadequate safety precautions could result in death or serious injury.

1. Purge fuel line and remove fuel tank. See 4.34 FUEL TANK.
2. Use HARNESS CONNECTOR TEST KIT (Part No. HD-41404), purple pin probes and patch cord.
3. Connect BREAKOUT BOX (Part No. HD-42682) to ECM. See 4.6 BREAKOUT BOX.
4. Use HARNESS CONNECTOR TEST KIT (Part No. HD-41404), purple pin probes and patch cord to BREAKOUT BOX (Part No. HD-42682) and gray socket probes and patch cord to FUEL INJECTOR TEST LAMP (Part No. HD-34730-2C).



Figure 4-52. Fuel Injector Connector

Scanalyzer Notes

The Scanalyzer icon appears at those points in the flow chart where the Scanalyzer can be used. If a number is printed next to the icon, then refer to the Scanalyzer notes at the bottom of the flow chart.

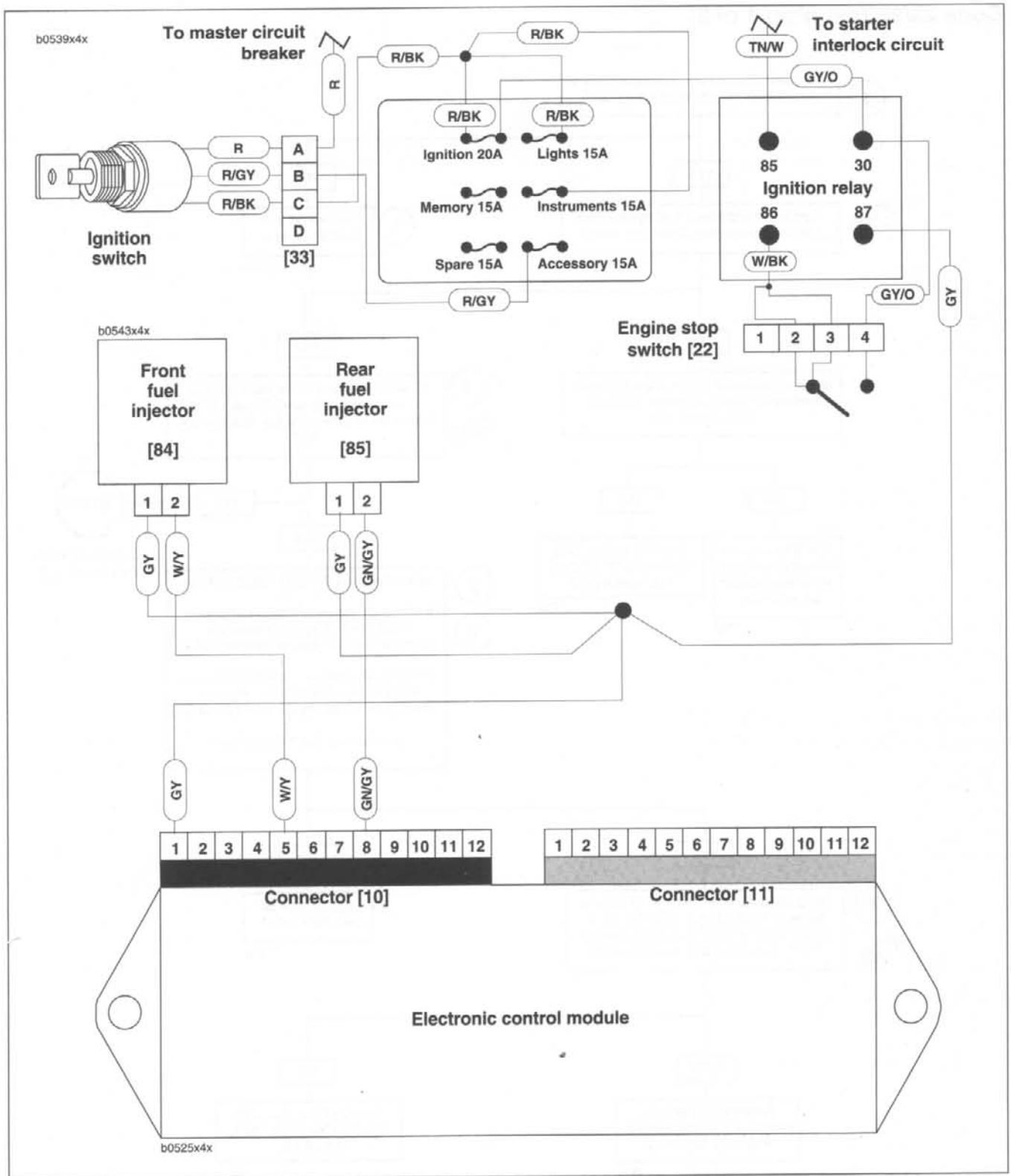
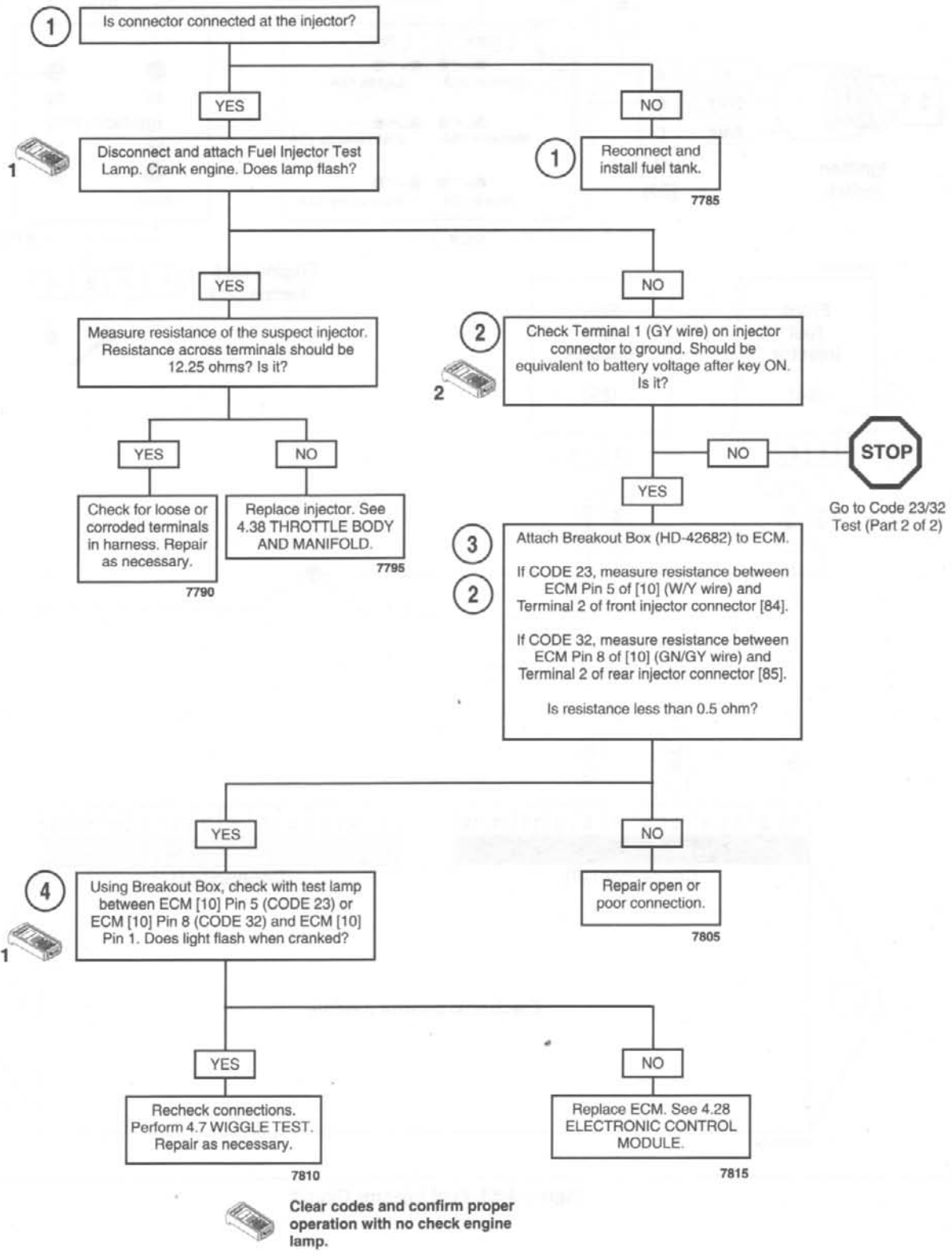


Figure 4-53. Fuel Injector Circuit

Table 4-21. Wire Harness Connectors in Figure 4-53.

NO.	DESCRIPTION	TYPE	LOCATION
[10]	ECM (black)	12-place Deutsch	under seat
[84]	Front injector	2-place	under fuel cell
[85]	Rear injector	2-place	under fuel cell

Code 23/32 Test (Part 1 of 2)

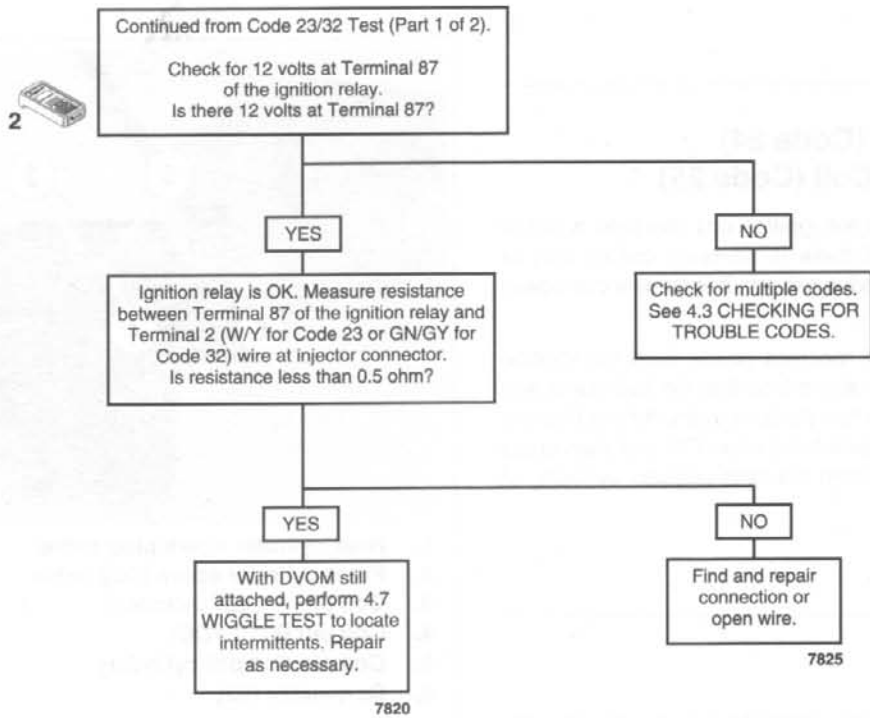


SCANALYZER NOTES

1 With the engine off, Scanalyzer (Active Diagnostic Test Mode) can be used to energize either the front or rear injector once each second for a total of five seconds.

2 With the engine off, Scanalyzer (Active Diagnostic Test Mode) can be used to turn fuel pump on for periods up to 30 seconds. Power to the pump also includes power to the fuel injectors and ignition coil.

Code 23/32 Test (Part 2 of 2)



Clear codes and confirm proper operation with no check engine lamp.

SCANALYZER NOTES



With the engine off, Scanalyzer (Active Diagnostic Test Mode) can be used to energize either the front or rear injector once each second for a total of five seconds.



With the engine off, Scanalyzer (Active Diagnostic Test Mode) can be used to turn fuel pump on for periods up to 30 seconds. Power to the pump also includes power to the fuel injectors and ignition coil.

GENERAL

**Front Ignition Coil (Code 24)
And Rear Ignition Coil (Code 25)**

A Code 24 or 25 will set if the ignition coil rise time is out of range. This could occur if there is an open coil or loss of power to the coil. If both codes are set, it is likely a coil power failure or a coil failure.

See Figure 4-54. The coil receives power from the ignition relay at coil pin B (4) at the same time that the fuel pump and injectors are activated. The fuel pump is active for the first two seconds after the ignition switch is turned ON and then shuts off until RPM is detected from the cam position sensors, at which time it is reactivated.

DIAGNOSTICS

Diagnostic Notes

The reference numbers below correlate with the circled numbers on the Code 24/25 flow charts.

1. Use HARNESS CONNECTOR TEST KIT (Part No. HD-41404), purple pin probes and patch cord.
2. Connect BREAKOUT BOX (Part No. HD-42682) to ECM. See 4.6 BREAKOUT BOX.

Scanalyzer Notes

The Scanalyzer icon appears at those points in the flow chart where the Scanalyzer can be used. If a number is printed next to the icon, then refer to the Scanalyzer notes at the bottom of the flow chart.

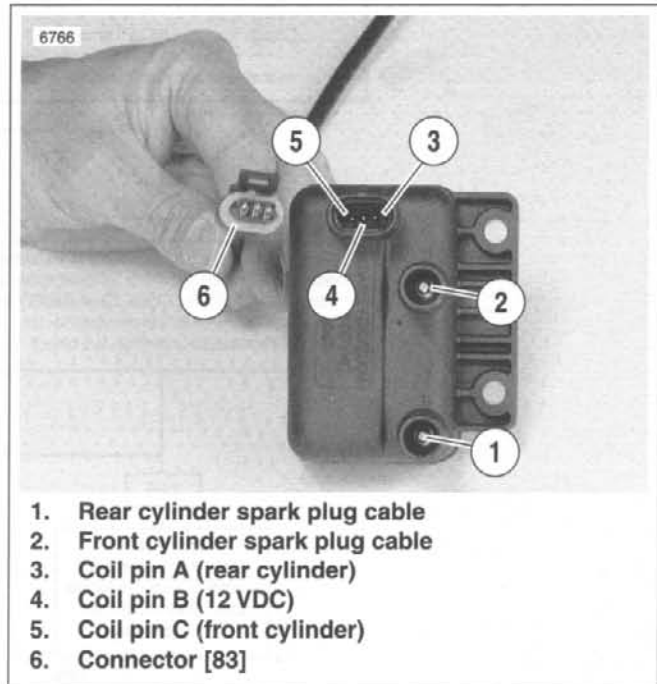


Figure 4-54. Ignition Coil

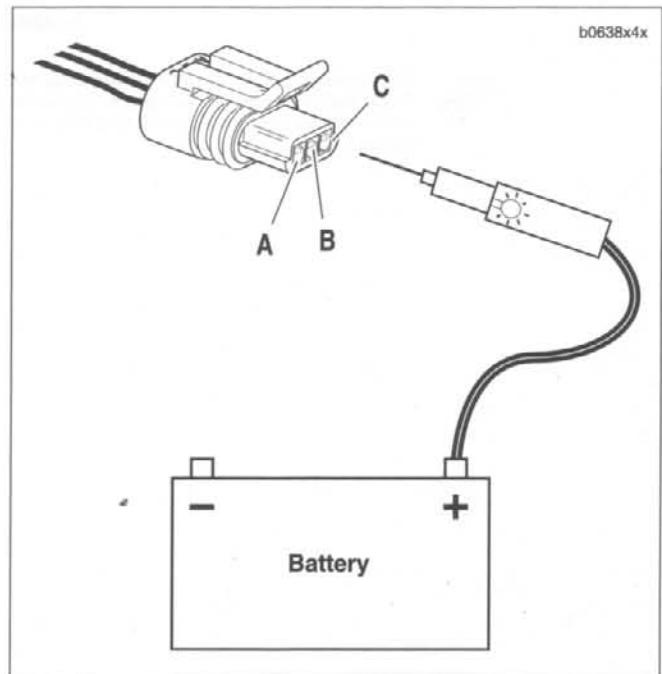


Figure 4-55. Testing Ignition Coil Connectors

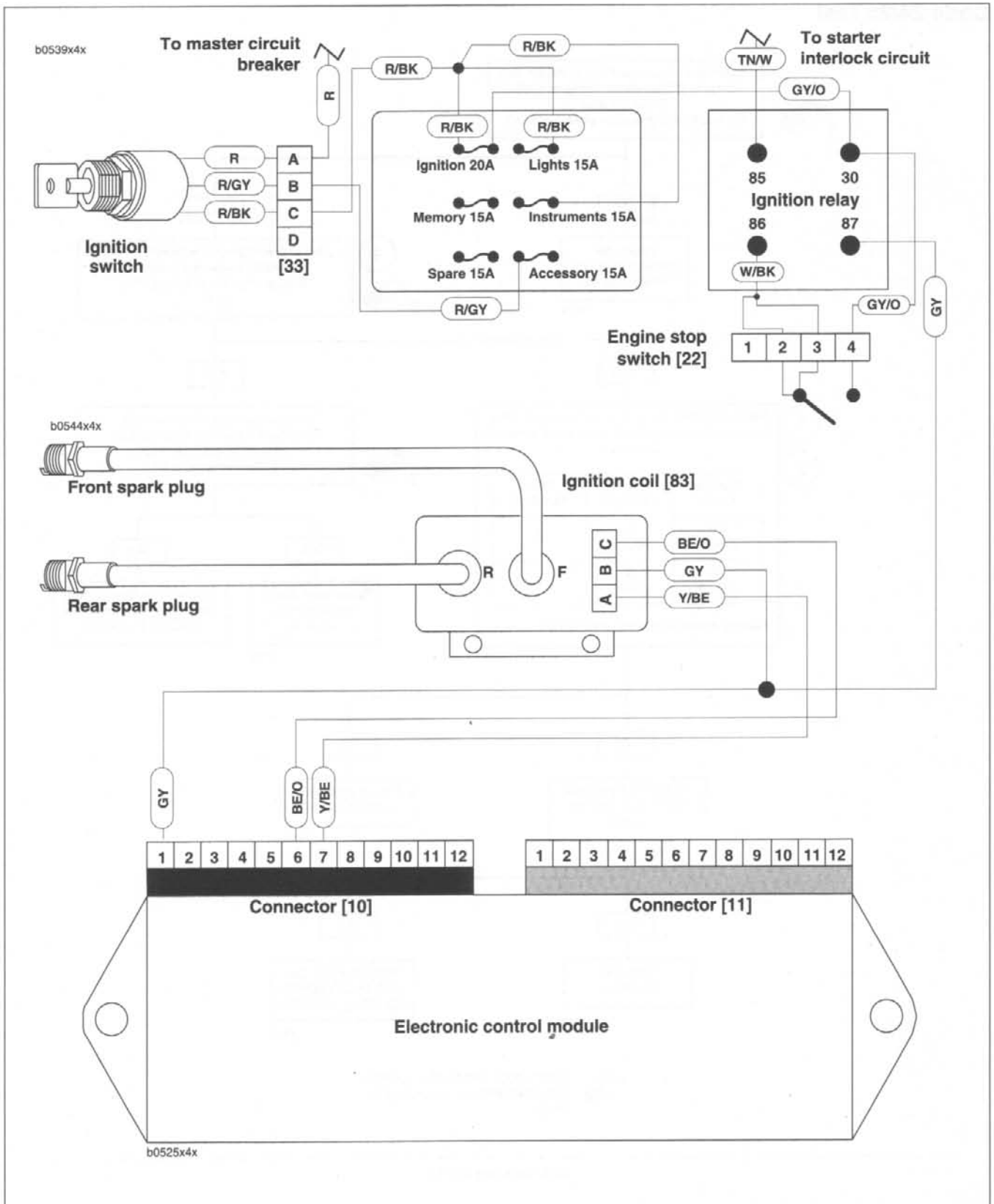
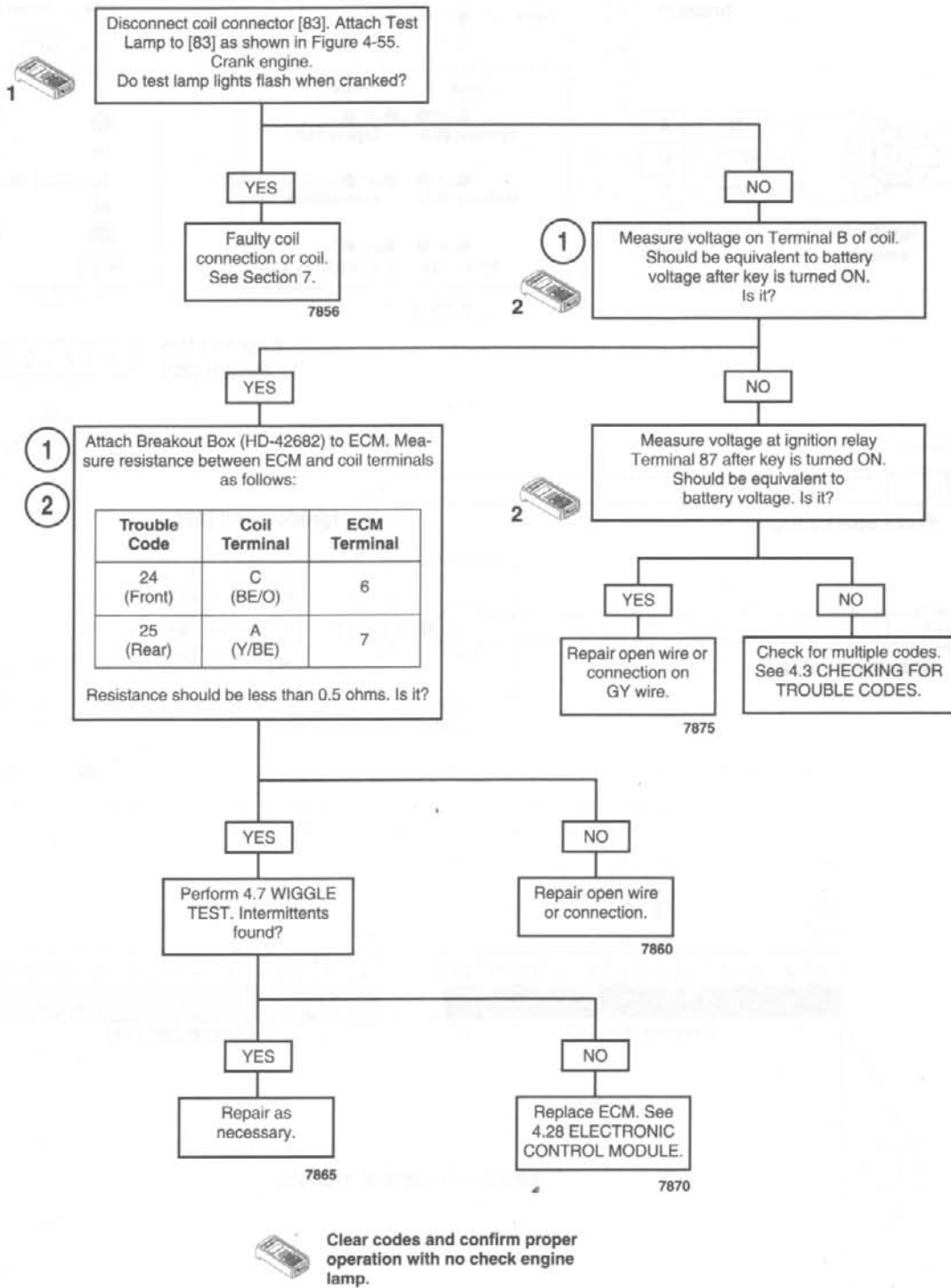


Figure 4-56. Ignition Coil Circuit

Table 4-22. Wire Harness Connectors in Figure 4-56.

NO.	DESCRIPTION	TYPE	LOCATION
[10]	ECM (black)	12-place Deutsch	under seat
[83]	Ignition coil connector	3-place Packard	under fuel cell, left side

Code 24/25 Test



SCANALYZER NOTES

1 With the engine off, Scanalyzer (Active Diagnostic Test Mode) can be used to energize either the front or rear injector once each second for a total of five seconds.

2 With the engine off, Scanalyzer (Active Diagnostic Test Mode) can be used to turn fuel pump on for periods up to 30 seconds. Power to the pump also includes power to the fuel injectors and ignition coil.

GENERAL

Fuel Pump

The fuel pump assembly is shown in Figure 4-57. ECM Pin 3 provides ground to the fuel pump. Code 33 will set if:

- BN/Y wire is shorted to 12 volts. This will also cause the ignition fuse to blow. See Figure 4-58.
- BN/Y wire is shorted to ground. This will cause the fuel pump to run continuously even when the motor is not running.
- Fuel pump motor stalls or spins without providing fuel pressure.

DIAGNOSTICS

Diagnostic Notes

The reference numbers below correlate with the circled numbers on the Code 33 flow chart.

1. Connect BREAKOUT BOX (Part No. HD-42682) to ECM. See 4.6 BREAKOUT BOX.
2. Use HARNESS CONNECTOR TEST KIT (Part No. HD-41404), red pin probe and patch cord.
3. Use HARNESS CONNECTOR TEST KIT (Part No. HD-41404), gray socket probe and patch cord.

Scanalyzer Notes

The Scanalyzer icon appears at those points in the flow chart where the Scanalyzer can be used.

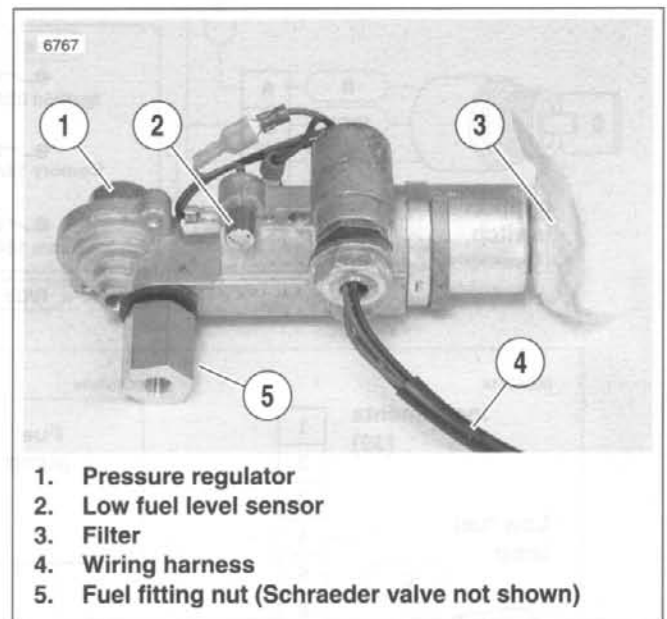


Figure 4-57. Fuel Pump Assembly

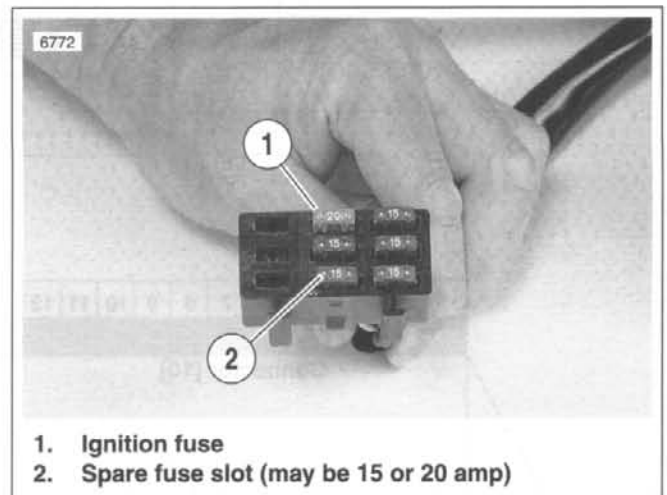


Figure 4-58. Ignition Fuse

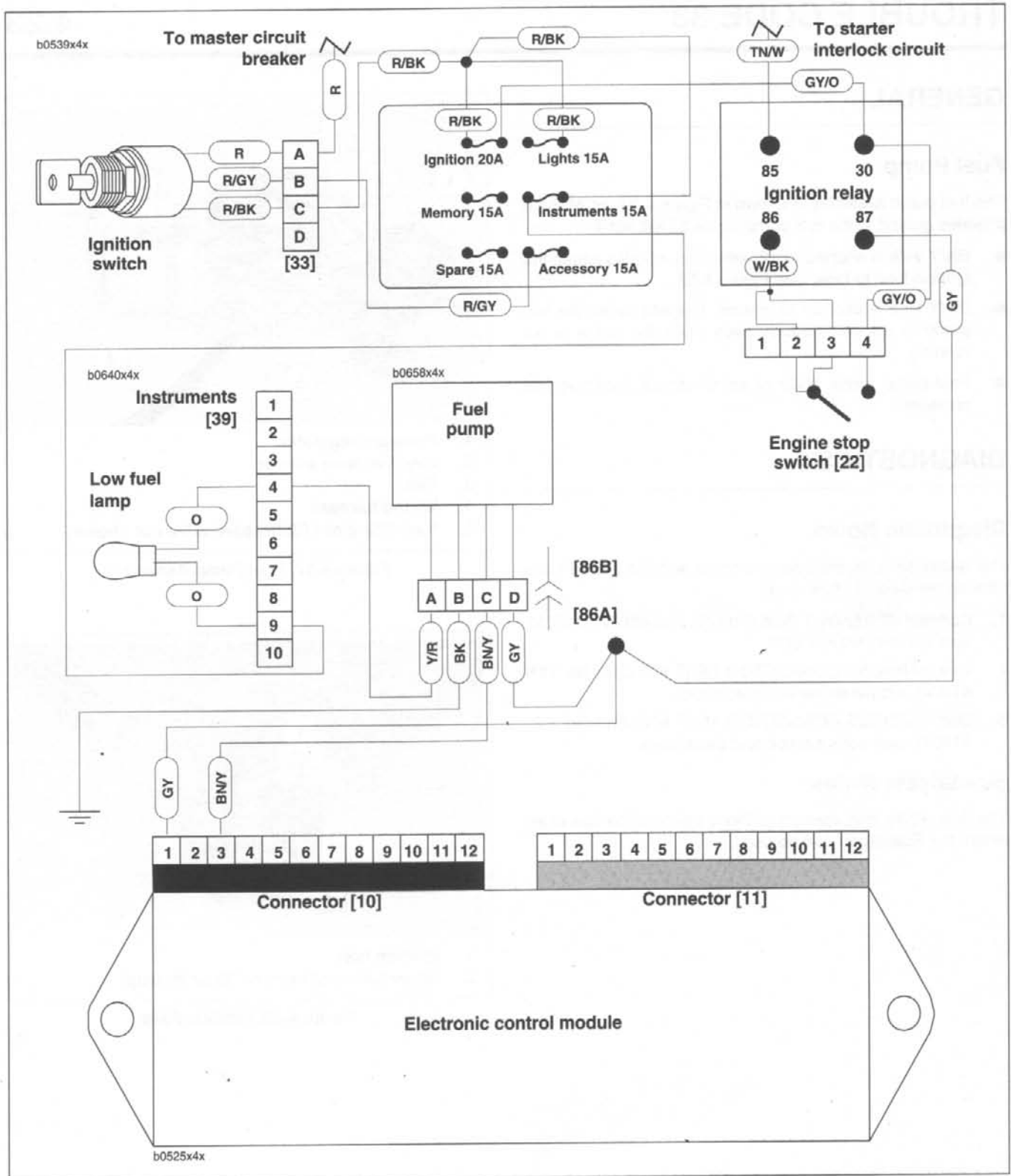
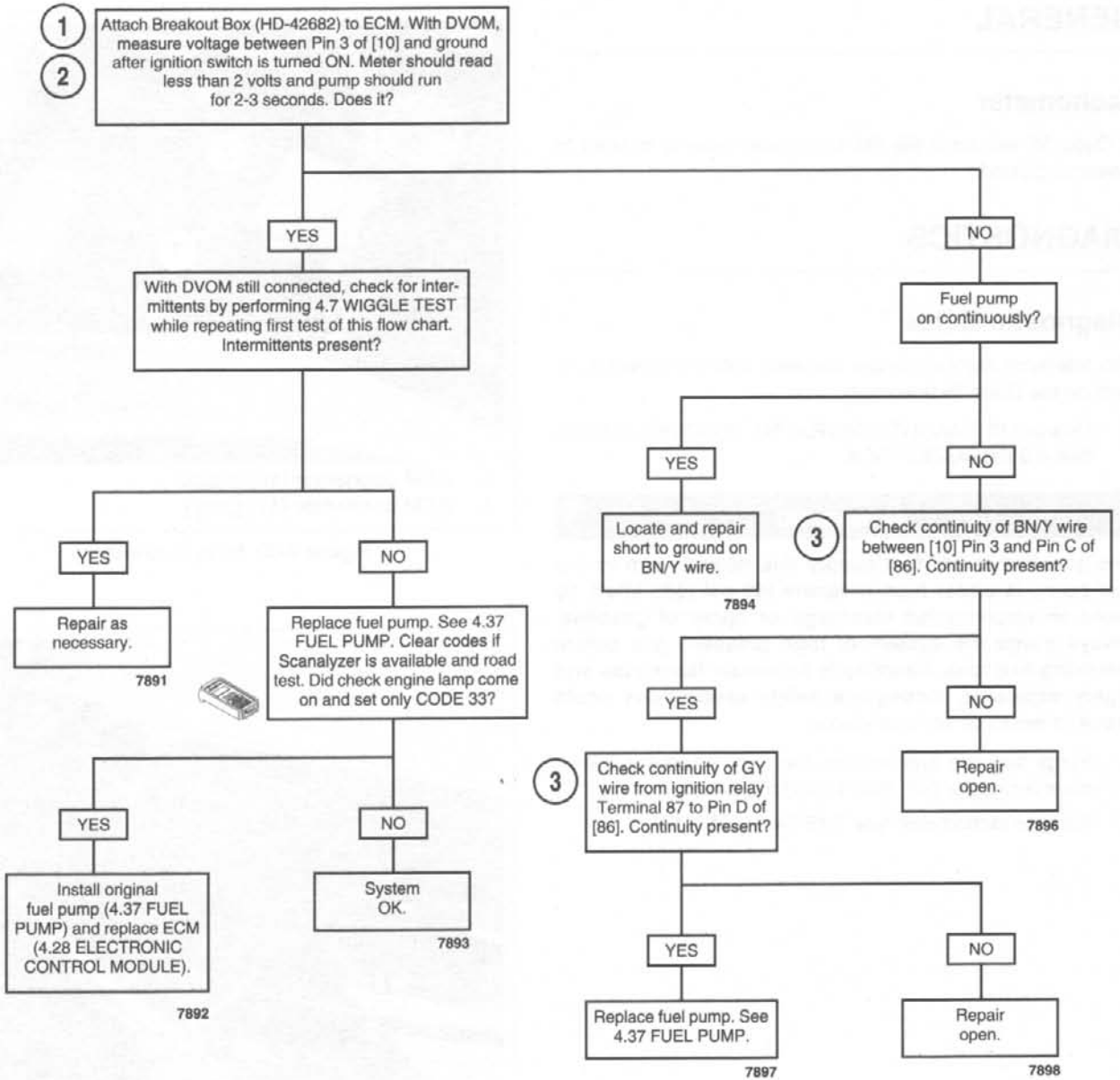


Figure 4-59. Fuel Pump Circuit

Table 4-23. Wire Harness Connectors in Figure 4-59.

NO.	DESCRIPTION	TYPE	LOCATION
[10]	ECM (black)	12-place Deutsch	under seat
[39]	Instruments	10-place Multilock	under fuel cell
[86]	Fuel pump	4-place Packard	above rear cylinder head, left side

Code 33 Test



Clear codes and confirm proper operation with no check engine lamp.

GENERAL

Tachometer

A Code 35 will set if the PK tachometer wire is shorted to power or ground.

DIAGNOSTICS

Diagnostic Notes

The reference numbers below correlate with the circled numbers on the Code 35 flow chart.

1. Connect BREAKOUT BOX (Part No. HD-42682) to ECM. See 4.6 BREAKOUT BOX.

WARNING

The gasoline in the fuel supply line downstream of the fuel pump is under high pressure (49 psi [338 kPa]). To avoid an uncontrolled discharge or spray of gasoline, always purge the system of high pressure gas before removing fuel tank. Gasoline is extremely flammable and highly explosive. Inadequate safety precautions could result in death or serious injury.

2. Purge fuel line and remove fuel tank to access instrument connector [39]. See 4.34 FUEL TANK.
3. Replace tachometer. See 7.19 TACHOMETER.

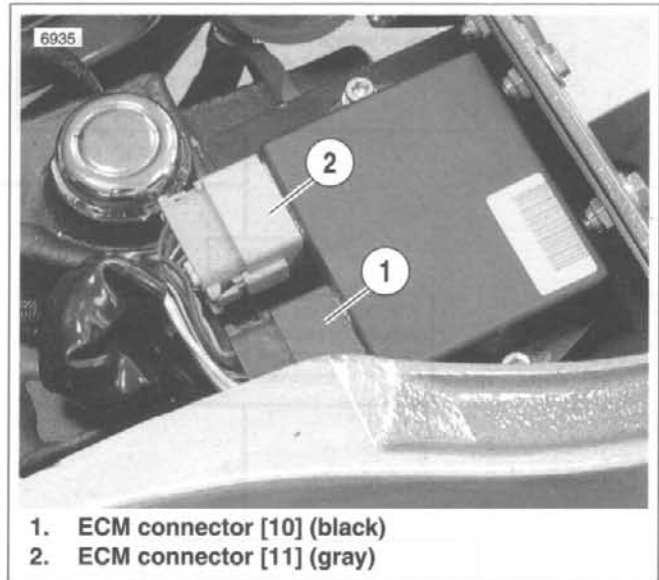


Figure 4-60. ECM Connectors

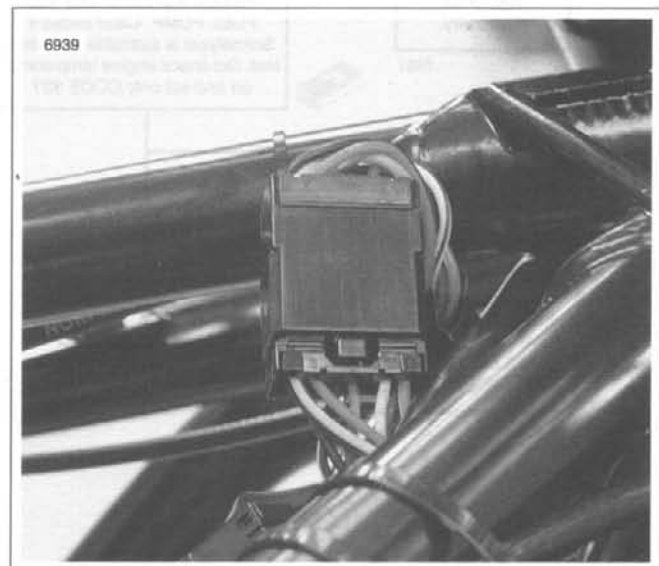


Figure 4-61. Instrument Connector [39]

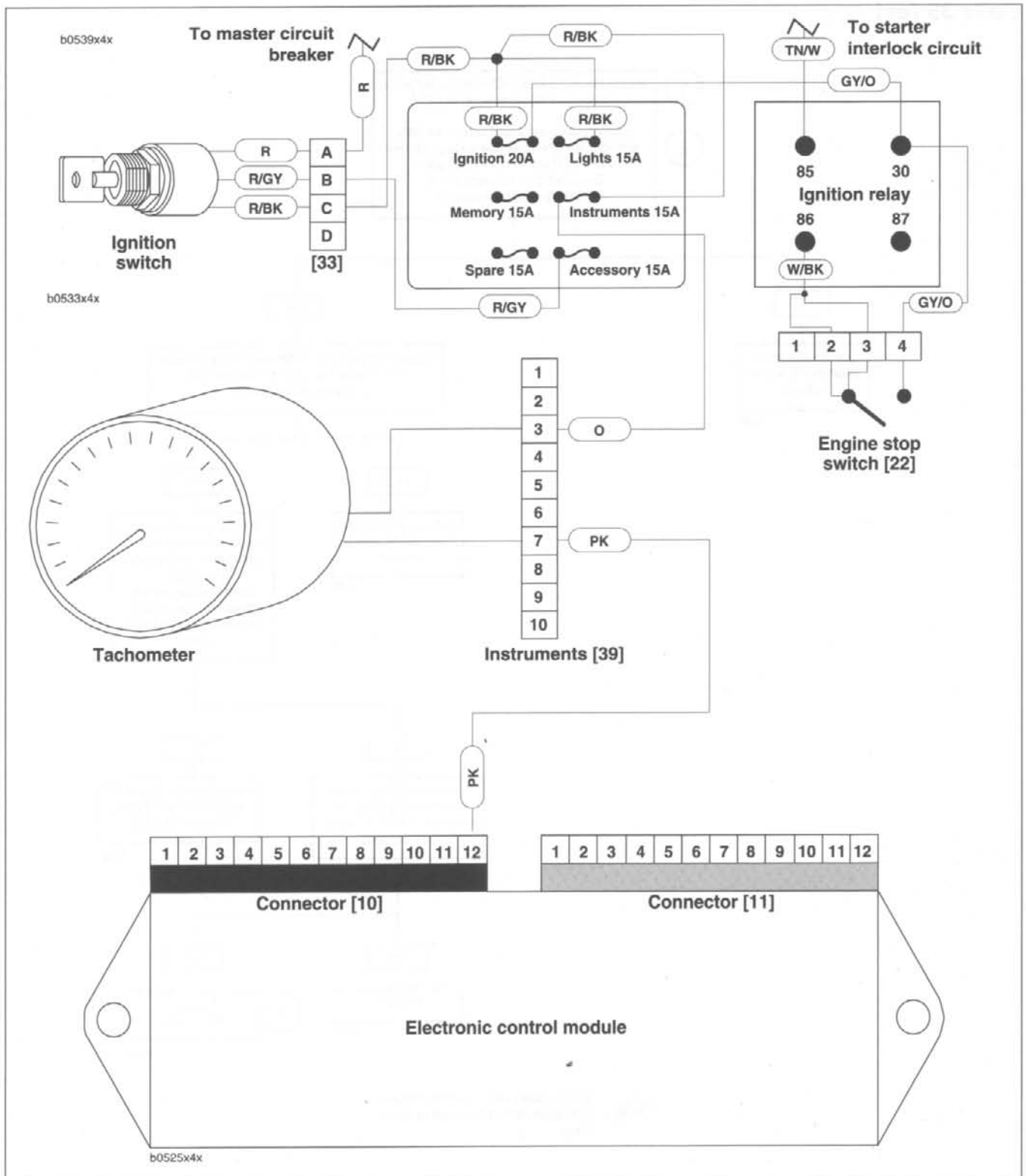
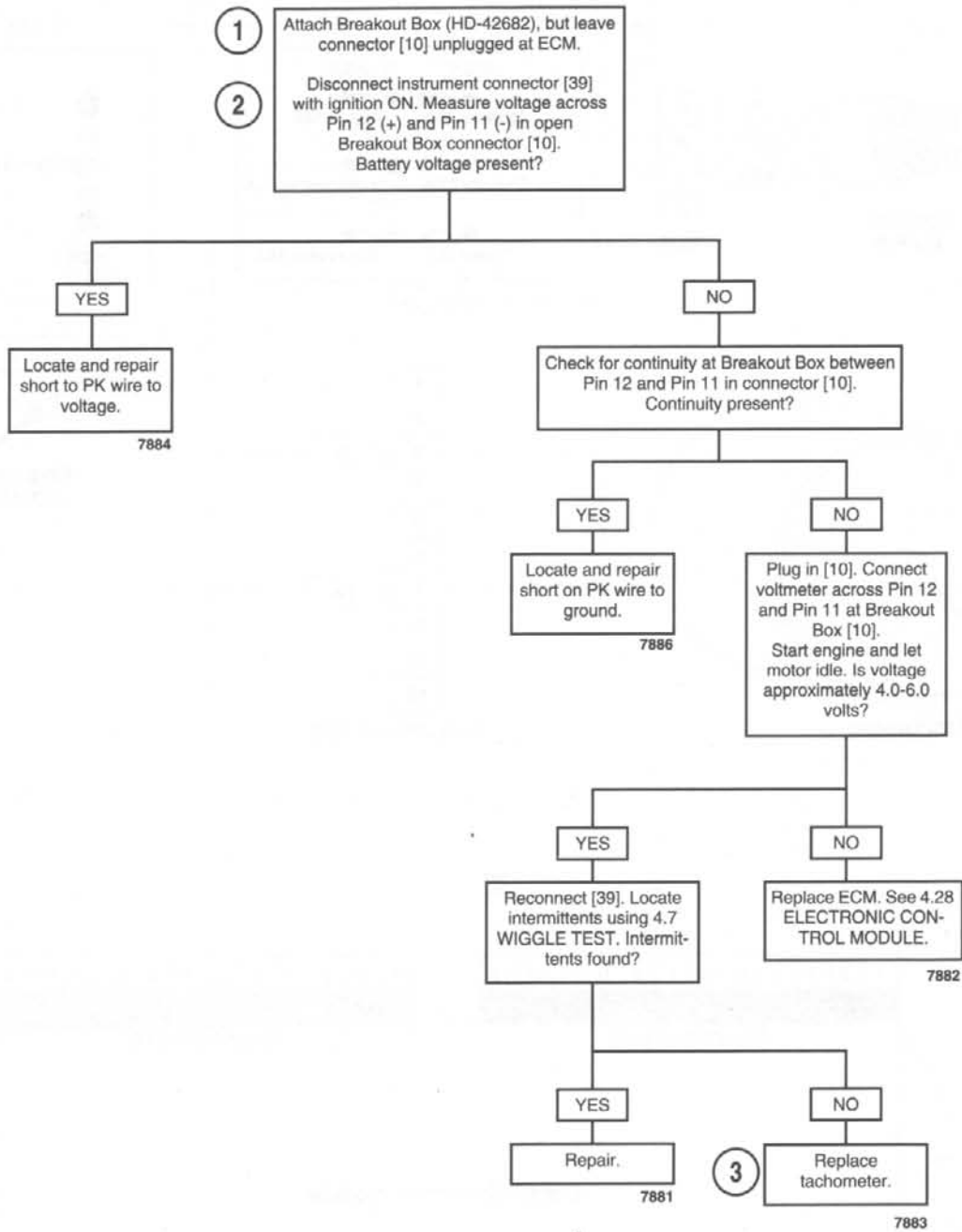


Figure 4-62. Tachometer Circuit

Table 4-24. Wire Harness Connectors in Figure 4-62.

NO.	DESCRIPTION	TYPE	LOCATION
[10]	ECM (black)	12-place Deutsch	under seat
[39]	Main harness to instruments	10-place Multilock	under fuel cell

Code 35 Test



Clear codes and confirm proper operation with no check engine lamp.

GENERAL

Bank Angle Sensor

See Figure 4-63. A Code 44 occurs when the bank angle sensor voltage is outside the normal operating range of 0.6-1.1 volts. This may be caused by:

- Short to ground in harness between sensor and electronic control module.
- Short to voltage in harness between sensor and electronic control module.
- Failed sensor.

If this code occurs, the engine may stop running. The engine may still be restarted and ridden to the dealership for repair.

DIAGNOSTICS

Diagnostic Notes

The reference numbers below correlate with the circled numbers on the Code 44 flow charts.

1. Use HARNESS CONNECTOR TEST KIT (Part No. HD-41404), gray pin probes and patch cord.
2. Connect BREAKOUT BOX (Part No. HD-42682) to ECM. See 4.6 BREAKOUT BOX.

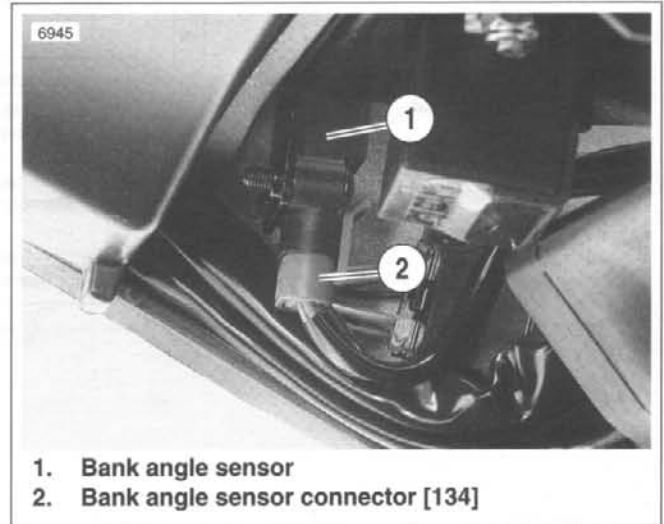


Figure 4-63. Bank Angle Sensor

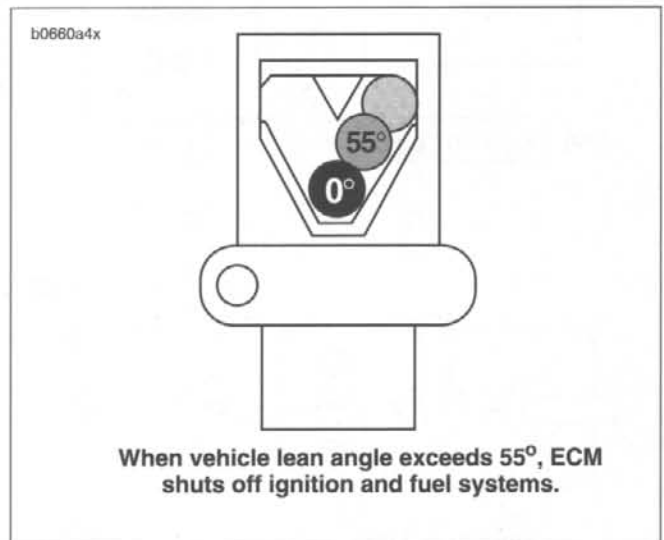


Figure 4-64. Bank Angle Sensor Operation

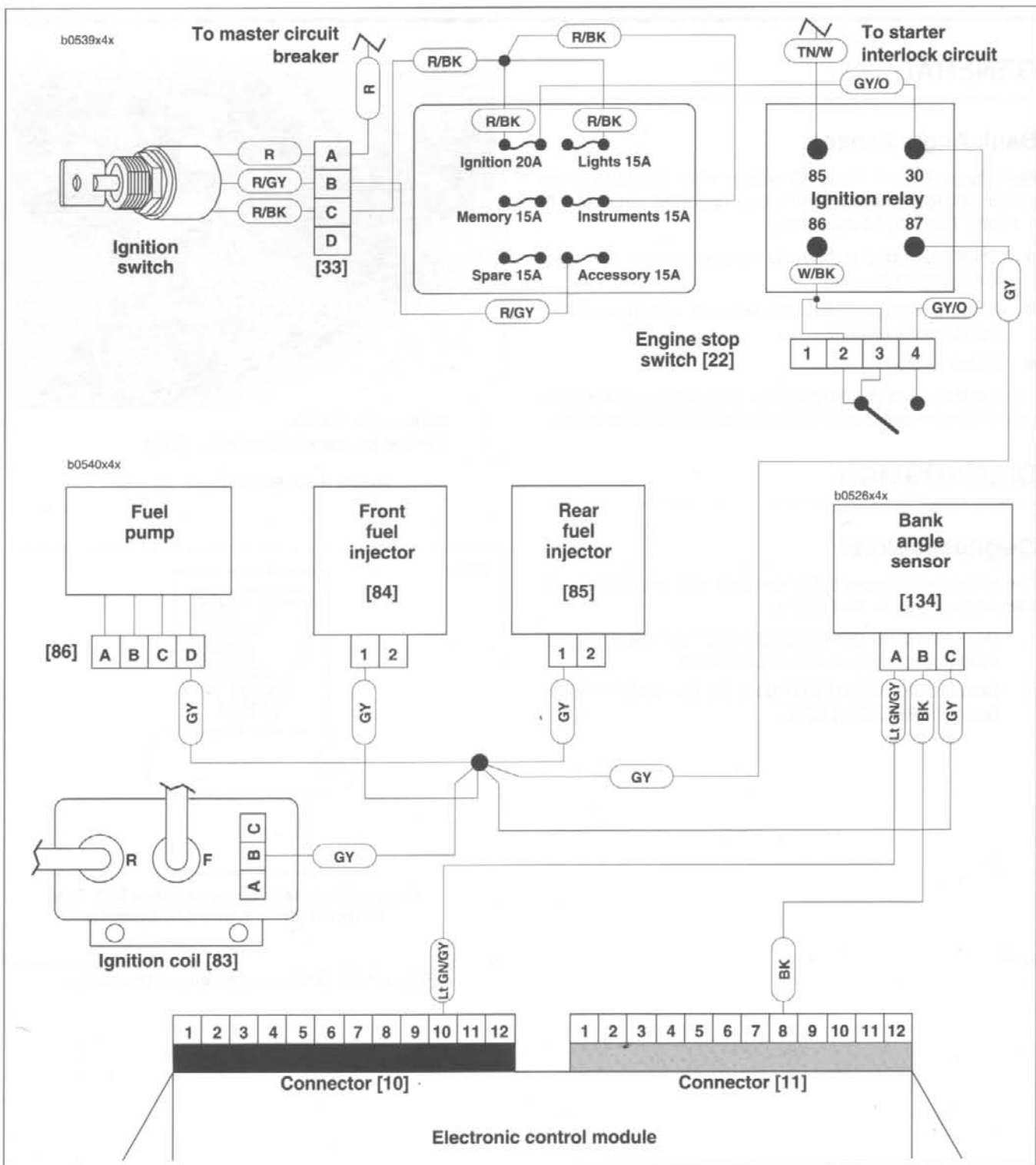
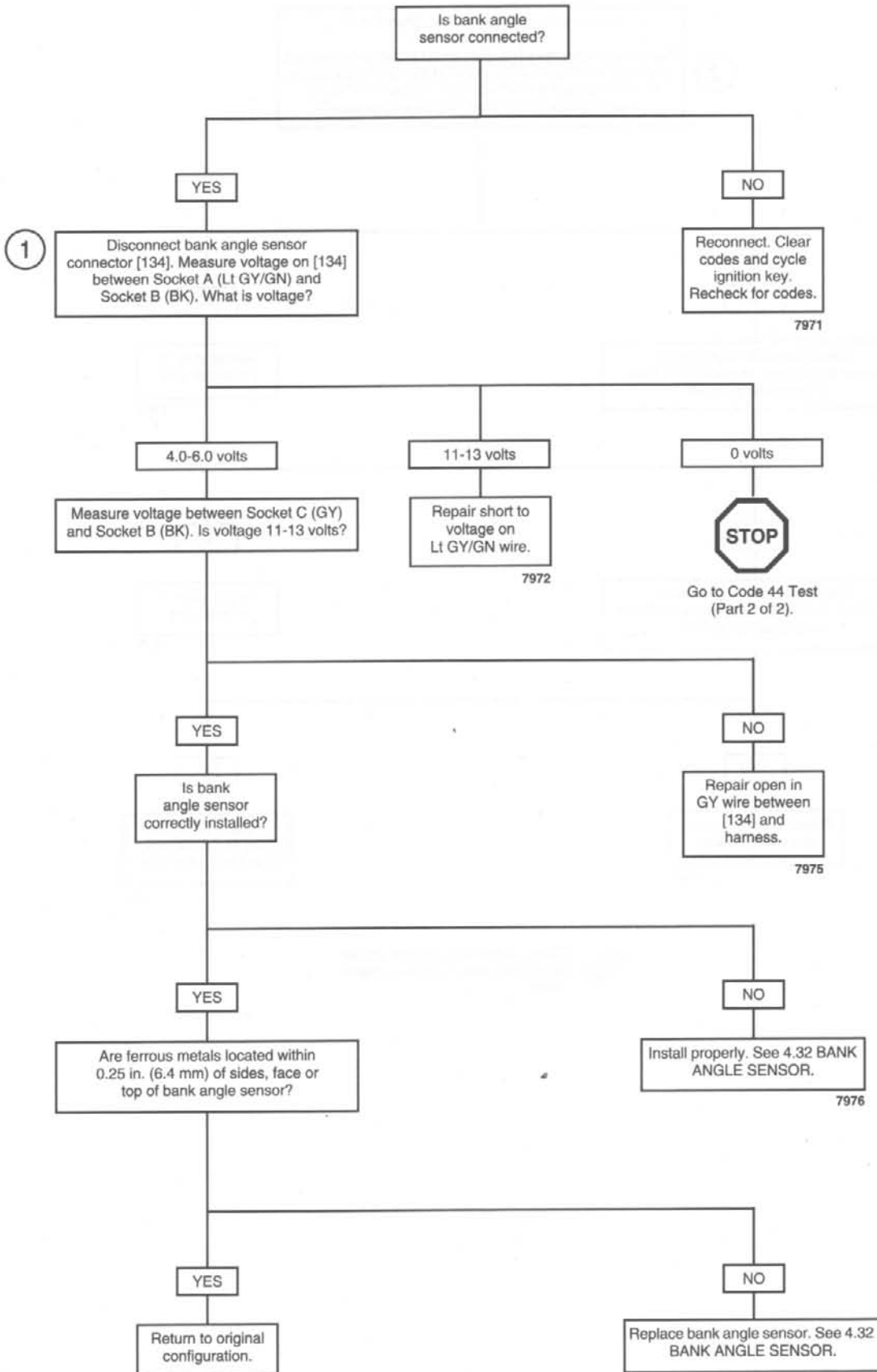


Figure 4-65. Bank Angle Sensor Circuit

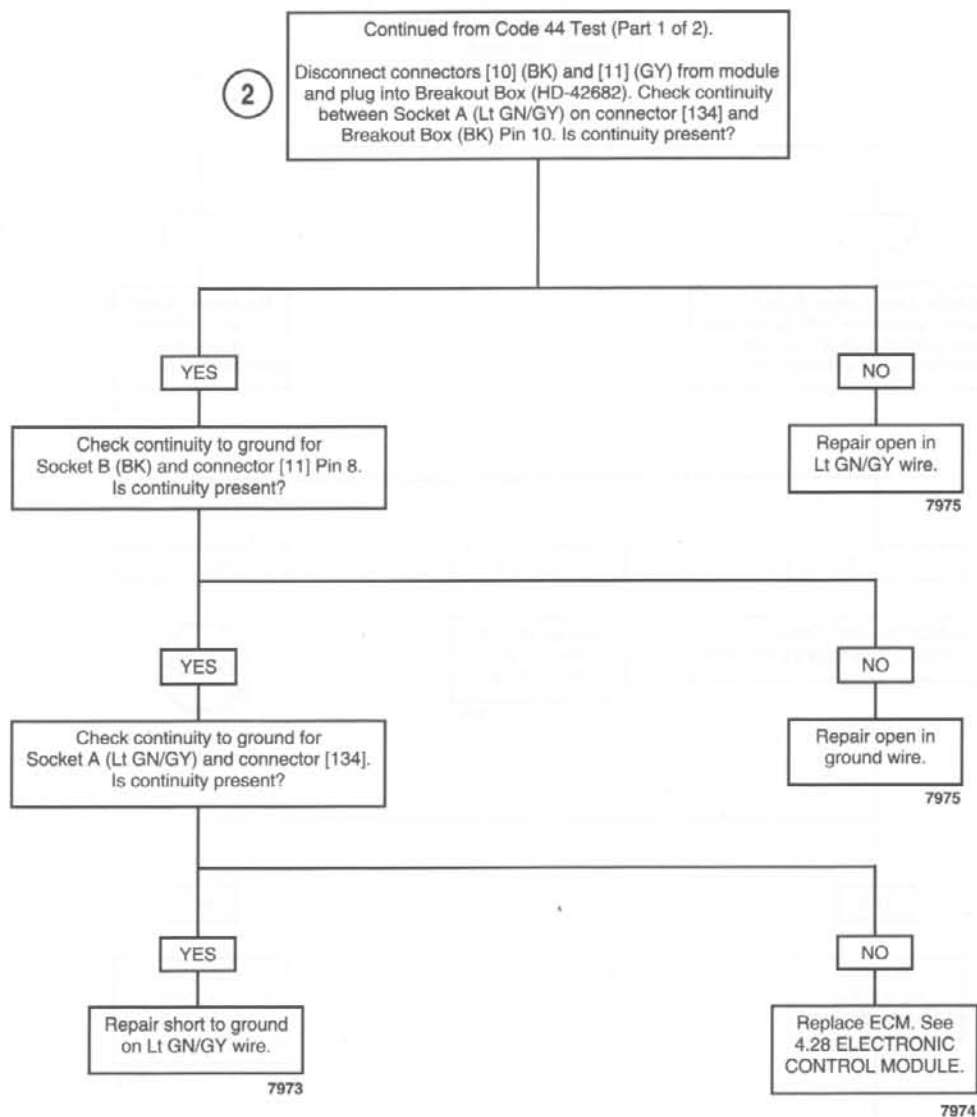
Table 4-25. Wire Harness Connectors in Figure 4-65.

NO.	DESCRIPTION	TYPE	LOCATION
[10]	ECM (black)	12-place Deutsch	under seat
[134]	Bank angle sensor	3-place Packard	under tail section, left side

Code 44 Test (Part 1 of 2)



Code 44 Test (Part 2 of 2)



Clear codes and confirm proper operation with no check engine lamp.

GENERAL

ECM Failure

All of the following codes indicate a failure which requires replacement of the ECM. See 4.28 ELECTRONIC CONTROL MODULE.

- Code 52 - RAM failure.
- Code 53 - ROM failure.
- Code 54 - EE PROM failure.
- Code 55 - Microprocessor failure.

NOTE

Dealership technicians filing warranty claims should use job/time code 7913 for all Code 52, 53, 54 and 55 ECM replacements.

GENERAL

Cam Sync Failure

This code occurs only when the engine is running if the electronic control module either does not receive a signal from the cam position sensor or receives an unexpected signal. The motorcycle may continue to run, not run normally or stop running altogether.

DIAGNOSTICS

Diagnostic Notes

The reference numbers below correlate with the circled numbers on the Code 56 flow charts.

1. Connect BREAKOUT BOX (Part No. HD-42682) to ECM. See 4.6 BREAKOUT BOX.
2. Use HARNESS CONNECTOR TEST KIT (Part No. HD-41404), black pin probes and patch cord.
3. See 4.29 CAM POSITION SENSOR AND ROTOR.

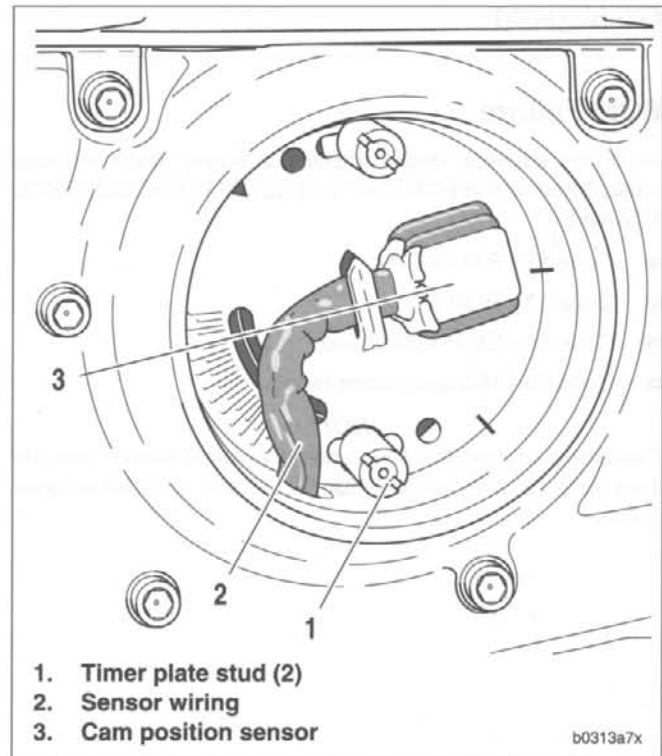


Figure 4-66. Cam Position Sensor

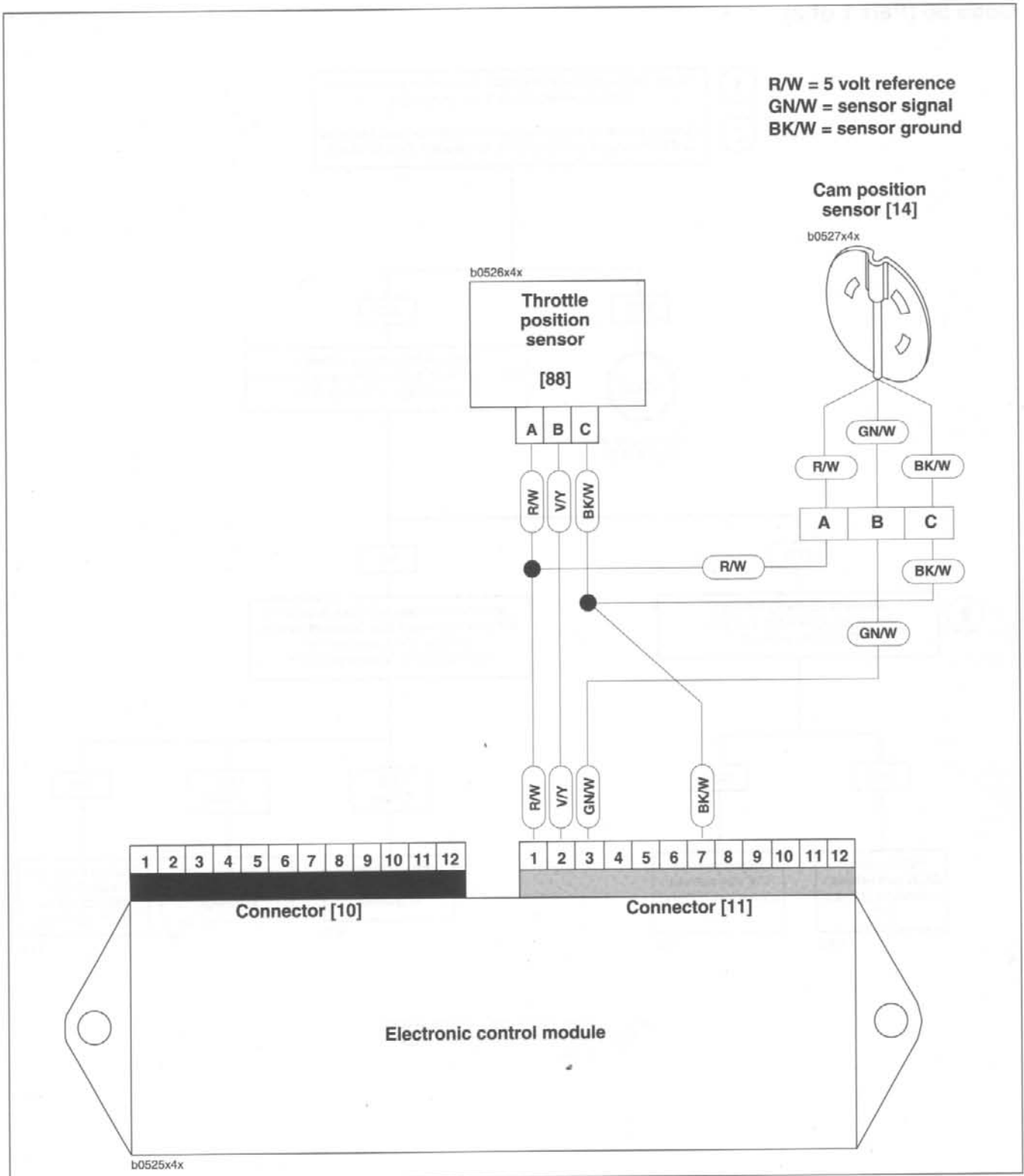
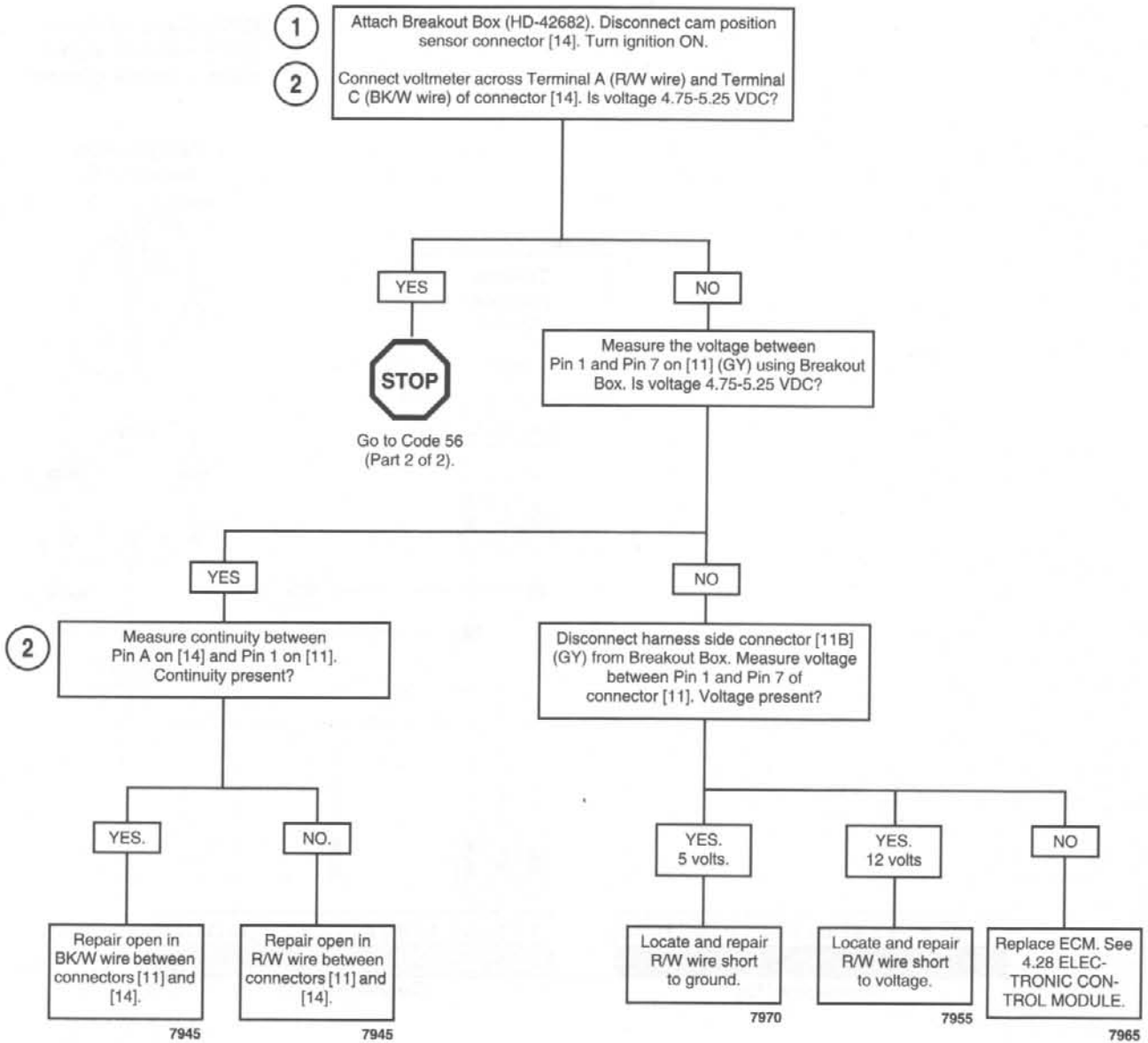


Figure 4-67. Cam Position Sensor Circuit

Table 4-26. Wire Harness Connectors in Figure 4-67.

NO.	DESCRIPTION	TYPE	LOCATION
[11]	ECM (gray)	12-place Deutsch	under seat
[14]	Cam position sensor	3-place Deutsch	near starter
[88]	TP sensor	3-place Packard	behind air cleaner backplate

Code 56 (Part 1 of 2)

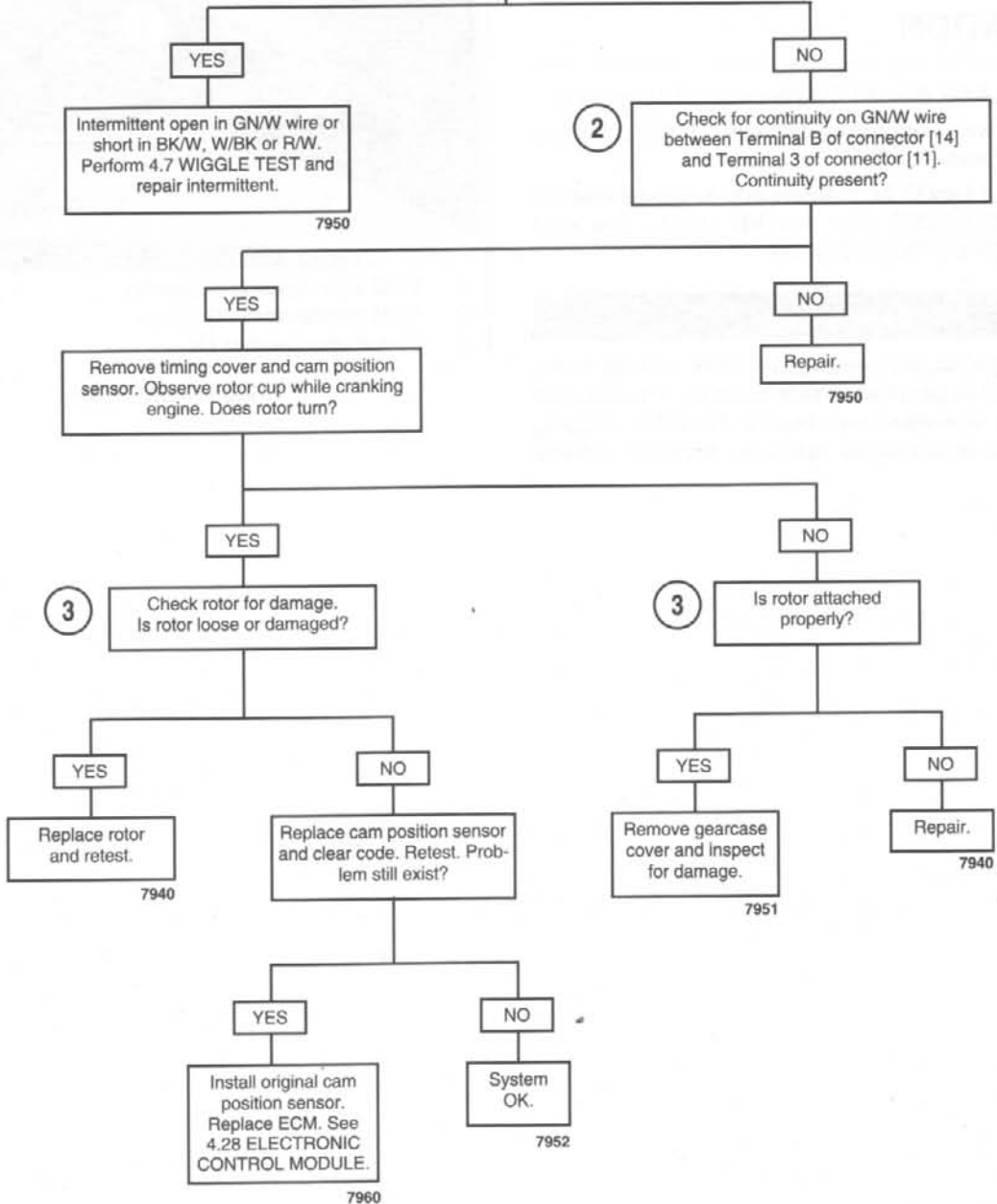


Clear codes and confirm proper operation with no check engine lamp.

Code 56 (Part 2 of 2)

Continued from Code 56 (Part 1 of 2).

Reconnect cam position sensor connector [14]. Using Breakout Box, measure voltage between Pin 3 and Pin 7 while cranking the engine. Is voltage 2-3 volts?



Clear codes and confirm proper operation with no check engine lamp.

REMOVAL

1. Remove seat.
2. See Figure 4-68. Remove two screws and washers (3) to detach ECM from bracket.
3. Unplug ECM connectors [10] and [11].

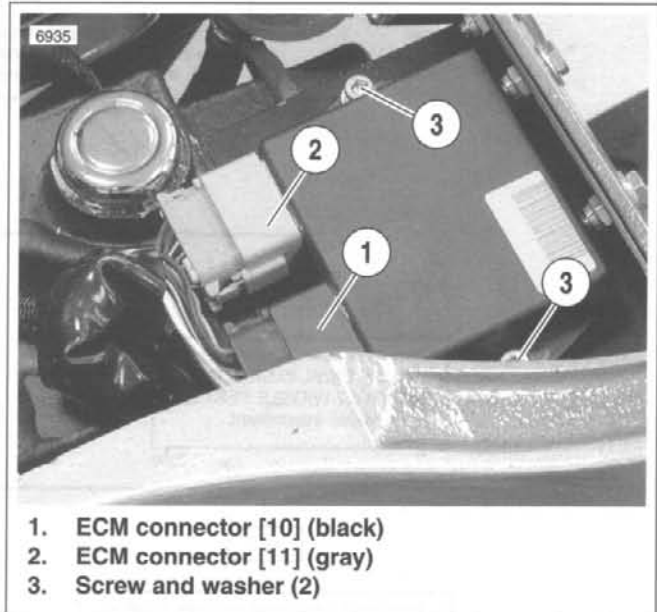
INSTALLATION

1. See Figure 4-68. Attach ECM connectors [10] and [11].
2. Align ECM with bracket mounting holes. Install using two screws and washers (3).
3. If installing a **new** ECM, calibrate throttle position sensor using SCANALYZER (Part No. HD-41325). See 4.33 THROTTLE POSITION SENSOR.

⚠ WARNING

After installing seat, pull upward on front of seat to be sure it is locked in position. If seat is loose, it could shift during vehicle operation and startle the rider, causing loss of control which could result in death or serious injury.

4. Install seat.



1. ECM connector [10] (black)
2. ECM connector [11] (gray)
3. Screw and washer (2)

Figure 4-68. ECM

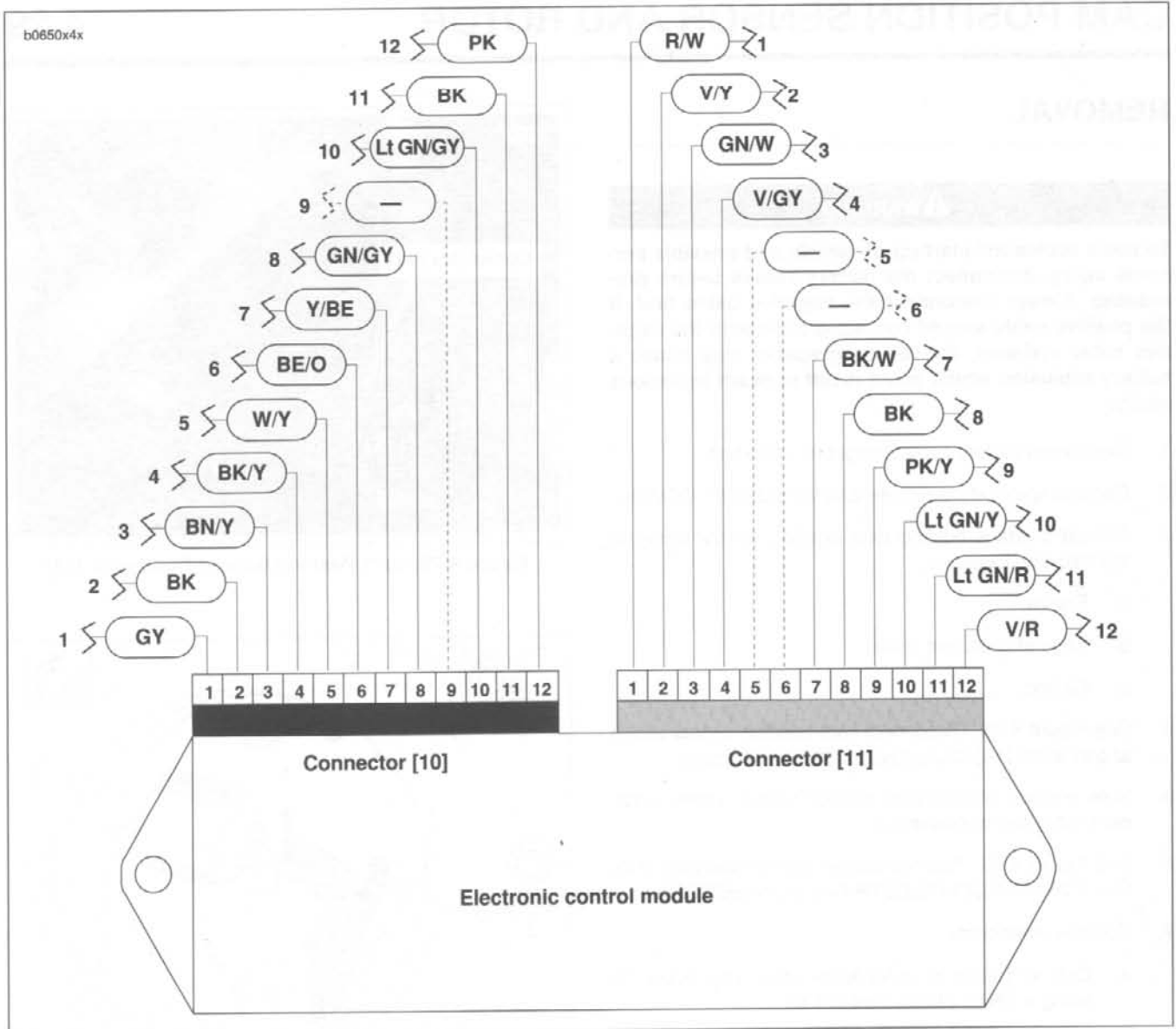


Figure 4-69. ECM Wiring

Table 4-27. Pin Table for ECM Connector [10] (Black)

PIN	FUNCTION
1	Switched ignition
2	System ground A (module)
3	Fuel pump output
4	Check engine lamp
5	Injector front output
6	Front coil primary
7	Rear coil primary
8	Injector rear output
9	No function
10	Bank angle sensor input
11	System ground B (coil)
12	Tachometer out

Table 4-28. Pin Table for ECM Connector [11] (Gray)

PIN	FUNCTION
1	5 volt sensor power
2	Throttle position sensor
3	Camshaft position sensor
4	Oxygen sensor
5	No function
6	No function
7	Sensor ground 1
8	Sensor ground 2
9	Engine temperature input
10	Intake air temperature input
11	Serial data receive
12	Serial data transmit

REMOVAL

⚠ WARNING

To avoid accidental start-up of vehicle and possible personal injury, disconnect the battery cables before proceeding. Always disconnect the negative cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion which could result in death or serious injury.

1. Disconnect battery cables, negative cable first.
2. Remove sprocket cover. See 2.38 SPROCKET COVER.
3. Cut cable straps holding cam position sensor wiring at the following locations:
 - a. Starter.
 - b. Edge of gearcase cover.
 - c. Oil line.
4. See Figure 4-70. Disconnect cam position sensor wiring at connector [14] located behind the starter motor.
5. Note position of each cam position sensor wiring terminal in plug end of connector.
6. See Figure 4-72. Remove connector terminal pins (16). See 7.26 DEUTSCH ELECTRICAL CONNECTORS.
7. Remove timer cover.
 - a. Drill off heads of outer timer cover pop rivets (1) using a 3/8 in. (9.525 mm) drill bit.
 - b. Tap remaining rivet shafts inboard through holes in timer cover (2) and inner cover (4).
 - c. Remove timer cover. Remove inner cover screws (3) and inner cover (4).
 - d. Carefully remove any remaining pieces of rivets from gearcase cover timer bore.
8. See Figure 4-71. To obtain approximate ignition timing during installation, scribe alignment marks (4) across cam position sensor (3) in two places.
9. See Figure 4-72. Remove timer plate studs. Carefully remove cam position sensor. Remove bolt (6) and trigger rotor (8).
10. Carefully remove camshaft oil seal (9) if damaged or if there is any evidence of oil leakage past the seal.

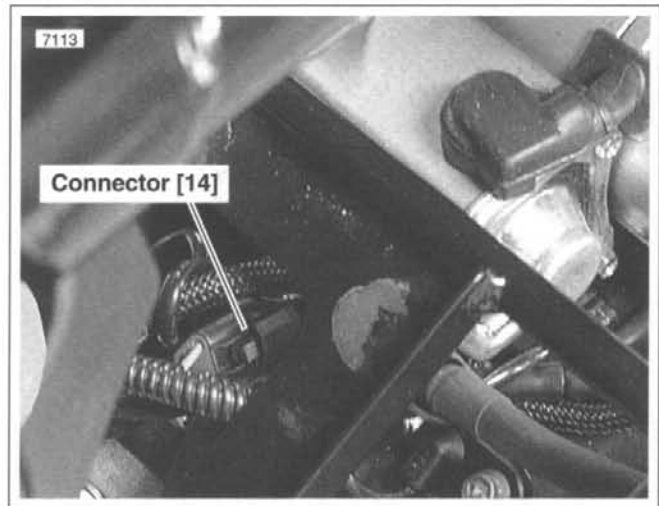


Figure 4-70. Cam Position Sensor Connector [14]

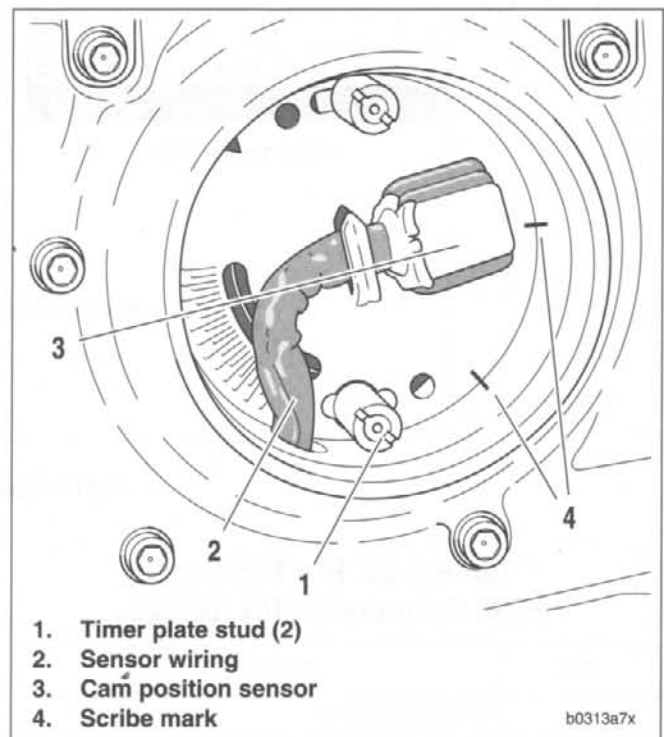
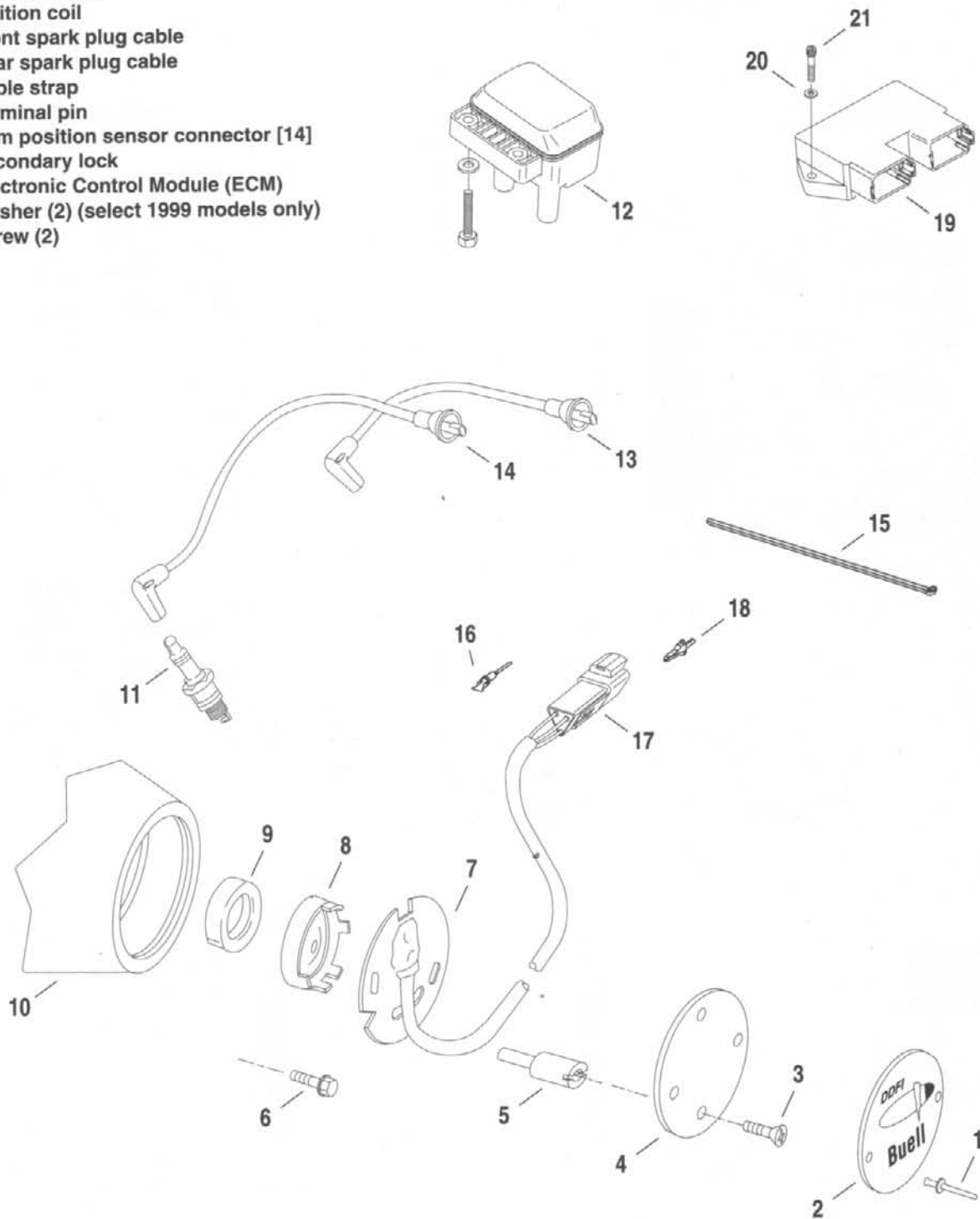


Figure 4-71. Marking Ignition Timing

1. Pop rivet (2)
2. Timer cover
3. Screw (2)
4. Inner cover
5. Timer plate stud (2)
6. Bolt
7. Cam position sensor
8. Trigger rotor
9. Seal
10. Gearcase cover
11. Spark plug (2)
12. Ignition coil
13. Front spark plug cable
14. Rear spark plug cable
15. Cable strap
16. Terminal pin
17. Cam position sensor connector [14]
18. Secondary lock
19. Electronic Control Module (ECM)
20. Washer (2) (select 1999 models only)
21. Screw (2)



b0764x7x

Figure 4-72. Ignition Components

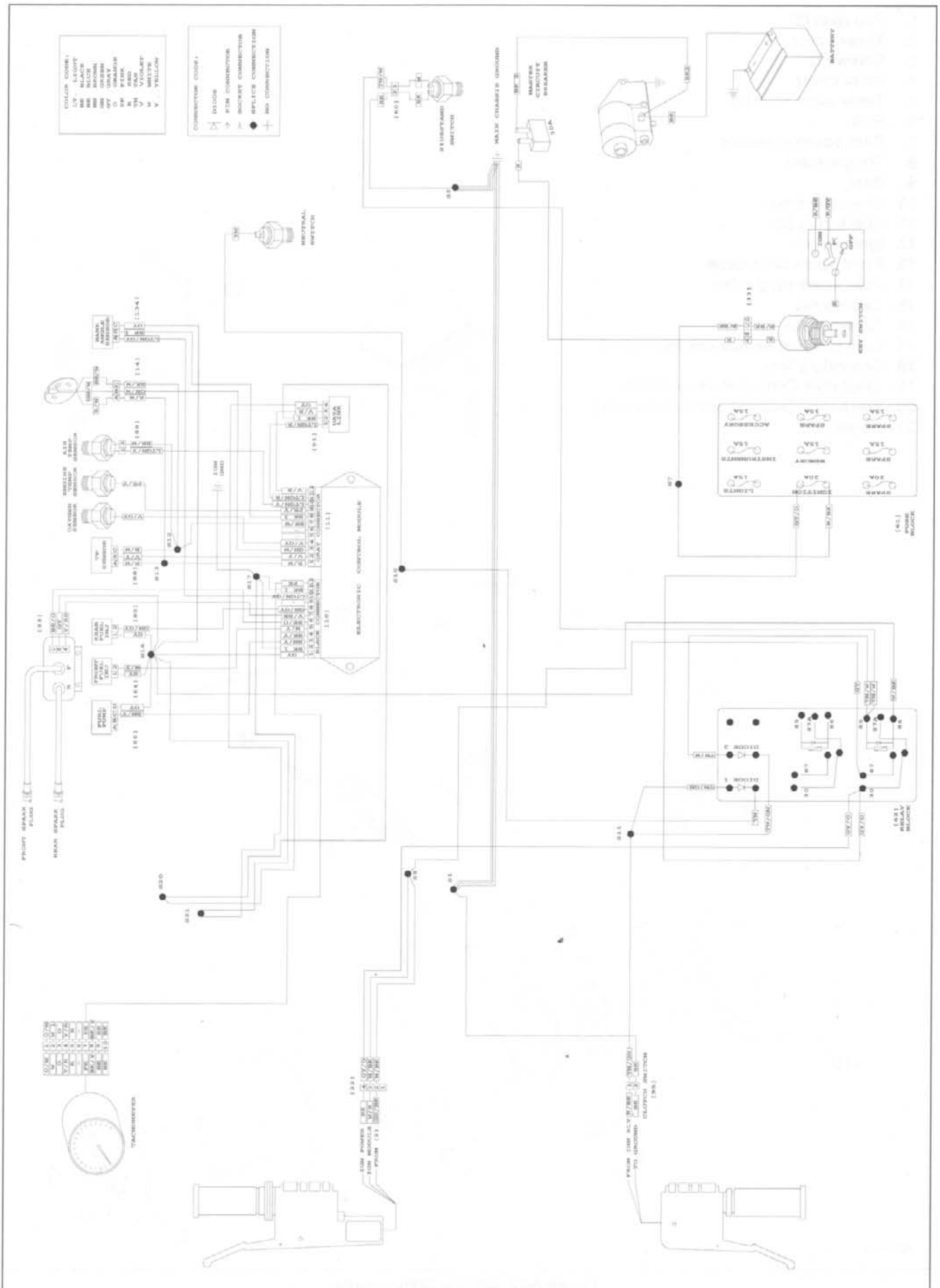


Figure 4-73. Ignition and Starting System Circuit

INSTALLATION

1. See Figure 4-72. With the lipped side facing inboard, install **new** camshaft oil seal (9) into gearcase cover (10), if removed. Press seal into position until flush with surface of timer bore.
2. Install trigger rotor (8).
 - a. Apply **LOCTITE THREADLOCKER 243** (blue) to threads of bolt (6).
 - b. Position trigger rotor (8) onto end of camshaft aligning notch with camshaft slot.
 - c. Install bolt to secure rotor. Tighten to **43-53 in-lbs** (4.9-6.0 Nm).
3. Install cam position sensor (7) and timer plate studs (5). Rotate cam position sensor to its previously marked position to obtain approximate ignition timing.

CAUTION

See Figure 4-74. Route sensor wires about 1-1/2 in. (38 mm) forward of secondary drive belt and sprocket. If wires are routed too far to the rear of this position, they could contact the moving secondary drive belt and/or sprocket resulting in damage to sensor wiring.

4. Route sensor wiring leads.
 - a. Downward through hole (7 o'clock position) in timer bore of gearcase cover.
 - b. Upward through bottom opening between right crankcase half and rear of gearcase cover.
 - c. Route wiring in front of tower shaft behind gearcase cover. Route wires upward to starter motor.
 - d. Cable strap wiring.
5. See Figure 4-75. Install sensor wiring terminals into correct positions in plug end of connector [14]. R/W, GN/W and BK/W wires of plug end (from cam position sensor) must match same color wires in receptacle end of connector (from ignition module wiring harness). Install pin terminals. See 7.26 DEUTSCH ELECTRICAL CONNECTORS.
6. See Figure 4-72. Attach connector (17) [14].
7. Check ignition timing. See 1.23 IGNITION TIMING.
8. Tighten timer plate studs (5) to **15-30 in-lbs** (1.7-3.4 Nm).
9. Install inner cover (4) using screws (3). Tighten to **12-20 in-lbs** (1.4-2.3 Nm).

CAUTION

Use only H-D Part No. 8699 rivets to secure outer timing cover. These rivets are specially designed so that no rivet end falls off into the timing compartment. Use of regular rivets can damage ignition system components and may allow water to enter the timing compartment.

10. Secure timer cover (2) to inner cover using **new** rivets.

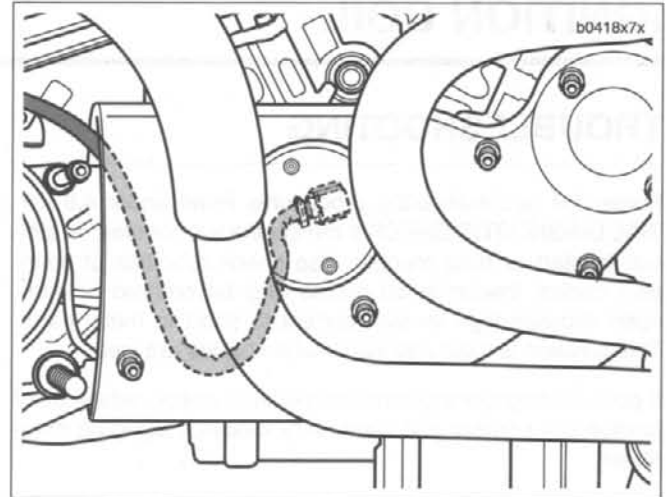


Figure 4-74. Routing Sensor Wires

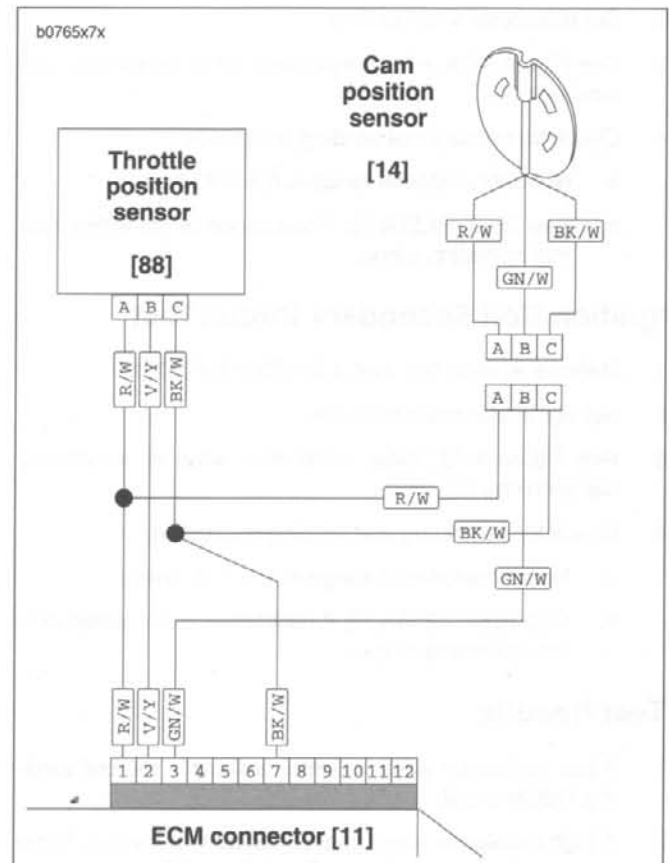


Figure 4-75. Connecting Sensor Wires

WARNING

Always connect the positive battery cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion which could result in death or serious injury.

11. Install battery cables, positive cable first.

TROUBLESHOOTING

Follow the troubleshooting procedures listed under 4.8 INITIAL DIAGNOSTIC CHECK if the engine will not start, is difficult to start or runs roughly. Also check condition of spark plug cables. Insulation on cables may be cracked or damaged allowing high tension current to short to metal parts. This problem is most noticeable when cables are wet.

If poor starting/running condition persists, check resistance of ignition coil primary and secondary windings using an ohmmeter.

Ignition Coil Primary Circuit Test

1. Remove ignition coil. See 4.30 IGNITION COIL.
2. Set ohmmeter scale to RX1.
3. See Figure 4-76. Place multimeter wires on primary coil windings (1).
4. Check for primary coil winding resistance.
 - a. Normal resistance range is 0.5-0.7 ohms.
 - b. See TEST RESULTS if resistance is not within normal operating range.

Ignition Coil Secondary Circuit Test

1. Remove ignition coil. See 4.30 IGNITION COIL.
2. Set ohmmeter scale to RX1K.
3. See Figure 4-76. Place multimeter wires on secondary coil windings (2).
4. Check for secondary coil winding resistance.
 - a. Normal resistance range is 5.5-7.5K ohms.
 - b. See TEST RESULTS if resistance is not within normal operating range.

Test Results

1. A low resistance value indicates a short in the coil winding. Replace coil.
2. A high resistance value might indicate that there is some corrosion/oxidation of the coil terminals. Clean the terminals and repeat resistance test. If resistance is still high after cleaning terminals, replace coil.
3. An infinite ohms (∞ or no continuity) resistance value indicates an open circuit (a break in the coil winding). Replace coil.

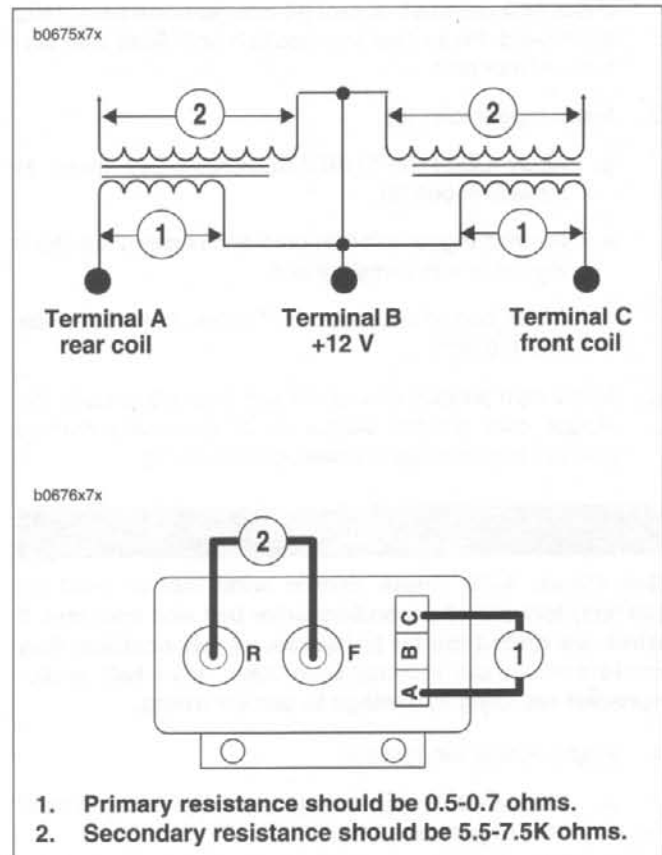


Figure 4-76. Ignition Coil Testing

Ignition Coil Substitution

If a coil tester is not available, use the following test.

NOTE

Coil will function without being attached to frame.

1. Substitute a **new** ignition coil by attaching it to any convenient point near the old coil. Transfer terminal wires to **new** coil.
2. Attach **new** spark plug cables to coil and plugs.
3. Test system. If ignition trouble is eliminated by the temporary installation of a **new** coil, carefully inspect old coil and cables for damage. The insulation on the cables may be cracked or otherwise damaged allowing high tension current to short to metal parts. This is most noticeable in wet weather or after the motorcycle has been washed.

REMOVAL

WARNING

To avoid accidental start-up of vehicle and possible personal injury, disconnect the battery cables before proceeding. Always disconnect the negative cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion which could result in death or serious injury.

1. Disconnect battery cables, negative cable first.
2. Remove left side scoop. See 2.44 AIR SCOOP.
3. See Figure 4-78. Disconnect the spark plug cables from the coil plug posts (1, 2).
4. Detach connector (7) [83].
5. Remove two screws and washers to drop coil from frame.

INSTALLATION

1. See Figure 4-77. Attach coil to frame with screws and washers. Tighten to 4-6 ft-lbs (5.4-8.1 Nm).
2. See Figure 4-78. Attach connector (7) [83].
3. Connect front spark plug cable to connector (2) and rear spark plug cable to connector (1).
4. Install left side scoop. See 2.44 AIR SCOOP.

⚠ WARNING

Always connect positive battery cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion which could result in death or serious injury.

5. Connect battery cables, positive cable first.

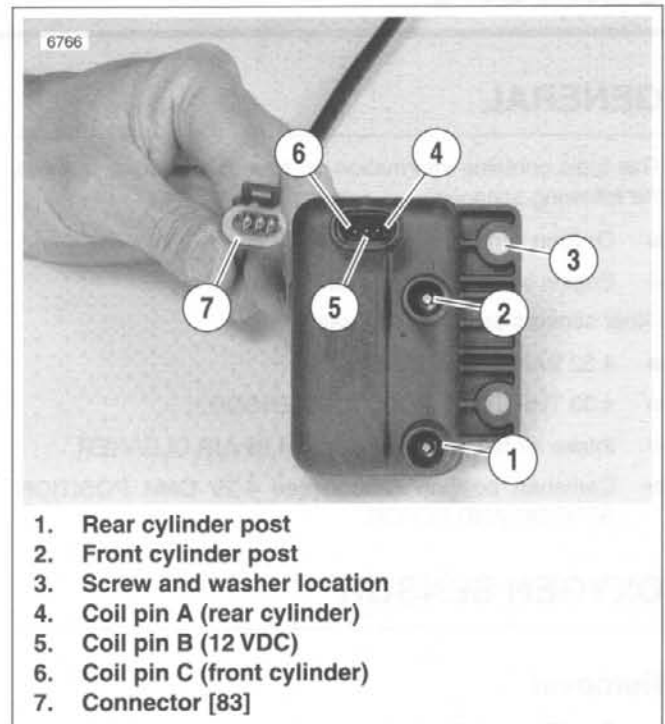


Figure 4-78. Ignition Coil

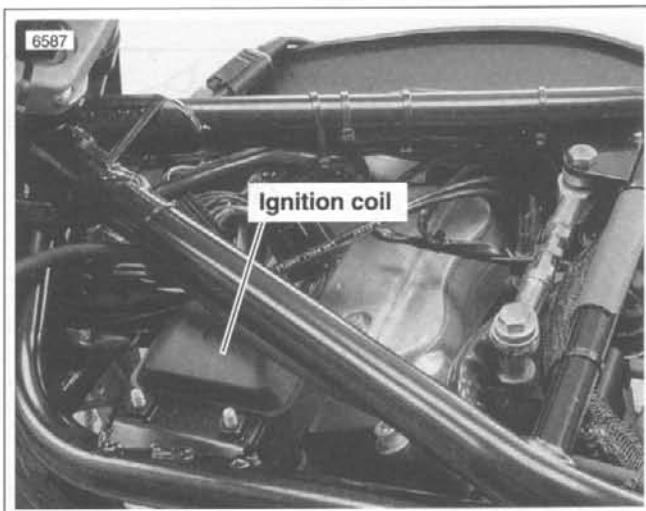


Figure 4-77. Ignition Coil Location

GENERAL

This topic contains information on how to remove and install the following sensors:

- Oxygen sensor.
- Engine temperature sensor.

Other sensors are listed separately:

- 4.32 BANK ANGLE SENSOR.
- 4.33 THROTTLE POSITION SENSOR.
- Intake air temperature sensor: 4.39 AIR CLEANER.
- Camshaft position sensor: see 4.29 CAM POSITION SENSOR AND ROTOR.

OXYGEN SENSOR

Removal

1. See Figure 4-79. Unplug 1-place connector [137] under battery tray.
2. Remove oxygen sensor from exhaust header using a 22 mm (or 7/8 in.) crowfoot or flare nut socket.

Installation

1. Apply LOCTITE ANTI-SEIZE LUBRICANT to threads of sensor. Make sure anti-seize is marked as safe for use with O₂ sensors.
2. See Figure 4-79. Thread sensor into exhaust header. Tighten to 42-45 ft-lbs (56.9-61Nm).
3. Connect sensor to wiring harness.

ENGINE TEMPERATURE SENSOR

Model Year Change

The engine temperature sensor will change to the location shown in Figure 4-91 later in 2000 model year production.

Removal

CAUTION

Do not pull on engine temperature sensor wiring. Excess strain to sensor wiring will cause sensor damage.

1. Unplug 1-place connector [90] above rear cylinder head.
2. See Figure 4-80. Remove sensor from rear cylinder head near spark plug.

Installation

CAUTION

Do not pull on engine temperature sensor wiring. Excess strain to sensor wiring will cause sensor damage.

1. See Figure 4-80. Screw sensor into rear cylinder head.
2. Connect 1-place connector [90] to wiring harness.

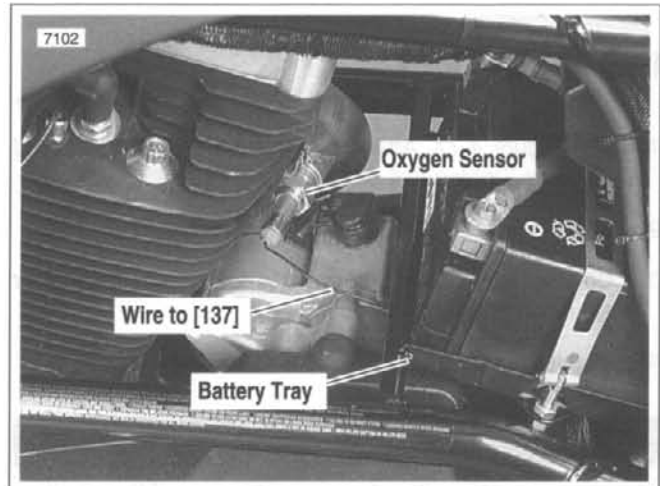


Figure 4-79. Installed Oxygen Sensor

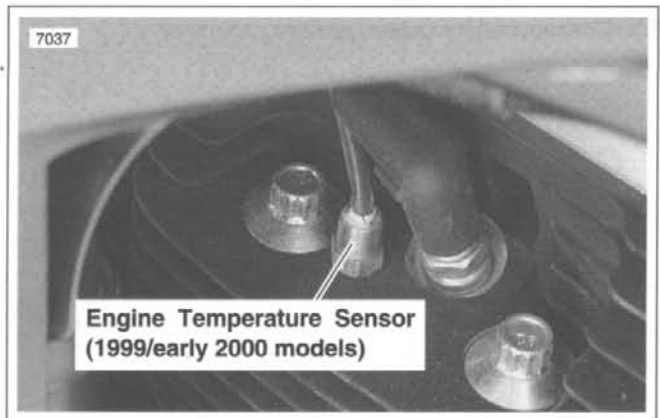


Figure 4-80. Engine Temperature Sensor Location

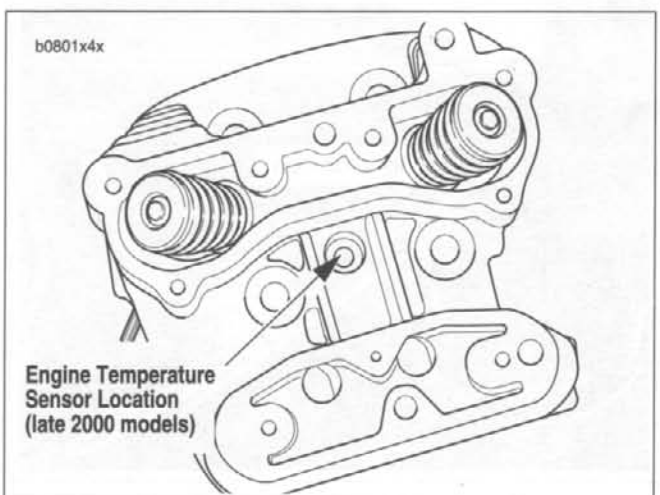


Figure 4-81. Engine Temperature Sensor Location

REMOVAL

1. See Figure 4-82. Locate bank angle sensor (1) below left side of tail section. Unplug sensor connector (2) [134].
2. Remove screw and washer (3) to detach sensor from frame.

INSTALLATION

1. See Figure 4-82. Plug connector (2) [134] into bank angle sensor.
2. Attach bank angle sensor to frame using screw and washer (3). Check that top of sensor is parallel to ground when motorcycle is standing upright (not on side stand).

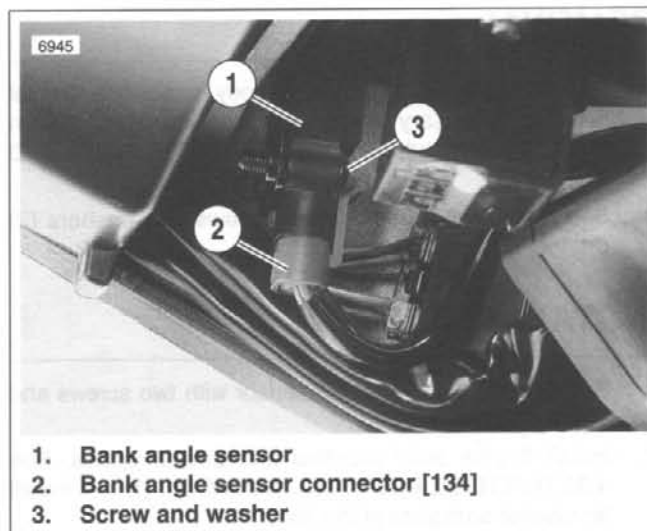


Figure 4-82. Bank Angle Sensor

REMOVAL

1. Remove front section of throttle body manifold. Note that it is not necessary to detach manifold/injector portion from cylinder heads. See 4.38 THROTTLE BODY AND MANIFOLD.
2. See Figure 4-83. Remove two screws and washers (2) (metric) to detach TP sensor.

INSTALLATION

1. See Figure 4-83. Attach TP sensor with two screws and washers (2) (metric).
2. Install throttle body manifold and throttle cables. See 4.38 THROTTLE BODY AND MANIFOLD. Do not install air cleaner backplate at this time.
3. See Figure 4-84. Attach throttle position sensor connector [88]. Slots on female connector [88B] must fully engage tabs on male connector housing [88A].
4. If installing a **new** ECM, calibrate throttle position sensor using SCANALYZER (Part No. HD-41325). See 4.33 THROTTLE POSITION SENSOR.
5. Install air cleaner backplate and cover.

CALIBRATION

1. Remove air cleaner cover and backplate.
2. Back out idle set screw to make sure throttle plate is in the fully closed position.
3. Open and **slowly** close throttle control grip 3-5 times. Do not allow throttle to snap shut.
4. Attach Scanalyzer to data link. See 4.4 SCANALYZER.
5. Calibrate TP sensor using Scanalyzer.
 - a. From Diagnostic Menu, press "7" to display Calibration Menu.
 - b. Press "1" to activate TPS Zero Function.
 - c. Press "Enter" to verify throttle plate is fully closed. Scanalyzer will then calibrate sensor. See Figure 4-85.
6. Verify that TP sensor is calibrated.
 - a. From the Scanalyzer Diagnostic Menu, press "3" to enter Data Monitor Menu.
 - b. Scroll down menu to find TP voltage. If voltage reads approximately 0.5-1.5 volts at hot idle, TP sensor is properly calibrated.

NOTE

TP sensor voltage at hot idle will vary according to position of idle set screw.

7. Disconnect Scanalyzer from motorcycle.
8. Install air cleaner backplate and cover.

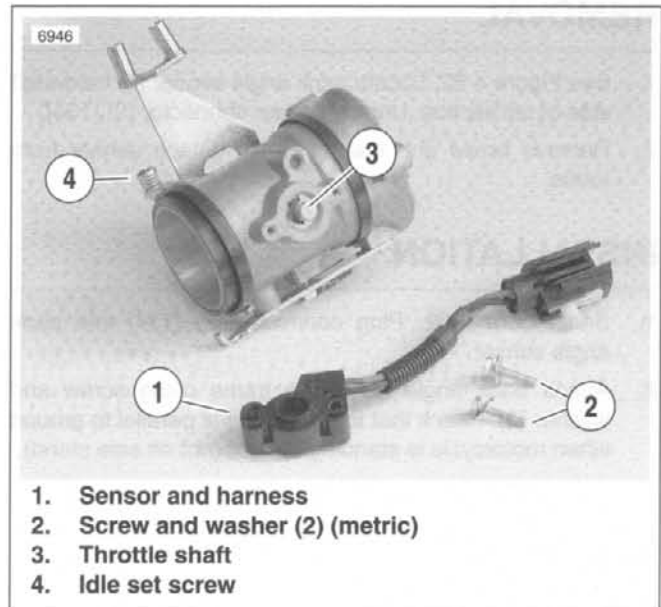


Figure 4-83. Throttle Position Sensor

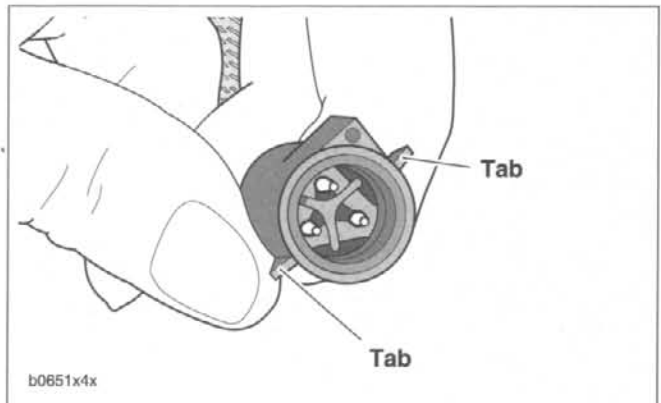


Figure 4-84. Tabs on [88A]



Figure 4-85. Calibration Mode

REMOVAL

WARNING

The gasoline in the fuel supply line downstream of the fuel pump is under high pressure (49 psi [338 kPa]). To avoid an uncontrolled discharge or spray of gasoline, always purge the system of high pressure gas before attaching fuel pressure gauge. Gasoline is extremely flammable and highly explosive. Inadequate safety precautions could result in death or serious injury.

1. Purge the fuel supply line of high pressure gasoline.
 - a. See Figure 4-86. Disconnect the 4-place fuel pump connector [86]. Connector is on the left side, above the rear cylinder spark plug.
 - b. With the motorcycle in neutral, start the engine and allow vehicle to run.
 - c. When the engine stalls, press the starter button for 3 seconds to remove any remaining fuel from fuel line.
2. See Figure 4-87. Remove seat, fuel tank cover and rear tank mount.
3. Prop fuel tank against frame to gain access to fuel supply fitting. Wrap a shop towel around the fuel supply fitting.

WARNING

A small amount of gasoline will drain from the fuel supply fitting and fuel line when removed. Thoroughly wipe up any spilt fuel immediately. Dispose of rags in a suitable manner. Gasoline is extremely flammable and highly explosive. Inadequate safety precautions could result in death or serious injury.

4. Remove fuel line from fuel supply fitting.
5. See Figure 4-88. Disconnect hose from vapor vent valve.
6. Remove fuel tank from frame.



Figure 4-86. Fuel Pump Connector [86]

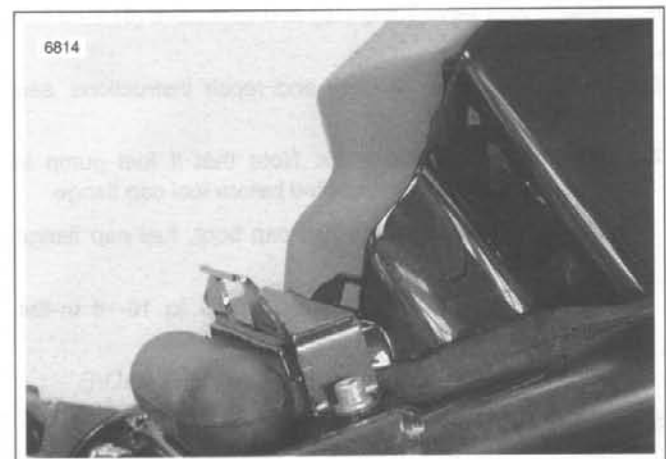


Figure 4-87. Fuel Tank Mount

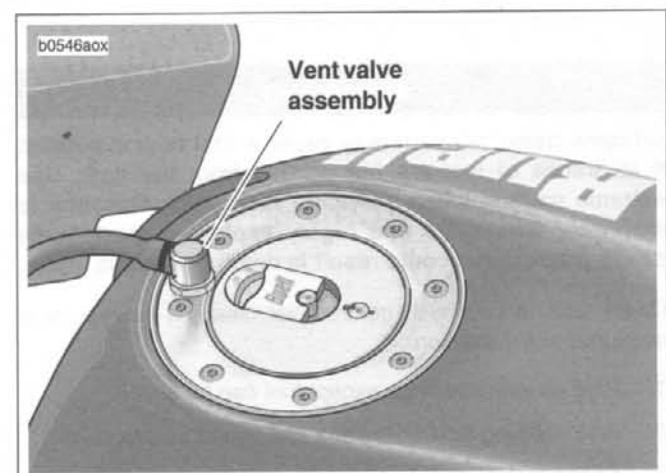


Figure 4-88. Vapor Vent Valve

DISASSEMBLY/ASSEMBLY

WARNING

An open flame or spark may cause a fuel tank explosion if all traces of fuel are not purged from the tank. Use extreme caution when servicing fuel tanks. Gasoline is extremely flammable and highly explosive. Inadequate safety precautions could result in death or serious injury.

1. Drain fuel tank before disassembly.
 - a. Using suitable external fuel pump, such as a Gas Caddy, pump fuel from tank and into suitable clean container.
 - b. See instructions for external fuel pump for correct use.
2. See Figure 4-89. Remove fuel filler cap (3) with attached O-ring (4).
3. Remove screws (5) from fuel cap flange (9).
4. Remove fuel cap flange and fuel cap boot (6).
5. Detach vent valve fitting (10) and vent valve (8) from fuel cap flange.
6. For all fuel pump removal and repair instructions, see 4.37 FUEL PUMP.
7. Assemble in reverse order. Note that if fuel pump is removed, it must be reinstalled before fuel cap flange.
 - a. Apply HYLOMAR to fuel cap boot, fuel cap flange and top of fuel tank.
 - b. See Figure 4-90. Tighten screws to 16-18 in-lbs (1.8-2.0 Nm) in the order shown.
 - c. Install vent valve and fitting. See VENT VALVE.
8. Perform Fuel Tank Pressure Test.

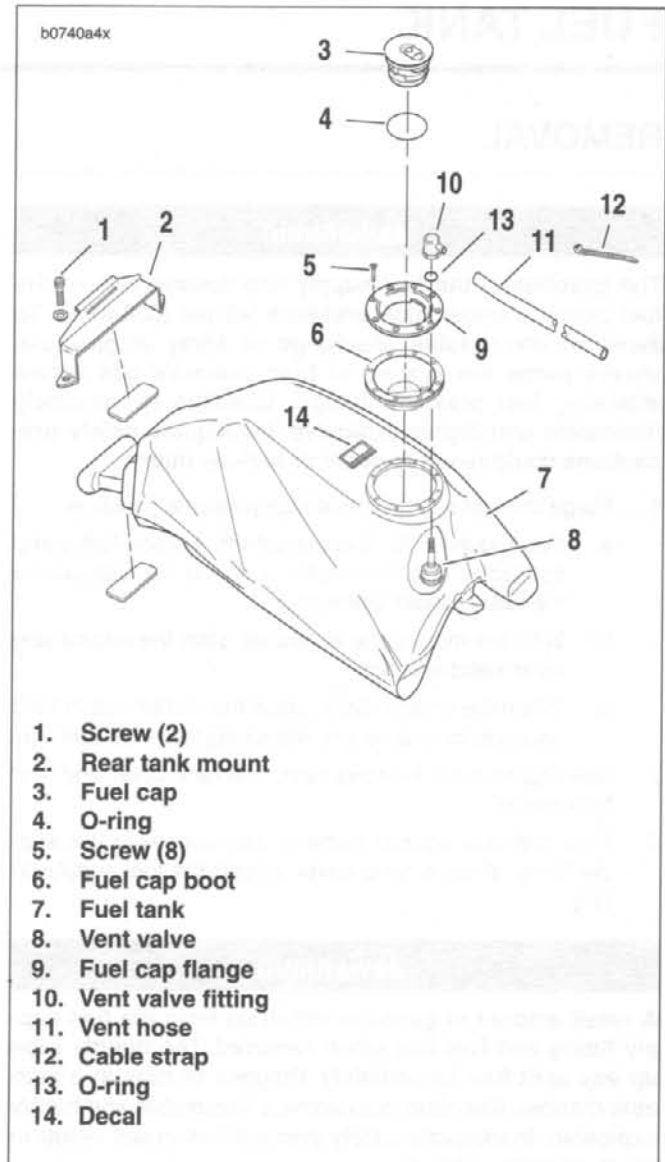


Figure 4-89. Fuel Tank

CLEANING, INSPECTION AND REPAIR

WARNING

An open flame or spark may cause a fuel tank explosion if all traces of fuel are not purged from the tank. Use extreme caution when servicing fuel tanks. Gasoline is extremely flammable and highly explosive. Inadequate safety precautions could result in death or serious injury.

Clean tank interior with commercial cleaning solvent or a soap and water solution.

1. Plug all tank openings except fuel cap hole.
2. Add cleaning agent. Replace fuel cap to seal tank.
3. Shake tank to agitate agent.
4. Thoroughly flush fuel tank after cleaning. Allow tank to air dry.
5. Carefully inspect fuel hose and vent hose for damage, wear or general deterioration. Replace as necessary.

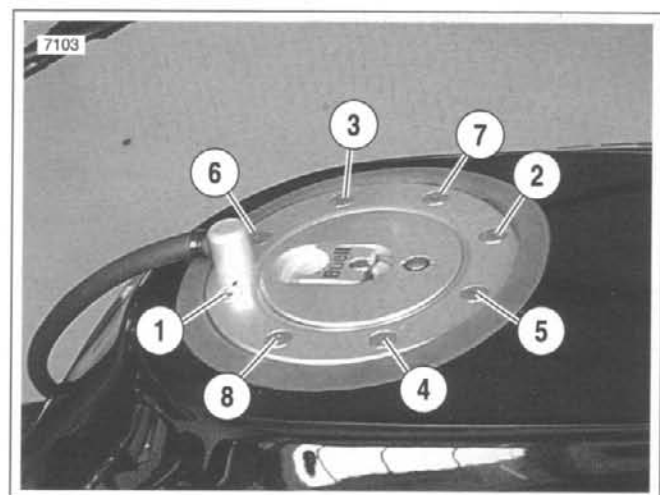


Figure 4-90. Tightening Flange (Typical)

INSTALLATION

1. Place fuel tank on frame and install fuel tank cover. See 2.43 FUEL TANK COVER.

CAUTION

Avoid pinching wiring harness and vent hose between fuel tank and frame during tank installation. Pinched hoses will negatively affect vehicle operation.

2. See Figure 4-89. Connect vent hose (11) to vent valve fitting (10). Clamp hose to fitting with a **new** cable strap (12).

WARNING

Always make sure fuel hoses are seated against the component they connect to and that hose clamps are properly tightened and positioned on straight section of fitting and not on the fitting barb. Failure to comply may result in fuel leakage which could result in death or serious injury.

NOTE

The barb is the larger outside diameter portion (bump) on the fuel fitting.

3. Connect fuel hose to fuel outlet with a **new** clamp. Make sure to push fuel hose all the way on to fitting and position hose clamp on fitting side of barb.
4. Attach 4-place fuel pump connector [86].

WARNING

After installing seat, pull upward on front of seat to be sure it is locked in position. If seat is loose, it could shift during vehicle operation and startle the rider, causing loss of control which could result in death or serious injury.

5. Install seat.

NOTE

Use a good quality unleaded gasoline (91 pump octane or higher). Octane rating is usually found on the pump.

6. Fill fuel tank. Turn ignition key ON and listen for fuel pump activation.
7. Carefully inspect for leaks.

FUEL TANK PRESSURE TEST

The fuel tank is a sealed, pressure-tested assembly when it leaves the factory. If the fuel cap flange seal is broken the fuel tank must be pressure tested as listed below before installation.

1. With fuel filter removed, gas cap installed and fuel vent valve installed, spray soap and water solution around fuel cap flange and fuel vent valve fitting.
2. Connect air hose to fuel vent valve. Shake the tank several times to seat the ball in the vent valve.

NOTE

Fuel tank must be pressurized slowly or fuel vent will snap shut and tank will not be pressurized. Slowly remove the fuel cap when complete to verify that tank was pressurized during test.

3. Slowly pressurize fuel tank to 3.3-4.3 psi (22.8-29.7 kPa). Check for air bubbles around fuel cap and flange.
4. Spray soap and water solution around two fittings on bottom of fuel tank. Check for air bubbles around two fittings.
5. Remove fuel cap from tank to make sure tank was pressurized.
6. Clean soap and water solution from fuel tank.
7. If bubbles were seen around fuel cap or flange, rework gas cap or fuel tank and retest until no bubbles are present when fuel tank is pressurized. If bubbles were seen around fittings on bottom of fuel tank, tighten fittings to specification. Reinstall fuel pump with new seals if required. See 4.37 FUEL PUMP.

MODEL YEAR CHANGE

All 1999 and 2000 Model Year Buell motorcycles are equipped with a new fuel tank vent valve.

GENERAL

The vent valve opens to allow gas vapor to escape the fuel tank and either vent to the atmosphere or to the charcoal canister on California Models (EVAP-equipped) and closes to prevent gasoline from leaking out of the fuel tank if the vehicle is tipped at an unusual angle.

REMOVAL

NOTE

The fuel tank must be drained to perform this service. The fuel tank does not need to be removed.

⚠ WARNING

Always disconnect the negative battery cable when working on motorcycle to prevent accidental startup. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion, which could result in death or serious injury.

1. Disconnect negative battery cable.

⚠ WARNING

An open flame or spark may cause a fuel tank explosion if all traces of fuel are not purged from the tank. Use extreme caution when servicing fuel tanks. Gasoline is extremely flammable and highly explosive. Inadequate safety precautions could result in death or serious injury.

2. Remove gas cap.
3. Relieve pressure from fuel system. Drain fuel tank.
 - a. Using suitable external fuel pump, such as a Gas Caddy, pump fuel from tank and into suitable clean container.
 - b. See instructions for external fuel pump for correct use.
4. See Figure 4-89. Cut cable tie holding vent hose to fitting and remove vent hose from fuel tank.
5. While holding vent valve with angled needle nose pliers, remove fitting from vent valve.
6. Pull the vent valve from the gasket and remove from fuel tank.

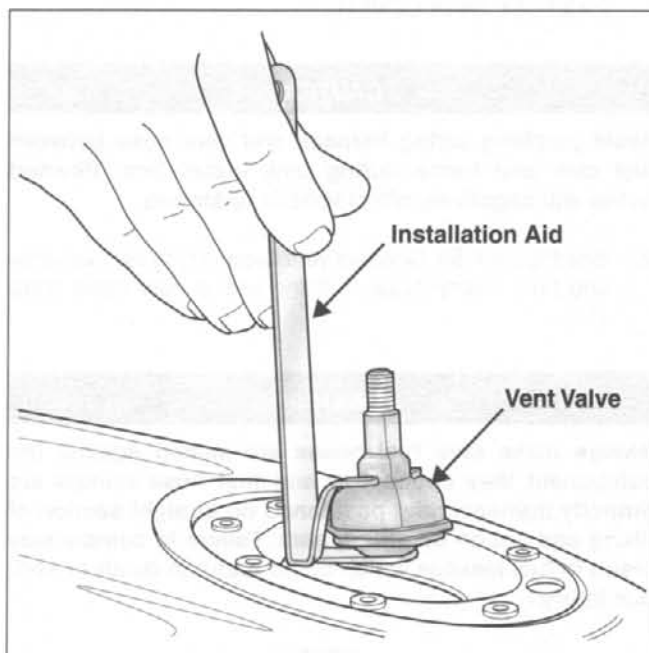


Figure 4-91. Installing Fuel Tank Vent

INSTALLATION

1. Wipe inside and outside vent valve mounting hole to make sure there is no gasoline or excess Hylomar sealant present.
2. See Figure 4-91. Using the fuel vent valve installation aid, lower the **new** fuel tank vent valve into the fuel tank through the fuel filler neck.
3. Position the fuel tank vent valve so the threaded portion at the top protrudes from the fuel vent opening on the fuel cap flange. Verify hole on top of vent valve is not blocked by Hylomar sealant and that vent protrudes completely from hole.
4. See Figure 4-89. Install **new** O-ring in groove on bottom of **new** fitting.
5. While holding vent valve with fuel vent valve installation aid, install fitting and O-ring to threaded portion of vent valve. Do not tighten. Remove fuel vent valve installation aid.

NOTE

The fuel vent fitting is installed dry. Do NOT use teflon tape or loctite products when installing vent fitting.

NOTE:

It may take a few tries and slight rotation of the vent valve to get the alignment mentioned in Step 6.

6. See Figure 4-92. Align fitting so right front point of hex is oriented to 12:00 position when fitting is tightened finger tight. Make sure O-ring remains in groove of fitting while tightening.

CAUTION

Do not overtighten vent fitting or attempt to tighten with standard "click-type" torque wrench. Overtightening vent will cause it to snap off and fall into fuel tank, requiring fuel tank removal.

7. Using a dial-type torque wrench, tighten vent fitting to 40-60 **in-lbs.** (4.5-6.8 Nm) until top fitting nozzle points to 12:00 position.

NOTE:

If fitting nozzle does not point to 12:00 position when tightening within specified torque range, loosen fitting, rotate vent valve and try again. Repeat as required to get proper alignment of nozzle within specified torque range.

8. See Figure 4-89. Attach vent hose to nozzle on fitting with **new** cable tie.
9. Fill fuel tank with proper fuel (91 Octane) and install gas cap.
10. Connect negative battery cable. Tighten to 40 **in-lbs** (4.5 Nm).
11. Pressurize fuel system.
12. Check for leaks. See Section 4 for procedure if leaks are found.

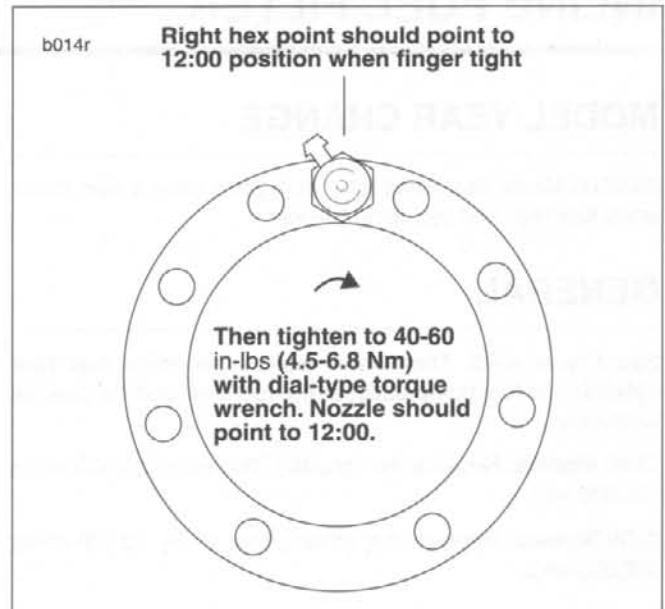


Figure 4-92. Fuel Tank Vent Alignment

MODEL YEAR CHANGE

All 2000 Model Year Buell X1 motorcycles have a **new** metal inline fuel filter and mounting bracket.

GENERAL

See Figure 4-93. There is a replaceable inline fuel filter between the fuel pump outlet at the fuel tank and the fuel rail assembly.

1999 Models: Replace this (plastic) filter every 24,000 miles (38,600 km).

2000 Models: Replace this (metal) filter every 20,000 miles (32,000 km).

REMOVAL/INSTALLATION

⚠ WARNING

The gasoline in the fuel supply line downstream of the fuel pump is under high pressure (49 psi [338 kPa]). To avoid an uncontrolled discharge or spray of gasoline, always purge the system of high pressure gas before removing fuel tank. Gasoline is extremely flammable and highly explosive. Inadequate safety precautions could result in death or serious injury.

1. Purge fuel line and remove fuel tank. See 4.34 FUEL TANK.
2. **2000 Models Only:** See Figure 4-94. Cut two cable ties that secure fuel filter to bracket.
3. Wrap a shop towel around the fuel filter.

⚠ WARNING

A small amount of gasoline will drain from the fuel line when the filter is removed. Thoroughly wipe up any spilt fuel immediately. Dispose of rags in a suitable manner. Gasoline is extremely flammable and highly explosive. Inadequate safety precautions could result in death or serious injury.

4. See Figure 4-93. Remove hose clamps from both sides to detach filter.
5. **2000 Models Only:** Position **new** filter in bracket with arrow pointing in direction of fuel flow. Install two cable ties around filter and bracket. NOTE: If bracket was removed for any reason, tighten bolt to 30-33 ft-lbs (41-45 Nm).

⚠ WARNING

Always make sure fuel hoses are seated against the component they connect to and that hose clamps are properly tightened and positioned on straight section of fitting and not on the fitting barb. Failure to comply may result in fuel leakage which could result in death or serious injury.

NOTE

The barb is the larger outside diameter portion (bump) on the fuel fitting. See Figure 4-93.

6. Install **new** filter with two **new** hose clamps. Arrow on filter must be pointing in direction of fuel flow. Make sure to push fuel hoses all the way on to fittings and position hose clamp on fitting side of barb.
7. Install fuel tank. See 4.34 FUEL TANK.

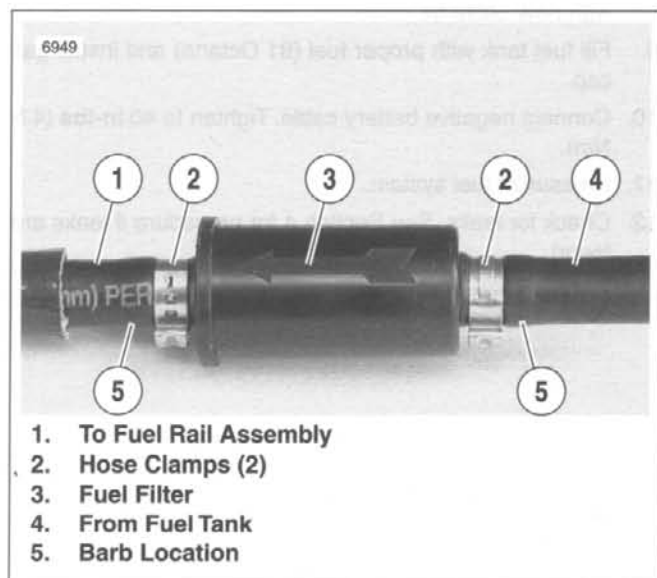


Figure 4-93. Inline Fuel Filter (1999 Models)

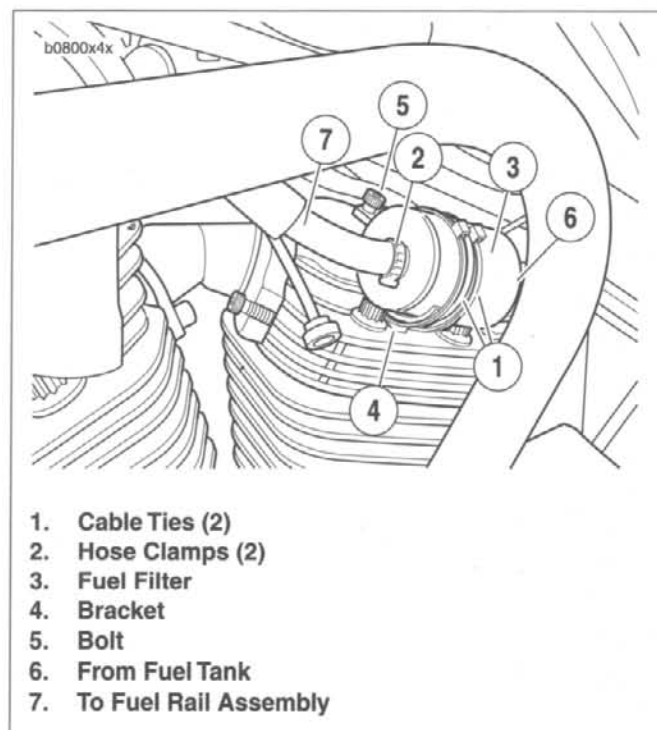


Figure 4-94. Inline Fuel Filter (2000 Models)

REMOVAL

WARNING

The gasoline in the fuel supply line downstream of the fuel pump is under high pressure (49 psi [338 kPa]). To avoid an uncontrolled discharge or spray of gasoline, always purge the system of high pressure gas before removing fuel tank. Gasoline is extremely flammable and highly explosive. Inadequate safety precautions could result in death or serious injury.

1. Purge fuel line and remove fuel tank. See 4.34 FUEL TANK.

WARNING

An open flame or spark may cause a fuel tank explosion if all traces of fuel are not purged from the tank. Use extreme caution when servicing fuel tanks. Gasoline is extremely flammable and highly explosive. Inadequate safety precautions could result in death or serious injury.

2. Drain fuel from tank.
 - a. Using suitable external fuel pump, such as a Gas Caddy, pump fuel from tank and into suitable clean container.
 - b. See instructions for external fuel pump for correct use.
3. Remove fuel filler cap flange assembly. See 4.34 FUEL TANK.
4. See Figure 4-95. Remove fuel fitting nut (1).
5. Remove electrical fitting nut (5) and washer/seal (6).
6. Push electrical and fuel fitting studs back into tank.
7. Reach inside fuel filler cap hole and remove pump assembly.

REPAIR

Fuel Pump Replacement

1. Remove fuel pump assembly from tank.
2. See Figure 4-96. Remove retaining clamp (5) from pump body (4) using a pair of cutters.
3. Pull pump outlet fitting from pump holder housing (2). Detach electrical wires (3) and discard old pump.
4. Place **new** rubber sleeve on **new** pump's outlet fitting.
5. Attach both electrical connectors (3) to **new** pump. Note that connectors are two different sizes.
6. Press pump fitting outlet into pump holder housing (2).
7. Place a **new** retaining clamp (5) over pump body. Position clamp inside groove (8) on pump holder housing.

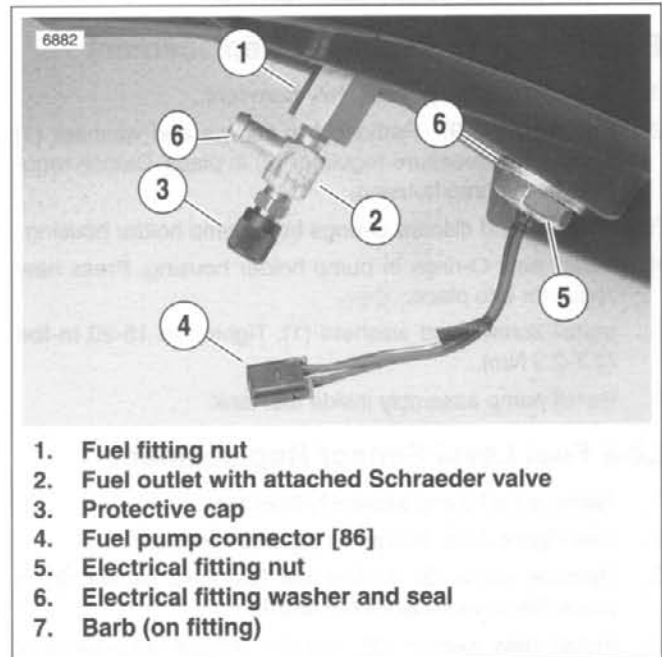


Figure 4-95. Fuel Pump Within Tank

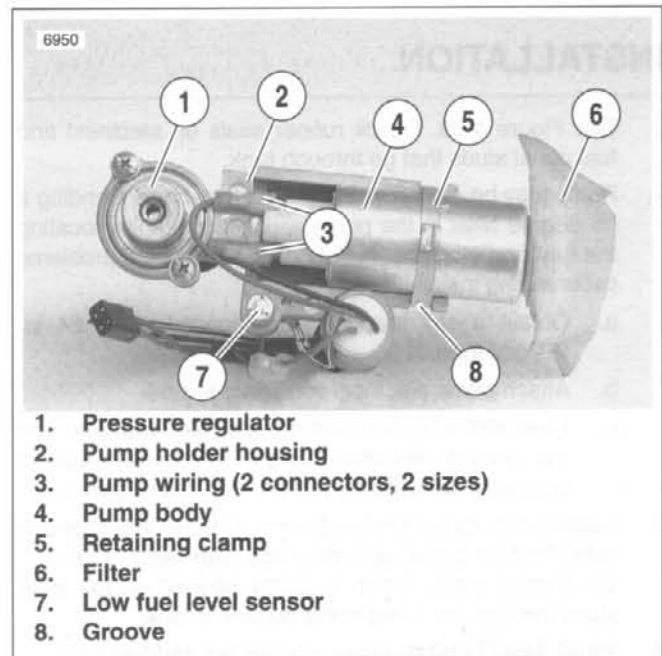


Figure 4-96. Fuel Pump Assembly

Table 4-29. Fuel Pump Assembly Specifications

SPECIFICATION	DATA
Pressure setting	49 PSI
Operating voltage	14 volts
Fuel delivery	70 LPH @ 49 PSI
Current draw	3 amps

8. Tighten clamp around pump.
9. Press **new** filter (6) onto pump being careful not to damage the pump assembly.
10. Install pump assembly inside fuel tank.

Fuel Pressure Regulator Replacement

1. Remove fuel pump assembly from tank.
2. See Figure 4-97. Remove two screws and washers (1) holding fuel pressure regulator (2) in place. Detach regulator from pump housing.
3. Remove and discard O-rings from pump holder housing.
4. Install **new** O-rings in pump holder housing. Press **new** regulator into place.
5. Install screws and washers (1). Tighten to 15-20 **in-lbs** (1.7-2.3 Nm).
6. Install pump assembly inside fuel tank.

Low Fuel Level Sensor Replacement

1. Remove fuel pump assembly from tank.
2. See Figure 4-98. Pull apart the wire connect (1).
3. Remove screw (3) holding low fuel level sensor (2) in place. Remove sensor from housing.
4. Install **new** sensor (2). Secure ground wire terminal under screw (3). Tighten to 16-20 **in-lbs** (1.8-2.3 Nm).
5. Attach wire connect.
6. Install pump assembly inside fuel tank.

INSTALLATION

1. See Figure 4-99. Check rubber seals on electrical and fuel outlet studs that go through tank.
2. Pump may be placed inside fuel tank by hand. Bending a 90 degree twist in the pump wiring will simplify locating the fuel and electrical outlet holes. However, if problems occur during installation:
 - a. Obtain a stiff piece of wire approximately 24 in. (61 cm) long.
 - b. Attach pump electrical connector to wire.
 - c. Feed wire into tank through fuel filler cap hole and out through electrical fitting hole (smaller hole) in bottom of tank. Gently pull on wire to seat pump.
3. Install pump assembly inside tank through fuel filler cap hole. Position pump assembly with filter facing motorcycle license plate. When properly aligned, press both studs through the holes in the bottom of tank.
4. Install **new** O-ring on brass adaptor nut and fuel stud.

WARNING

Do NOT overtighten fuel fitting nuts. Overtightening fasteners may result in excessive compression of rubber sealing washers and fuel leakage which could result in death or serious injury.

5. Torque both nuts to 60-75 **in-lbs** (6.8-8.5 Nm).
6. Install fuel filler cap flange assembly. See 4.34 FUEL TANK.
7. Install fuel tank. See 4.34 FUEL TANK.

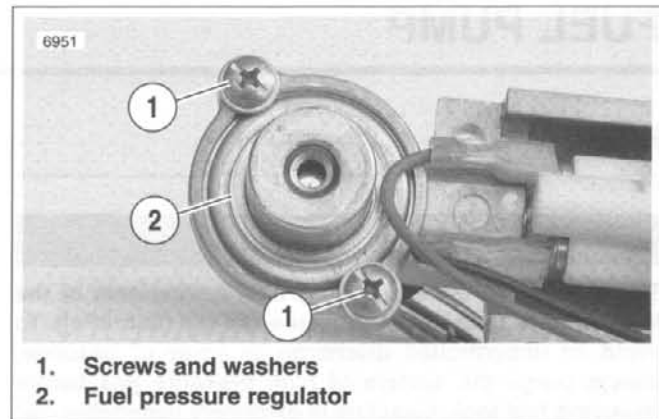


Figure 4-97. Fuel Pressure Regulator

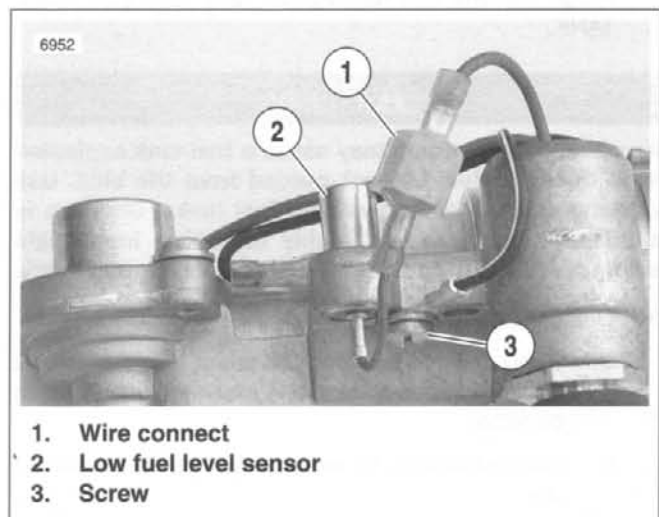


Figure 4-98. Low Fuel Level Sensor

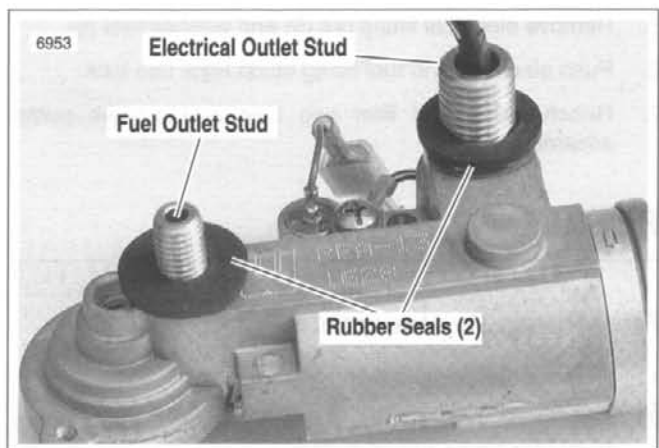


Figure 4-99. Rubber Seals

GENERAL

See Figure 4-100. The throttle body and manifold consist of the following components:

- Fuel injectors (front and rear).
- Fuel supply fitting.
- Idle speed adjustment screw.
- Cable bracket.
- Throttle position sensor.
- Throttle lever.

REMOVAL

⚠ WARNING

The gasoline in the fuel supply line downstream of the fuel pump is under high pressure (49 psi [338 kPa]). To avoid an uncontrolled discharge or spray of gasoline, always purge the system of high pressure gas before removing fuel tank. Gasoline is extremely flammable and highly explosive. Inadequate safety precautions could result in death or serious injury.

1. Purge fuel line and remove fuel tank. See 4.34 FUEL TANK.
2. Remove air cleaner cover and backplate. See 4.39 AIR CLEANER.
3. See Figure 4-100. On California models, pull EVAP hose from fitting (3).

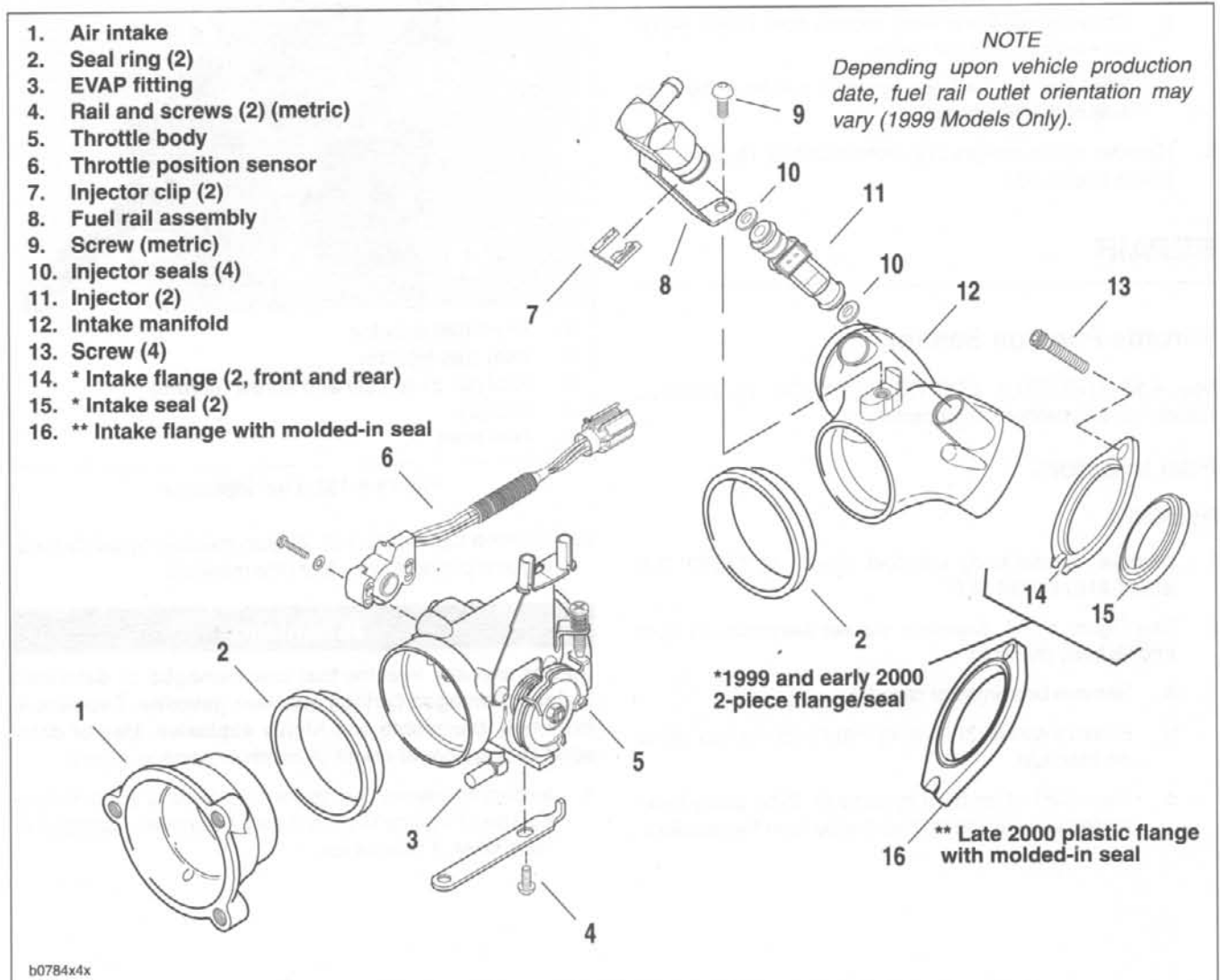
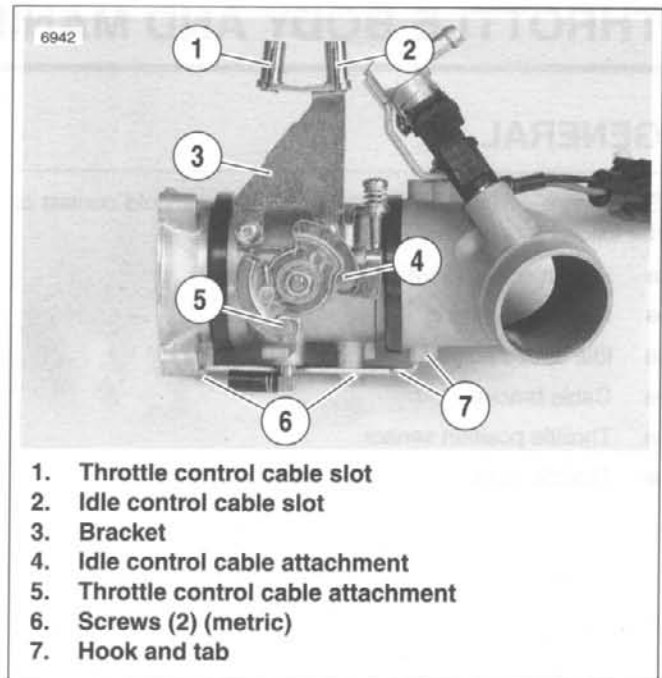


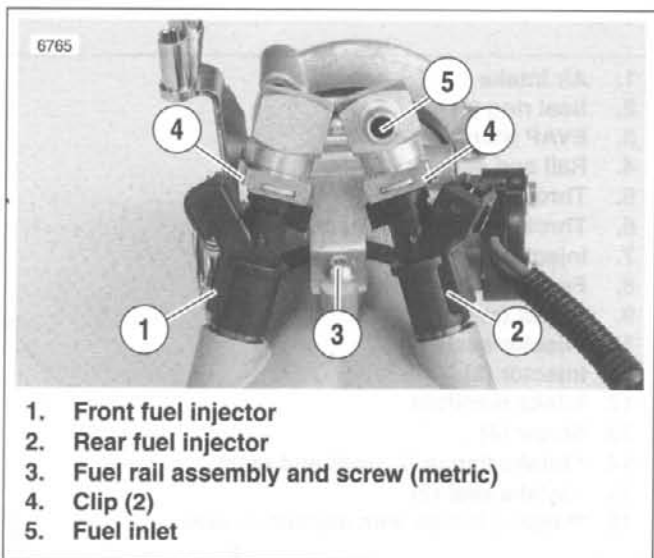
Figure 4-100. Throttle Body Manifold

4. Label and detach throttle cables.
 - a. **2000 Models Only:** Remove screw and throttle cable brackets from throttle cables.
 - b. See Figure 4-101. Increase throttle cable freeplay. Through the slots (1, 2) in the side of the bracket (3), remove both throttle cables.
 - c. Using needle nose pliers, pull the cable barrels from attachment points (4, 5).
5. Detach wiring.
 - a. Disconnect throttle position sensor by lifting both tabs on the connector while rocking the connection and pulling apart.
 - b. If removing entire throttle body manifold assembly, disconnect fuel injectors. Depress wire form on connector and use a rocking motion to detach electrical connectors from injectors.
6. If only removing front portion of throttle body manifold, remove two screws (6) (metric). Detach hook on rail from tab on manifold (7) and slide front portion out.
7. See Figure 4-100. Remove assembly from motorcycle.
 - a. On primary cover side, loosen but do not remove the two front and rear intake flange screws (13). For best results use a 1/4 inch ball Allen bit with an end driver at least 4 inches long.
 - b. On gearcase cover side, remove both intake flange screws from cylinder heads.
 - c. Slide the throttle body manifold out from the right side of the bike frame.
8. Remove intake flanges (14) from manifold. Remove and discard seals (15).



1. Throttle control cable slot
2. Idle control cable slot
3. Bracket
4. Idle control cable attachment
5. Throttle control cable attachment
6. Screws (2) (metric)
7. Hook and tab

Figure 4-101. Throttle Cable Bracket



1. Front fuel injector
2. Rear fuel injector
3. Fuel rail assembly and screw (metric)
4. Clip (2)
5. Fuel inlet

Figure 4-102. Fuel Injectors

REPAIR

Throttle Position Sensor

See 4.33 THROTTLE POSITION SENSOR for removal, installation and calibration procedures.

Fuel Injectors

REMOVAL

1. Remove throttle body manifold. See 4.38 THROTTLE BODY AND MANIFOLD.
2. See Figure 4-102. Separate fuel rail assembly (3) from throttle body manifold.
 - a. Remove both injector clips (4).
 - b. Remove screw (3) (metric) that holds the fuel rail to the manifold.
 - c. Separate fuel rail from injectors (1, 2) by gently rocking the fuel rail and pulling it away from the injectors.

3. Remove fuel injectors (1, 2) from manifold by gently rocking and pulling it away from the manifold.

⚠ WARNING

Do not use any injector that has damaged or deformed O-rings. Damaged O-rings may leak gasoline. Gasoline is extremely flammable and highly explosive. Use of damaged O-rings could result in death or serious injury.

4. Inspect all injector O-rings for cuts, tears or general deterioration. Replace O-rings if they have been damaged or have taken a definite set.

INSTALLATION

1. Apply a thin coat of clean engine oil to top and bottom injector O-rings.
2. See Figure 4-103. Install fuel injectors.
 - a. Place an O-ring on each side of injector.
 - b. Install both injectors (4) into throttle body manifold.
 - c. Press the fuel rail (1) onto the top of the injectors.
 - d. Secure the fuel rail to the manifold with screw (metric). Tighten securely.
3. Snap the injector clips (2) over the flange on the fuel rail outlet and into the top groove in the injector.
4. Install throttle body manifold. See 4.38 THROTTLE BODY AND MANIFOLD.

TESTING

1. Remove air cleaner cover.
2. Conduct test.
 - a. With throttle held wide open, turn key ON for two seconds.
 - b. Turn key OFF for two seconds.
 - c. Repeat Steps A and B five consecutive times. Replace fuel injectors if there is any evidence of raw fuel in throttle bottle manifold.
3. Install air cleaner cover.

INSTALLATION

NOTE

If only installing front portion of throttle manifold, begin installation with Step 3.

1. See Figure 4-104. Install front and rear intake flanges onto manifold with the counterbore facing out. Each intake flange is labeled and the pieces are not interchangeable.
2. Place a **new** seal in each intake flange with the beveled side against the counterbore.
3. See Figure 4-105. Attach both throttle cables. Add free-play to cables if necessary.
 - a. With the manifold assembly close to the right side of the bike but not fully installed, place idle control cable end (1) into hole on guide (2). Wrap the cable into the channel.
 - b. Place the end of the cable housing into the bracket by sliding the cable through the slot (3). Adjust the cable so it will not dislodge from the bracket.
 - c. Repeat procedure for the throttle control cable.
 - d. Verify that the cables are seated in the channels on the guide. Check that the cable ends are positioned in the bosses on the cable bracket.
 - e. **2000 Models Only:** Install screw and throttle cable brackets to throttle cables.
 - f. Verify operation by turning throttle grip and observing the cable action and throttle valve movement.

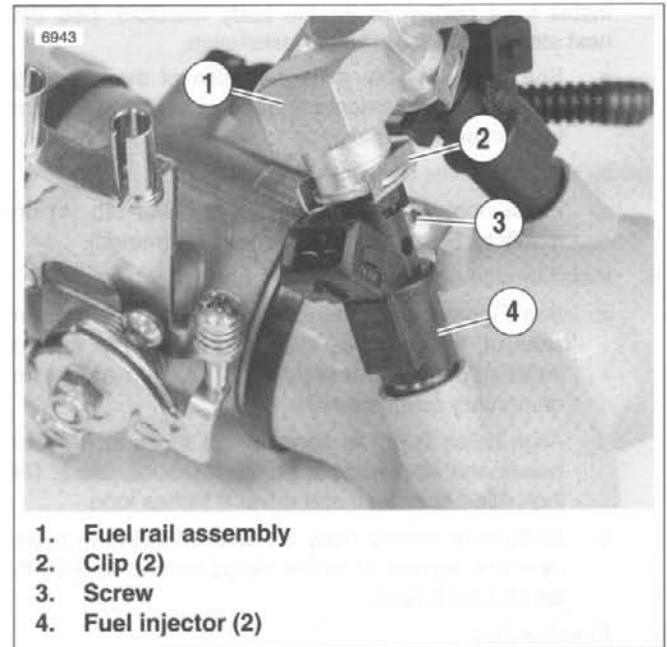


Figure 4-103. Installing Injectors

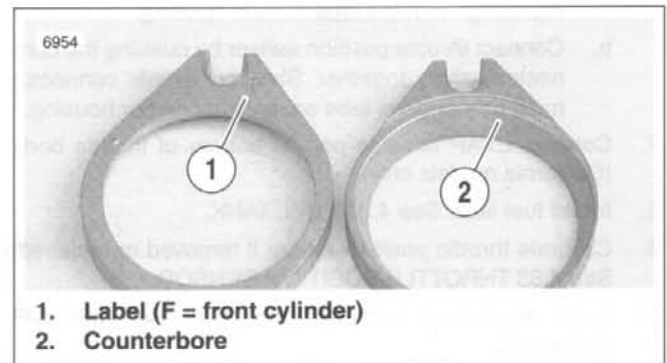


Figure 4-104. Intake Flanges (1999 Shown)

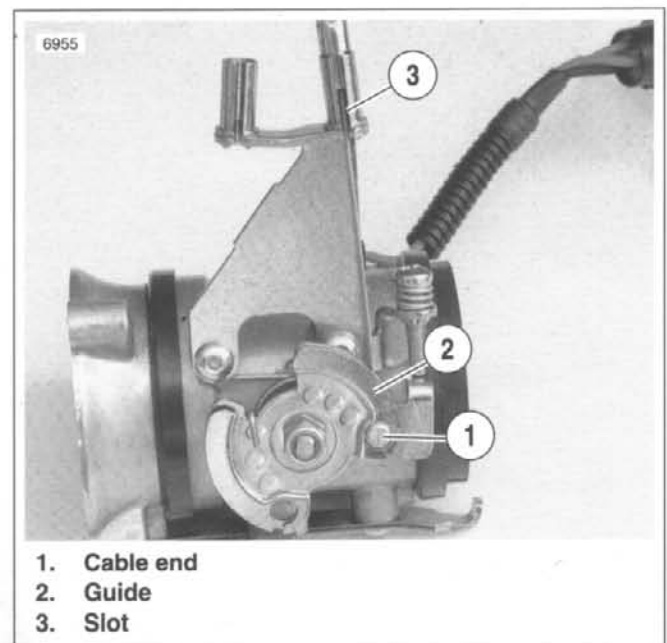


Figure 4-105. Idle Control Cable Installation

4. Install front portion of throttle body manifold. See the next step for entire assembly installation.
 - a. See Figure 4-106. If front portion of throttle body was removed, lubricate surface of seal ring (5) that will contact manifold.
 - b. Press throttle body into manifold.
 - c. Place hook (3) on bottom rail (2) over tab (4) on manifold. Secure with two screws (1) (metric).
5. Install throttle body manifold assembly.
 - a. See Figure 4-107. Standing on the gearcase cover side of the vehicle, slide the assembly toward installed position. Manifold should slide over screws on primary cover side of engine.
 - b. Align holes in intake flanges with those in cylinder heads and start screws. For best results, use a 1/4 inch Allen head with end driver 8 inches long.
 - c. Make sure throttle body is centered between cylinders and tighten all intake flange screws to 6-10 ft-lbs (8.1-13.6 Nm).
6. Attach wiring.
 - a. Injector cables are tagged F(ront) and R(ear) for ease of assembly. Push connector halves together until latches "click." Grooves in female connector must align with the tabs in male housing.
 - b. Connect throttle position sensor by pushing the connector halves together. Slots on female connector must fully engage tabs on male connector housing.
7. Connect EVAP hose to port at bottom of throttle body (California models only).
8. Install fuel tank. See 4.34 FUEL TANK.
9. Calibrate throttle position sensor if removed or replaced. See 4.33 THROTTLE POSITION SENSOR.
10. Install air cleaner backplate and cover. See 4.39 AIR CLEANER.
11. Check throttle cable adjustment.

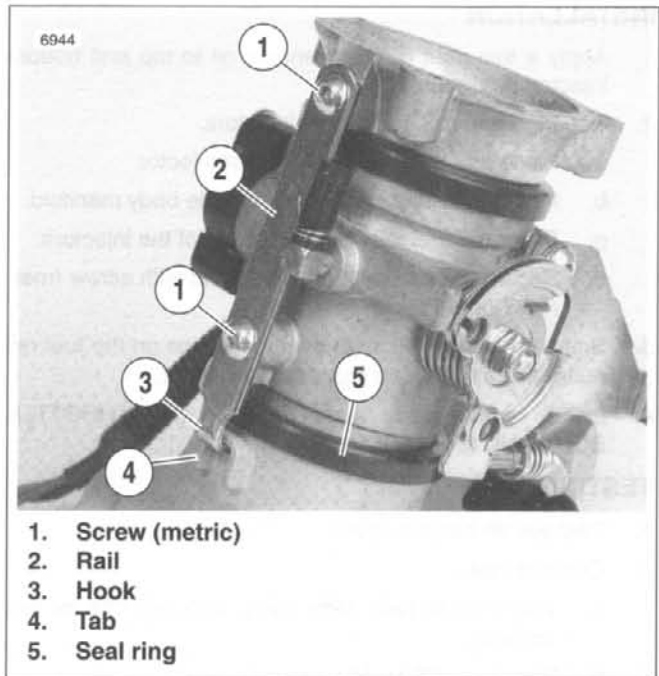


Figure 4-106. Front Portion of Throttle Body

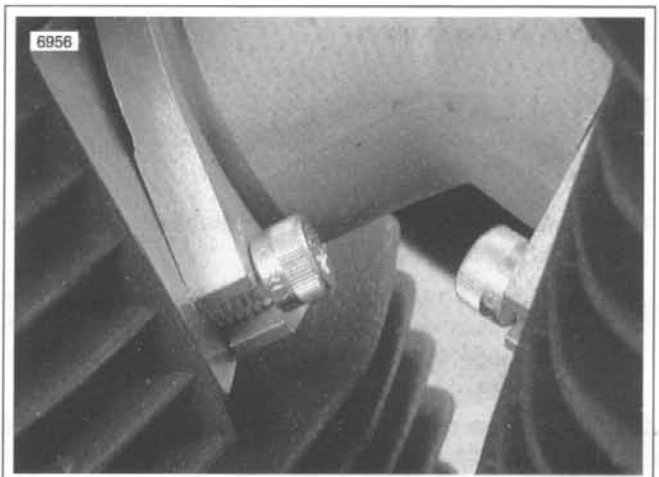


Figure 4-107. Intake Flange Screws, Primary Cover Side

REMOVAL

1. See Figure 4-108. Remove two screws (3) and washers (2) from front and one bolt (27) and washer (2) from back of air cleaner cover (1).
2. Remove air cleaner cover (1) and air filter (5).
3. Disconnect plug (29) from IAT (inlet air temperature) sensor (11).
4. Remove hose (13) from snorkel (7).
5. Remove three screws (9) from snorkel plate (8). Remove snorkel plate (8), snorkel (7) from support plate (24).
6. Remove three screws (17) and washers (18) and bolts (22) and washers (2) securing air cleaner backing plate (21) to wellnuts (25) in clamps (26).
7. Remove air cleaner backing plate (21).
 - a. Disconnect breather hoses (15,19) from fittings (23).
 - b. If necessary, pry grommet (20) from air cleaner backing plate.
8. Remove IAT sensor (11) from top of snorkel (7).
9. Remove breather bolts (23) from support plate (24) and remove support plate.
7. If removed, position **new** gasket (10) in position on snorkel (7) flange.
8. Place snorkel (7) into position on backing plate (21) ensuring inlet end is in gasket (6) properly.
9. Place snorkel plate (8) into position and secure with screws (9).
10. Connect IAT sensor plug (29) to sensor (11).
11. Install hose (13) on snorkel (7).
12. Place a small piece of double sided tape at the upper-center of the air filter foam gasket that fits against the backing plate (21).
13. Position air filter (5) on air cleaner backing plate (21).
14. Install air cleaner cover (1).
 - a. Position air cleaner cover (1) over air cleaner backing plate (21), making sure that air filter (5) is correctly positioned.
 - b. Install long bolt (27) and washer (2) first.
 - c. Align air cleaner cover (1) and secure with two screws (3) and washers (2). Torque to 27-29 **in lbs** (3.1-3.3 Nm).

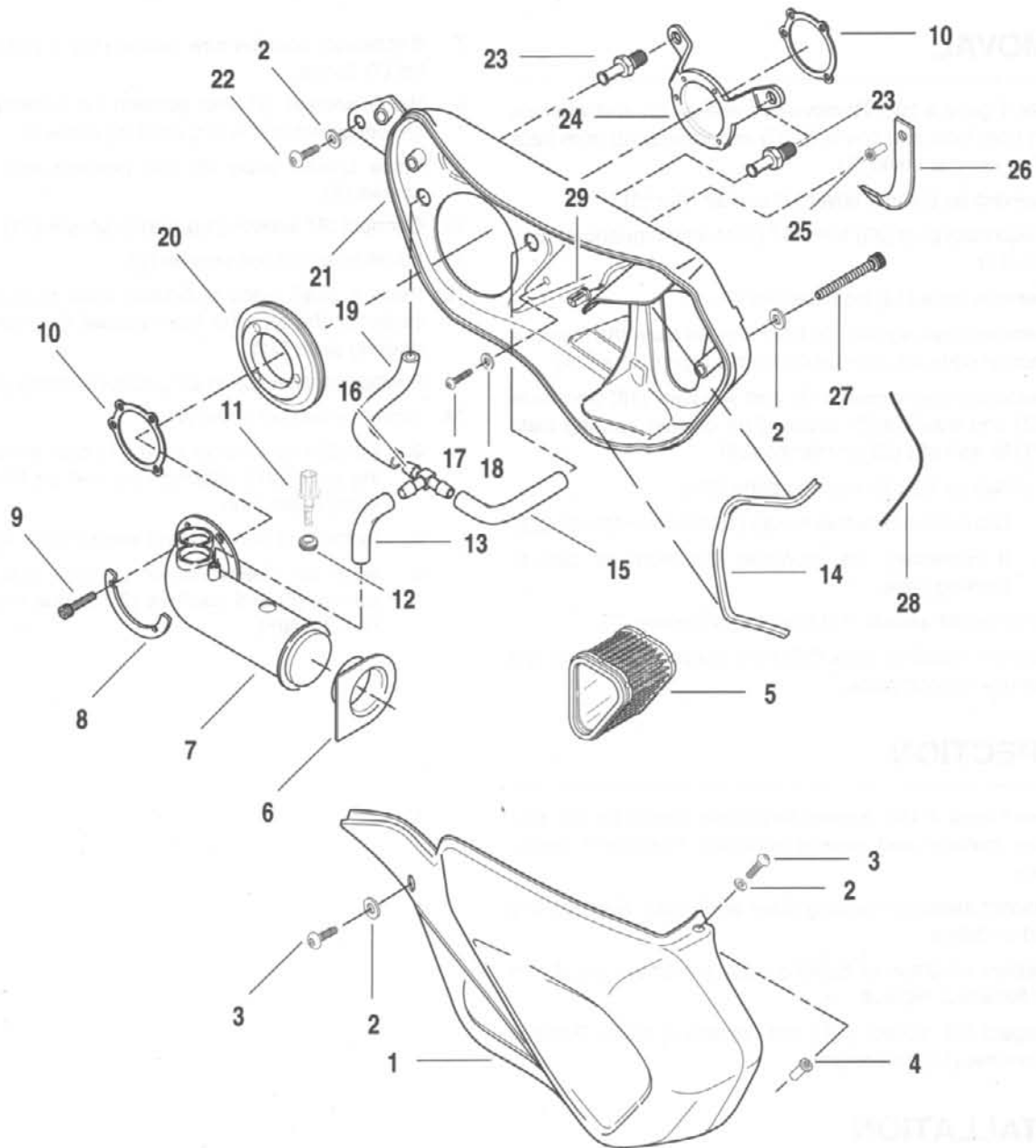
INSPECTION

1. See Figure 4-108. Inspect air cleaner. Check for dirt, torn filter material and general condition. Replace if necessary.
2. Inspect inside of backing plate and cover. Remove any dirt or debris.
3. Inspect condition of backing plate grommet (20). If torn or flattened, replace.
4. Inspect IAT sensor (11) and replace if faulty. Replace grommet (12) if necessary.

INSTALLATION

1. See Figure 4-108. Install **new** gasket (10) on back of support plate (24).
2. Install support plate (24) with breather bolts (23) into cylinder heads.
3. Install air cleaner backing plate (21).
 - a. Insert air inlet temperature sensor plug (29) through air cleaner backing plate (21) from back side of air cleaner backing plate.
 - b. Position breather hoses (15, 19) on breather bolts (23).
4. Install, but do not tighten, three screws (17) and washers (18) to secure air cleaner backing plate (21) to wellnuts (25) in clamps (26). Tighten after installing all three fasteners.
5. Install bolt (22) and washer (2) to secure backing plate to vehicle frame.
6. Install IAT sensor (11) and grommet (12) into snorkel (7).

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- 1. Cover, air cleaner
- 2. Washer (3)
- 3. Screw (2)
- 4. Wellnut
- 5. Filter element
- 6. Gasket, snorkel
- 7. Snorkel, internal
- 8. Snorkel plate
- 9. Screw
- 10. Gasket (2)

- 11. IAT sensor
- 12. IAT grommet
- 13. Breather hose, snorkel
- 14. Gasket
- 15. Breather hose
- 16. Breather tee
- 17. Screw (3)
- 18. Washer (3)
- 19. Breather hose
- 20. Grommet

- 21. Backing plate
- 22. Bolt
- 23. Bolt, breather (2)
- 24. Support plate
- 25. Wellnut (3)
- 26. Clamp (3)
- 27. Screw
- 28. Gasket
- 29. IAT plug and wiring

Figure 4-108. Air Cleaner

EVAPORATIVE EMISSIONS CONTROL-CA MODELS 4.40

GENERAL

Buell motorcycles sold in the state of California are equipped with an evaporative (EVAP) emissions control system. The EVAP system prevents fuel hydrocarbon vapors from escaping into the atmosphere and is designed to meet the California Air Resource Board (CARB) regulations in effect at the time of manufacture.

The EVAP functions in the following manner:

- See Figure 4-109. Hydrocarbon vapors in the fuel tank are directed through the vent valve and stored in the carbon canister. If the vehicle is tipped at an abnormal angle, the vent valve closes to prevent liquid gasoline from leaking out of the fuel tank through the fuel tank vent hose.
- See Figure 4-110. When the engine is running, manifold venturi negative pressure (vacuum) slowly draws off the hydrocarbon vapors from the carbon canister through the canister vent hose. These vapors pass through the throttle body manifold and are burned as part of normal combustion in the engine. The large diameter canister-to-air cleaner backplate hose (canister fresh air inlet hose) supplies the canister with fresh air from the air cleaner.

TROUBLESHOOTING

WARNING

Verify that the evaporative emissions system hoses do not contact hot exhaust or engine parts. The hoses contain flammable vapors that can be ignited if damaged, which could result in death or serious injury.

The system has been designed to operate with a minimum of maintenance. Check that all hoses are properly routed and connected and are not pinched or kinked. Periodically check all mounting hardware for tightness.

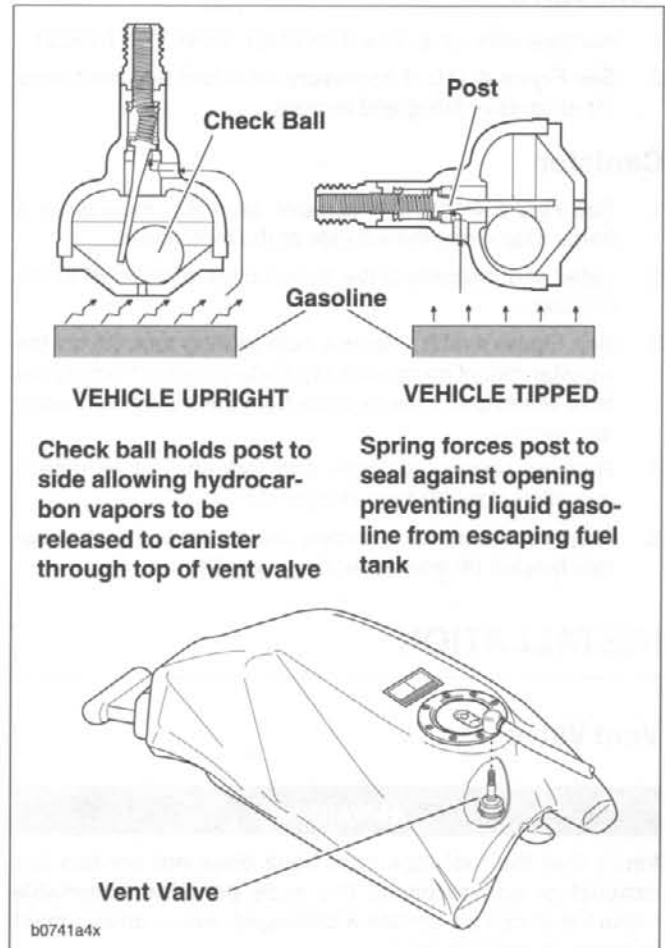


Figure 4-109. Vent Valve Operation

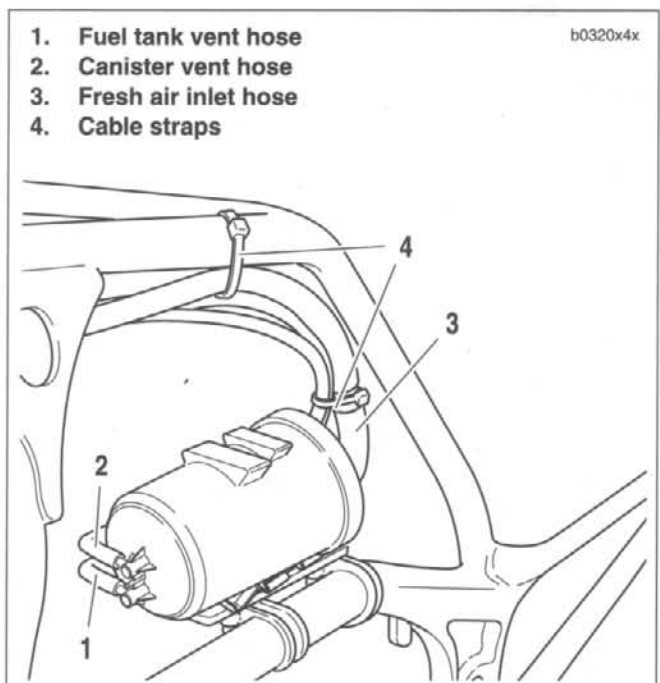


Figure 4-110. Typical Carbon Canister Installation.

REMOVAL

Vent Valve

1. Remove vent valve. See 4.35 FUEL TANK VENT VALVE
2. See Figure 4-110. If necessary, label fuel tank vent hose (1) at canister fitting and remove.

Canister

1. See Figure 4-110. The canister assembly mounts on a frame tube along the left side of the motorcycle.
2. Label and disconnect the three hoses connected to the canister.
3. See Figure 4-112. Depress both locking tabs (3) on the canister mounting bracket (4). Slide canister towards the front wheel until it disengages from the mounting bracket and remove.
4. Remove screws, washers and locknuts (6) to detach mounting plate (2) from clamps (1).
5. Remove countersunk screws and locknuts (5) to separate bracket (4) from mounting plate (2).

INSTALLATION

Vent Valve

WARNING

Verify that the fuel tank vent hose does not contact hot exhaust or engine parts. The hose contains flammable vapors that can be ignited if damaged, which could result in death or serious injury.

1. Install vent valve. See 4.35 FUEL TANK VENT VALVE.
2. See Figure 4-110. Attach fuel tank vent hose (1) to canister if disconnected.

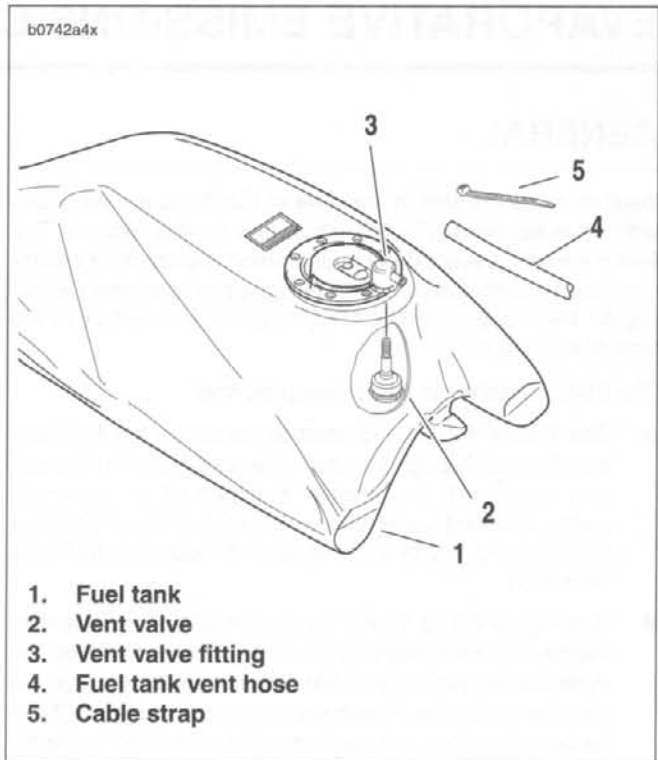


Figure 4-111. Vent Valve

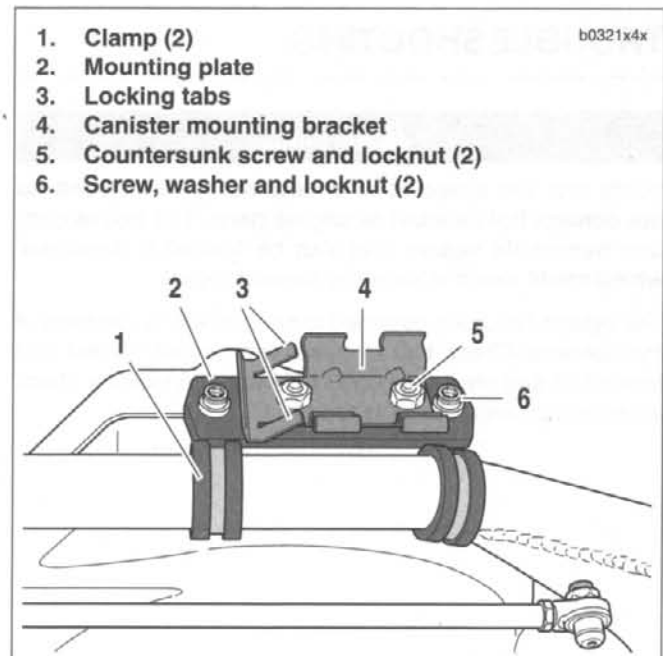


Figure 4-112. Carbon Canister Mounting

Canister

1. See Figure 4-112. Install canister mounting bracket (4) on mounting plate (2) with countersunk screws and lock-nuts (5).
2. Install mounting plate assembly on frame by attaching mounting clamps (1) using screws, washers and lock-nuts (6). Tighten to 6-8 ft-lbs (8.1-10.8 Nm).
3. Depress locking tabs (3) and slide canister into locked position on canister mounting bracket (4). Locking tabs (3) must engage canister; bend tabs outward somewhat if canister is not held securely.

⚠ WARNING

Always make sure fuel hoses are seated against the component they connect to and that hose clamps are properly tightened and positioned on straight section of fitting and not on the fitting barb. Failure to comply may result in fuel leakage which could result in death or serious injury.

NOTE

The barb is the larger outside diameter portion (bump) on the fuel fitting.

4. See Figure 4-110. Connect all three hoses to the canister. Make sure to push fuel tank vent hose all the way on to carbon canister fitting and position hose clamp on fitting side of barb.
5. Measure distance to closest point of rear cylinder head. If clearance is not at least 0.5 in. (12.7 mm), move canister bracket clamps.

HOSE ROUTING

Throttle Body Manifold

See Figure 4-113. Route the evaporative emissions control hose at the throttle body manifold. To gain access to the hose, remove the fuel tank and/or air cleaner and backplate assembly if necessary.

Canister Hose Routings

1. See Figure 4-110. Connect one end of the canister fresh air inlet hose (3) to the carbon canister.

⚠ WARNING

Always make sure fuel hoses are seated against the component they connect to and that hose clamps are properly tightened and positioned on straight section of fitting and not on the fitting barb. Failure to comply may result in fuel leakage which could result in death or serious injury.

NOTE

The barb is the larger outside diameter portion (bump) on the fuel fitting.

2. Connect fuel tank vent hose (1) and canister vent hose (2) to the carbon canister. Canister vent hose attaches to the top fitting. Make sure to push fuel tank vent hose all the way on to carbon canister fitting and position hose clamp on fitting side of barb.



Figure 4-113. Emissions Hose Attachment

3. Route both hoses (1, 2) towards fresh air inlet hose (3) at rear of canister.
4. Cable strap the three hoses together where the hose connector attaches the two pieces of fresh air inlet hose (3).
5. Route the smaller hoses forward along the top left frame tube. The canister vent hose (2) and fuel tank hose (1) run together until the canister vent hose (2) turns between the cylinders.

⚠ WARNING

Always make sure fuel hoses are seated against the component they connect to and that hose clamps are properly tightened and positioned on straight section of fitting and not on the fitting barb. Failure to comply may result in fuel leakage which could result in death or serious injury.

NOTE

The barb is the larger outside diameter portion (bump) on the fuel fitting.

6. See Figure 4-113. Connect the canister vent hose to elbow fitting. Make sure to push hose all the way on to elbow and position hose clamp on fitting side of barb.
7. See Figure 4-111. Connect the fuel tank vent hose (6) to vent valve fitting (5) using a new cable strap (7).
8. Route fresh air inlet hose upward and forward along the top left frame tube. Continue running hose to air cleaner backplate fitting. Secure hose to frame using new cable straps.

ELECTRIC STARTER 5

SUBJECT	PAGE NO.
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5.2 Electric Starter System	5-2
5.3 Starting System Diagnosis	5-6
5.4 Starter Activation Circuits	5-8
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SPECIFICATIONS

STARTER	
Free speed	3000 RPM (min.) @ 11.5 V
Free current	90 amp (max.) @ 11.5 V
Stall current	400 amp (max.) @ 2.4 V
Stall torque	8.1 ft-lbs (11.0 Nm) (min.) @ 2.4 V

SERVICE WEAR LIMITS	IN.	MM
Brush length minimum	0.433	11.0
Commutator diameter minimum	1.141	28.981

TORQUE VALUES

ITEM	TORQUE		NOTES
Battery cable bolts (1999 Models)	40 in-lbs	4.5 Nm	metric, page 5-18
Battery terminal bolts (2000 Models)	60-96 in-lbs	6.8-10.9 Nm	page 5-18
Starter battery positive cable nut	60-85 in-lbs	6.8-9.6 Nm	metric, page 5-18
Starter mounting bolts	13-20 ft-lbs	17.6-27.1 Nm	page 5-18

GENERAL

The starter is made up of an armature, field winding assembly, solenoid, drive assembly, idler gear and drive housing.

The starter motor torque is increased through gear reduction. The gear reduction consists of the drive pinion on the armature, an idler gear and a clutch gear in the drive housing. The idler gear is supported by rollers. The clutch gear is part of the overrunning clutch/drive assembly.

The overrunning clutch is the part which engages and drives the clutch ring gear. It also prevents the starter from overrunning. The field windings are connected in series with the armature through brushes and commutator segments.

Wiring Diagrams

For additional information concerning the starting system circuit, see the wiring diagram at the end of Section 7, ELECTRICAL.

Starter Relay

The starter relay is not repairable. Replace the unit if it fails.

Starter Interlock

See 7.5 STARTER INTERLOCK for operation and troubleshooting information.

OPERATION

See Figure 5-1. When the starter switch is pushed, the starter relay is activated and battery current flows into the pull-in winding (10) and the hold-in winding (11), to ground.

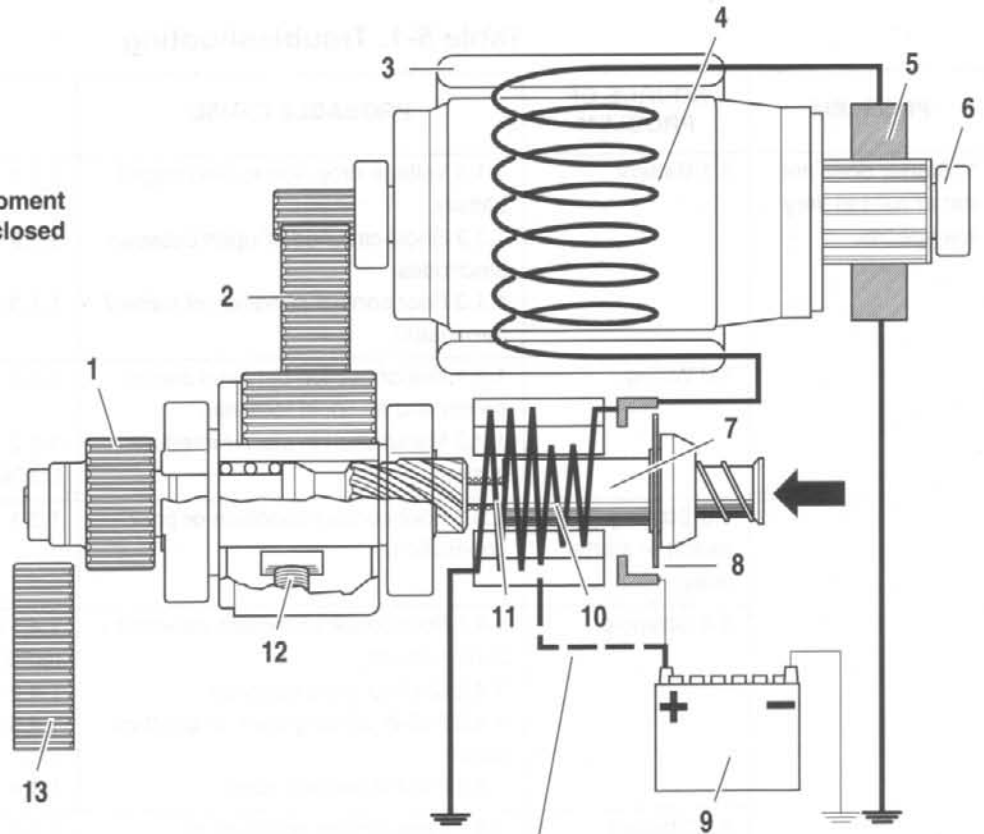
The magnetic forces of the pull-in and hold-in windings in the solenoid push the plunger (7) causing it to shift to the left. This action engages the pinion gear (1) with the clutch ring gear (13). At the same time, the main solenoid contacts (8) are closed, so battery current flows directly through the field windings (3) to the armature (4) and to ground. Simultaneously, the pull-in winding (10) is shorted.

The current continues flowing through the hold-in winding (11) keeping the main solenoid contacts (8) closed. At this point, the starter begins to crank the engine.

After the engine has started, the pinion gear (1) turns freely on the pinion shaft through the action of the overrunning clutch (12). The overrunning clutch prevents the clutch ring gear (13) (which is now rotating under power from the engine) from turning the armature (4) too fast.

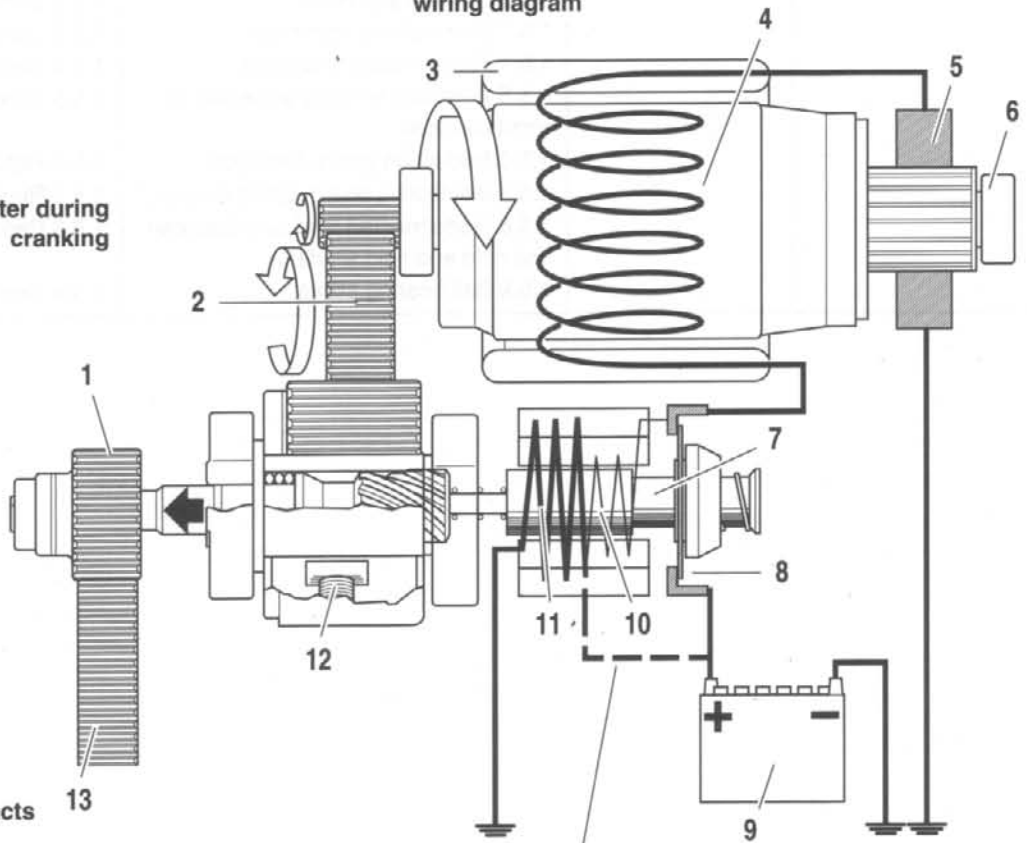
When the starter switch is released, the current of the hold-in winding (11) is fed through the main solenoid contacts (8) and the direction of the current in the pull-in winding (10) is reversed. The solenoid plunger (7) is returned to its original position by the return spring, which causes the pinion gear (1) to disengage from the clutch ring gear (13).

Starter at moment
starter switch is closed



Starting circuit-see
wiring diagram

Starter during
cranking



Starting circuit-see
wiring diagram

1. Pinion gear
2. Idler gear
3. Field winding
4. Armature
5. Brush
6. Ball bearing
7. Solenoid plunger
8. Main solenoid contacts
9. Battery
10. Pull-in winding
11. Hold-in winding
12. Overrunning clutch
13. Clutch ring gear

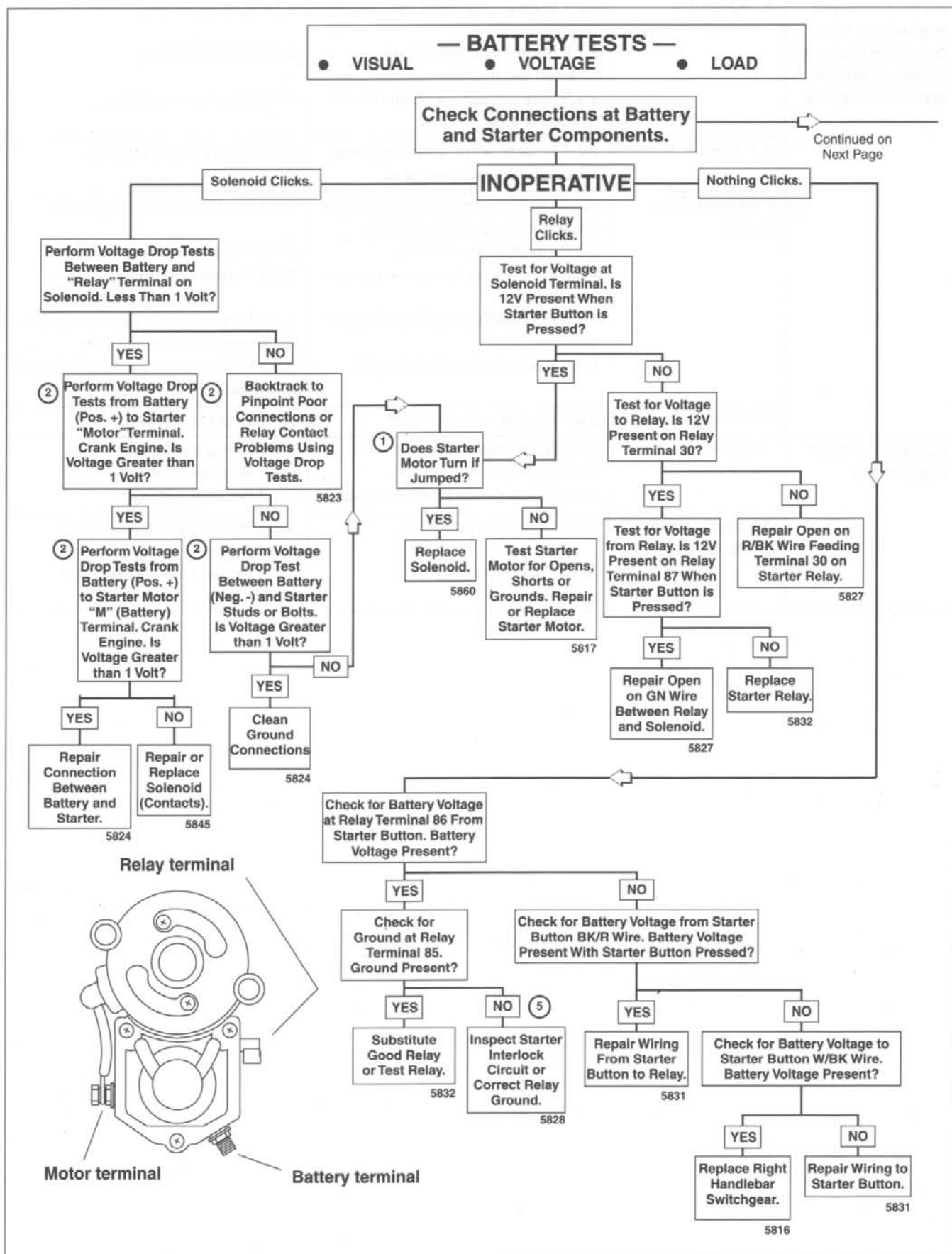
Figure 5-1. Starter Operation

Table 5-1. Troubleshooting

PROBLEM	SOURCE OF PROBLEM	PROBABLE CAUSE	SOLUTION
1. Starter does not run or runs at very low speeds.	1.1 Battery.	1.1.1 Voltage drop due to discharged battery. 1.1.2 Short-circuited or open between electrodes. 1.1.3 Poor contact condition of battery terminal(s).	1.1.1 Charge battery. 1.1.2 Replace battery. 1.1.3 Clean and retighten.
	1.2 Wiring.	1.2.1 Disconnection between starter switch and solenoid terminal. 1.2.2 Malfunction in starter interlock system.	1.2.1 Repair or replace wire. 1.2.2 See 7.5 STARTER INTER-LOCK.
	1.3 Starting switch or starter relay.	1.3.1 Poor contact condition or poor connection.	1.3.1 Replace.
	1.4 Solenoid.	1.4.1 Poor contact condition caused by burnt contact. 1.4.2 Contact plate removed. 1.4.3 Pull-in winding open or short-circuited. 1.4.4 Hold-in winding open.	1.4.1 Polish contact surface or replace solenoid assembly. 1.4.2 Repair. 1.4.3 Replace solenoid assembly. 1.4.4 Replace solenoid assembly.
	1.5 Starting motor.	1.5.1 Poor contact condition of brushes. 1.5.2 Commutator burnt. 1.5.3 Commutator high mica. 1.5.4 Field winding grounded. 1.5.5 Armature winding grounded or short-circuited. 1.5.6 Reduction gears damaged. 1.5.7 Insufficient brush spring tension. 1.5.8 Disconnected lead wire between solenoid and field windings. 1.5.9 Ball bearing sticks.	1.5.1 Check brush spring tension. 1.5.2 Correct on lathe or replace. 1.5.3 Correct by undercutting. 1.5.4 Replace. 1.5.5 Replace. 1.5.6 Replace. 1.5.7 Replace. 1.5.8 Repair or replace lead wire. 1.5.9 Replace bearing.

Table 5-1. Troubleshooting (Continued)

PROBLEM	SOURCE OF PROBLEM	PROBABLE CAUSE	SOLUTION
2. Pinion does not engage with ring gear while starter is running or engine cannot be cranked.	2.1 Battery.	2.1.1 Voltage drop due to discharged battery. 2.1.2 Short-circuited or open between electrodes. 2.1.3 Poor contact condition of battery terminal(s).	2.1.1 Charge battery. 2.1.2 Replace battery. 2.1.3 Clean and retighten.
	2.2 Wiring.	2.2.1 Disconnection between starter switch and solenoid terminal.	2.2.1 Repair or replace wire.
	2.3 Overrunning clutch.	2.3.1 Overrunning clutch malfunction (rollers or compression spring). 2.3.2 Pinion teeth worn out. 2.3.3 Pinion does not run in overrunning direction. 2.3.4 Poor sliding condition of spline teeth. 2.3.5 Reduction gears damaged.	2.3.1 Replace overrunning clutch. 2.3.2 Replace overrunning clutch. 2.3.3 Replace overrunning clutch. 2.3.4 Remove foreign materials, dirt, or replace overrunning clutch. 2.3.5 Replace overrunning clutch and idler gear.
	2.4 Ring gear.	2.4.1 Excessively worn teeth.	2.4.1 Replace ring gear.
3. Starter does not stop running.	3.1 Solenoid.	3.1.1 Return spring worn. 3.1.2 Coil layer shorted. 3.1.3 Contact plate melted and stuck.	3.1.1 Replace solenoid. 3.1.2 Replace solenoid. 3.1.3 Replace solenoid.
	3.2 Starting switch or starter relay.	3.2.1 Unopened contacts. 3.2.2 Poor returning.	3.2.1 Replace starting switch or starter relay. 3.2.2 Replace starting switch or starter relay.



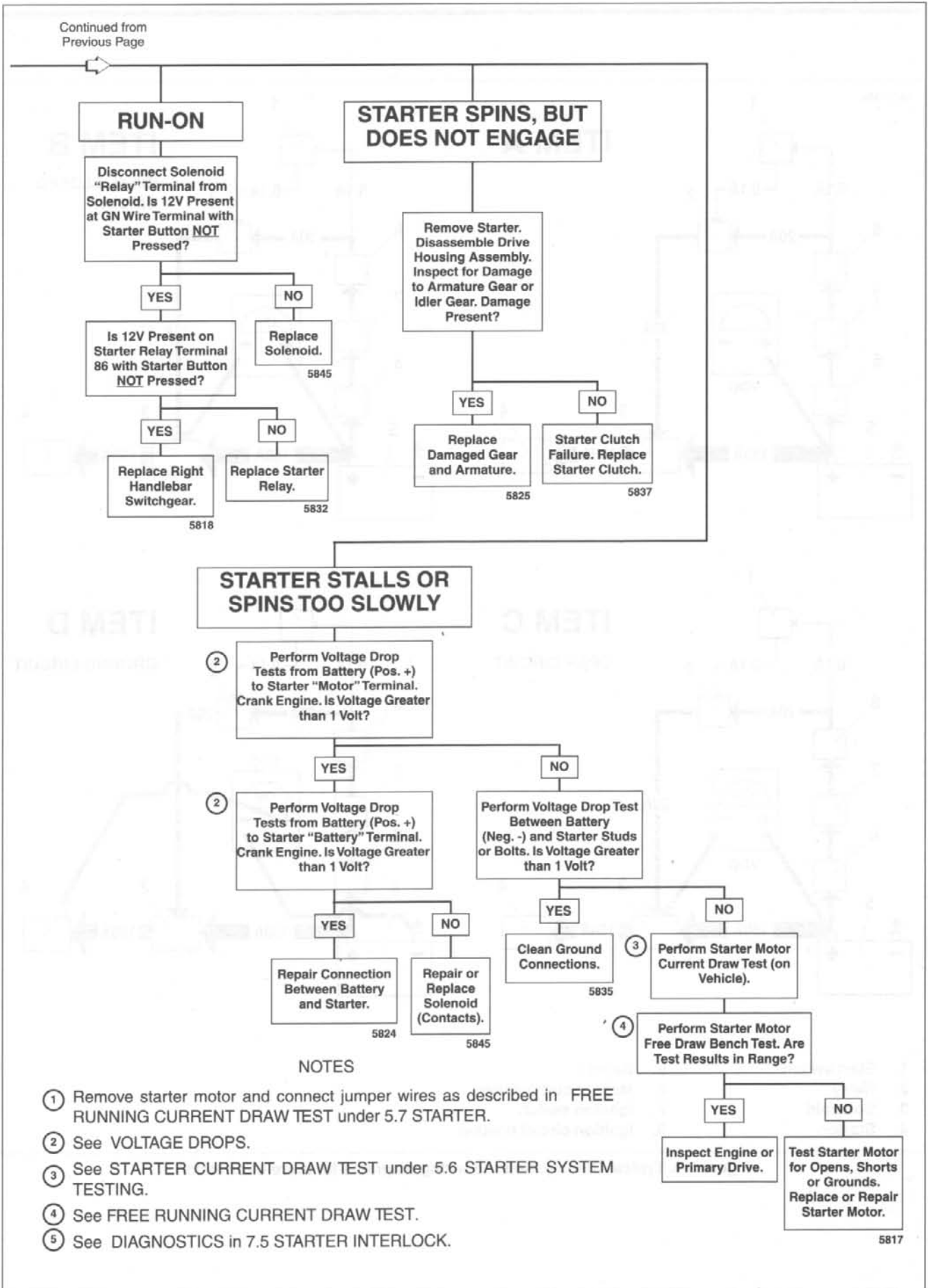

Relay terminal

Motor terminal

Battery terminal

Figure 5-2. Starting System Diagnosis, Part 1

Continued from Previous Page



NOTES

- ① Remove starter motor and connect jumper wires as described in FREE RUNNING CURRENT DRAW TEST under 5.7 STARTER.
- ② See VOLTAGE DROPS.
- ③ See STARTER CURRENT DRAW TEST under 5.6 STARTER SYSTEM TESTING.
- ④ See FREE RUNNING CURRENT DRAW TEST.
- ⑤ See DIAGNOSTICS in 7.5 STARTER INTERLOCK.

Figure 5-3. Starting System Diagnosis, Part 2

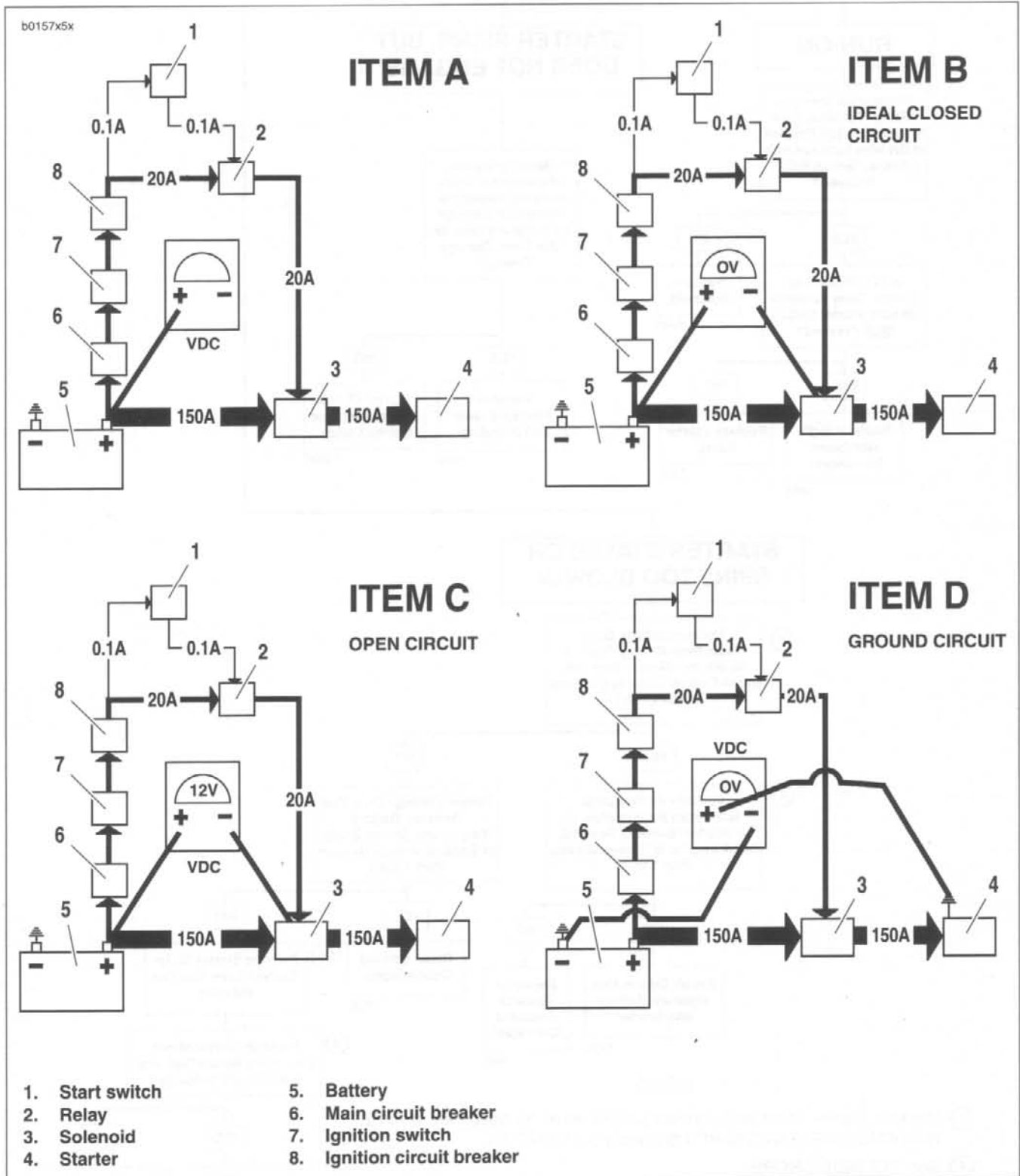


Figure 5-4. Typical Circuitry. Refer to wiring diagrams for more information.

GENERAL

The troubleshooting table beginning on page 5-4 contains detailed procedures to solve and correct problems. Follow the 5.3 STARTING SYSTEM DIAGNOSIS diagram to diagnose starting system problems. The VOLTAGE DROPS procedure below will help you to locate poor connections or components with excessive voltage drops.

VOLTAGE DROPS

Check the integrity of all wiring, switches, circuit breakers and connectors between the source and destination.

The voltage drop test measures the difference in potential or the actual voltage dropped between the source and destination.

1. See ITEM A in Figure 5-4. Attach your red meter lead to the most positive part of the circuit, which in this case would be the positive post of the battery (5).
2. See ITEM B in Figure 5-4. Attach the black meter lead to the final destination or component in the circuit (solenoid terminal from relay).
3. Activate the starter and observe the meter reading. The meter will read the voltage dropped or the difference in potential between the source and destination.
4. An ideal circuit's voltage drop would be 0 volts or no voltage dropped, meaning no difference in potential.
5. See ITEM C in Figure 5-4. An open circuit should read 12 volts, displaying all the voltage dropped, and the entire difference in potential displayed on the meter.
6. Typically, a good circuit will drop less than 1 volt.
7. If the voltage drop is greater, back track through the connections until the source of the potential difference is found. The benefit of doing it this way is speed.
 - a. Readings aren't as sensitive to real battery voltage.
 - b. Readings show the actual voltage dropped, not just the presence of voltage.
 - c. This tests the system as it is actually being used. It is more accurate and will display hard to find poor connections.
 - d. This approach can be used on lighting circuits, ignition circuits, etc. Start from most positive and go to most negative (the destination or component).
8. See ITEM D in Figure 5-4. The negative or ground circuit can be checked as well.
 - a. Place the negative lead on the most negative part of the circuit (or the negative battery post). Remember, there is nothing more negative than the negative post of the battery.
 - b. Place the positive lead to the ground you wish to check.
 - c. Activate the circuit. This will allow you to read the potential difference or voltage dropped on the negative or ground circuit. This technique is very effective for identifying poor grounds due to powdered paint. Even the slightest connection may cause an ohmmeter to give a good reading. However, when sufficient current is passed through, the resistance caused by the powdered paint will cause a voltage drop or potential difference in the ground circuit.

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WIRE COLOR	
1	BLACK
2	BLUE
3	BROWN
4	GRAY
5	GREEN
6	RED
7	YELLOW
8	ORANGE
9	PINK
10	WHITE
11	GRAY
12	BLACK

CONNECTOR CODES:	
DL	DIODE
PCF	PIV CONNECTOR
W	WICKERY CONNECTOR
RF	REFLEX CONNECTOR
+	NO CONNECTOR

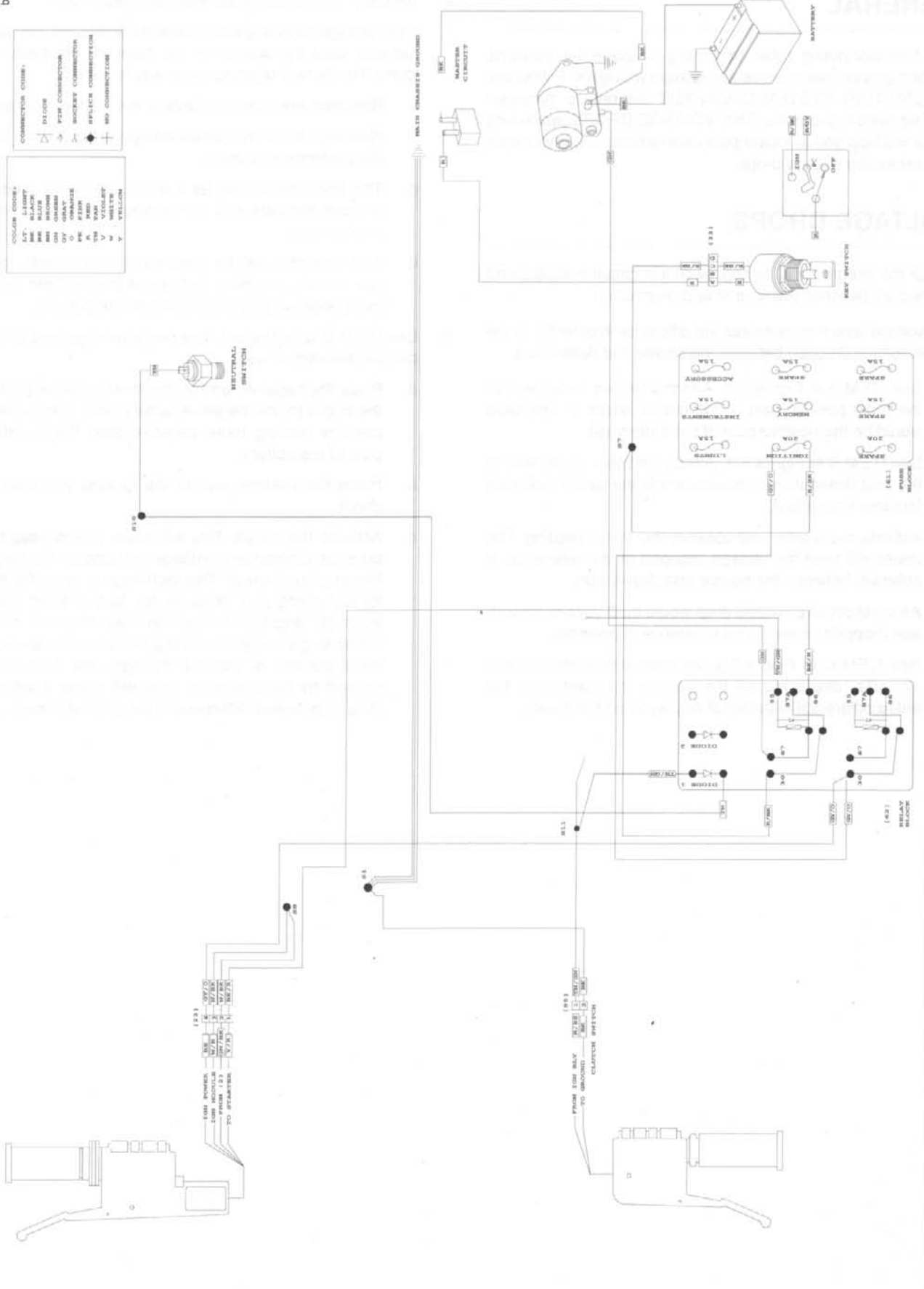


Figure 5-5. Electric Starting System Circuit

“ON-MOTORCYCLE” TESTS

Starter Relay Test

1. See Figure 5-6. Locate starter relay. The relay is attached to the relay block underneath the seat.
2. To test relay, proceed to Step 3. If installing a **new** starter relay, remove old relay. Install **new** relay into relay block.
3. See Figure 5-7. Obtain a 12 volt battery and a continuity tester or ohmmeter.
 - a. Pull relay from relay block.
 - b. Connect positive battery lead to the 86 terminal.
 - c. Connect negative battery lead to the 85 terminal to energize relay.
 - d. Check for continuity between the 30 and 87 terminals. A good relay shows continuity (continuity tester lamp “on” or a zero ohm reading on the ohmmeter). A malfunctioning relay will not show continuity and must be replaced.
4. If starter relay is functioning properly, proceed to STARTER CURRENT DRAW TEST.

Starter Current Draw Test

NOTE

- *Engine temperature should be stable and at room temperature.*
- *Battery should be fully charged.*

See Figure 5-8. Check starter current draw with an induction ammeter before disconnecting battery. Proceed as follows:

1. Verify that transmission is in neutral. Disconnect spark plug wires from spark plug terminals.
2. Clamp induction ammeter over positive battery cable next to starter.
3. With ignition key switch ON, turn engine over by pressing starter switch while taking a reading on the ammeter.

Disregard initial high current reading which is normal when engine is first turned over.

- a. Typical starter current draw will range between 140-180 amperes.
- b. If starter current draw exceeds 180 amperes, then the problem may be in the starter or starter drive. Remove starter for further tests. See 5.7 STARTER.

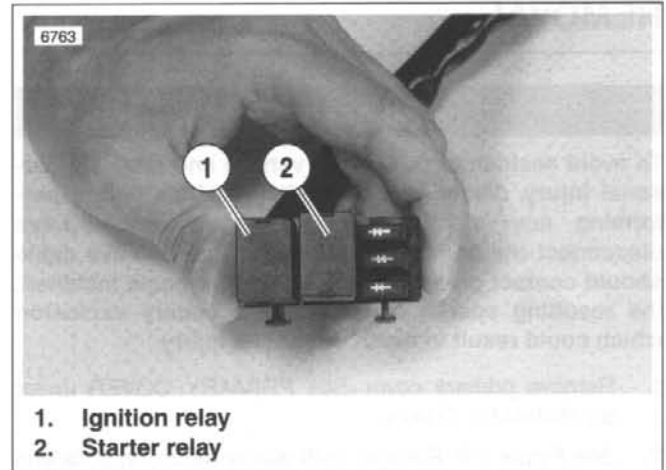


Figure 5-6. Starter Relay Block

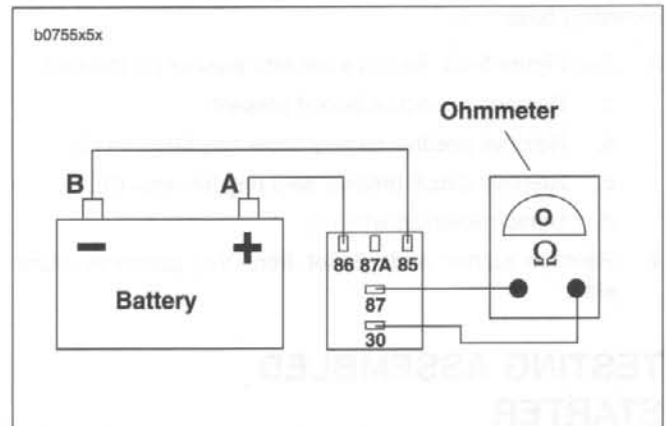


Figure 5-7. Starter Relay Test

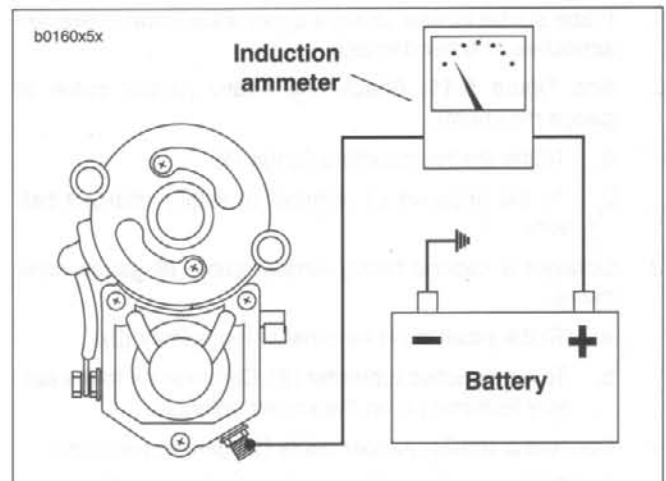


Figure 5-8. Starter Draw Test

REMOVAL

⚠ WARNING

To avoid accidental start-up of vehicle and possible personal injury, disconnect the battery cables before performing any of the following procedures. Always disconnect the negative cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks could cause a battery explosion which could result in death or serious injury.

1. Remove primary cover. See PRIMARY COVER under 6.2 PRIMARY CHAIN.
2. See Figure 5-9. Remove both starter mounting bolts and washers (1).

NOTE

A ball hex driver may be required to gain access to the starter mounting bolts.

3. See Figure 5-10. Remove nut with washer (1) (metric).
 - a. Remove protective boot if present.
 - b. Remove positive battery cable ring terminal (2).
 - c. Remove circuit breaker wire ring terminal (3).
 - d. Detach solenoid wire (4).
4. Remove starter and gasket from the gearcase cover side.

TESTING ASSEMBLED STARTER

Free Running Current Draw Test

1. Place starter in vise, using a clean shop towel to prevent scratches or other damage.
2. See Figure 5-11. Attach one heavy jumper cable (6 gauge minimum).
 - a. To the starter mounting flange (1).
 - b. To the negative (-) terminal of a fully charged battery.
3. Connect a second heavy jumper cable (6 gauge minimum).
 - a. To the positive (+) terminal of the battery (2).
 - b. To an inductive ammeter (3). Continue on to the battery terminal (4) on the starter solenoid.
4. Connect a smaller jumper cable (14 gauge minimum).
 - a. To the positive (+) terminal of the battery (2).
 - b. To the solenoid relay terminal (5).
5. Check ammeter reading.
 - a. Ammeter should show 90 amps maximum.
 - b. If reading is higher, disassemble starter for inspection. See 5.7 STARTER.

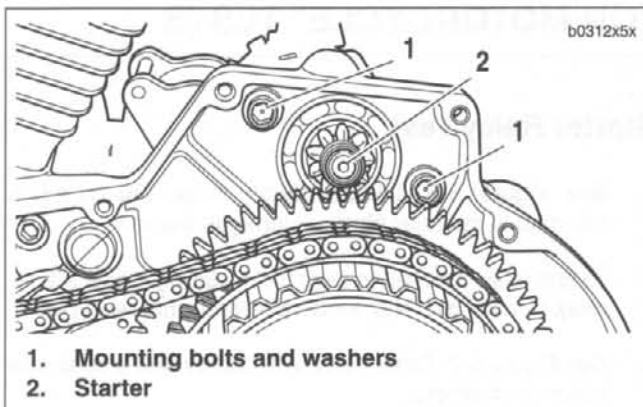


Figure 5-9. Starter Mounting

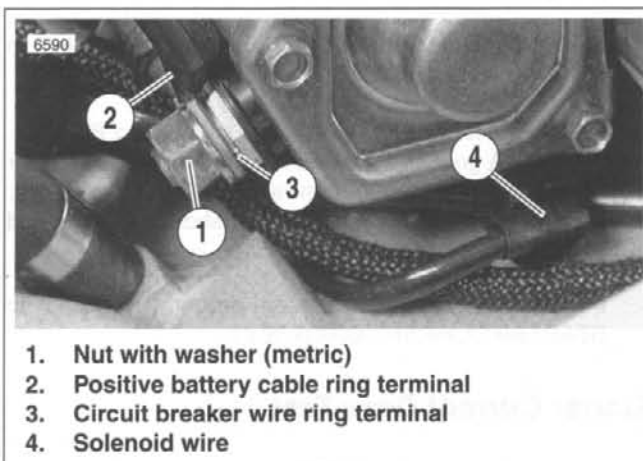


Figure 5-10. Starter Wires (Protective Boot Not Shown)

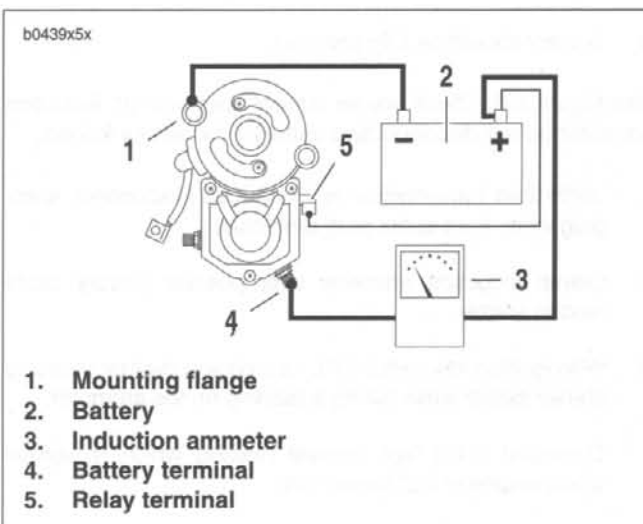


Figure 5-11. Free Running Current Draw Test

- c. If starter current draw on vehicle was over 200 amps and this test was within specification, there may be a problem with engine or primary drive.

Starter Solenoid

NOTE

Do not disassemble solenoid. Before testing, disconnect field wire from motor terminal as shown in Figure 5-12.

CAUTION

Each test should be performed for only 3-5 seconds to prevent damage to solenoid.

NOTE

The solenoid Pull-in, Hold-in, and Return tests must be performed together in one continuous operation. Conduct all three tests one after the other in the sequence given without interruption.

Solenoid Pull-in Test

1. See Figure 5-12. Using a 12 volt battery, connect three separate test leads as follows:
 - a. Solenoid housing to negative battery post.
 - b. Solenoid motor terminal to negative battery post.
 - c. Solenoid relay terminal to positive battery post.
2. Observe starter pinion.
 - a. If starter pinion pulls in strongly, solenoid is working properly.
 - b. If starter pinion does not pull in, replace the solenoid.

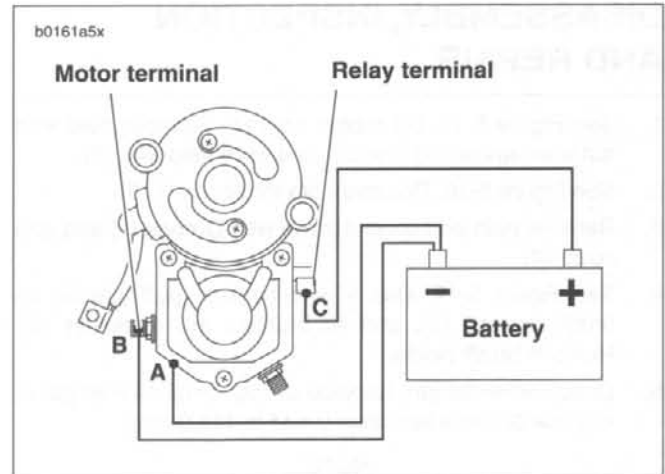


Figure 5-12. Pull-In Test

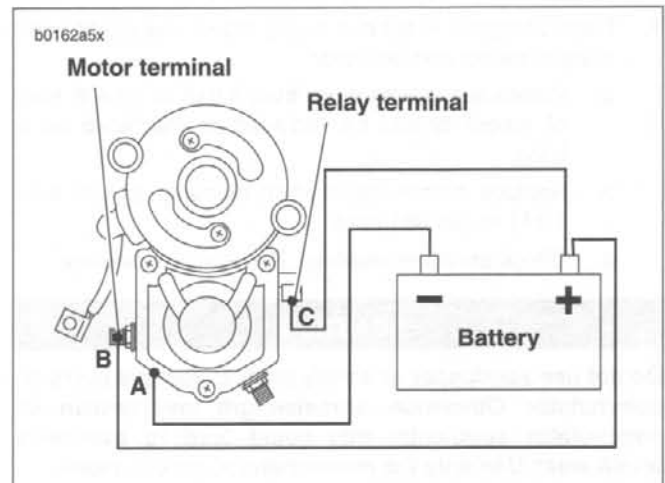


Figure 5-13. Hold-In Test

Solenoid Hold-in Test

1. See Figure 5-13. With test leads still connected in the manner specified in the previous SOLENOID PULL-IN TEST, **disconnect solenoid motor terminal/battery negative test lead (B) at negative battery post only; reconnect loose end of this test lead to positive battery post instead.**
2. Observe starter pinion.
 - a. If starter pinion remains in pull-in position, solenoid is working properly.
 - b. If starter pinion does not remain in pull-in position, replace the solenoid.

Solenoid Return Test

1. See Figure 5-14. With test leads still connected in the manner specified at the end of the previous SOLENOID HOLD-IN TEST, **disconnect solenoid relay terminal/positive battery post test lead (C) at either end.**
2. Observe starter pinion.
 - a. If starter pinion returns to its original position, solenoid is working properly.
 - b. If starter pinion does not return to its original position, replace the solenoid.

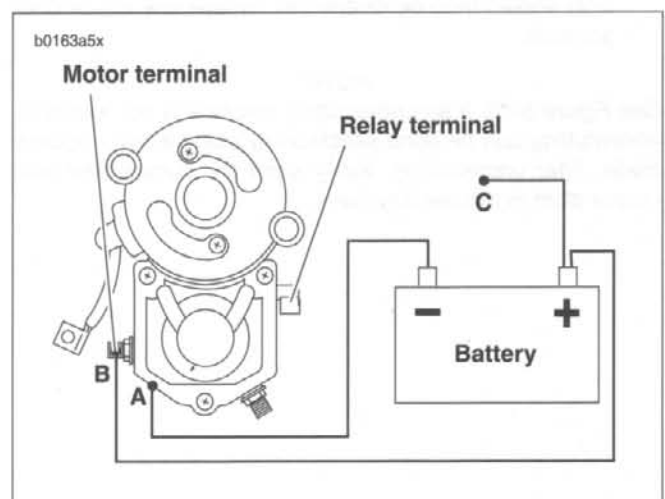


Figure 5-14. Return Test

DISASSEMBLY, INSPECTION AND REPAIR

1. See Figure 5-15. Lift rubber boot (1). Remove field wire nut with washer (2) (metric) to detach field wire (3).
2. See Figure 5-16. Remove both thru-bolts (1, 3).
3. Remove both end cover screws with O-rings (2) and end cover (4).
4. See Figure 5-17. Use a wire hook to pull upward on brush springs (3), and lift brushes out of holder (2). Remove brush holder.
5. Check brush length. Replace all four brushes if length of any one brush is less than 0.433 in. (11.0 mm).

NOTE

Brushes not available separately. Purchase a **new** field frame (1) and brush holder (2) to replace brushes.

6. Remove armature (4) and field frame (1).
7. Place armature in lathe or truing stand and check commutator runout and diameter.
 - a. Commutators with more than 0.016 in. (0.406 mm) of runout should be replaced or machined on a lathe.
 - b. Replace commutators when diameter is less than 1.141 in. (28.981 mm)
 - c. Check armature bearings. Replace if necessary.

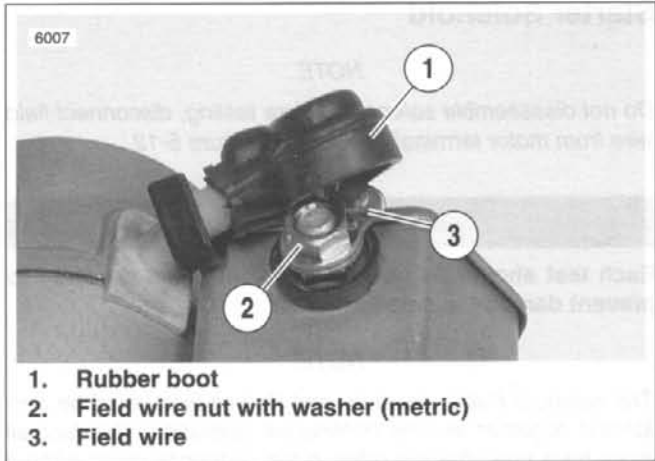
CAUTION

Do not use sandpaper or emery cloth to remove burrs on commutator. Otherwise, abrasive grit may remain on commutator segments; this could lead to excessive brush wear. Use only the recommended crocus cloth.

8. Check depth of mica on commutator. If undercut is less than 0.008 in. (0.203 mm), use an undercutting machine to undercut the mica to 1/32 in. (0.794 mm) deep. The slots should then be cleaned to remove any dirt or copper dust.

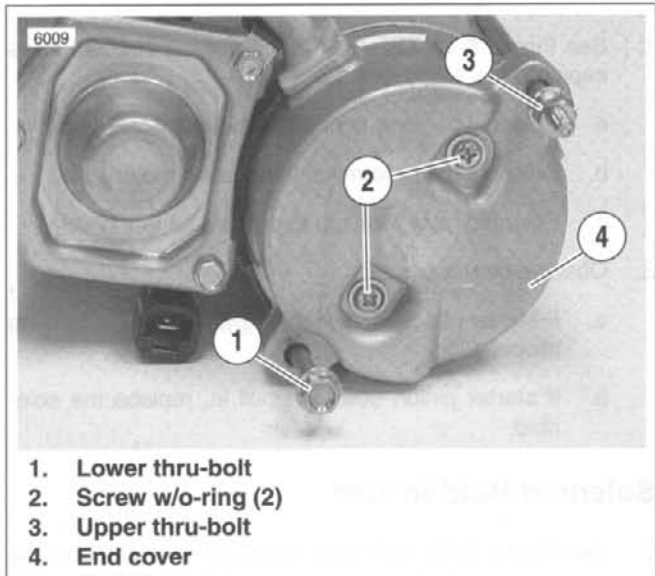
NOTE

See Figure 5-18. If an undercutting machine is not available, undercutting can be done satisfactorily using a thin hacksaw blade. After undercutting, lightly sand the commutator with crocus cloth to remove any burrs.



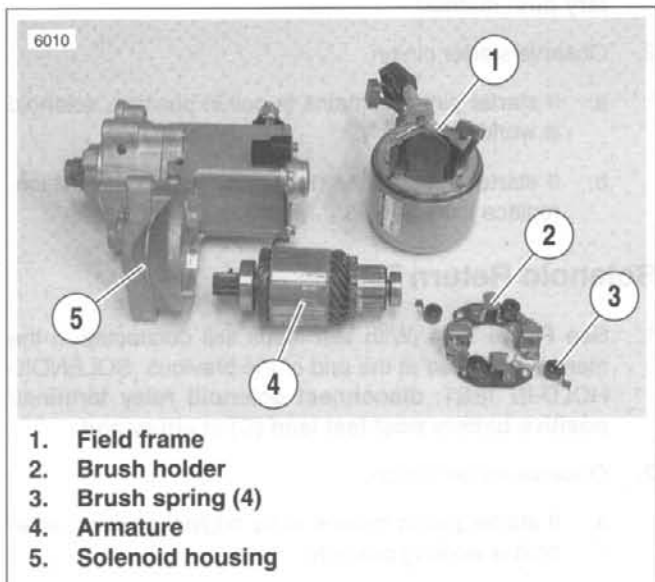
1. Rubber boot
2. Field wire nut with washer (metric)
3. Field wire

Figure 5-15. Field Wire



1. Lower thru-bolt
2. Screw w/o-ring (2)
3. Upper thru-bolt
4. End cover

Figure 5-16. Removing the Thru-Bolts



1. Field frame
2. Brush holder
3. Brush spring (4)
4. Armature
5. Solenoid housing

Figure 5-17. Starter Components

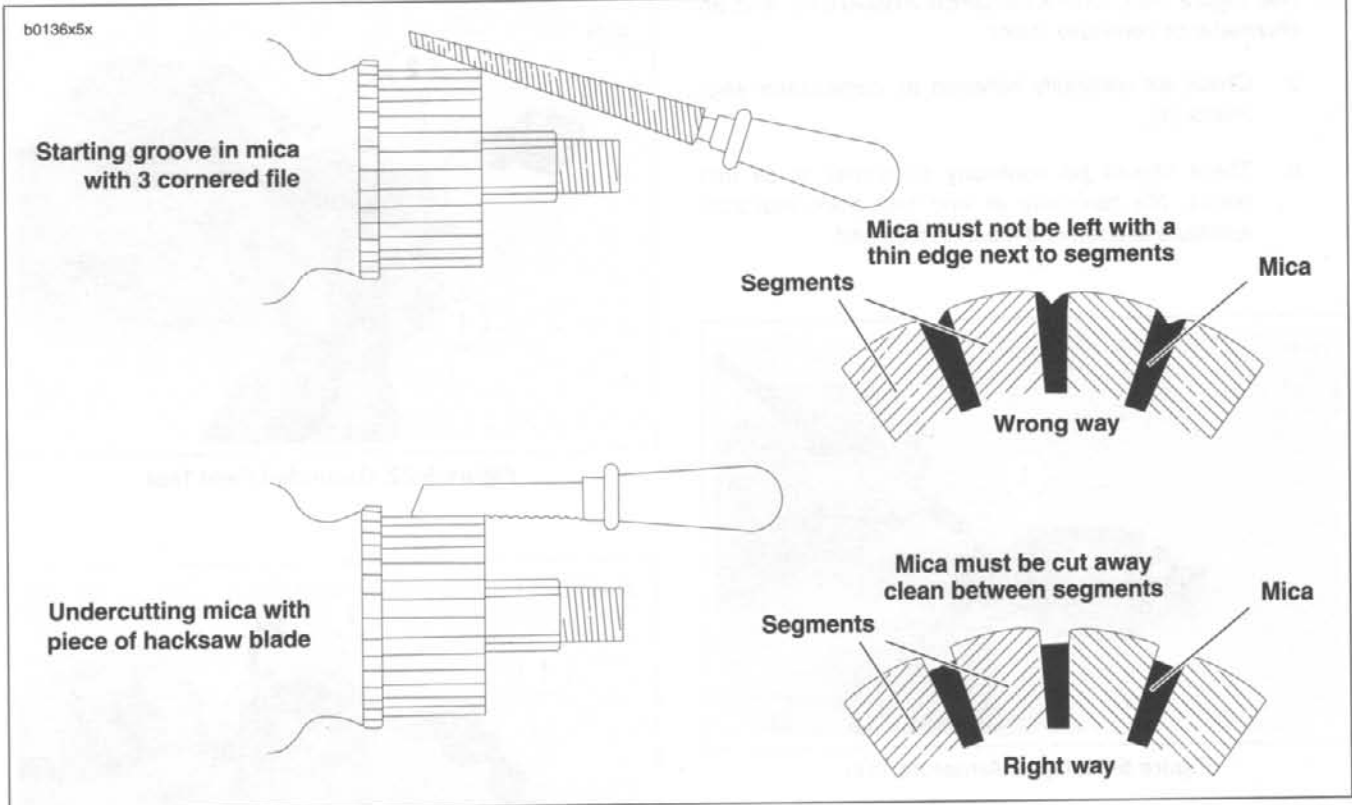


Figure 5-18. Undercutting Mica Separators

9. See Figure 5-19. Check for SHORTED ARMATURE with a growler.
 - a. Place armature on growler (1).
 - b. Hold a thin steel strip (2) (hacksaw blade) against armature core and slowly turn armature.
 - c. A shorted armature will cause the steel strip to vibrate and be attracted to the core. Replace shorted armatures.
10. See Figure 5-20. Check for a GROUNDED ARMATURE with an ohmmeter or continuity tester.
 - a. Touch one probe to any commutator segment (1).
 - b. Touch the other probe to the armature core (2).
 - c. There should be no continuity (infinite ohms). If there is continuity, then the armature is grounded. Replace grounded armatures.

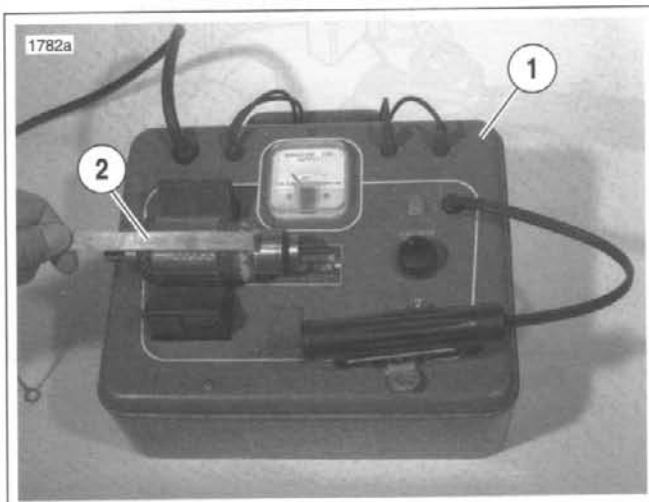


Figure 5-19. Shorted Armature Test Using Growler

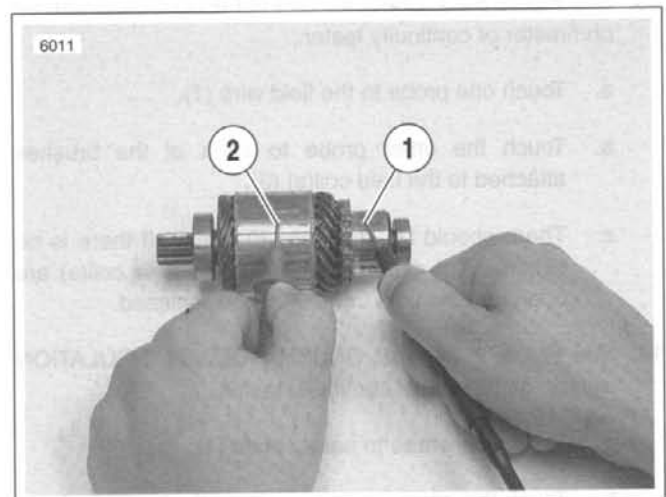


Figure 5-20. Grounded Armature Test

11. See Figure 5-21. Check for OPEN ARMATURE with an ohmmeter or continuity tester.
 - a. Check for continuity between all commutator segments (1).
 - b. There should be continuity (0 ohms) at all test points. No continuity at any test point indicates armature is open and must be replaced.

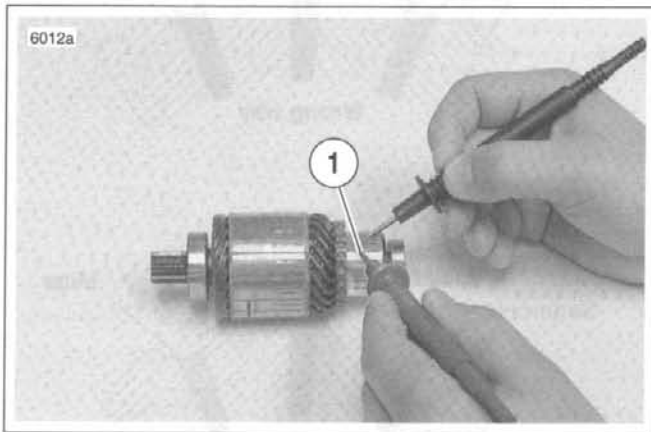


Figure 5-21. Open Armature Test

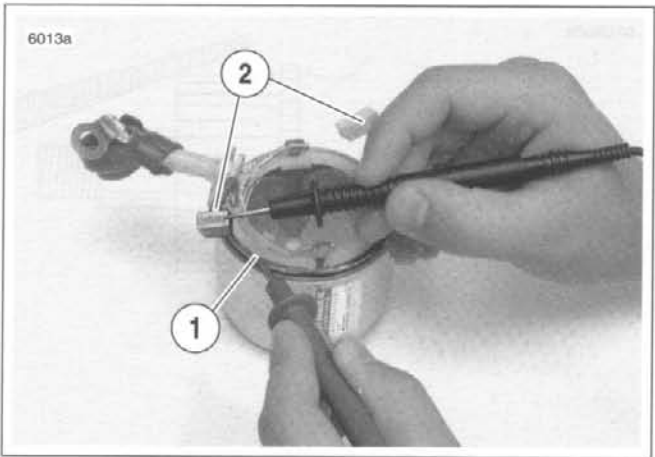


Figure 5-22. Grounded Field Test

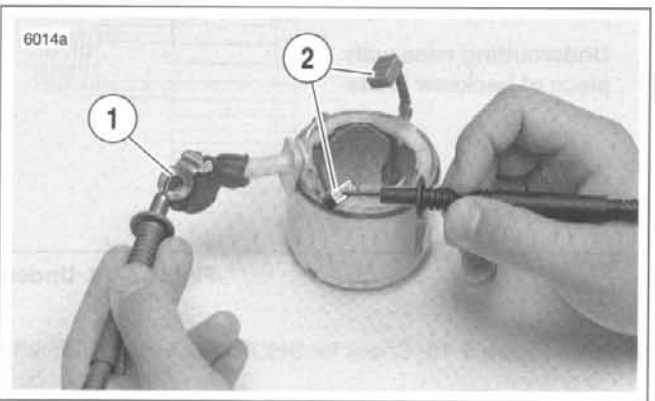


Figure 5-23. Open Field Test

12. See Figure 5-22. Check for GROUNDED FIELD COIL with an ohmmeter or continuity tester.
 - a. Touch one probe to the frame (1).
 - b. Touch the other probe to each of the brushes (2) attached to the field coil.
 - c. There should be no continuity (infinite ohms). If there is any continuity at either brush, then the field coil(s) are grounded and the field frame must be replaced.
13. See Figure 5-23. Check for OPEN FIELD COILS with an ohmmeter or continuity tester.
 - a. Touch one probe to the field wire (1).
 - b. Touch the other probe to each of the brushes attached to the field coil(s) (2).
 - c. There should be continuity (0 ohms). If there is no continuity at either brush, then the field coil(s) are open and the field frame must be replaced.
14. See Figure 5-24. Test BRUSH HOLDER INSULATION with an ohmmeter or continuity tester.
 - a. Touch one probe to holder plate (1).
 - b. Touch the other probe to each of the positive (insulated) brush holders (2).
 - c. There should be no continuity (infinite ohms). If there is continuity at either brush holder, replace the brush holder assembly.

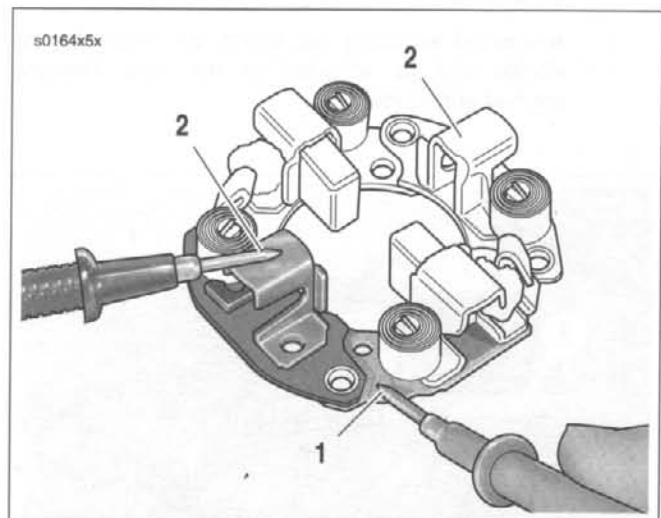


Figure 5-24. Brush Holder Insulation Test

15. See Figure 5-25. Remove two drive housing mounting screws (6). Remove drive housing (5) from solenoid housing.
16. Remove drive (1), idler gear (2), idler gear bearing (3), and O-ring (4) from drive housing (O-ring is located in drive housing groove).

ASSEMBLY

1. See Figure 5-25. Clean, inspect and lubricate drive assembly components. Lubricate parts with high temperature grease, such as LUBRIPLATE 110.
2. See Figure 5-26. When installing drive assembly components, open end of idler bearing cage (15) faces toward solenoid.
3. When installing drive housing (10) to solenoid housing (11), use **new** O-ring (16). Be sure to install return spring (17) and ball (18).

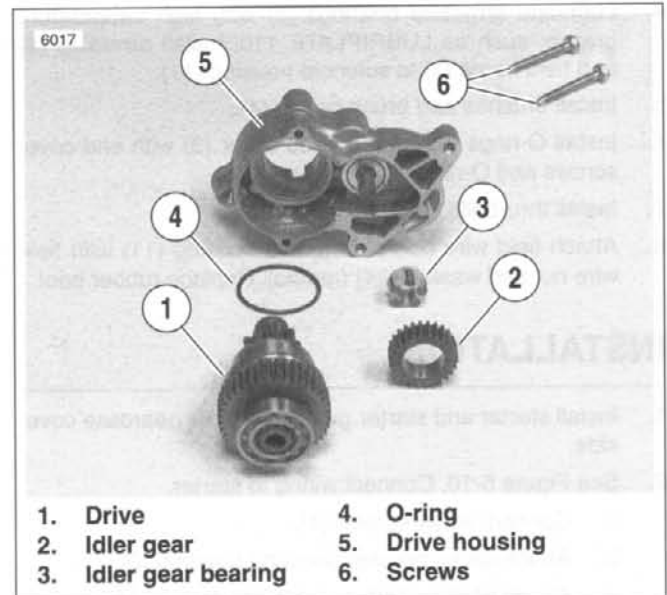
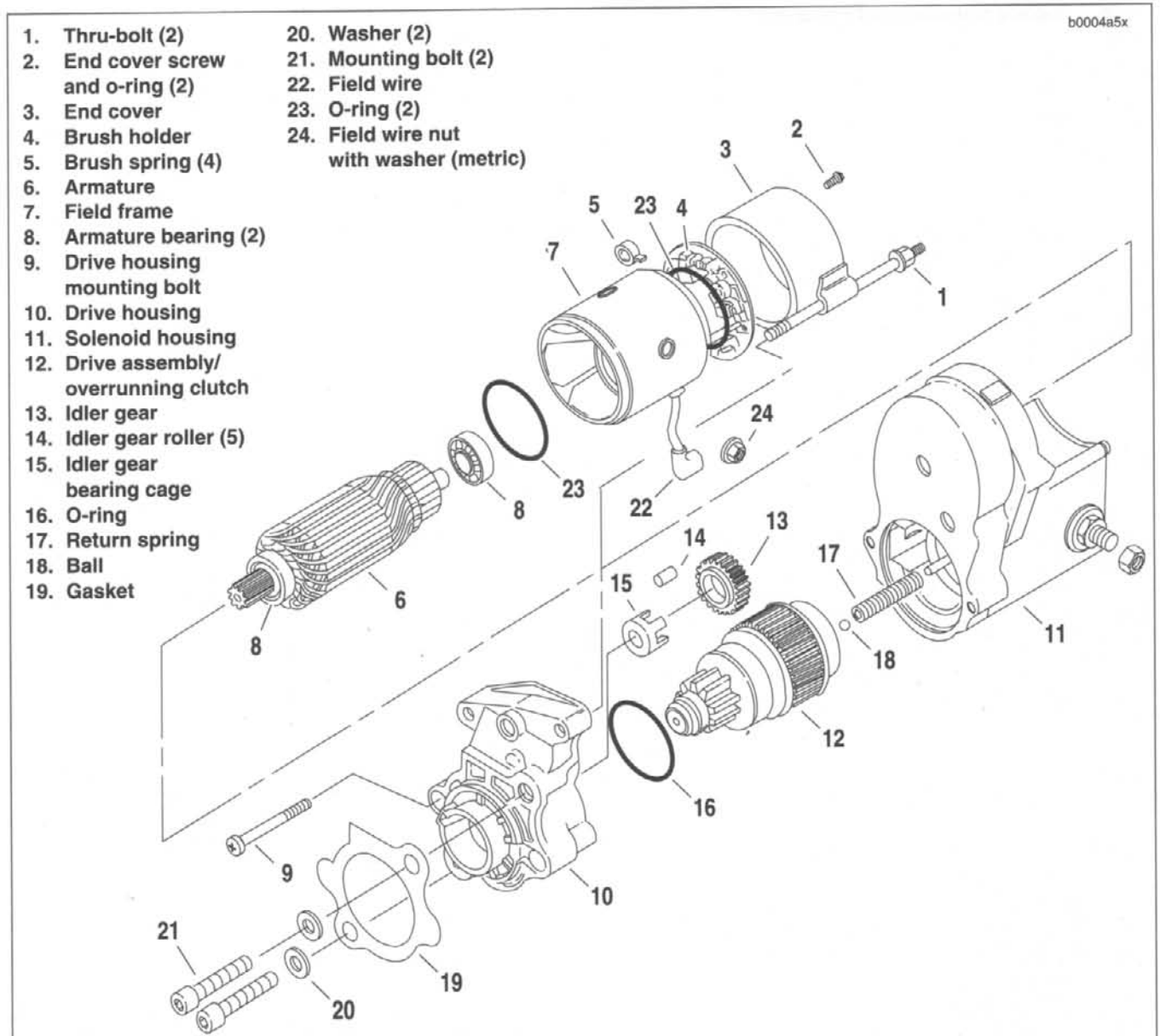


Figure 5-25. Starter Drive Assembly



- | | |
|---------------------------------------|---|
| 1. Thru-bolt (2) | 20. Washer (2) |
| 2. End cover screw and o-ring (2) | 21. Mounting bolt (2) |
| 3. End cover | 22. Field wire |
| 4. Brush holder | 23. O-ring (2) |
| 5. Brush spring (4) | 24. Field wire nut with washer (metric) |
| 6. Armature | |
| 7. Field frame | |
| 8. Armature bearing (2) | |
| 9. Drive housing mounting bolt | |
| 10. Drive housing | |
| 11. Solenoid housing | |
| 12. Drive assembly/overrunning clutch | |
| 13. Idler gear | |
| 14. Idler gear roller (5) | |
| 15. Idler gear bearing cage | |
| 16. O-ring | |
| 17. Return spring | |
| 18. Ball | |
| 19. Gasket | |

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Figure 5-26. Starter Assembly

4. Lubricate armature bearings (8) with high temperature grease, such as LUBRIPLATE 110. Install armature (6) and field frame (7) to solenoid housing (11).
5. Install brushes and brush holder (4).
6. Install O-rings (23). Attach end cover (3) with end cover screws and O-rings (2).
7. Install thru-bolts (1).
8. Attach field wire (22) to solenoid housing (11) with field wire nut and washer (24) (metric). Replace rubber boot.

INSTALLATION

1. Install starter and starter gasket from the gearcase cover side.
2. See Figure 5-10. Connect wiring to starter.
 - a. Connect solenoid wire (4).
 - b. Attach circuit breaker wire ring terminal (3).
 - c. Attach positive battery cable ring terminal (2).
 - d. Install nut with washer (1) (metric). Tighten to 60-85 **in-lbs** (6.8-9.6 Nm).
 - e. Replace protective boot if present.

3. See Figure 5-9. Install both starter mounting bolts and washers. Tighten to 13-20 ft-lbs (17.6-27.1 Nm).
4. Install primary cover. See PRIMARY COVER under 6.2 PRIMARY CHAIN.
5. Fill transmission to proper level with fresh lubricant. See 1.12 CLUTCH.

WARNING

Always connect positive battery cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks could cause a battery explosion which could result in death or serious injury.

6. Connect battery cables, positive cable first.
 - 1999 Models:** Tighten terminal hardware (metric) to 40 **in-lbs** (4.5 Nm).
 - 2000 Models:** Tighten terminal hardware to 60-85 **in-lbs** (6.8-9.6 Nm).

GENERAL

CAUTION

See Figure 5-27. Do not tighten nut (7) without removing items 1-5. Movement will cause damage to the contact.

The starter solenoid is a switch that is designed to open and close the starting circuit electromagnetically. The switch consists of contacts and a winding around a hollow cylinder containing a movable plunger.

DISASSEMBLY

1. See Figure 5-27. Remove screws (1) and clip (2).
2. Remove cover (3) and gasket (4). Discard gasket.
3. Remove plunger (5) from solenoid housing (6).

ASSEMBLY

1. See Figure 5-27. Replace wire connection hardware as necessary.
2. Install plunger (5) in solenoid housing (6).
3. Install **new** gasket (4) onto cover (3).
4. Position cover with gasket onto solenoid housing. Install clip (2) and screws (1).

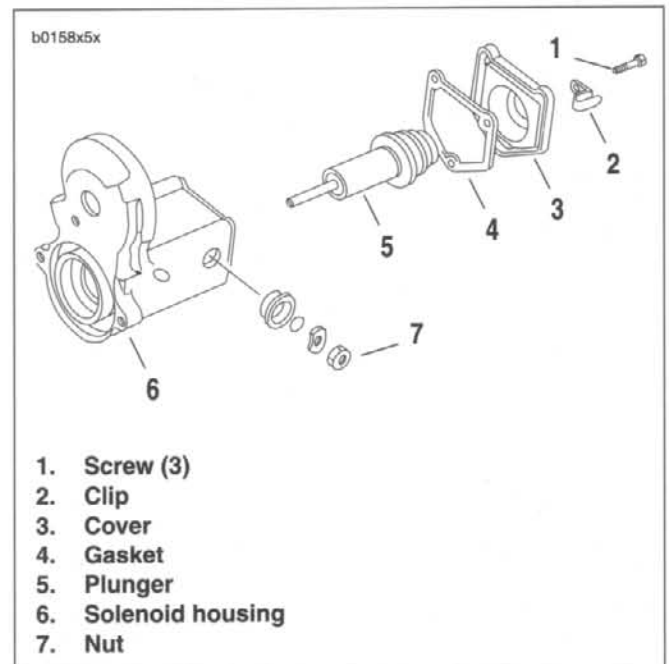


Figure 5-27. Starter Solenoid

DRIVE/TRANSMISSION 6

SUBJECT	PAGE NO.
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6.3 Secondary Drive Belt	6-6
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6.13 Transmission Installation and Shifter Pawl Adjustment	6-34

SPECIFICATIONS

TRANSMISSION		
Transmission type	5 forward speed, foot shift	
Clutch type	Wet – multiple disc	
Clutch fluid capacity	1.0 quart	0.95 liter
Fluid part no.-quart	98854-96	
Fluid part no.-gallon	98855-96	

PRIMARY DRIVE (ENGINE-TO-TRANSMISSION)	
Engine sprocket	35 teeth
Clutch sprocket	56 teeth
Ratio	1.60: 1

TRANSMISSION GEAR RATIOS	FINAL*	OVERALL**
First (low) gear	2.69	9.717
Second gear (1999 Models)	1.97	7.118
Second gear (2000 Models)	1.85	6.687
Third gear	1.43	5.180
Fourth gear	1.18	4.269
Fifth (high) gear	1.00	3.615

FINAL DRIVE (TRANSMISSION-TO-REAR WHEEL)	
Transmission sprocket	27 teeth
Rear wheel sprocket	61 teeth
Secondary drive belt	128 teeth
Ratio	2.26:1

*Final gear ratios indicate number of mainshaft revolutions required to drive output sprocket one revolution.

**Overall gear ratios indicate number of engine revolutions required to drive rear wheel one revolution.

CLUTCH PLATE	NUMBER REQUIRED	NEW COMPONENT THICKNESS		SERVICE WEAR LIMITS (MINIMUM THICKNESS)	
		IN.	MM	IN.	MM
Friction plate (fiber)	8	0.0866 + 0.0031	2.1996 + 0.0787	0.006	0.152
Steel plate	6	0.0629 + 0.0020	1.5977 + 0.0508	0.006	0.152
Clutch pack				0.661 minimum	16.789 minimum

NOTE

Service wear limits are given as a guideline for measuring components that are not **new**. For measurement specifications not given under SERVICE WEAR LIMITS, see NEW COMPONENTS.

TORQUE VALUES

ITEM	TORQUE		NOTES
Access door mounting bolts	13-17 ft-lbs	17.6-23.0 Nm	LOCTITE THREADLOCKER 243 (blue), page 6-34
Clutch inspection cover TORX screws with washers	7-9 ft-lbs	9.5-12.2 Nm	page 6-3
Clutch mainshaft nut	70-80 ft-lbs	94.9-108.5 Nm	LOCTITE THREADLOCKER 262 (red), left hand threads, page 6-16
Countershaft retainer TORX screw	13-17 ft-lbs	17.6-23.0 Nm	LOCTITE THREADLOCKER 243 (blue), page 6-29
Engine sprocket nut	190-210 ft-lbs	257.6-284.7 Nm	LOCTITE THREADLOCKER 262 (red), page 6-16
Footpeg bolts	10-15 ft-lbs	13.6-20.3 Nm	page 6-7
Isolator bolt	100-110 ft-lbs	135.6-149.1 Nm	LOCTITE THREADLOCKER 262 (red), page 6-7
Primary chain adjuster locknut	10-12 ft-lbs	13.6-16.3 Nm	on interior of chaincase, page 6-4
Primary chain adjuster locknut	20-25 ft-lbs	27.1-33.9 Nm	on exterior of chaincase, page 6-4
Primary chain inspection cover screws	40-60 in-lbs	4.5-6.8 Nm	page 6-3
Primary cover bolts (1999 Models)	80-110 in-lbs	9.0-12.4 Nm	3 lengths, page 6-5
Primary cover bolts (2000 Models)	100-120 in-lbs	11-14 Nm	3 lengths, page 6-5
Shifter lever pinch screw	100-120 in-lbs	11.3-13.6 Nm	page 6-5
Shifter shaft assembly locknuts	90-110 in-lbs	10.2-12.4 Nm	bottom nut first, same torque for top, page 6-34
Sideplate screws	19 ft-lbs	25.8 Nm	page 6-7
Transmission detent plate nut	13-17 ft-lbs	17.6-23.0 Nm	page 6-23
Transmission drain plug	14-21 ft-lbs	19.0-28.5 Nm	remove debris from end, page 6-5
Transmission sprocket nut	See note	See note	LOCTITE THREADLOCKER 262 (red), left hand threads, special torque turn method, page 6-35
Transmission sprocket screws	90-110 in-lbs	10.2-12.4 Nm	replace after 3 removals, page 6-36

GENERAL

An opening between the primary drive and transmission compartments allows the same lubricant supply to lubricate moving parts in both compartments.

Since the primary chain runs in lubricant, little service will be required other than checking lubricant level and chain tension. If, through hard usage, the primary chain does become worn, it must be replaced. Remove and install the chain following the procedure under 6.5 PRIMARY DRIVE/CLUTCH.

ADJUSTMENT/LUBRICATION

See 1.15 PRIMARY CHAIN for inspection and adjustment procedures.

See 1.12 CLUTCH for complete lubrication service on the primary chain.

REMOVAL

Primary Cover

⚠ WARNING

To avoid accidental start-up of vehicle and possible personal injury, disconnect the battery cables before proceeding. Always disconnect the negative cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion which could result in death or serious injury.

1. Raise rear wheel off floor using REAR WHEEL SUPPORT STAND (Part No. B-41174).
2. Remove muffler. See 2.35 EXHAUST SYSTEM.
3. See Figure 6-1. Place a drain pan under the engine. Remove drain plug (9) and drain lubricant from primary drive.

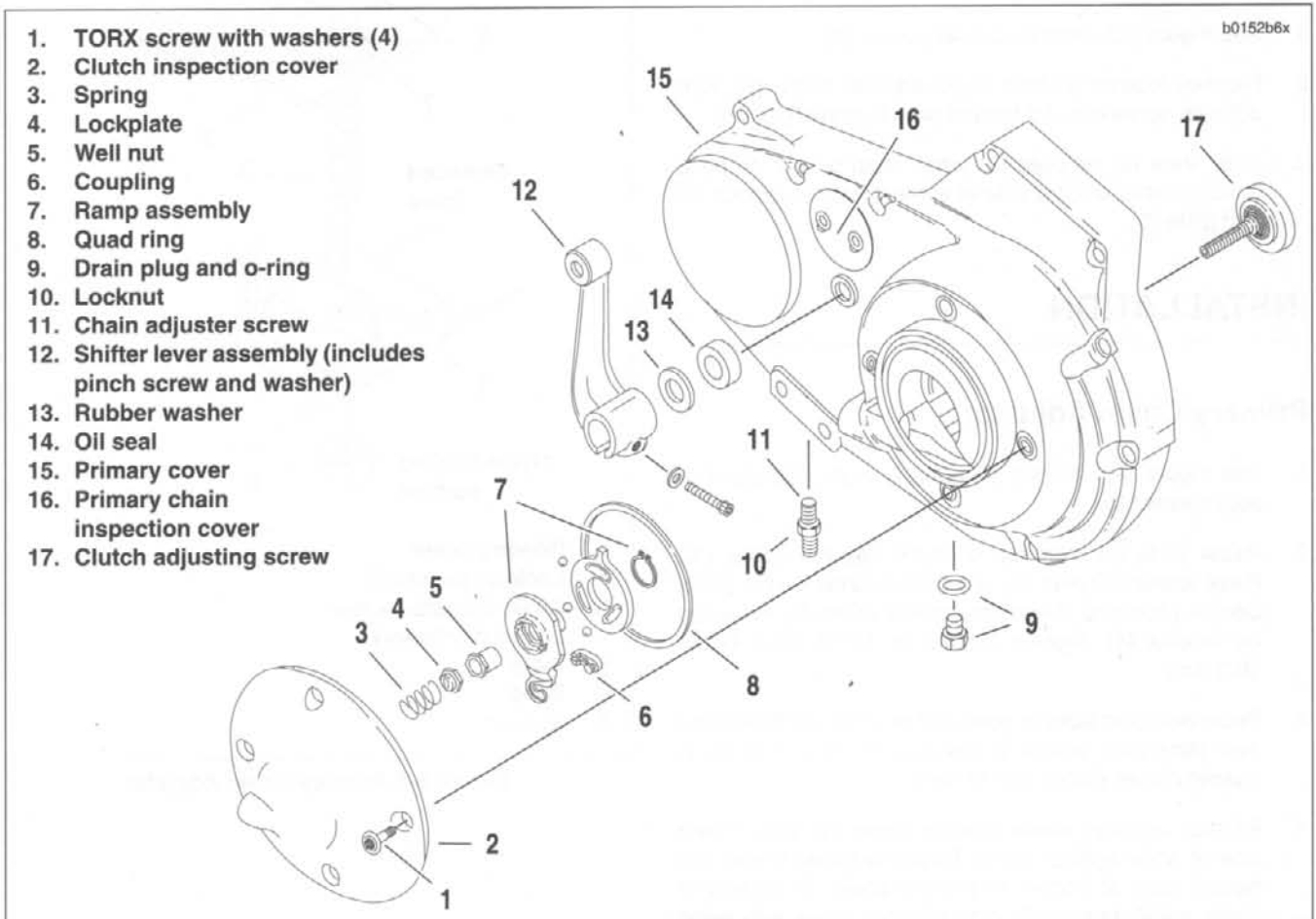


Figure 6-1. Primary Cover

4. Remove shifter lever assembly (12) and rubber washer (13). Do not scratch primary cover (15).
5. Add freeplay to clutch cable. See 1.12 CLUTCH.
6. Loosen locknut (10). Turn chain adjuster screw (11) counterclockwise (outward) to relax primary chain tension.
7. Remove four TORX screws with washers (1) and clutch inspection cover (2). Remove and discard Quad ring (8) from groove in primary cover.
8. Slide spring (3) with attached hex lockplate (4) from flats of clutch adjusting screw (17).
9. Turn clutch adjusting screw (17) clockwise to release ramp and coupling mechanism. As the adjusting screw is turned, ramp assembly (7) moves forward. Unscrew well nut (5) from end of adjusting screw.
10. Remove hook of ramp from button to the rear of cable end coupling (6). Remove cable end from slot in coupling. Remove coupling and ramp assembly.
11. Remove screws which secure primary cover. Remove cover and gasket. Discard gasket.
12. Remove and discard shifter lever oil seal (14).

Primary Chain Adjuster

1. See Figure 6-2. Remove primary cover (1).
2. Remove locknut (2) from chain adjuster screw (3). Turn adjuster screw out of threaded boss in primary cover.
3. Slide shoe (6) off plate (5) (shoe must be slid off plate toward closed or blind side of shoe). Remove locknut (4) and plate (5).

INSTALLATION

Primary Chain Adjuster

1. See Figure 6-3. If shoe (6) is badly worn, replace it or adjust assembly.
2. Install plate (5) over top of chain adjuster screw (3). Place spacer (7) over top of adjuster screw next to plate. Secure plate and spacer to adjuster screw by threading on locknut (4). Tighten locknut to 10-12 ft-lbs (13.6-16.3 Nm).
3. Place plate into slots at open end of shoe (6). Slide shoe over plate until locknut at top end of adjuster screw is against closed (blind) side of shoe.
4. Position adjuster inside primary cover (1) with closed side of shoe against cover. Thread adjuster screw into tapped boss at bottom of primary cover. At outside of cover, install locknut (2) onto adjuster screw with nylon sealing surface toward cover. Tighten to 20-25 ft-lbs (27.1-33.9 Nm).
5. Install primary cover.

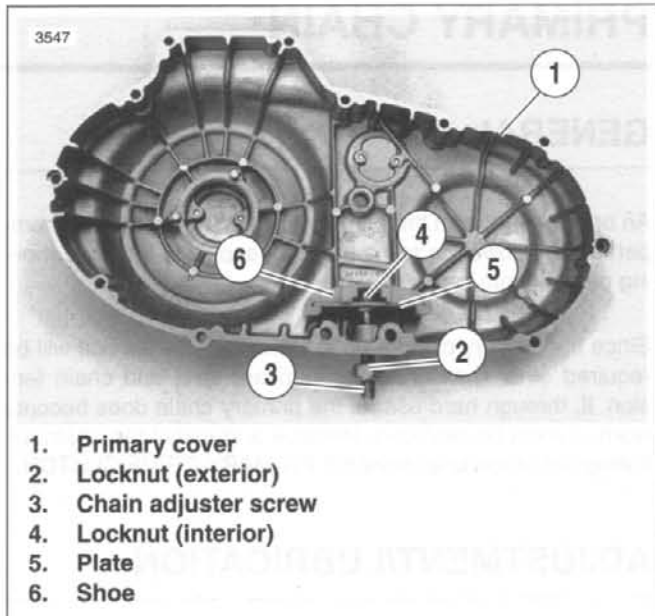


Figure 6-2. Removing Primary Chain Adjuster

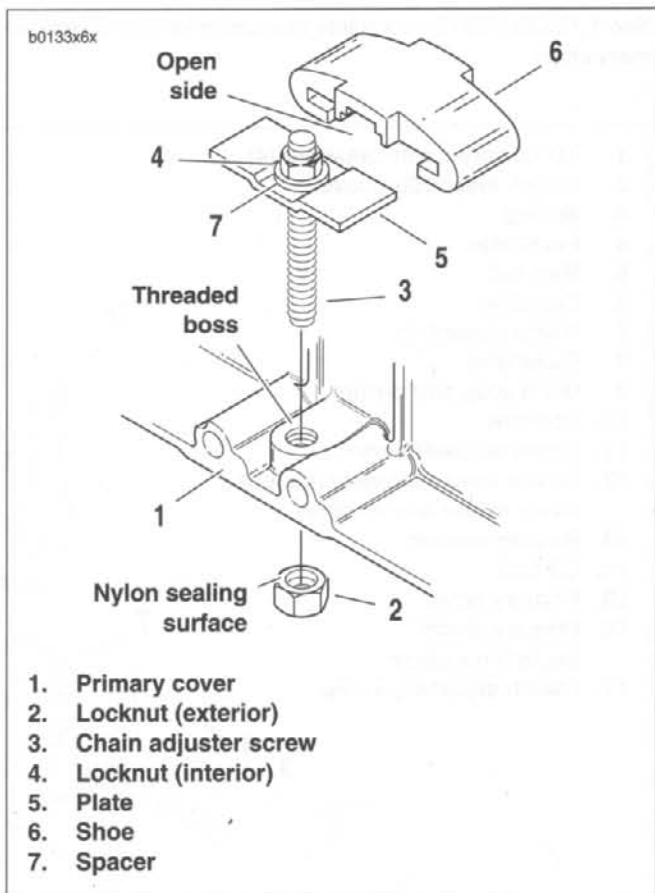


Figure 6-3. Primary Chain Adjuster

Primary Cover

1. Remove foreign material from magnetic drain plug. Install plug and tighten to 14-21 ft-lbs (19.0-28.5 Nm).
2. Wipe gasket surface clean. Install **new** gasket on primary cover.
3. See Figure 6-4. Install primary cover and gasket onto left crankcase half using mounting bolts.
 - a. **1999 Models:** Tighten bolts to 80-110 **in-lbs** (9.0-12.4 Nm).
 - b. **2000 Models:** Tighten bolts to 100-120 **in-lbs** (11-14 Nm).
4. See Figure 6-1. Install **new** shifter lever oil seal (14).
5. Fit coupling (6) over cable end with rounded side inboard, the ramp connector button outboard. With retaining ring side of ramp assembly facing inward, place hook of ramp (7) around coupling button and rotate assembly counterclockwise until tang on inner ramp fits in slot of primary cover.
6. Thread well nut (5) on adjusting screw (17) until slot of screw is accessible with a screwdriver. Fit well nut hex into recess of outer ramp and turn adjusting screw counterclockwise.
7. Fill transmission to proper level with fresh lubricant. See 1.12 CLUTCH.
8. Adjust clutch. See 1.12 CLUTCH.
9. Adjust primary chain tension. See 1.15 PRIMARY CHAIN.
10. Install rubber washer (13) and shifter lever assembly (12).
11. See Figure 6-5. Shifter lever (2) must bisect primary chain inspection cover (1). Tighten pinch screw (3) to 100-120 **in-lbs** (11.3-13.6 Nm).
12. Install muffler. See 2.35 EXHAUST SYSTEM.

WARNING

Always connect positive battery cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion which could result in death or serious injury.

13. Connect battery cables, positive cable first.

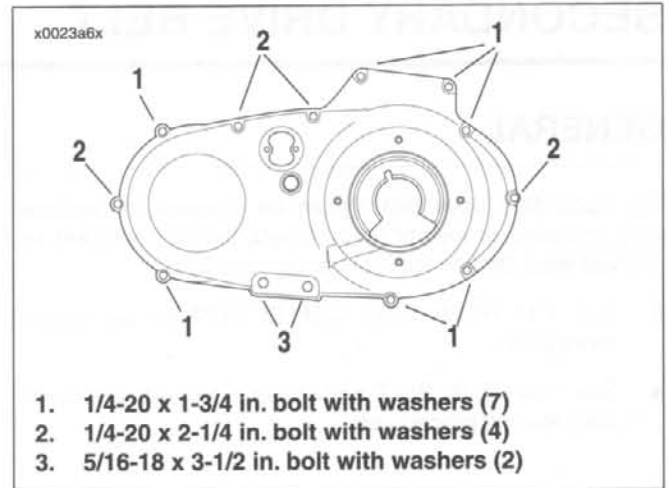


Figure 6-4. Install Primary Cover Bolts

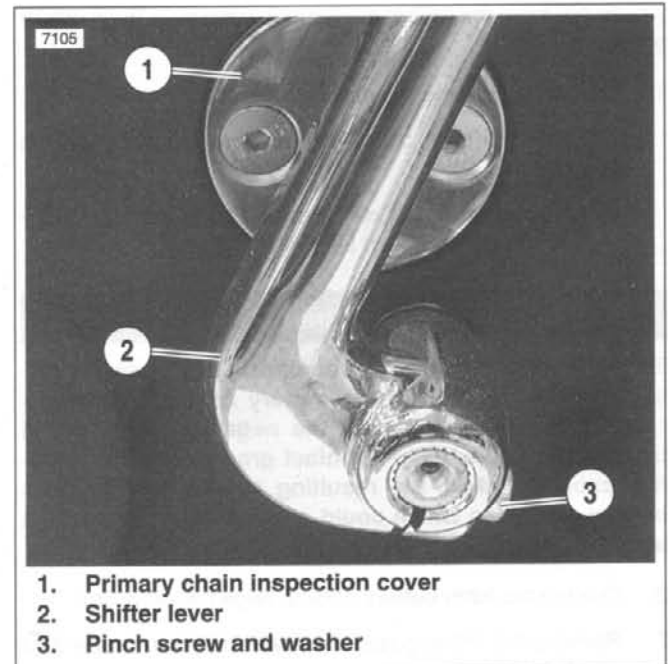


Figure 6-5. Shifter Lever

GENERAL

The secondary drive belt should be checked for unusual wear, cracking or loss of teeth. Check the belt sprocket for unusual wear, broken teeth or damaged flange.

- See 1.13 REAR BELT DEFLECTION for adjustment information.
- See 1.14 REAR BELT AND SPROCKET for inspection and cleaning procedures.

REMOVAL

Belt removal requires special lifts to support the motorcycle. If you do not have the proper equipment, have your Buell dealer perform the repair.

1. Lift and secure the motorcycle.
 - a. Place vehicle on a lift and anchor front wheel in place.
 - b. Raise rear wheel off lift using REAR WHEEL SUPPORT STAND (Part No. B-41174).

WARNING

To avoid accidental start-up of vehicle and possible personal injury, disconnect the battery cables before proceeding. Always disconnect the negative cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion which could result in death or serious injury.

2. Disconnect **both** battery cables, negative cable first.
3. Remove the stone guard and lower belt guard. See 2.41 BELT GUARDS.
4. Remove chin fairing. See 2.42 CHIN FAIRING
5. Remove sprocket cover. See 2.42 CHIN FAIRING.
6. Remove rear fender. See 2.40 REAR FENDER.
7. See Figure 6-6. Remove rear wheel.
 - a. Remove rear axle nut (1) (metric), lockwasher (2), washer (3) and right side axle carrier (4).
 - b. Hold axle adjuster bolt (5) with a 5/16 in. wrench. Loosen locknut (6) and axle adjusters (7). Repeat on left side.
 - c. From left side, slowly pull rear axle from swingarm. As axle is removed, remove right side spacer, rear brake caliper mount, left side axle carrier and washer. Suspend rear brake caliper mount from frame with a piece of rope. Push rear wheel forward and slip off belt.
8. See Figure 6-7. Loosen isolator bolt (1) until rubber isolator is able to be rotated. Do not remove bolt.

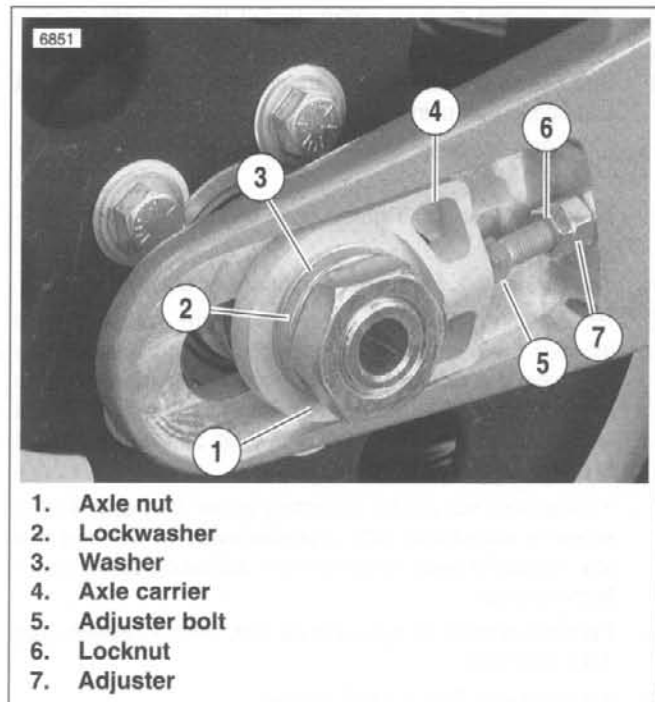


Figure 6-6. Rear Axle, Right Side

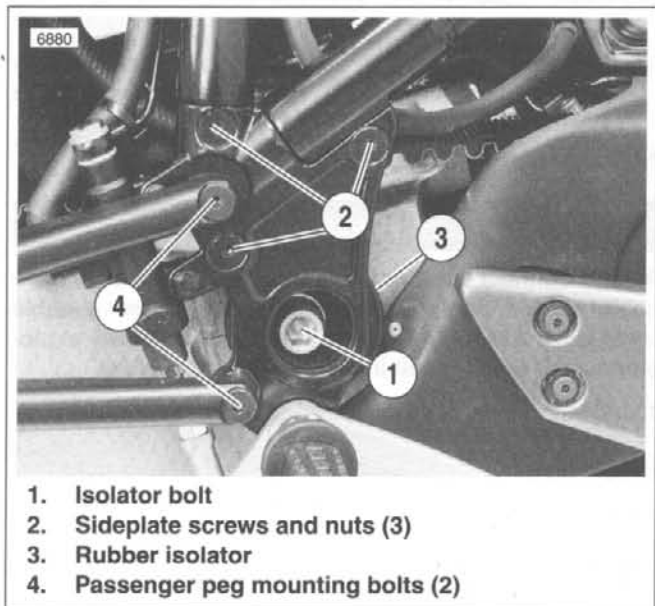


Figure 6-7. Sideplate

9. Remove right side passenger peg mounting bolts (4).
10. Remove the three allen screws and nuts (2) from the sideplate. Detach the sideplate using special care to watch how the rear brake line is twisted.
11. Slide the drive belt from the sprockets between the frame and rubber isolator.
12. Inspect belt and sprockets. See 1.14 REAR BELT AND SPROCKET.

INSTALLATION

1. Slide a **new** belt over the sprockets.

CAUTION

- Use caution when installing isolator bolts. Make sure isolator bolt hole is aligned with threaded hole in bearing adjusting bolt to avoid cross-threading bolt.

- Observe seam on rubber isolator after isolator bolt is tightened. If seam twists, apply more **LOCTITE ANTI-SEIZE** to underside of isolator bolt heads. Failure to comply will result in damage to rubber isolators. See Figure 6-9.

2. See Figure 6-8. Install rubber isolators (4).
 - a. Apply **LOCTITE THREADLOCKER 262** (red) to isolator bolt threads.
 - b. Apply **LOCTITE ANTI-SEIZE** to bottom of isolator bolt head.
 - c. Align metal pin (3) with frame and hole in isolator.
 - d. Install isolator bolts (1) and washers (2) through isolators (4) and into the mount.
 - e. Tighten to 100-110 ft-lbs (135.6-149.1 Nm).
 - f. See Figure 6-9. After tightening isolator bolts, verify that seam on isolators is perpendicular to swingarm mount block.
3. Install rear fender. See 2.40 REAR FENDER.
4. Align the **new** belt and rear wheel. See 1.13 REAR BELT DEFLECTION.
5. Install sprocket cover.
6. See Figure 6-7. Install sideplate and right side passenger peg mount.
 - a. Tighten sideplate screws (2) to 19 ft-lbs (25.8 Nm).
 - b. Tighten peg bolts (4) to 10-15 ft-lbs (13.6-20.3 Nm).
7. Install chin fairing. See 2.42 CHIN FAIRING.
8. Install stone guard and belt guard. See 2.41 BELT GUARDS.

WARNING

Always connect positive battery cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion which could result in death or serious injury.

9. Connect battery cables, positive cable first.

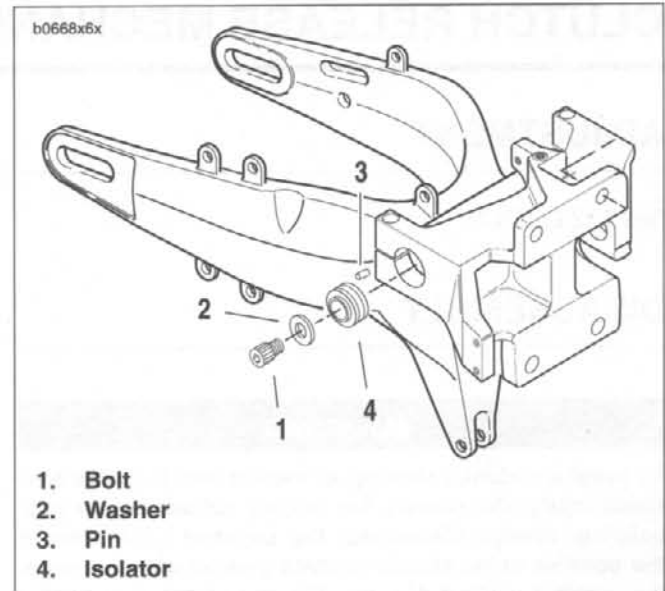


Figure 6-8. Installing Isolators

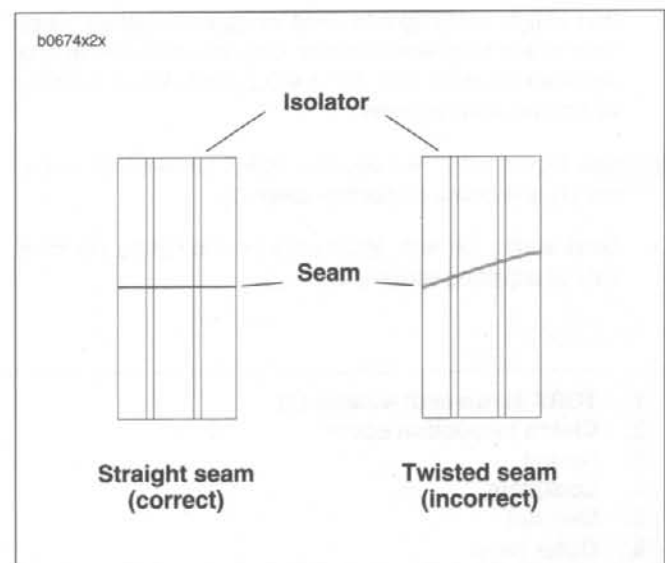


Figure 6-9. Isolator Alignment

ADJUSTMENT

See 1.12 CLUTCH.

DISASSEMBLY

WARNING

To avoid accidental start-up of vehicle and possible personal injury, disconnect the battery cables before proceeding. Always disconnect the negative cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion which could result in death or serious injury.

1. Pull clutch cable ferrule (end of cable housing) away from clutch hand lever bracket. Gap between ferrule and bracket should be 1/16-1/8 (1.6-3.2 mm). Adjust freeplay by turning cable adjuster.
2. See Figure 6-10. Remove four TORX screws with washers (1) and clutch inspection cover (2).
3. Slide spring (3) with attached screw lockplate (4) from flats of adjusting screw (12).

4. Turn adjusting screw (12) clockwise to release ramp and coupling mechanism. As the adjusting screw is turned, ramp assembly moves forward. Unscrew nut (5) from end of adjusting screw.
5. Remove hook of ramp from cable end coupling (16). Remove cable end (10) from slot in coupling.
6. Remove and discard retaining ring (13) from ramp assembly to separate inner and outer halves. Remove three balls (7) from ramp sockets.

CLEANING, INSPECTION AND REPAIR

1. Thoroughly clean all parts in cleaning solvent.
2. See Figure 6-10. Inspect three balls (7) of release mechanism and ball socket surfaces of inner and outer ramps for wear, pitting, surface breakdown and other damage. Replace parts as necessary.
3. Check hub fit of inner (15) and outer (6) ramps. Replace ramps if excessively worn.
4. Check clutch cable for frayed or worn ends. Replace cable if damaged or worn.
5. Change or add transmission fluid if necessary. See 1.12 CLUTCH.

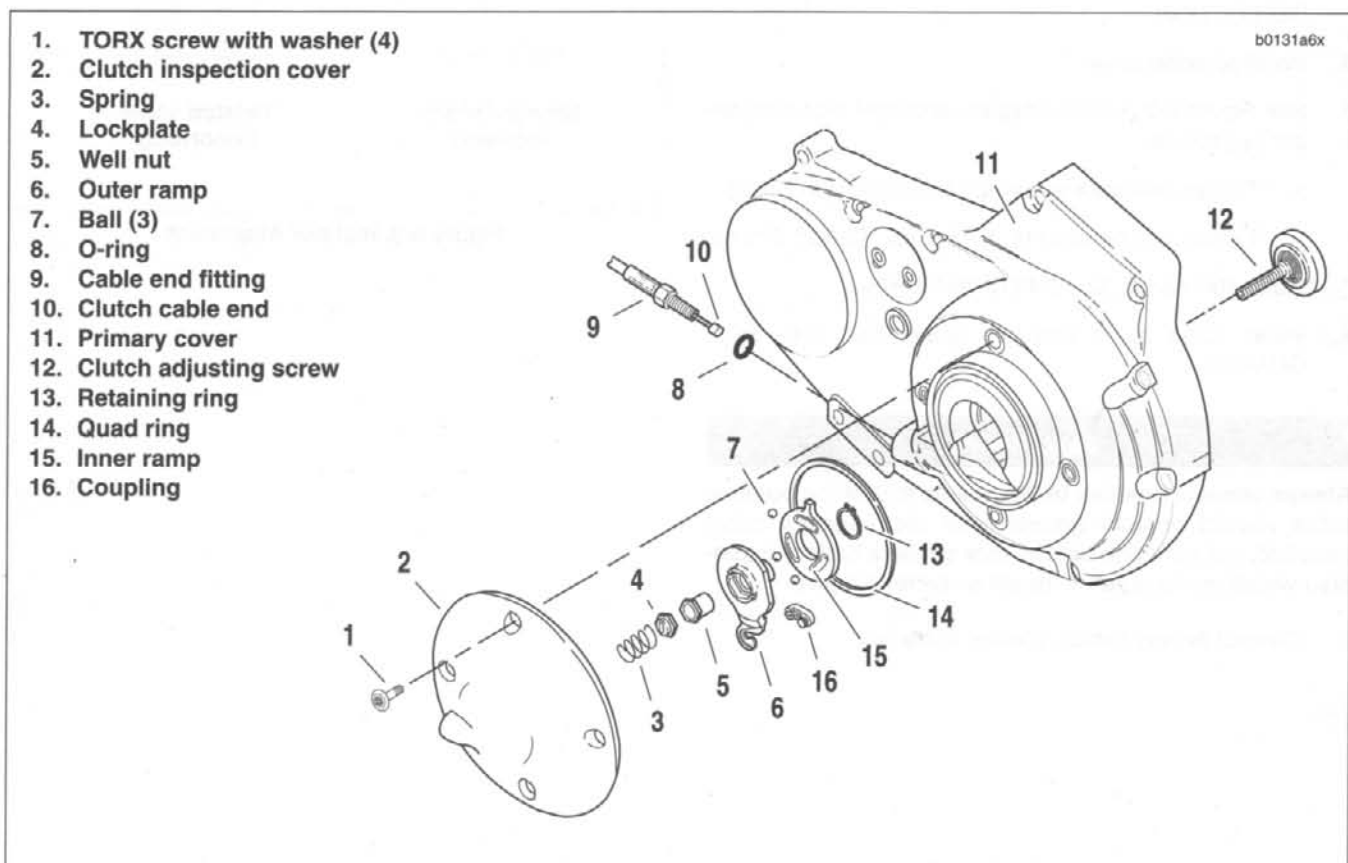


Figure 6-10. Clutch Release Mechanism

ASSEMBLY

1. See Figure 6-11. Assemble inner and outer ramp.
 - a. Apply multi-purpose grease to balls (2) and ramps (1, 3).
 - b. Insert balls in sockets of outer ramp (1).
 - c. Install inner ramp (3) on hub of outer ramp (1) with tang 180° from hook of outer ramp.
 - d. Install **new** retaining ring (4) in groove of outer ramp hub.
2. See Figure 6-12. Install ramp assembly.
 - a. Fit coupling (5) over cable end (4) with rounded side inboard, the ramp connector button outboard.
 - b. With retaining ring side of ramp assembly facing inward, place hook of ramp around coupling button.
 - c. Rotate assembly counterclockwise until tang on inner ramp fits in slot of primary cover (6).
3. Secure assembly in place.
 - a. Thread well nut (2) on adjusting screw (3) until slot of screw is accessible with a screwdriver.
 - b. Fit nut hex into recess of outer ramp (1).
 - c. Turn adjusting screw counterclockwise until resistance is felt.
4. Adjust clutch release mechanism. See 1.12 CLUTCH.

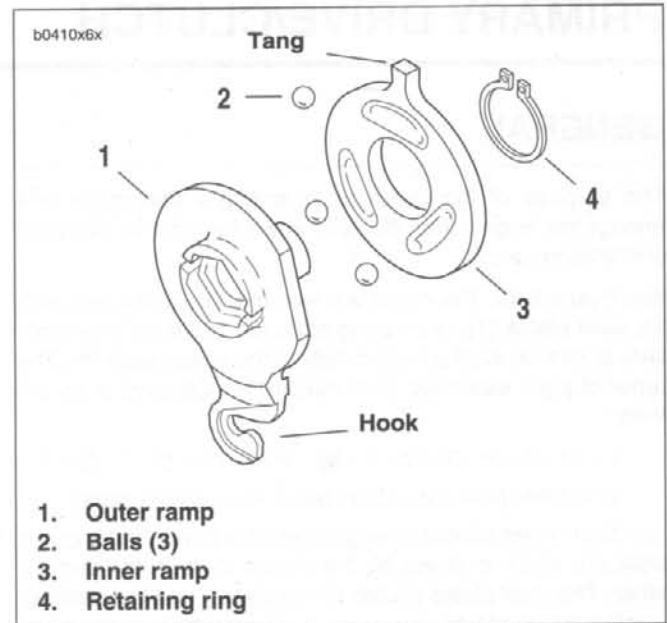


Figure 6-11. Inner and Outer Ramp

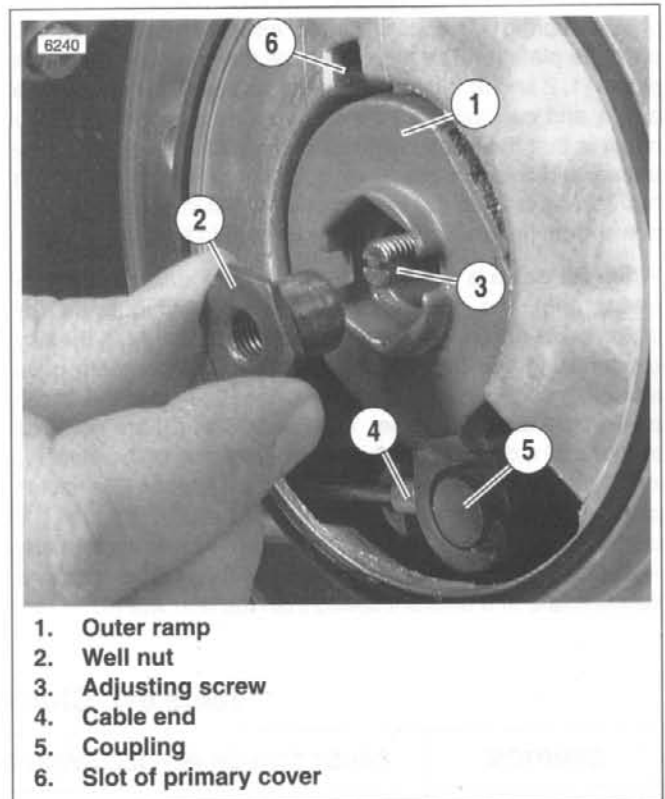


Figure 6-12. Nut and Outer Ramp

GENERAL

The purpose of the clutch is to smoothly disengage and engage the engine from the rear wheel for starting, stopping and shifting gears.

See Figure 6-13. The clutch is a wet, multiple-disc clutch with six steel plates (1), one spring plate (2) and eight fiber (friction) plates (3) stacked alternately in the clutch shell (4). The order of plate assembly, from inboard to outboard, is as follows:

F - St - F - St - F - St - F - **Sp** - F - St - F - St - F - St - F

(F = Fiber plate, St = Steel plate, Sp = Spring plate)

The fiber plates (clutch driving plates) are keyed to the clutch shell (4), which is driven by the engine through the primary chain. The steel plates (clutch driven plates) and the centrally located spring plate (also a clutch driven plate) are keyed to the clutch hub (5), which drives the rear wheel through the transmission and secondary drive belt.

When the clutch is engaged (clutch lever released), the diaphragm spring (7) applies strong inward force against the pressure plate (6). The pressure plate then presses the clutch plates (1, 2 and 3) together, allowing no slippage between the plates and causing the plates to turn as a single unit. The result is that the rotational force of the clutch shell (4) is fully transmitted through the "locked" clutch plates to the clutch hub (5). As long as the transmission is set in a forward gear, power from the engine will be transmitted to the rear wheel.

When the clutch is disengaged (clutch lever pulled to left handlebar grip), the pressure plate (6) is pulled outward (by clutch cable action) against the diaphragm spring (7), thereby compressing the diaphragm spring. With the pressure plate retracted, strong inward force no longer squeezes the clutch plates (1, 2 and 3) together. The fiber plates (3) are now free to rotate at a different relative speed than that of the steel (1) and spring (2) plates (i.e. - slippage between the clutch plates occurs). The result is that the rotational force of the clutch shell (4) is no longer fully transmitted through the "unlocked" clutch plates to the clutch hub (5). The engine is free to rotate at a different speed than the rear wheel.

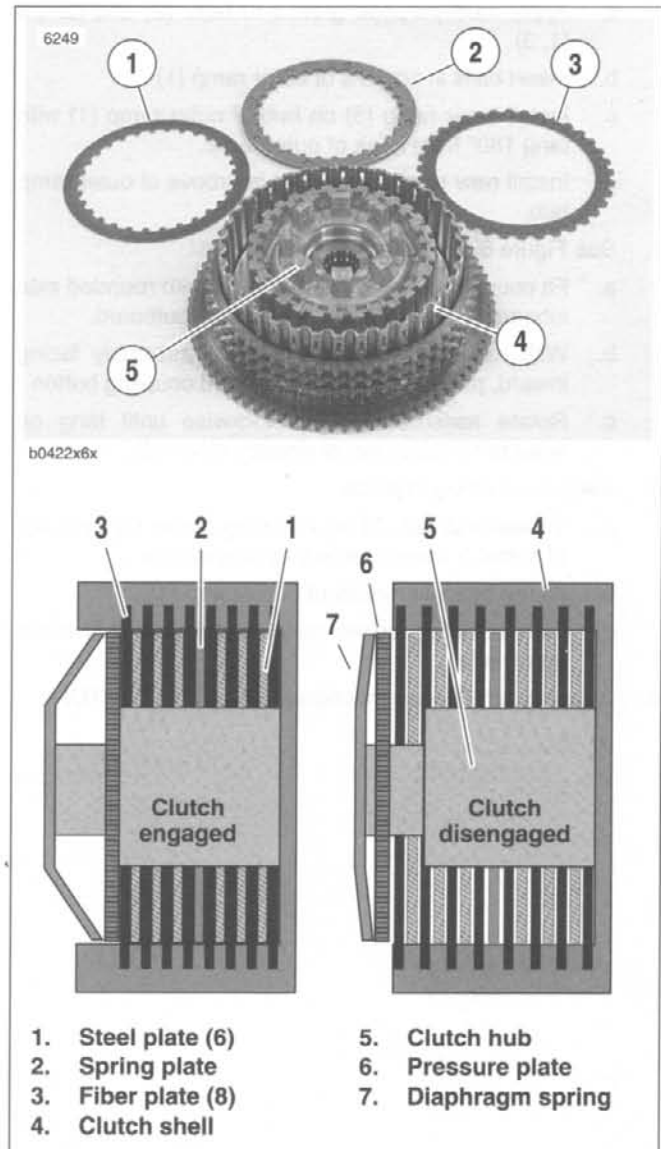


Figure 6-13. Clutch Plates and Hub/Shell Assembly

Table 6-1. Clutch Troubleshooting

SYMPTOM	CAUSE (CHECK IN FOLLOWING ORDER)	REMEDY
Clutch slips.	Incorrect clutch release adjustment. Worn clutch plates.	Check and adjust clutch release mechanism. Check service wear limits. Replace plates.
Clutch drags.	Incorrect clutch release adjustment. Worn clutch release ramps or balls. Warped clutch steel plates. Blade worn or damaged clutch gear splines. Overfilled primary.	Check and adjust clutch release mechanism. Replace release ramps and/or balls. Replace clutch steel plates. Replace clutch gear or hub as required. Drain lubricant to correct level.

REMOVAL/DISASSEMBLY

Clutch Pack

⚠ WARNING

To avoid accidental start-up of vehicle and possible personal injury, disconnect the battery cables before proceeding. Always disconnect the negative cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion which could result in death or serious injury.

1. Remove primary cover. See 6.2 PRIMARY CHAIN.

⚠ WARNING

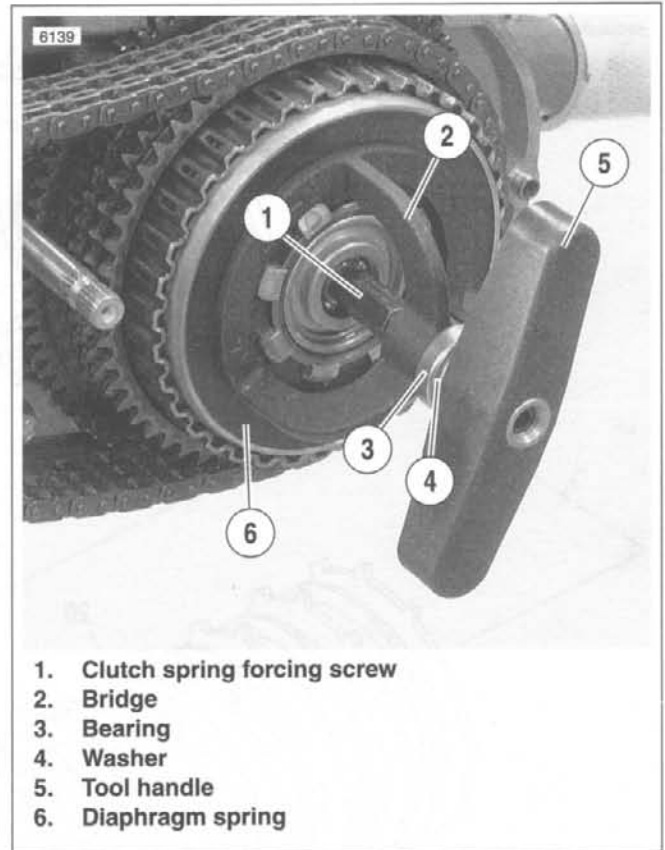
Do not attempt to disassemble the clutch without **SPRING COMPRESSING TOOL** (Part No. HD-38515-A), **CLUTCH SPRING FORCING SCREW** (Part No. HD-38515-91) and proper eye protection. Otherwise, the highly compressed diaphragm spring could fly out with great force, which could result in death or serious injury.

2. See Figure 6-14. Attach tools to compress clutch diaphragm spring.
 - a. Thread the **CLUTCH SPRING FORCING SCREW** (Part No. HD-38515-91) (1) onto the clutch adjusting screw.
 - b. Place the bridge (2) of **SPRING COMPRESSING TOOL** (Part No. HD-38515-A) against diaphragm spring (6).
 - c. Install bearing (3) and washer (4).
 - d. Thread the tool handle (5) onto end of forcing screw.

CAUTION

See Figure 6-15. Turn compressing tool handle (5) only the amount required to release spring seat (9) and remove snap ring (8). Excessive compression of diaphragm spring (6) could damage clutch pressure plate (7).

3. Remove pressure plate assembly.
 - a. Place a wrench on the clutch spring forcing screw (1) flats to prevent the forcing screw from turning.
 - b. Turn compressing tool handle (5) clockwise until tool relieves pressure on snap ring (8) and spring seat (9). Remove and discard snap ring (8).
 - c. Unseat spring seat (9) from the groove in clutch hub prongs.
 - d. Remove pressure plate assembly.
4. See Figure 6-16. Remove the clutch pack from the hub/shell assembly. The pack consists of eight fiber plates (18), six steel plates (19) and a spring plate (20).



1. Clutch spring forcing screw
2. Bridge
3. Bearing
4. Washer
5. Tool handle
6. Diaphragm spring

Figure 6-14. Compressing Clutch Diaphragm Spring



1. Clutch spring forcing screw
2. Bridge
3. Bearing
4. Washer
5. Tool handle
6. Diaphragm spring
7. Pressure plate
8. Snap ring
9. Spring seat

Figure 6-15. Pressure Plate Assembly

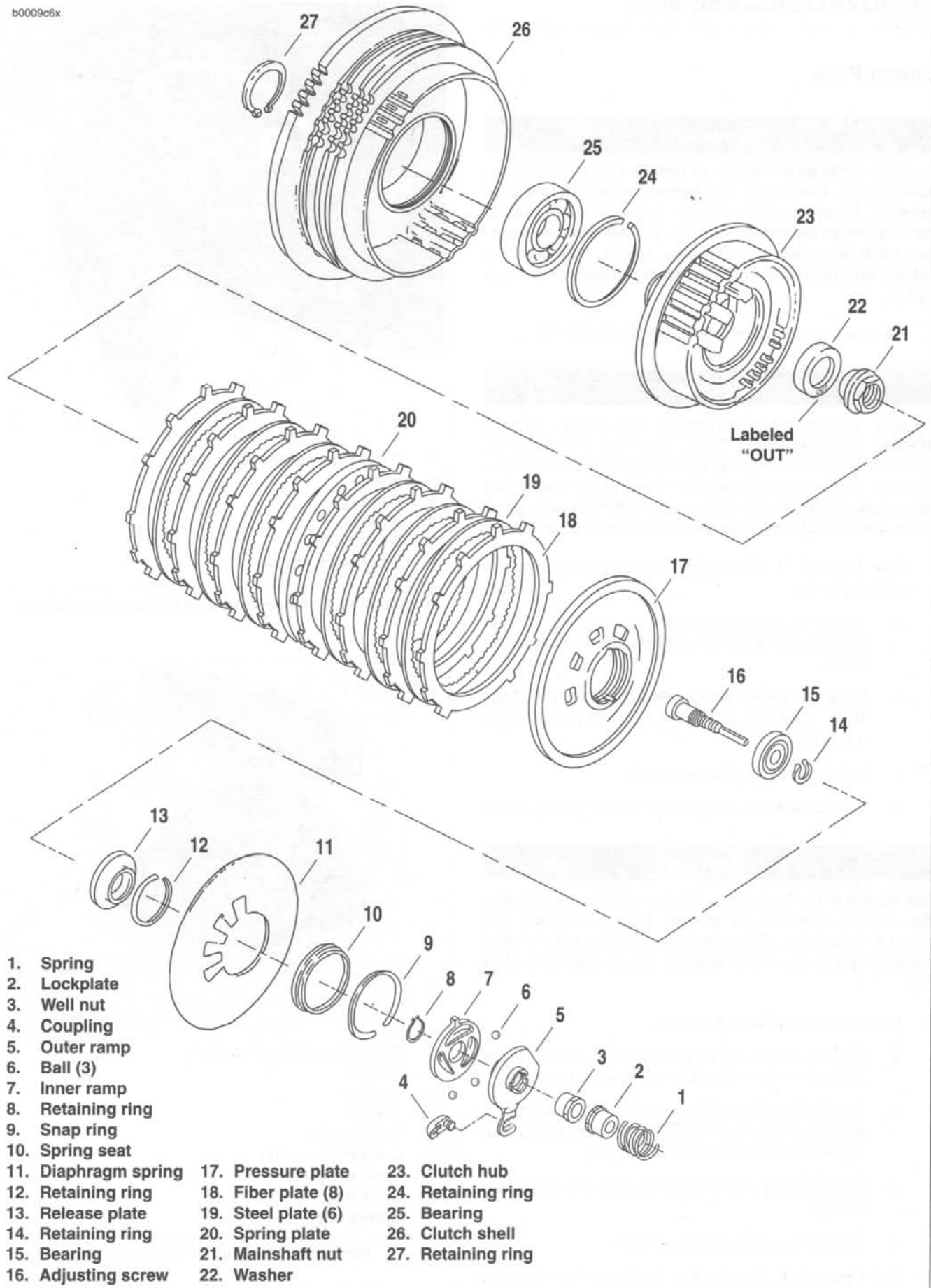


Figure 6-16. Clutch Assembly

Primary Chain/Drive

WARNING

To avoid accidental start-up of vehicle and possible personal injury, disconnect the battery cables before proceeding. Always disconnect the negative cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion which could result in death or serious injury.

1. Remove primary cover. See 6.2 PRIMARY CHAIN.
2. Loosen engine sprocket.
 - a. Install SPROCKET LOCKING LINK (Part No. HD-38362).
 - b. Remove the engine sprocket nut.
 - c. Loosen, but do not remove, engine sprocket. If necessary, use the slotted portion of TWO CLAW PULLER (Part No. HD-97292-61) and two bolts to loosen the engine sprocket.
3. See Figure 6-17. Remove adjusting screw assembly.
 - a. Remove large retaining ring (1).
 - b. Remove adjusting screw assembly (2, 3 and 4) from pressure plate.

CAUTION

See Figure 6-16. Mainshaft nut (21) has left-hand threads. To prevent damage, turn nut clockwise to loosen and remove from mainshaft.

4. Remove mainshaft nut (21) and washer (22).
5. Remove the clutch assembly, primary chain and engine sprocket as a unit.
 - a. Inspect primary chain and sprockets for damage or excessive wear.
 - b. Inspect stator and rotor. See 7.7 ALTERNATOR.
 - c. Replace damaged parts as necessary.
6. Install adjusting screw assembly into pressure plate.
 - a. See Figure 6-18. Align two tabs on perimeter of release plate with corresponding recesses in pressure plate.
 - b. See Figure 6-17. Secure the adjusting screw assembly with large retaining ring (1).
7. Attach tools to compress clutch diaphragm spring. See Step 2 of CLUTCH PACK under 6.5 PRIMARY DRIVE/CLUTCH.
8. Remove clutch pack components. See Steps 3-4 of CLUTCH PACK under 6.5 PRIMARY DRIVE/CLUTCH.

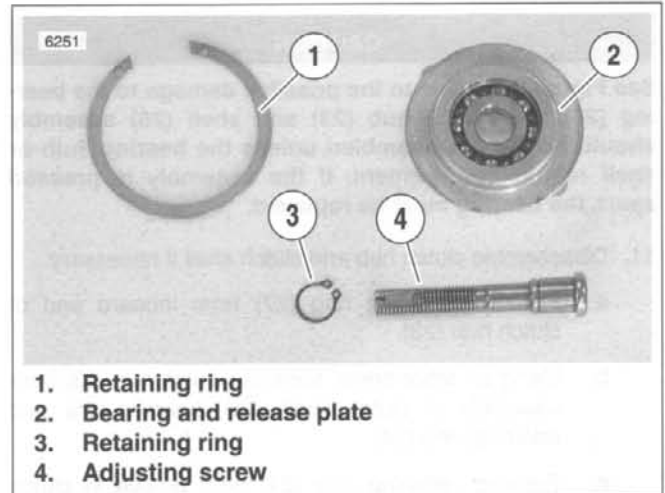


Figure 6-17. Adjusting Screw Assembly

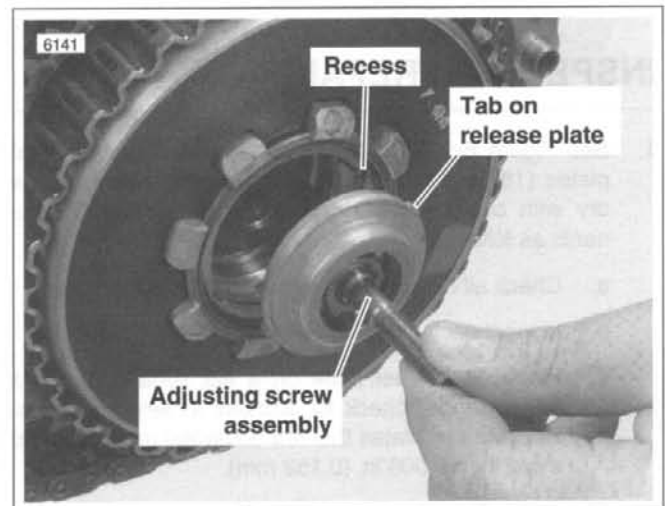


Figure 6-18. Aligning Tabs

9. See Figure 6-15. Disassemble pressure plate.
 - a. Place a wrench on the clutch spring forcing screw (1) flats to prevent the forcing screw from turning.
 - b. Turn the compressing tool handle (5) counterclockwise until the handle spins off.
 - c. Remove washer (4), bearing (3) and bridge (2).
 - d. Remove clutch spring forcing screw (1) from clutch adjusting screw.
 - e. Remove spring seat (9) and diaphragm spring (6) from pressure plate (7).
10. See Figure 6-17. Remove and disassemble adjusting screw assembly.
 - a. Remove large retaining ring (1).
 - b. Remove adjusting screw assembly (2, 3 and 4) from pressure plate.
 - c. If necessary, disassemble adjusting screw assembly. Remove and discard small retaining ring (3) and then separate the adjusting screw (4) from the bearing and release plate (2). Remove bearing from release plate.

CAUTION

See Figure 6-16. Due to the possible damage to the bearing (25), the clutch hub (23) and shell (26) assembly should not be disassembled unless the bearing, hub or shell require replacement. If the assembly is pressed apart, the bearing must be replaced.

11. Disassemble clutch hub and clutch shell if necessary.
 - a. Remove retaining ring (27) from inboard end of clutch hub (23).
 - b. Using an arbor press, separate clutch hub (23) from assembly of clutch shell (26), bearing (25) and retaining ring (24).
 - c. Remove retaining ring (24) from groove in clutch shell (26).
 - d. Press on the inboard side of bearing (25) outer race to remove bearing from clutch shell.

INSPECTION/REPAIR

1. See Figure 6-16. Wash all parts, except fiber (friction) plates (18) and bearing (25), in cleaning solvent. Blow dry with compressed air. Examine the clutch components as follows:
 - a. Check all clutch plates for wear and discoloration.
 - b. Inspect each steel (drive) plate (19) for grooves.
 - c. Place each steel plate on a flat surface. Using a feeler gauge, check for flatness in several places. Replace any plates that are damaged or are warped more than 0.006 in. (0.152 mm).
2. Check the diaphragm spring (11) for cracks or bent tabs. Install a **new** spring if either condition exists.
3. See Figure 6-19. Check fiber plates for thickness.
 - a. Wipe the lubricant from the eight fiber plates and stack them on top of each other.
 - b. Measure the thickness of the eight stacked fiber plates with a dial caliper or micrometer. The minimum thickness must be 0.661 in. (16.789 mm).
 - c. If the thickness is less than specified, discard the fiber plates and steel plates. Install a **new** set of both friction and steel plates.
4. See Figure 6-20. Check the clutch shell.
 - a. Inspect primary chain sprocket (1) and the starter ring gear (2) on the clutch shell. If either sprocket or ring gear are badly worn or damaged, replace the clutch shell.
 - b. Check the slots that mate with the clutch plates on both clutch shell (4) and hub (3). If slots are worn or damaged, replace shell and/or hub.
 - c. If clutch shell was removed from motorcycle, check the bearing for smoothness. Rotate the clutch shell while holding the clutch hub. If bearing is rough or binds, it must be replaced.

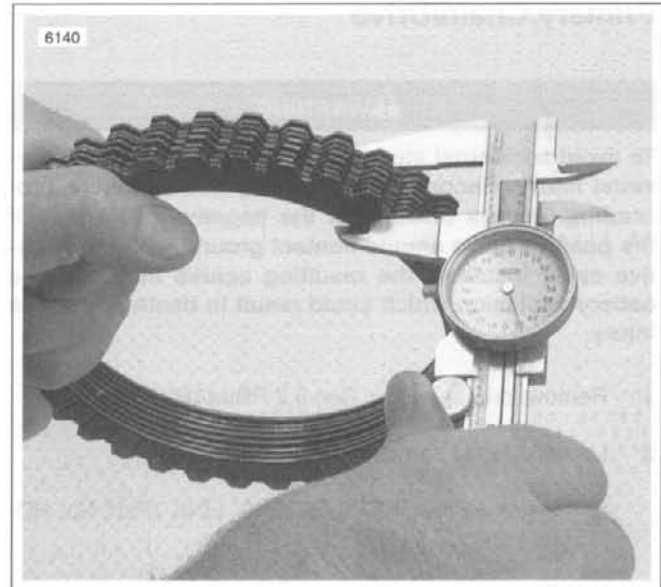


Figure 6-19. Measuring Friction Plates

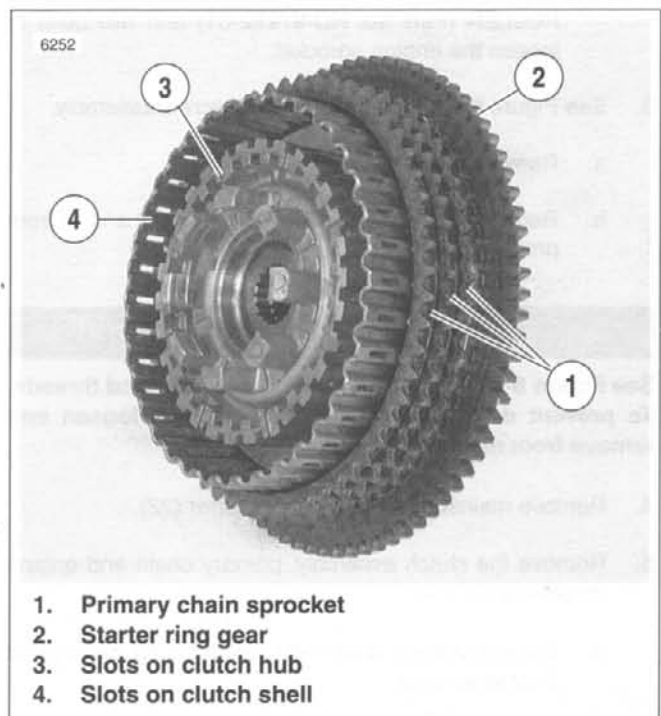


Figure 6-20. Checking Clutch Shell

ASSEMBLY

Clutch Pack

- See Figure 6-16. Install the clutch pack, which consists of eight fiber plates (18), six steel plates (19) and a spring plate (20), into the clutch hub (23). The order of plate assembly, from inboard to outboard, is as follows:

F - St - F - St - F - St - F - **Sp** - F - St - F - St - F - St - F

(F = Fiber plate, St = Steel plate, Sp = Spring plate)

CAUTION

See Figure 6-15. Turn compressing tool handle (5) only the amount required to install spring seat (9) and snap ring (8). Excessive compression of diaphragm spring (6) could damage clutch pressure plate (7).

- Place assembly of spring seat, **new** snap ring, diaphragm spring, pressure plate, adjusting screw components and compressing tool onto clutch hub and against clutch pack.
 - See Figure 6-21. Align square openings of pressure plate and diaphragm spring (1) so that the assembly can be installed over prongs (2) of clutch hub.
 - Position spring seat (5) with its larger O.D. side toward diaphragm spring (1).
 - See Figure 6-15. Place a wrench on the clutch spring forcing screw (1) flats to prevent the forcing screw from turning.
 - Turn compressing tool handle (5) clockwise until diaphragm spring (6) compresses just enough to install spring seat (9) and **new** snap ring (8) into the groove in clutch hub prongs.
 - With snap ring positioned against outboard side of spring seat, and fully seated in groove of clutch hub, carefully loosen and remove compression tool.

Primary Drive

- See Figure 6-22. Assemble clutch hub and shell if necessary.
 - Press **new** bearing (3) in clutch shell (4). Secure bearing with a **new** retaining ring (2).
 - Press inboard end of clutch hub (1) into shell bearing (3). Secure with **new** retaining ring (5) on end of hub.
- Assemble pressure plate hardware.
 - See Figure 6-17. Place bearing inside release plate. Insert adjusting screw (4) through bearing and release plate (2). Secure with **new** retaining ring (3).
 - See Figure 6-21. Position diaphragm spring (1) with its concave side facing toward pressure plate onto pressure plate assembly.

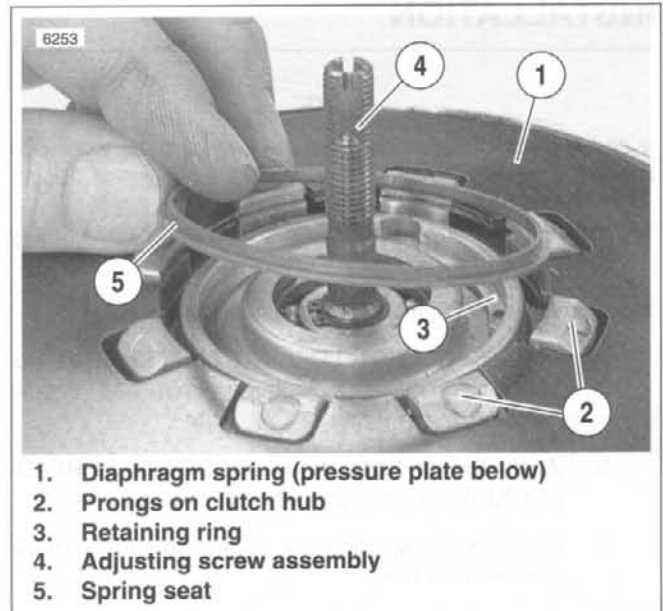


Figure 6-21. Spring Seat Installation

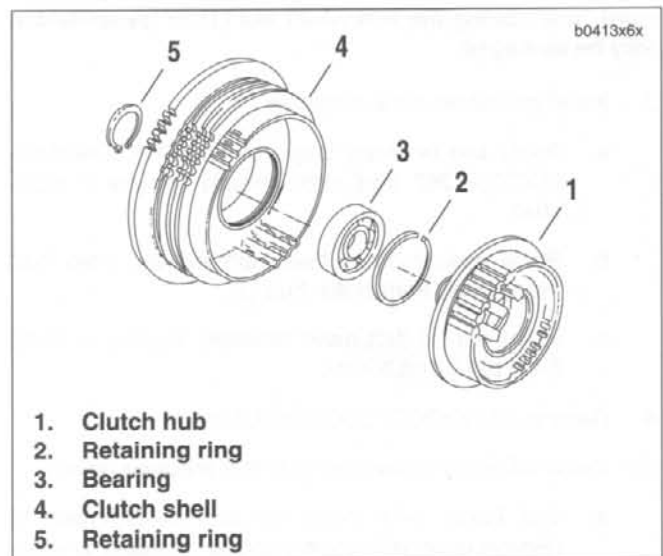


Figure 6-22. Clutch Hub and Shell Assembly

- Insert adjusting screw assembly (4) into pressure plate. Secure with large retaining ring (3).
 - Position spring seat (5) with its larger O.D. side toward diaphragm spring.
- Attach tools to compress clutch diaphragm spring. See Step 2 of CLUTCH PACK under 6.5 PRIMARY DRIVE/CLUTCH. Do not tighten compressing tool against diaphragm spring at this time.
 - Install the clutch pack. Follow all instructions of CLUTCH PACK under 6.5 PRIMARY DRIVE/CLUTCH.

INSTALLATION

NOTE

If clutch pack replacement was the only service work performed, start with Step 5.

1. Install the engine sprocket, clutch assembly and primary chain as a unit into primary chaincase.
2. See Figure 6-23. Install the engine sprocket nut.
 - a. Place SPROCKET LOCKING LINK (3) (Part No. HD-38362) between primary chain and engine sprocket.
 - b. Apply two or three drops of LOCTITE THREAD-LOCKER 262 (red) onto threads of sprocket shaft.
 - c. Install engine sprocket nut. Tighten to 190-210 ft-lbs (257.6-284.7 Nm).

CAUTION

See Figure 6-24. Washer (2) must be installed with the word "out" facing the mainshaft nut (1) or transmission may be damaged.

3. Install mainshaft nut and washer.
 - a. Apply two or three drops of LOCTITE THREAD-LOCKER 262 (red) onto threads on end of mainshaft.
 - b. Place washer (2) on mainshaft with the word "out" facing away from clutch hub (3).
 - c. Install nut (1) (**left-hand threads**). Tighten to 70-80 ft-lbs (94.9-108.5 Nm).
4. Remove SPROCKET LOCKING LINK.
5. Install adjusting screw assembly into pressure plate.
 - a. See Figure 6-18. Align two tabs on perimeter of release plate with corresponding recesses in pressure plate.
 - b. See Figure 6-17. Secure the adjusting screw assembly with retaining ring.
6. Install primary cover. See 6.2 PRIMARY CHAIN.

WARNING

Always connect positive battery cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion which could result in death or serious injury.

7. Connect battery cables, positive cable first.

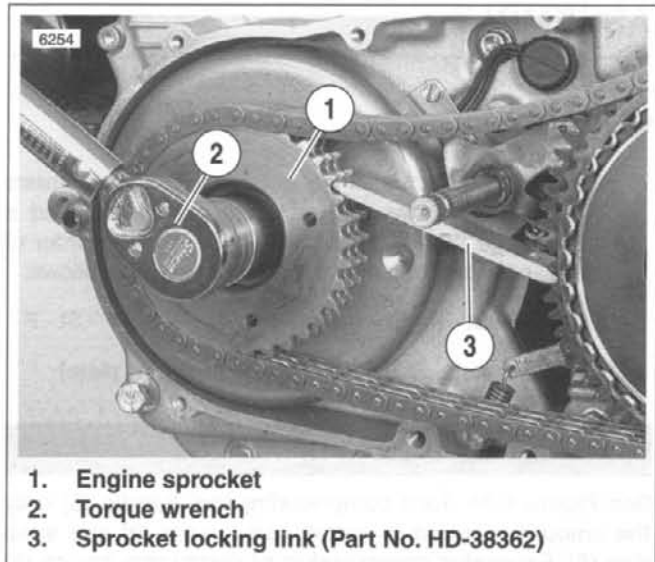


Figure 6-23. Sprocket Locking Link

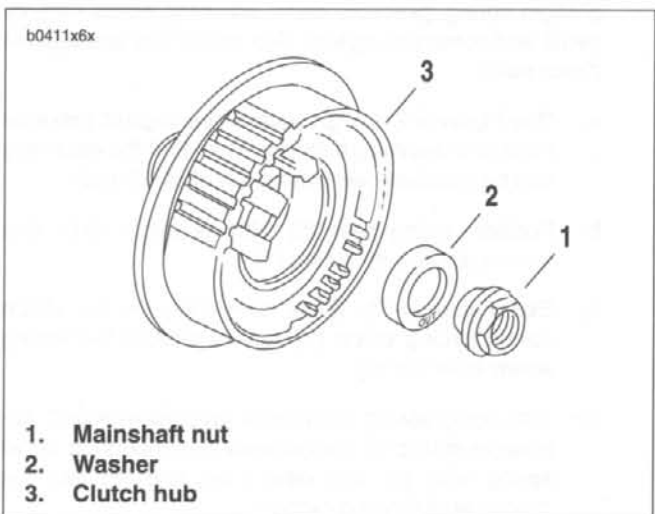


Figure 6-24. Mainshaft Nut and Washer

MODEL YEAR CHANGE

All 2000 Model Year Buell motorcycles have a taller second gear. Revised gear ratios are listed in 6.1 SPECIFICATIONS.

GENERAL

See Figure 6-25. The transmission is a five-speed constant-mesh type housed in an extension of the crankcase. The transmission permits the rider to vary the ratio of engine speed-to-rear driving wheel speed in order to meet the varying conditions of operation.

See Figure 6-26. The transmission is foot-operated by the gear shift lever, which transmits the force through a gear shifter shaft. The shifter shaft actuates a pawl and a shifter fork drum. The shifter fork drum moves shifter forks, which slide a series of shifter clutch gears, on the mainshaft and countershaft, into and out of mesh with the other gears.

LUBRICATION

Drain transmission and refill to correct level with fresh, clean lubricant at least once each year or every 5000 miles (8000 km), whichever comes first. For best results, drain lubricant while hot.

See 1.12 CLUTCH for more information.

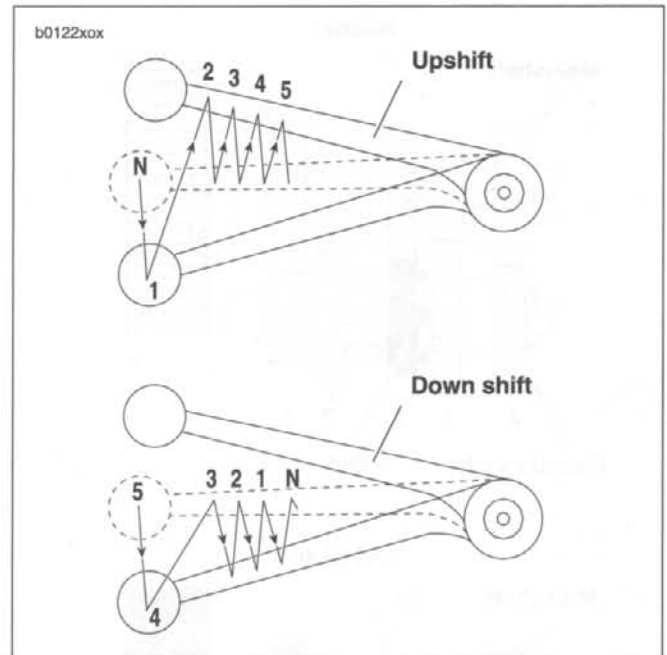


Figure 6-25. Transmission Pattern

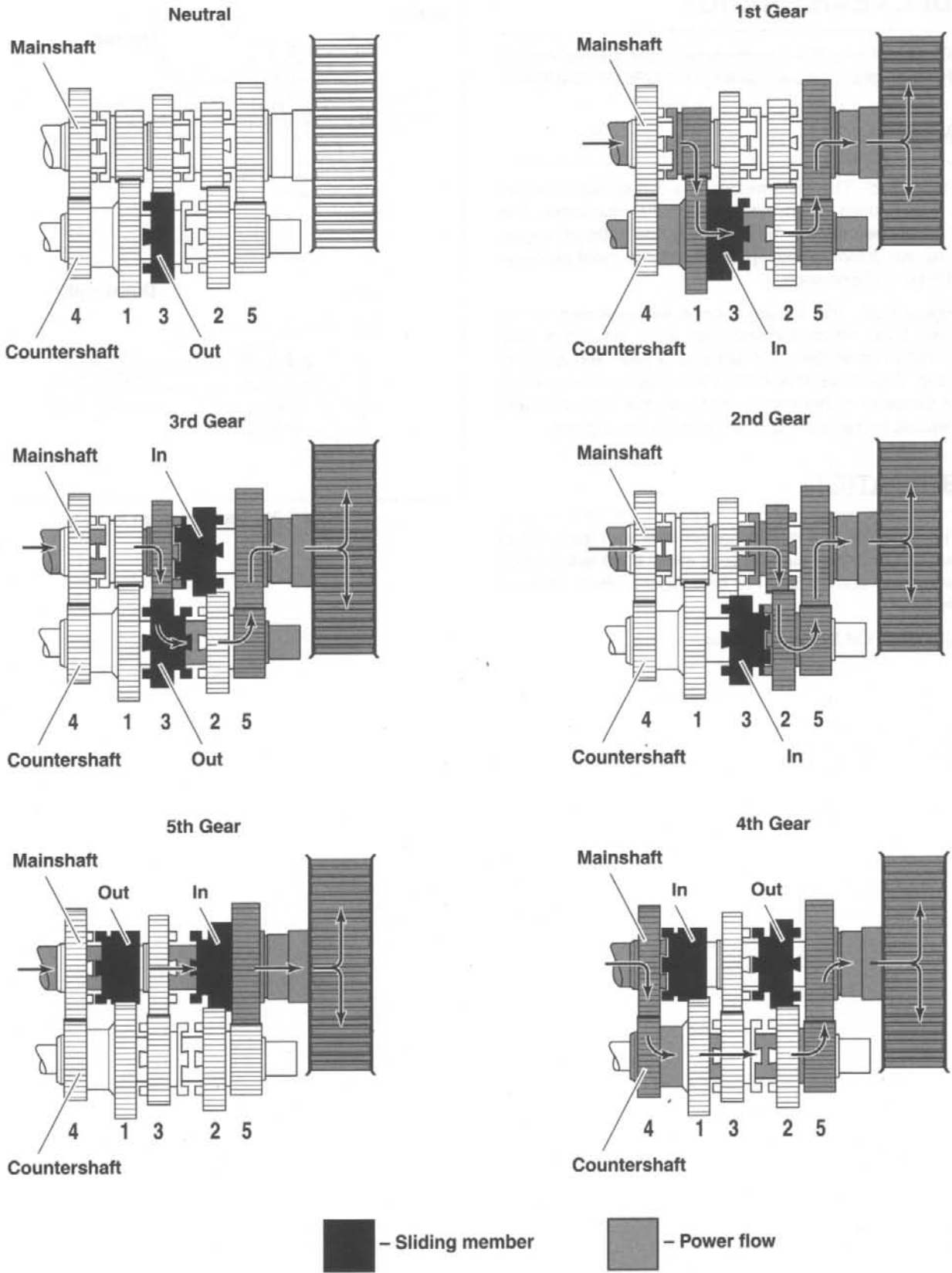


Figure 6-26. Transmission Power Flow

GENERAL

The rear compartment of the left and right crankcase halves form the transmission case. An access cover (door) allows removal of transmission components without removing the engine or disassembling (splitting) the crankcase.

REMOVAL

1. Raise rear wheel off floor using REAR WHEEL SUPPORT STAND (Part No. B-41174).
2. Remove muffler and drain primary drive/transmission. See TRANSMISSION FLUID.
3. Remove sprocket cover. See 2.38 SPROCKET COVER.
4. Remove rear fender. See 2.40 REAR FENDER.
5. See Figure 6-27. Move rear wheel forward.
 - a. Loosen rear axle nut (2) (metric).
 - b. Hold axle adjuster bolt (1) with a 5/16 in. wrench. Loosen locknut (3).
 - c. Turn adjusters (4) on each side of swingarm an equal number of turns counterclockwise.
 - d. Move rear wheel as far forward as possible.
6. See Figure 6-28. Place transmission in first gear. Remove two socket head screws (5) and lockplate (4).

CAUTION

Transmission sprocket nut has left-hand threads. To prevent damage, turn nut clockwise to loosen and remove from main drive gear shaft.

7. Remove transmission sprocket nut (3) from main drive gear shaft (1).
8. Remove secondary drive belt from transmission sprocket (2). Remove transmission sprocket from main drive gear shaft (1).
9. Remove primary cover. See 6.2 PRIMARY CHAIN.
10. Remove clutch assembly, primary chain and engine sprocket. See PRIMARY CHAIN/DRIVE under 6.5 PRIMARY DRIVE/CLUTCH.

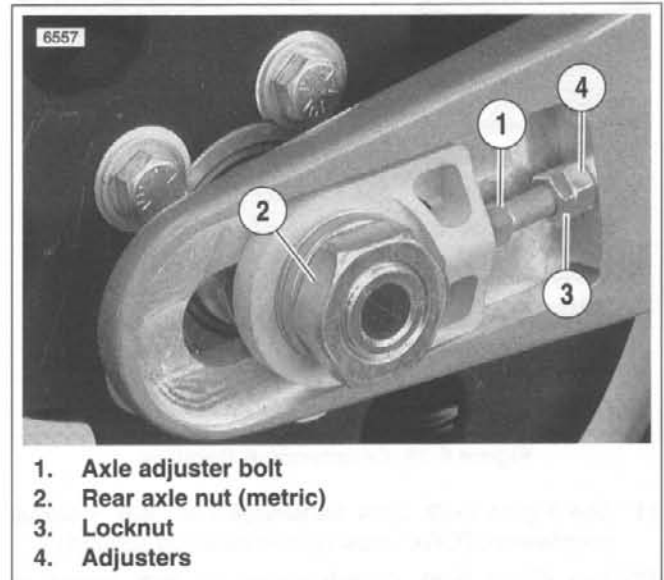


Figure 6-27. Rear Axle Assembly

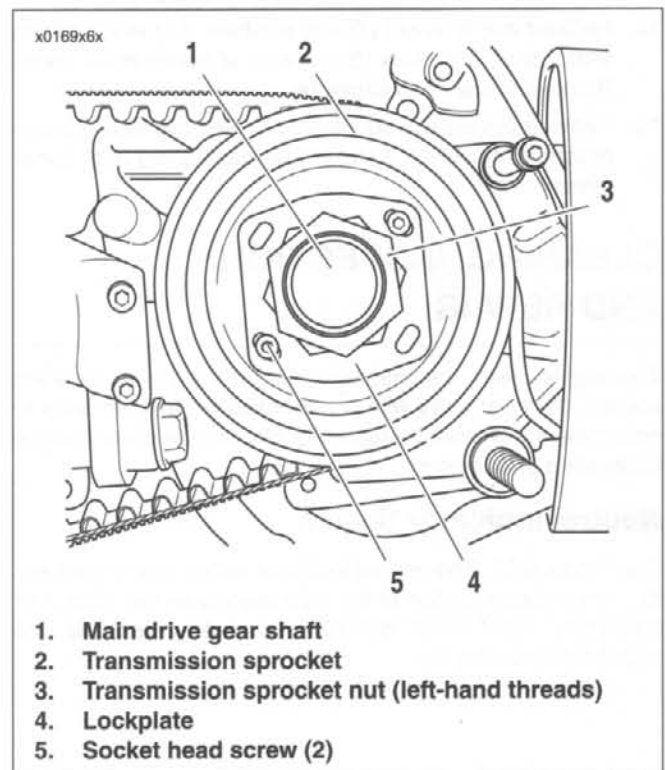


Figure 6-28. Transmission Sprocket

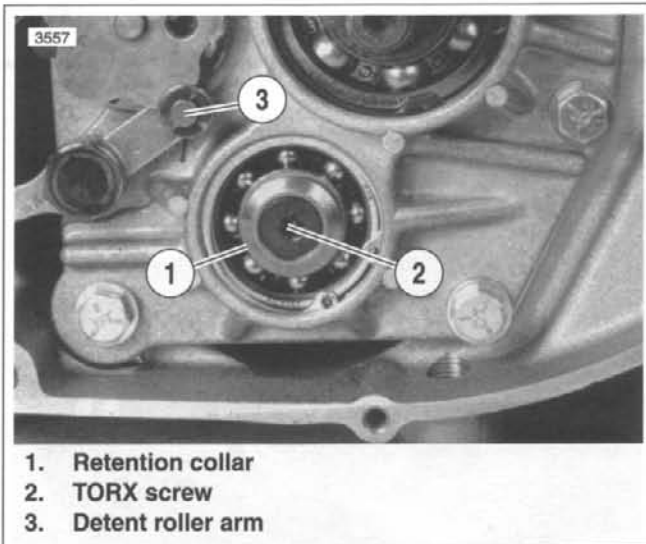


Figure 6-29. Countershaft Retainer

11. See Figure 6-29. Lock transmission in gear. Remove countershaft TORX screw (2) and retention collar (1).
12. See Figure 6-30. Detach spring (1) from groove in post (2).
13. Remove retaining ring (9) and detent plate (8). You will need to use a **new** retaining ring for installation.
14. Remove two locknuts (3) and washers (10) which attach shifter shaft assembly (6) to studs at transmission case. Remove shifter shaft assembly.
15. Remove five access door bolts (7). Remove transmission assembly by pulling it straight outward, away from transmission case.

CLEANING, INSPECTION AND REPAIR

Thoroughly clean transmission compartment with cleaning solvent. Blow parts dry with compressed air. Inspect parts to determine if any must be replaced. Replace all parts that are badly worn or damaged.

Neutral Indicator Switch

See Figure 6-31. The neutral indicator switch is threaded into the transmission portion of the right crankcase half. See 7.23 NEUTRAL INDICATOR SWITCH for testing, removal and installation procedures.

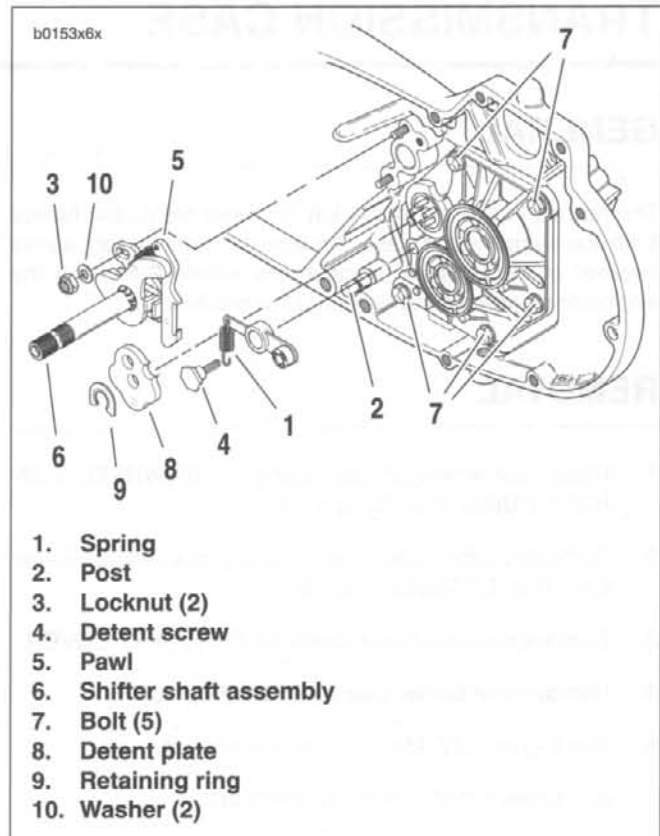


Figure 6-30. Shifter Shaft Assembly

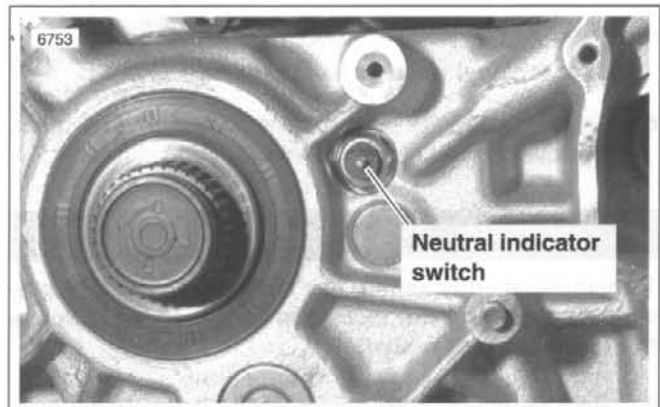


Figure 6-31. Neutral Indicator Switch

DISASSEMBLY

1. Remove transmission assembly. See 6.7 TRANSMISSION CASE. Mount transmission assembly in vise with protected jaws.
2. See Figure 6-32. Remove nut (10), washer (14), detent screw (18), plates (8, 9), detent arm (16) and spring (17).
3. Remove and discard the three fork cotter pins (4).
4. Remove three shifter fork pins (5). A small magnet is useful in freeing the fork pins (5).

5. Slide shifter fork drum (7) away from access door, through shifter forks. The neutral indicator pin prevents removal in the other direction.
6. Remove shifter forks (1, 2 and 3).

CLEANING, INSPECTION AND REPAIR

1. See Figure 6-32. Clean all parts except bearings (19, 20) with solvent.

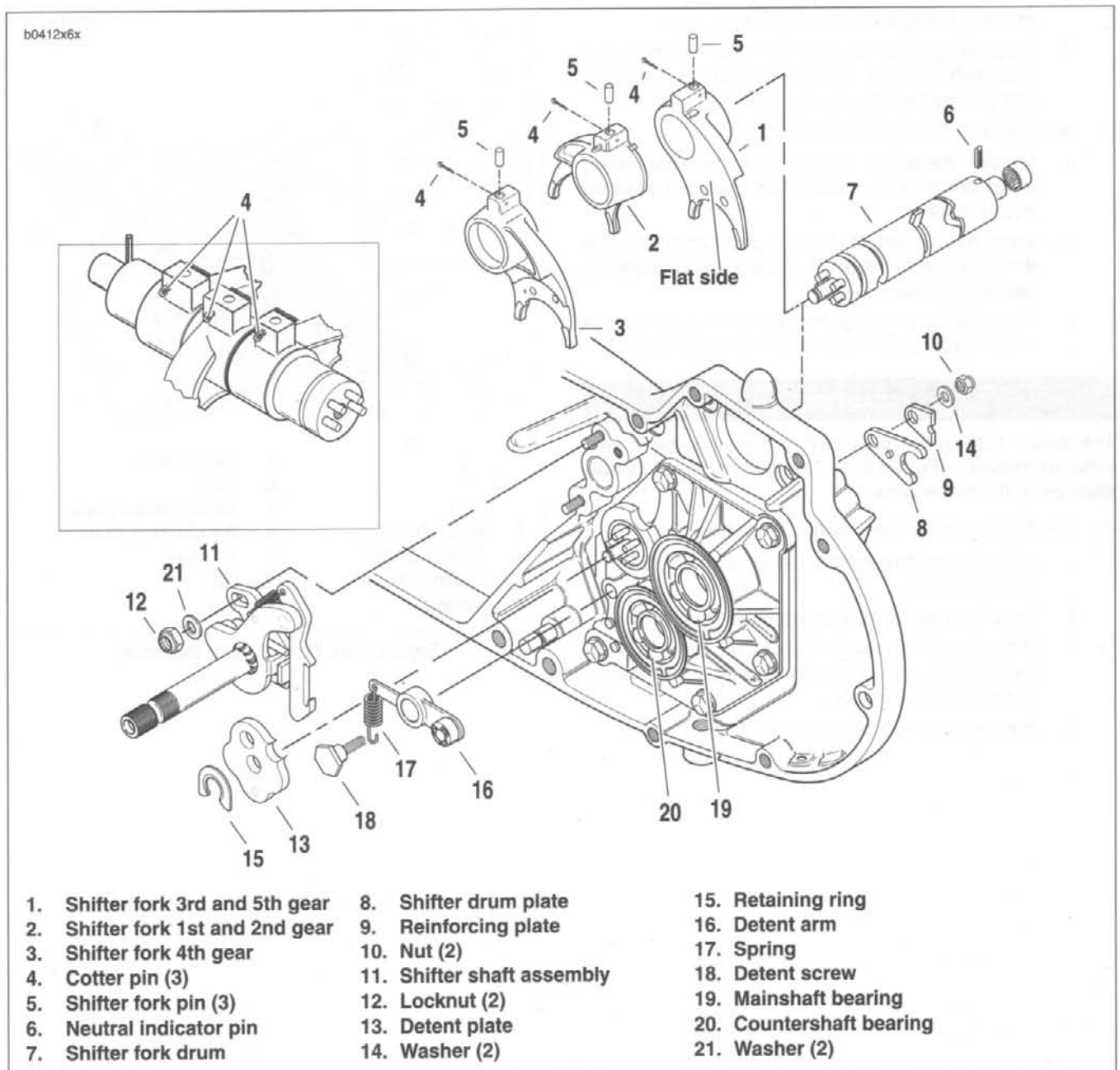


Figure 6-32. Shifter Mechanism

2. Inspect bearings (19, 20) and shifter drum ends. If ends of shifter drum are pitted or grooved, replace the shifter drum and bearings. If replacing bearings, see 6.11 ACCESS DOOR BEARINGS.
3. Inspect shifter fork drum (7) for cracks or wear. Replace if necessary.

ASSEMBLY

1. See Figure 6-33. Identify all shifter forks before assembly. Note shape of fork and location of fork pin holes.
2. Install shifter forks.
 - a. Lubricate the shaft bore of all three shifter forks (1, 2 and 3) with SPORT-TRANS FLUID.
 - b. Place 3rd and 5th gear shifter fork (1) in the fork groove of mainshaft 2nd gear. Be sure the flat side of fork is facing the access cover.
 - c. Place 1st and 2nd gear shifter fork (2) in the fork groove of countershaft 3rd gear. Be sure the flat side of fork is facing away from the access door.
 - d. Place 4th gear shifter fork (3) in the fork groove of mainshaft 1st gear. Be sure the flat side of fork is facing away from the access door.
3. See Figure 6-32. Install shifter shaft drum.
 - a. Position the shifter drum shaft so that the neutral indicator pin (6) is upward. The shaft is then in the neutral position.
 - b. Insert the pin end of shifter drum shaft (7) through the hubs of shifter forks (1, 2 and 3) and through the bearing in access cover.
 - c. Align the hole through the top of each shifter fork with the appropriate cam groove in the shifter drum.

CAUTION

The cotter pins must be inserted through the shifter forks as shown in Figure 6-33. This will prevent possible damage to the cotter pins.

4. See Figure 6-32. Secure shifter mechanism.
 - a. Lubricate the three shifter fork pins (5) with SPORT-TRANS FLUID.
 - b. Drop fork pins (5) through the holes in shifter forks.
 - c. With a small screwdriver press on the pins while manipulating the forks back and forth until the pin seats in the drum groove.
 - d. Secure shifter fork pins with new cotter pins (4).

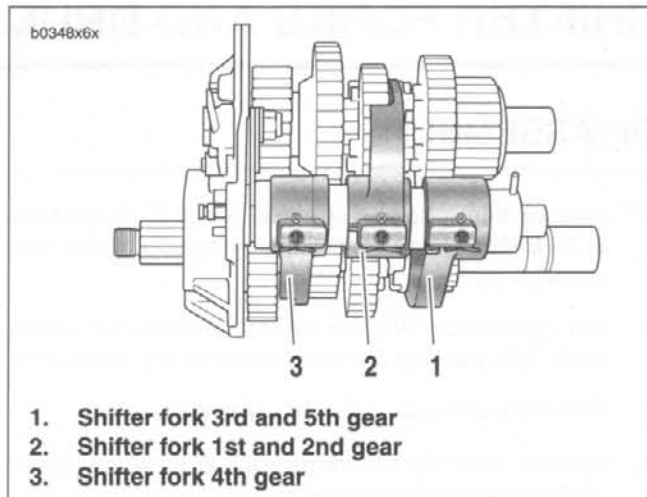


Figure 6-33. Shifter Fork Identification

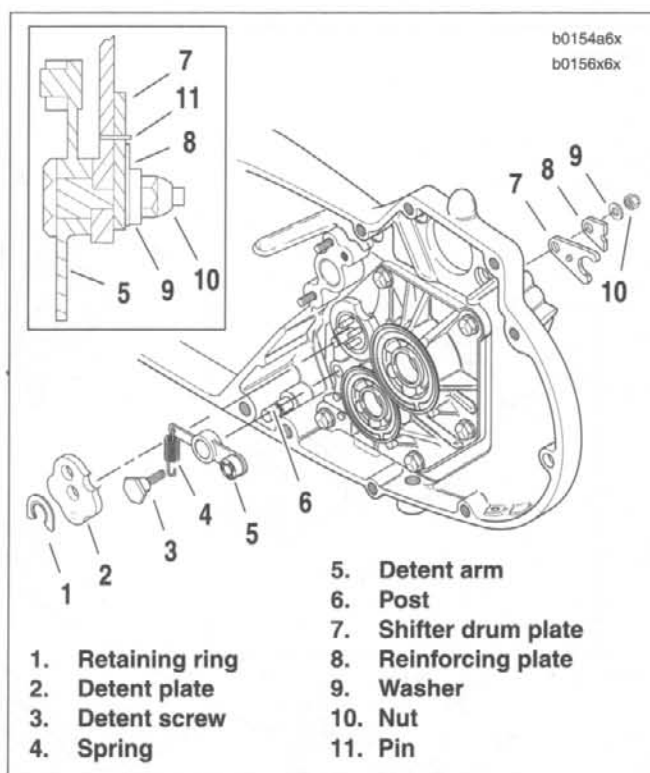


Figure 6-34. Detent Plate Mounting

NOTE

See Figure 6-34. Detent plate (2) and retaining ring (1) are not installed at this time. These parts are installed during transmission installation after the final shifter pawl adjustment is made. See 6.13 TRANSMISSION INSTALLATION AND SHIFTER PAWL ADJUSTMENT.

5. Install detent plate hardware.
 - a. At the inside of the access door, place the shifter drum plate (7) in the groove of the drum shaft. See inset Figure 6-34.
 - b. Correctly align reinforcement plate (8) with the pin pressed in the shifter drum plate (7).
 - c. Insert detent screw (3) through detent arm (5), access door, shifter drum plate (7), reinforcing plate (8) and washer (9).
 - d. Thread nut (10) on detent screw. Tighten to 13-17 ft-lbs (17.6-23.0 Nm).

NOTE

See Figure 6-35. Install detent roller arm (2) between countershaft bearing (1) and detent plate (3) location.

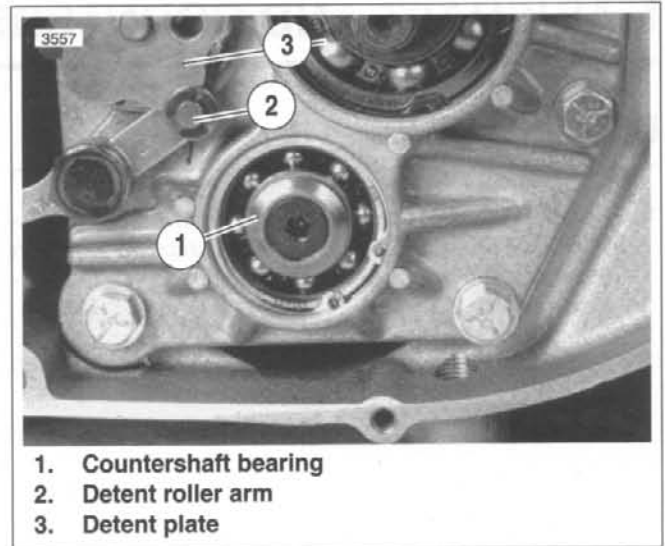


Figure 6-35. Detent Roller Arm

DISASSEMBLY

1. Remove transmission assembly. See 6.7 TRANSMISSION CASE. See Figure 6-36. Clamp transmission assembly in a vise, with protective jaws, to work on disassembly.
2. Remove shifter forks and drum as described under 6.8 SHIFTER FORKS AND DRUM.

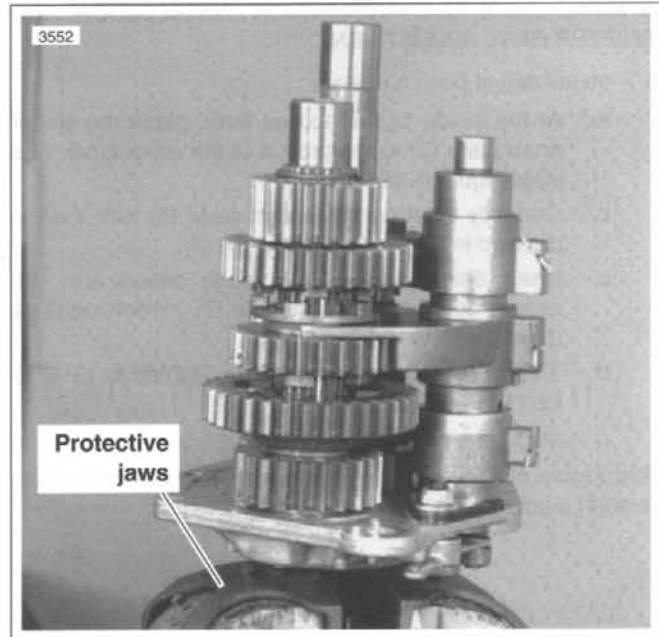


Figure 6-36.

NOTE

As the transmission runs, each part develops a certain wear pattern and a kind of "set" with its mating parts. For this reason, it is important that each component be reinstalled in its original location and facing its original direction.

3. See Figure 6-37. As each component is removed, place it on a clean surface in the exact order of removal.

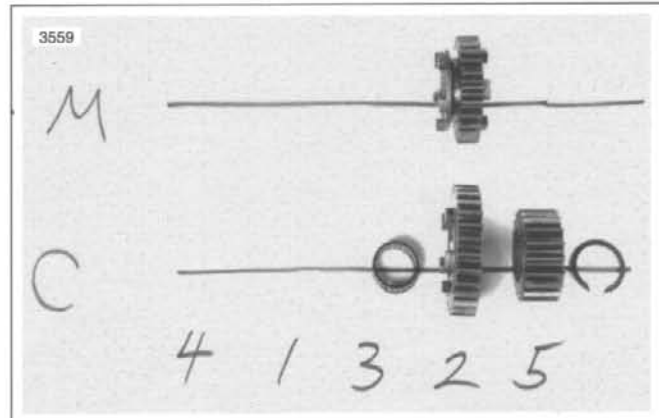


Figure 6-37.

See Figure 6-38. Using RETAINING RING PLIERS (Part No. J-5586) remove and discard retaining ring (5) next to countershaft 5th gear (12). Slide countershaft 5th (12), mainshaft 2nd (22) and countershaft 2nd (11) off end of shafts.

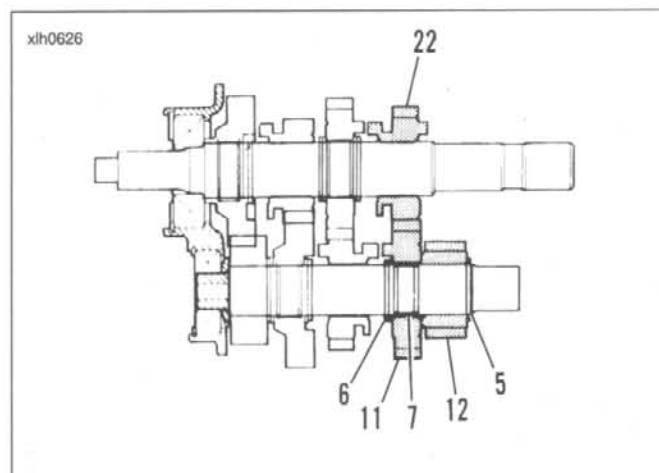


Figure 6-38.

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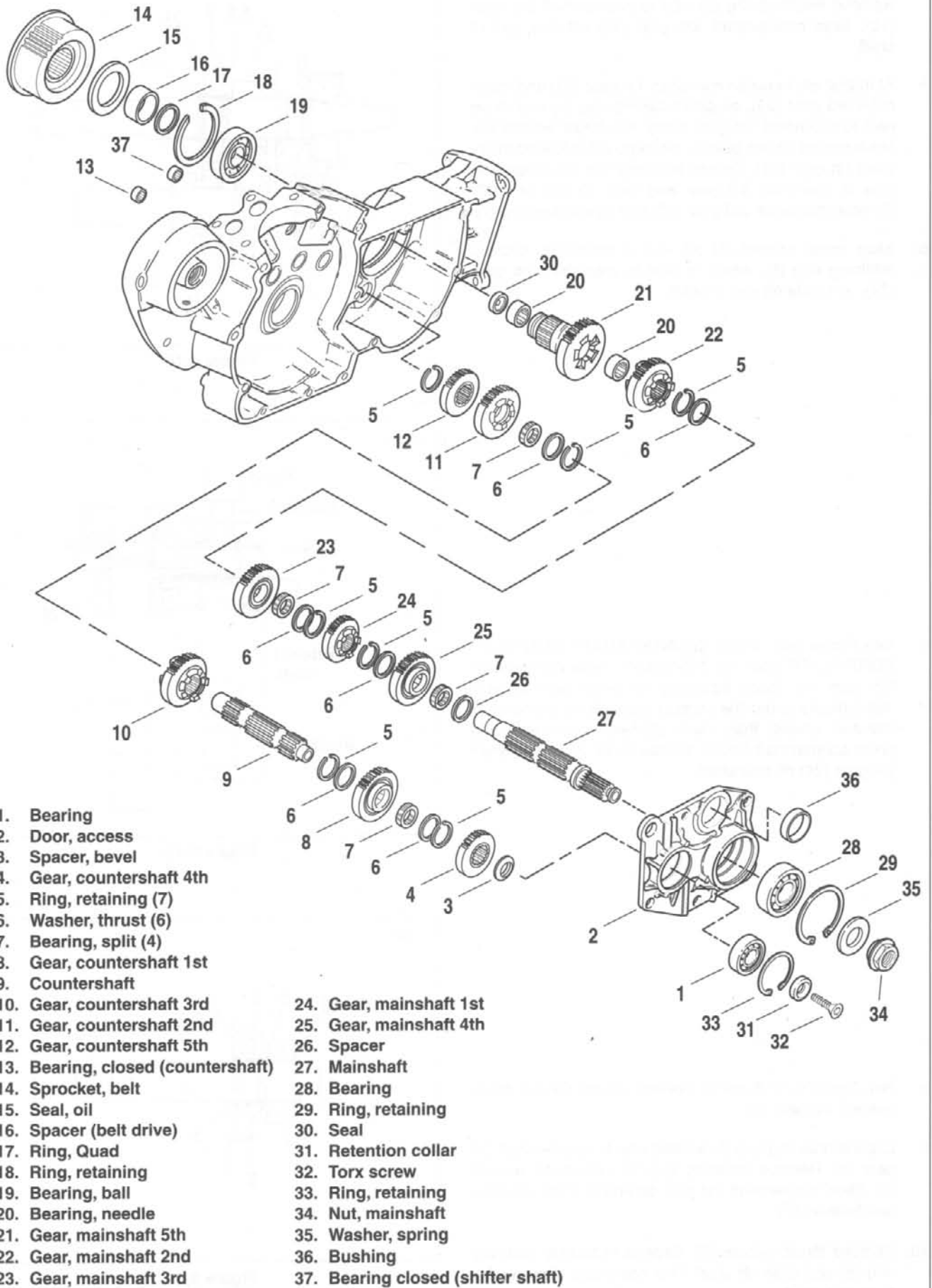


Figure 6-39. Transmission Assembly

4. Remove split bearing (7) that was under gear (11) and thrust washer (6) on the countershaft. See Figure 6-40. Remove retaining ring (5) next to countershaft 3rd gear (10). Slide countershaft 3rd gear (10) off free end of shaft.
5. At mainshaft, between mainshaft 1st gear (24) and mainshaft 3rd gear (23), expand retaining ring (5) and move next to mainshaft 1st gear along with thrust washer (6). Move mainshaft 3rd gear as far as possible toward mainshaft 1st gear (24). Expand retaining ring (5) at opposite side of mainshaft 3rd gear and slide off end of shaft. Remove mainshaft 3rd gear (23) and its split bearing (7).
6. Slide thrust washer (6) off end of mainshaft. Expand retaining ring (5), which is next to mainshaft 1st gear (24), and slide off end of shaft.

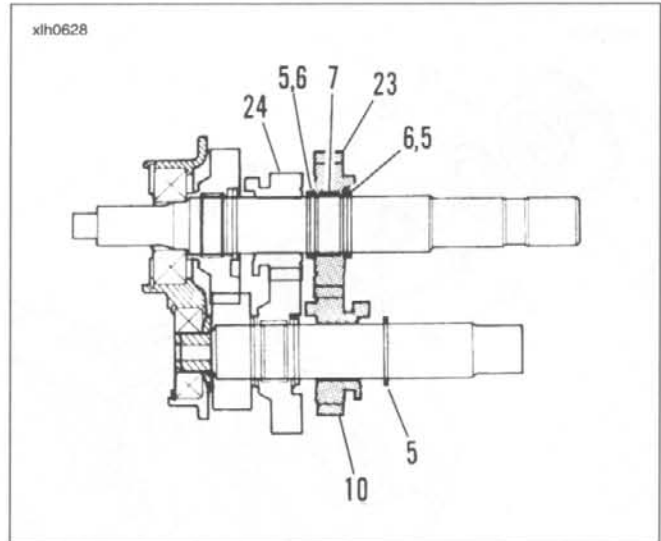


Figure 6-40.

7. See Figure 6-41. Place COUNTERSHAFT GEAR SUPPORT PLATE (Part No. HD-37404) under countershaft 4th gear (4). Place assembly on press with suitable metal blocks under the support plate. Place a socket or mandrel, smaller than inside diameter of bearing, and press countershaft free of access cover. Slide mainshaft 1st gear (24) off mainshaft.

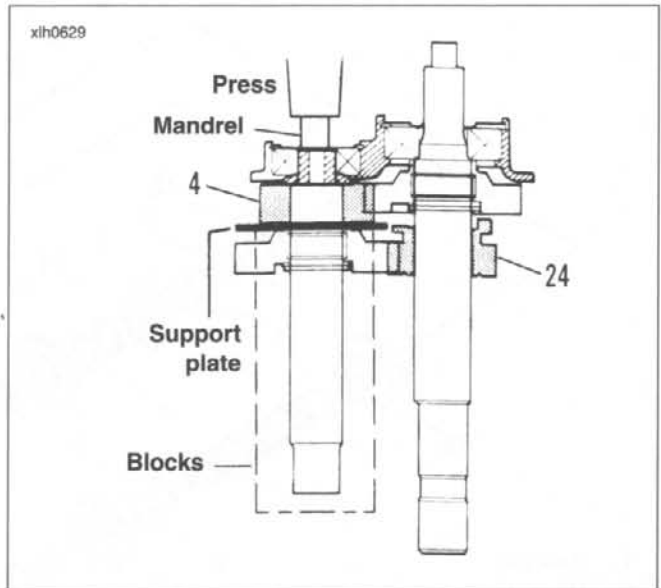


Figure 6-41.

8. See Figure 6-42. Remove beveled spacer (3) and countershaft 4th gear (4).
9. Expand retaining ring (5) located next to countershaft 1st gear (8). Remove retaining ring (5) and thrust washer (6). Slide countershaft 1st gear off end of shaft. Remove split bearing (7).
10. Remove thrust washer (6). Expand remaining retaining ring (5) and slide off shaft. This completes disassembly of countershaft.

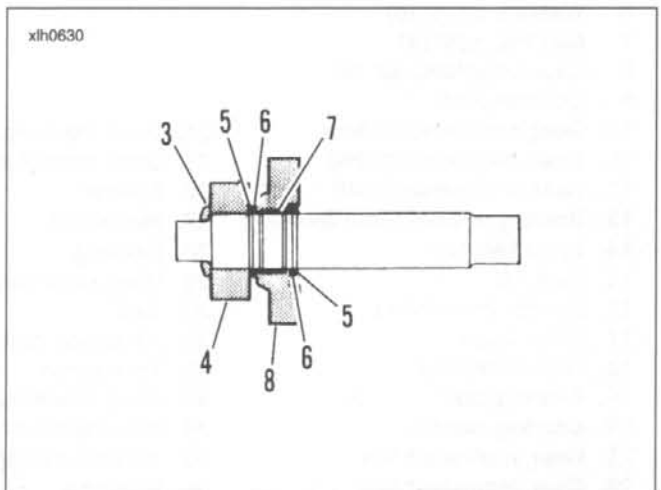


Figure 6-42.

11. See Figure 6-43. Place mainshaft and access door assembly on arbor press with support under mainshaft 4th gear (25). Press on end of shaft until mainshaft is free of access door bearing. Remove spacer (26), mainshaft 4th gear (25) and split bearing (7).
12. Remove thrust washer (6). Expand and remove remaining retaining ring (5).

CLEANING, INSPECTION AND REPAIR

1. Clean all parts (except bearings) in cleaning solvent and blow dry with compressed air.
2. Check gear teeth for damage. If gears are pitted, scored, rounded, cracked or chipped, they should be replaced.
3. Inspect the engaging dogs on the gears. Replace the gears if dogs are rounded, cracked, battered, chipped or dimpled.
4. Discard all retaining rings that were removed.

ASSEMBLY

CAUTION

During assembly, the split bearings (7) and the internal bores of the gears must be lubricated with SPORT-TRANS FLUID prior to assembly. Leaving these parts dry could accelerate wear at start-up and may result in vehicle damage.

1. Find a section of pipe that matches the inner race of mainshaft bearing (28). See Figure 6-44. Place the door assembly, outside downward, on a press with the inner race of bearing (28) resting on the section of pipe. Insert the splined end of the shaft through the bearing and hold in a vertical position. Press the shaft into the bearing until the bearing bottoms against the shaft shoulder.

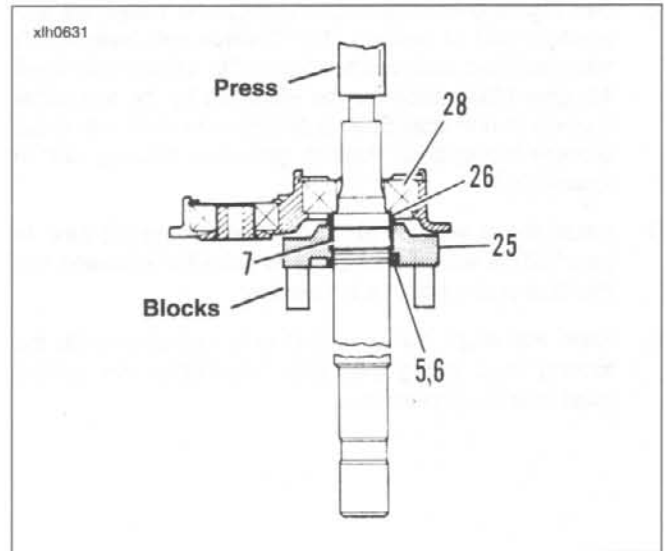


Figure 6-43.

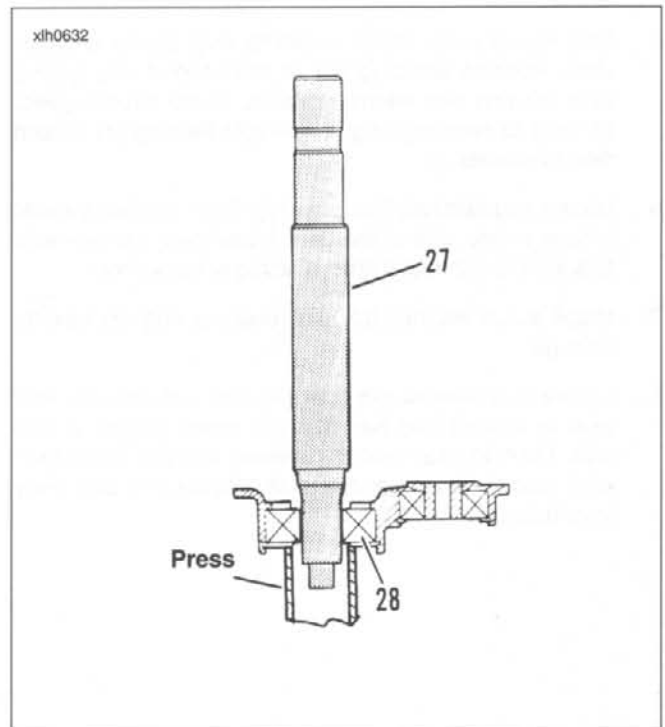


Figure 6-44.

2. See Figure 6-45. Place spacer (26) over mainshaft and position next to bearing (28). Position split bearing (7) into machined seat next to spacer (26). Locate mainshaft 4th gear (25), which can be identified by the two radial grooves at one side. Slide gear (25) onto shaft with radial grooves facing door. Position gear over bearing next to spacer (26).
3. Install thrust washer (6) and retaining ring (5) next to gear (25). It will be necessary to push the retaining ring into final position with a screwdriver.
4. Slide mainshaft 1st gear (24) onto mainshaft with the locking dogs facing gear (25). The shifter fork groove must face the access door.

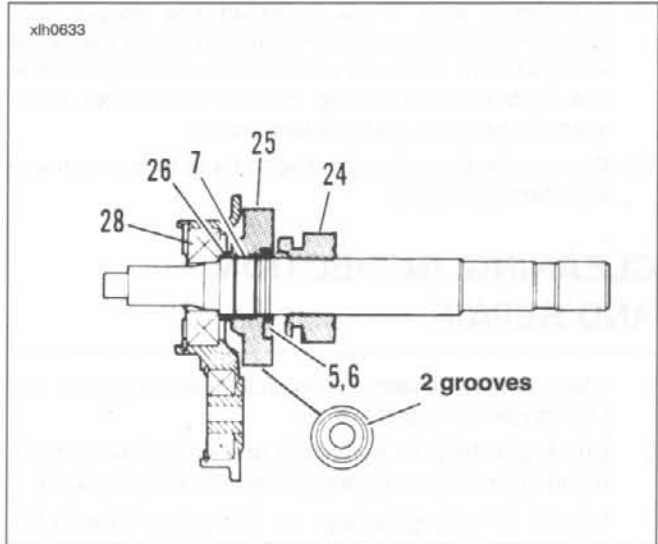


Figure 6-45.

5. See Figure 6-46. Install retaining ring (5) on countershaft. Position retaining ring in the second ring groove from the end with internal threads. Install thrust washer (6) next to retaining ring. Install split bearing (7) in seat next to washer (6).
6. Locate countershaft first gear (8). Gear (8) has a radial groove at one side of the gear. Install gear (8) over split bearing (7) with radial groove facing access door.
7. Install thrust washer (6) and retaining ring (5) next to gear (8).
8. Locate countershaft 4th gear (4). This flat, shoulderless gear is splined and has a single radial groove at one side. Position gear next to retaining ring (5). Place beveled washer (3) over end of shaft with beveled side away from gear (4).

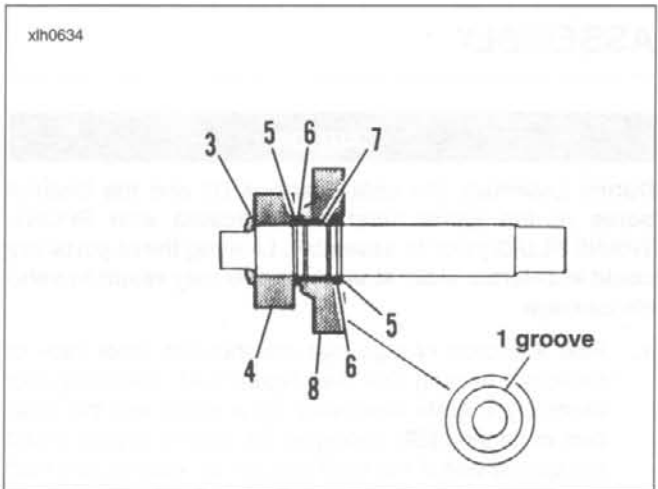


Figure 6-46.

9. See Figure 6-47. Stand countershaft assembly on press with beveled washer upward. Place access cover and mainshaft assembly on top of countershaft with bearing (1) in access cover over end of countershaft. Place a socket or section of pipe on inner race of bearing (1). Hold assembly straight, making sure gear teeth on countershaft are engaged with gear teeth on mainshaft, and press bearing onto shaft until beveled spacer bottoms against bearing.

NOTE

When correctly installed, countershaft 4th gear should have zero end play.

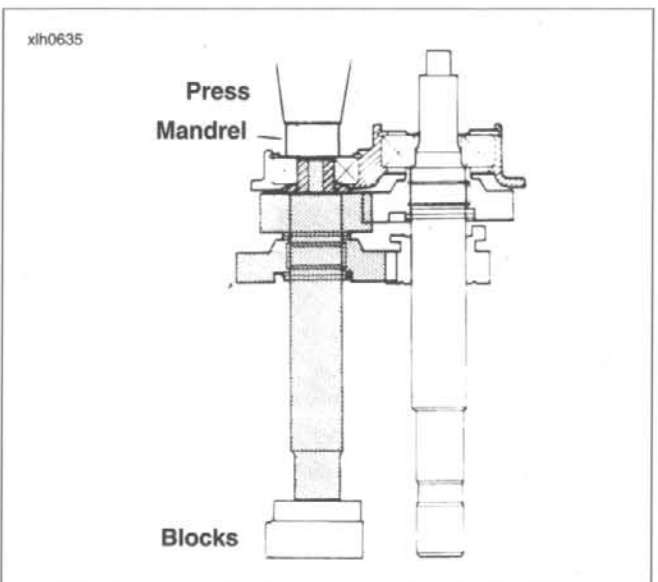


Figure 6-47.

10. See Figure 6-48. At mainshaft, install retaining ring (5) and thrust washer (6). Install split bearing (7) in seat next to thrust washer (6).
11. Install mainshaft 3rd gear (23) onto shaft over bearing (7).
12. Install thrust washer (6) and retaining ring (5) next to gear (23).
13. Install countershaft 3rd gear (10) onto shaft. The shifter fork groove must face away from the access door.

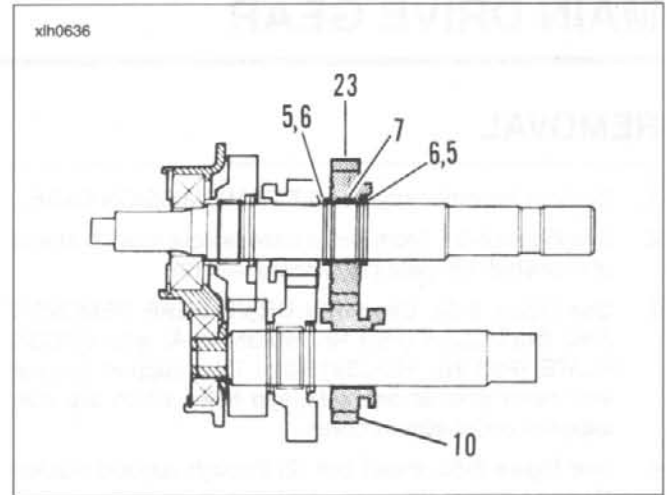


Figure 6-48.

14. See Figure 6-49. Install retaining ring (5) and thrust washer (6) on countershaft. Install split bearing (7) into seat next to thrust washer (6).
15. Install countershaft 2nd gear (11) over bearing (7).
16. Install mainshaft 2nd gear (22) onto shaft. The shifter fork groove must face the access door.
17. Install shouldered countershaft 5th gear (12). The single radial groove must face away from the access door.
18. Expand retaining ring (5) and slide into groove next to countershaft 5th gear (12).

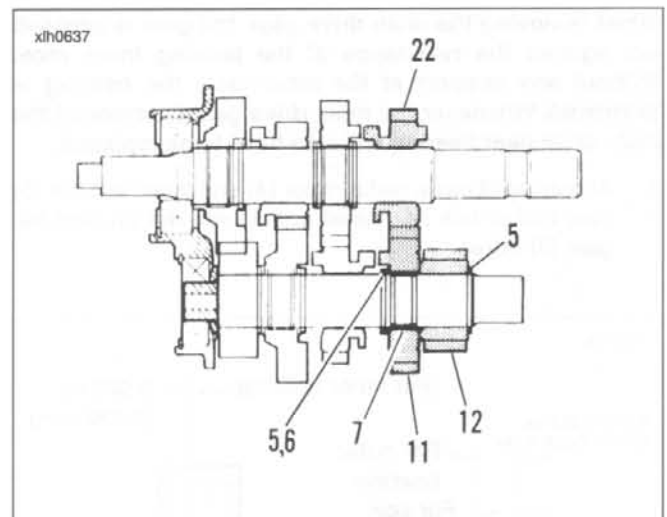


Figure 6-49.

19. See Figure 6-50. At outside of access door, position retention collar (31) next to end of countershaft with beveled side facing outward. Apply a few drops of LOCTITE THREADLOCKER 243 (blue) to the threads of TORX screw (32). Insert TORX screw (32) through retention collar and thread into end of shaft. Place transmission in gear and tighten TORX screw to 13-17 ft-lbs (17.6-23.0 Nm).

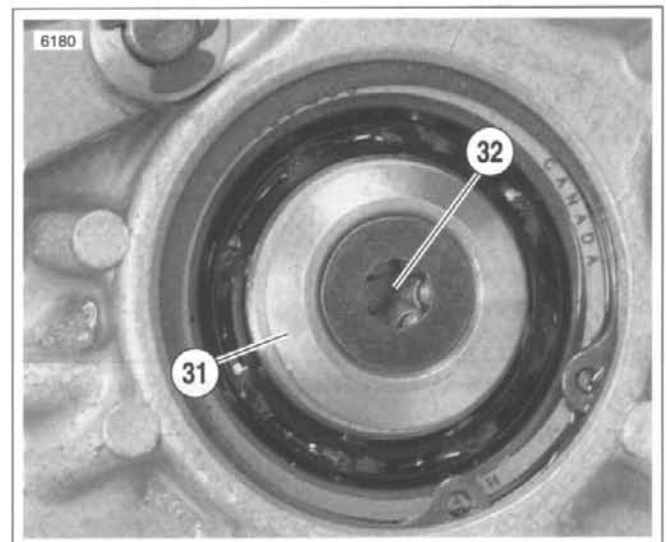


Figure 6-50.

20. Install shifter forks and drum. See 6.8 SHIFTER FORKS AND DRUM.

REMOVAL

1. Remove transmission. See 6.7 TRANSMISSION CASE.
2. See Figure 6-51. From inside case tap out seal (3) at end of mainshaft 5th gear (1). Discard seal (3).
3. See Figure 6-52. Use MAIN DRIVE GEAR REMOVER AND INSTALLER (Part No. HD-35316-A) with CROSS PLATE (Part No. HD-35316-91). Take support bracket and insert pins, at one side, into holes which are now exposed under access cover.
4. See Figure 6-53. Insert bolt (2) through support bracket (1) and 5th gear (3).

CAUTION

When removing the main drive gear, the gear is pressed out against the resistance of the bearing inner race. Without any support at the inner race, the bearing is destroyed. Whenever the main drive gear is removed the main drive gear bearing will also have to be replaced.

5. At outside of case, place driver (4) and thrust washer (5) over end of bolt (2). Install and tighten nut (6) until 5th gear (3) is free.

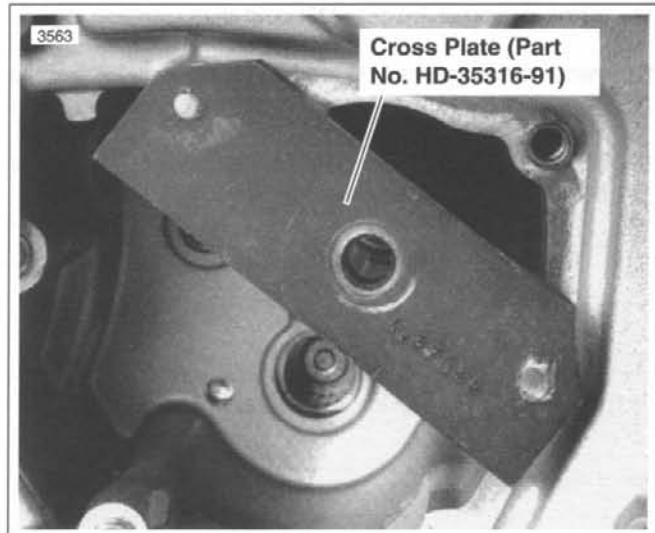


Figure 6-52. Support Bracket Mounting

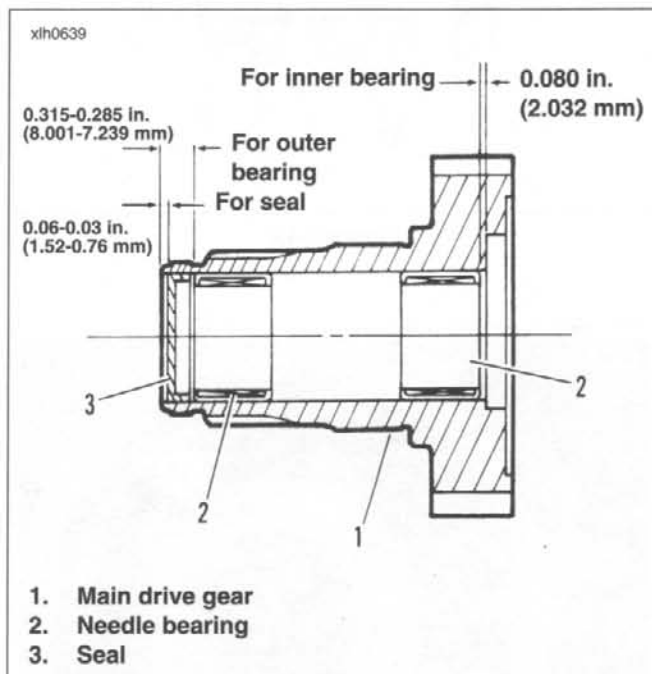


Figure 6-51. Main Drive Gear Assembly

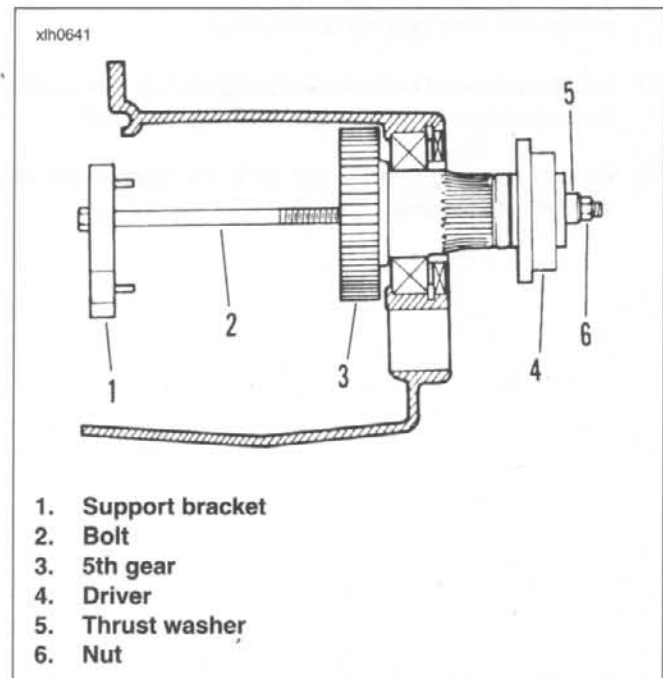


Figure 6-53. Removing Main Drive Gear

DISASSEMBLY

Drive out needle bearings from inside bore of main drive gear. Do not reuse bearings after removal.

ASSEMBLY

1. See Figure 6-54. Use INNER/OUTER MAIN DRIVE GEAR NEEDLE BEARING INSTALLATION TOOL (Part No. HD-37842A) for assembly. Select which end of tool to use.
 - a. The end stamped 0.080 in. (2.032 mm) is for driving the bearing into the inner end.
 - b. The end stamped 0.315 in. (8.001 mm) is for the outer end bearing.
2. Assemble parts. The installation tool will automatically bottom on the gear when the correct depth is reached.
 - a. Place main drive gear on a press.
 - b. Press in the outer bearing to a depth of 0.315-0.285 in. (8.001-7.239 mm).
 - c. Press in the inner bearing to a depth of 0.080 in. (2.032 mm).

INSTALLATION

1. Replace main drive gear bearing. See 6.10 MAIN DRIVE GEAR.
2. See Figure 6-55. Use MAIN DRIVE GEAR REMOVER AND INSTALLER TOOL for assembly.
 - a. Take bolt (2) and place washer (5) followed by main drive gear (4) over end of bolt.
 - b. From inside of case insert bolt and main drive gear through inner race of ball bearing.
 - c. Insert threaded end of bolt (2) through installer cup (3) and thrust washer (1).
 - d. Thread nut (6) onto end of bolt (2). Tighten nut (6) until shoulder on gear (4) bottoms against inner race of bearing.
3. See Figure 6-51. Tap in **new** seal (3) at threaded end of 5th gear.

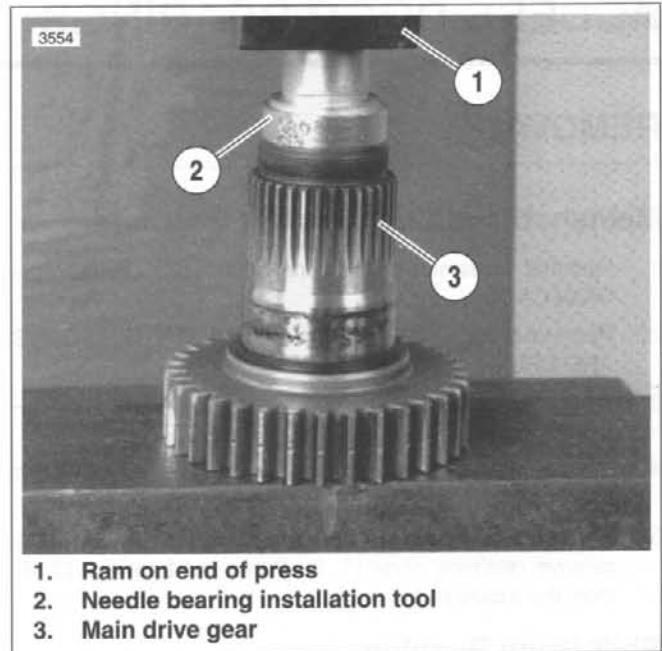


Figure 6-54. Needle Bearing Installation Tool

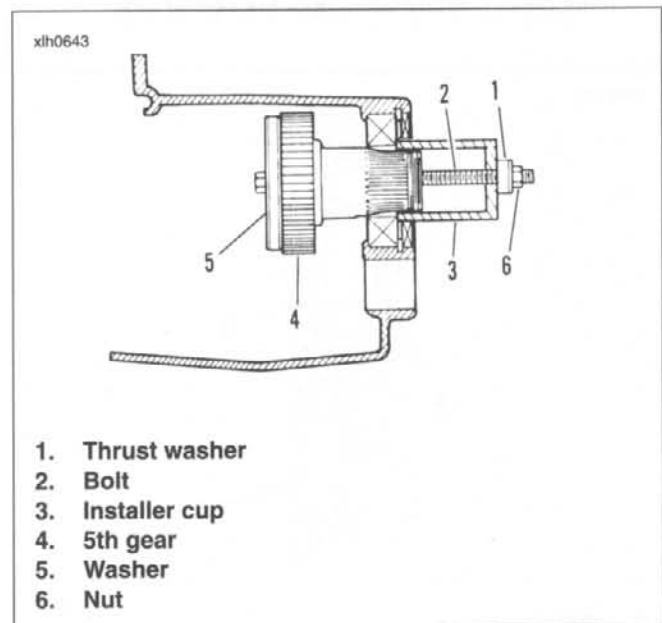


Figure 6-55. Main Drive Gear Installation

REMOVAL

Mainshaft and Countershaft Bearings

1. Remove transmission assembly. See 6.7 TRANSMISSION CASE.
2. Remove shifter forks and drum. See 6.8 SHIFTER FORKS AND DRUM.
3. Remove countershaft and mainshaft. See 6.9 MAINSHAFT AND COUNTERSHAFT.
4. Inspect the mainshaft and countershaft ball bearings for pitting, scoring, discoloration or other damage.
5. See Figure 6-56. If bearing replacement is required, remove retaining rings (1, 2). Press out bearings (3, 4) from the inside of the door.

Shift Drum Bushing

1. Inspect the shifter drum bushing for pitting, scoring, discoloration or excessive wear. If bushing requires replacement press bushing out of door from either side.

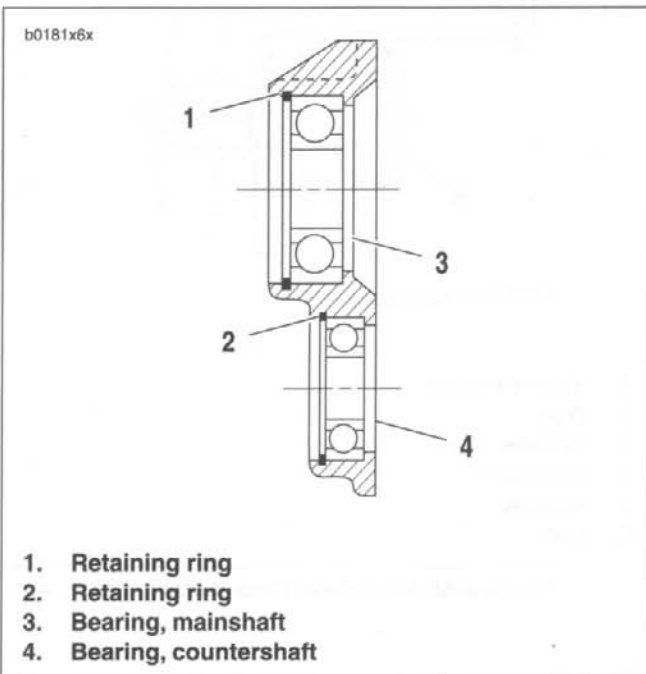


Figure 6-56. Ball Bearing Assembly

INSTALLATION

Mainshaft and Countershaft Bearings

1. Lay access door on press with inside surface of door downward.
2. Lay bearing squarely over bore with printed side of bearing upward. Place section of pipe or tubing (slightly smaller than outside diameter of bearing) against outer race. Press bearing into bore until bearing bottoms against shoulder.
3. Install **new** retaining ring with beveled side facing away from bearing.

Shift Drum Bushing

1. Lay access door on press with outside surface of door downward.
2. See Figure 6-57. Lay bushing squarely over bore. Locate socket or pipe that is slightly larger than diameter of bushing. Place socket or pipe on bushing and press into bore until bushing is flush with or 0.020 in. (0.508 mm) below inside surface. If using a pressing tool larger than diameter of bushing, the pressing tool will bottom against door when bushing is flush with top surface.

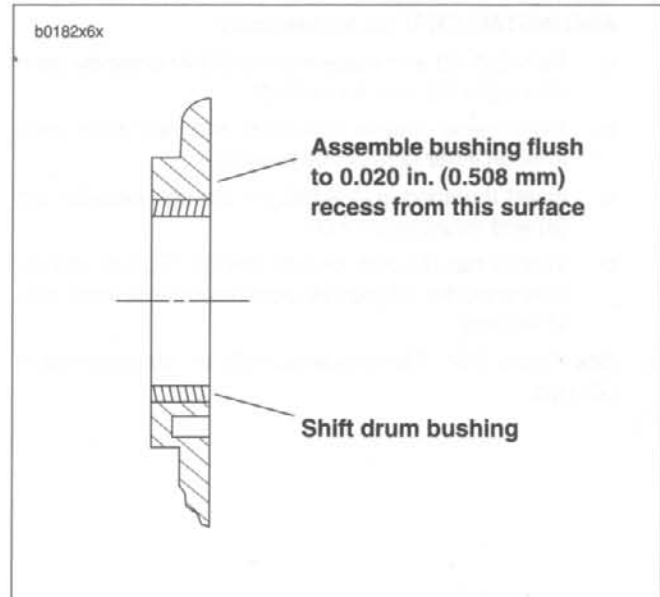


Figure 6-57. Shift Drum Bushing Assembly

REMOVAL

1. Remove transmission assembly. See 6.7 TRANSMISSION CASE. Remove main drive 5th gear. See 6.10 MAIN DRIVE GEAR.
2. At outside of case remove seal next to 5th gear bearing retainer. Remove retaining ring.
3. From inside transmission case drive bearings (5th gear, countershaft or shifter shaft) out of bores. Carefully tap bearings free by working around bearing diameter to keep bearing from skewing.

INSTALLATION

Mainshaft 5th Gear Ball Bearing

1. Locate MAIN DRIVE GEAR REMOVER AND INSTALLER (Part No. HD-35316-A). See Figure 6-58. Place support bracket pins in appropriate holes in transmission case.
2. See Figure 6-59. Insert bolt (2) through support bracket (1), **new** bearing (3), driver (4) and thrust bearing (5). Thread nut (6) on end of bolt. Tighten nut carefully until bearing is started in bore squarely. Tighten nut (6) until bearing is seated against shoulder in bore.
3. At outside of case install beveled retaining ring in groove inside bearing bore with beveled side facing outside of case.
4. Lubricate bearing with SPORT-TRANS FLUID.

Countershaft Needle Bearing

1. Find a suitable bearing driver 1-1/4 in. (31.75 mm) in diameter.
2. From the outside of the case place the needle bearing open end first next to the bearing bore. Hold the driver squarely against the closed end of the bearing and tap the bearing into place. The bearing is properly positioned when it is driven inward flush or 0.030 in. (0.762 mm) below the outside surface of the case.
3. Lubricate bearing with SPORT-TRANS FLUID.

Shift Drum Needle Bearing

1. Find a suitable bearing driver 13/16 in. (20.64 mm) in diameter.
2. From the outside of the case place the needle bearing, open end first, next to the bearing bore. Hold the driver squarely against the closed end of the bearing and tap the bearing into place. The bearing is properly positioned when driven inward flush or 0.030 in. (0.762 mm) below the outside surface.
3. Lubricate bearing with SPORT-TRANS FLUID.

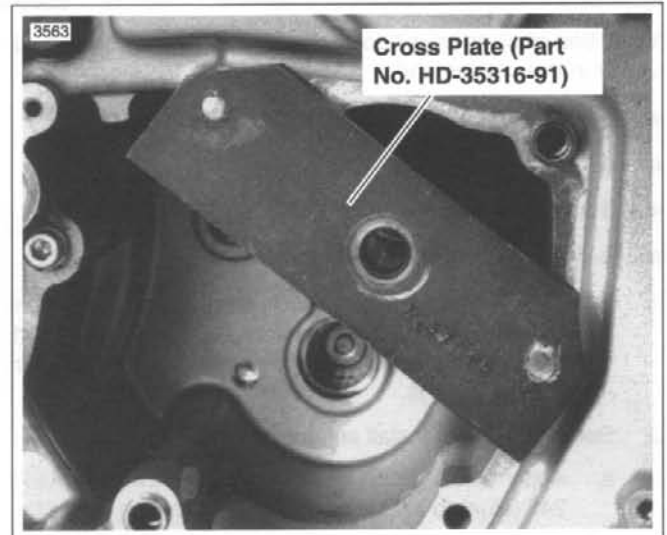


Figure 6-58. Cross Plate Mounting

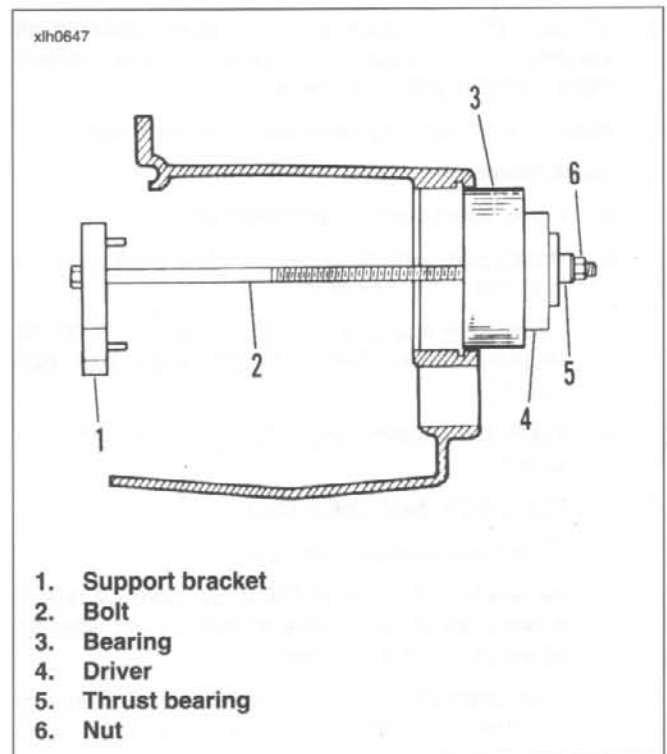


Figure 6-59. Installing Mainshaft Ball Bearing

TRANSMISSION INSTALLATION AND SHIFTER PAWL ADJUSTMENT

6.13

Verify that all parts have been properly installed, as described earlier in this section under:

- 6.12 RIGHT TRANSMISSION CASE BEARINGS
 - 6.10 MAIN DRIVE GEAR
 - 6.9 MAINSHAFT AND COUNTERSHAFT
 - 6.8 SHIFTER FORKS AND DRUM
1. Carefully insert transmission into case opening. Position the assembly so that the mainshaft enters fifth gear, and so that the countershaft and drum shifter shaft enter their respective bearings.
 2. See Figure 6-60. Install access door.
 - a. Apply a few drops of **LOCTITE THREADLOCKER 243** (blue) to all five access door mounting bolts (7).
 - b. Insert bolts through access door into tapped holes in right transmission case.
 - c. Tighten to 13-17 ft-lbs (17.6-23.0 Nm).
 3. Lift pawl (5) over drum pins and place shifter shaft assembly (6) on studs at transmission case. Loosely install a washer (10) and locknut (3) on each stud.
 4. Attach loop of spring (1) over and into groove in post (2).
 5. Install detent plate.
 - a. Place detent plate (8) over drum pins.
 - b. Rotate plate until blind holes in plate align with pins in end of shifter fork drum.
 - c. Install **new** retaining ring (9) using **SHIFT DRUM RETAINING RING INSTALLER** (Part No. HD-39151).
 - d. Verify that retaining ring is fully engaged with drum groove.
 6. See Figure 6-61. Align shifter shaft.
 - a. Place transmission in third gear.
 - b. Place a No. 32 drill bit (0.116 in. dia.) through hole in detent plate (3), and between pawl (2) and drive pin at end of shifter drum shaft.
 - c. Push down top of crank (4) to remove all clearance between pawl and drill bit; this will correctly align pawl to shift drum pins (do not push down with too great a force, as this might cause the shifter drum to rotate).
 - d. With bit in place, tighten shifter shaft assembly bottom locknut (1) first to 90-110 **in-lbs** (10.2-12.4 Nm). Then, tighten shifter shaft assembly top locknut (1) to the same torque.
 - e. **Remove drill bit.**
 7. See Figure 6-39. Place **new** quad ring (17) over threaded end of fifth gear (21), and position next to the gear taper. Install spacer (16) over threaded end of fifth gear with chamfered end toward quad ring. Slide spacer up against bearing (19).

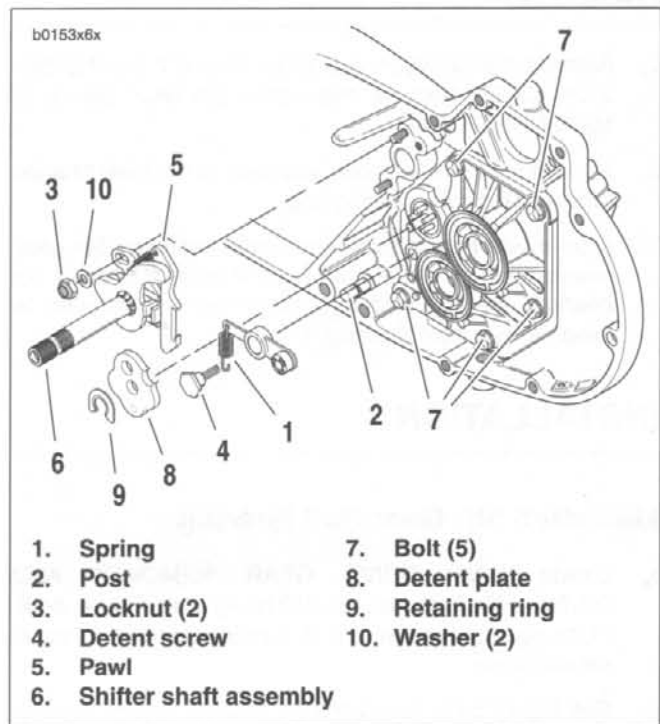


Figure 6-60. Installing Access Door

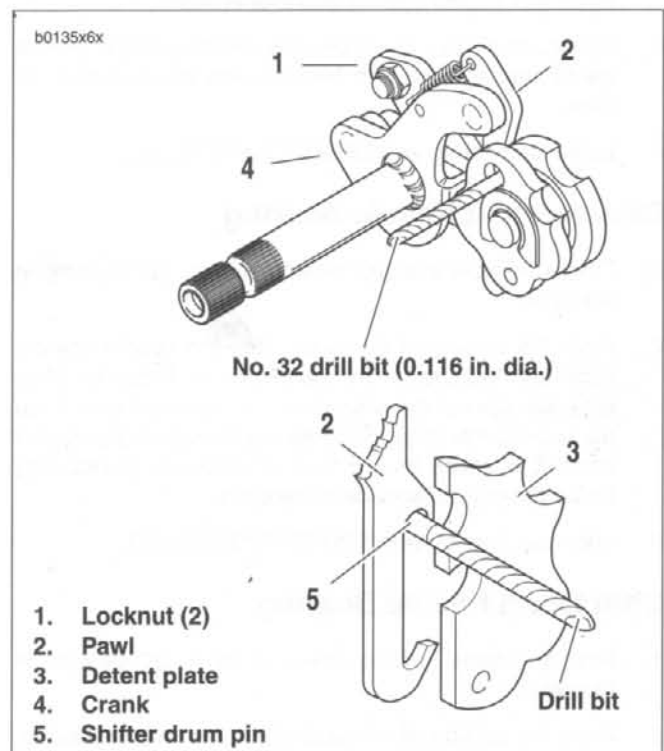


Figure 6-61. Shifter Shaft Assembly Alignment

8. Install seal.
 - a. Coat lips of seal (15) with SPORT-TRANS FLUID.
 - b. Position seal over spacer (16) with lips of seal toward case.
 - c. Gently tap seal into bore of case until the outside of seal is flush with outer edge of bore.

NOTE

It is acceptable to recess seal to about 0.030 in. (0.762 mm) below outer edge of bore. Seal recession will be limited by seal bottoming against retaining ring (18).

9. See Figure 6-62. Increase belt deflection by loosening rear axle and moving rear wheel forward. Install transmission sprocket (2) with secondary drive belt onto main drive gear shaft (1).
10. Place transmission in neutral.
11. Apply a few drops of LOCTITE THREADLOCKER 262 (red) to the **left-hand threads** of transmission sprocket nut (3). Position nut with washer-faced side facing transmission sprocket. Turn the nut **counterclockwise** to install it onto main drive gear shaft.
 - a. See Figure 6-63. Install SPROCKET HOLDING TOOL (1) (Part No. HD-41321) as shown. Use MAINSHAFT LOCKNUT WRENCH (2) (Part No. HD-94660-37B) and a torque wrench to tighten sprocket nut to 50 ft-lbs (67.8 Nm) INITIAL TORQUE ONLY.
 - b. See Figure 6-64. Scribe a line on the transmission sprocket nut and continue the line on the transmission sprocket as shown.
 - c. Tighten the transmission sprocket nut an additional 30°-40°.
 - d. See Figure 6-62. Install lockplate (4) over nut (3) so that two of lockplate's four drilled holes (diagonally opposite) align with sprocket's (2) two tapped holes.

NOTE

The lockplate has four screw holes and can be turned to either side, so you should be able to find a position without having to additionally tighten the nut. If you cannot align the screw holes properly, the nut may be additionally TIGHTENED until the screw holes line up, but do not exceed 45° as specified above. Never LOOSEN nut to align the screw holes.

- e. See Figure 6-64. If lockplate will not align with holes, tighten nut to 45° maximum.

CAUTION

Maximum allowable tightening of sprocket nut is 45° of counterclockwise rotation, after initially tightening to 50 ft-lbs. Do not loosen sprocket nut while attempting to align the screw holes. If you cannot align lockplate and sprocket screw holes, nut may be additionally tightened 45° as specified above. Tightening too much or too little may cause the nut to come loose during vehicle operation which may result in vehicle damage.

12. If you cannot align lockplate and sprocket screw holes, nut may be additionally tightened until screw holes align.

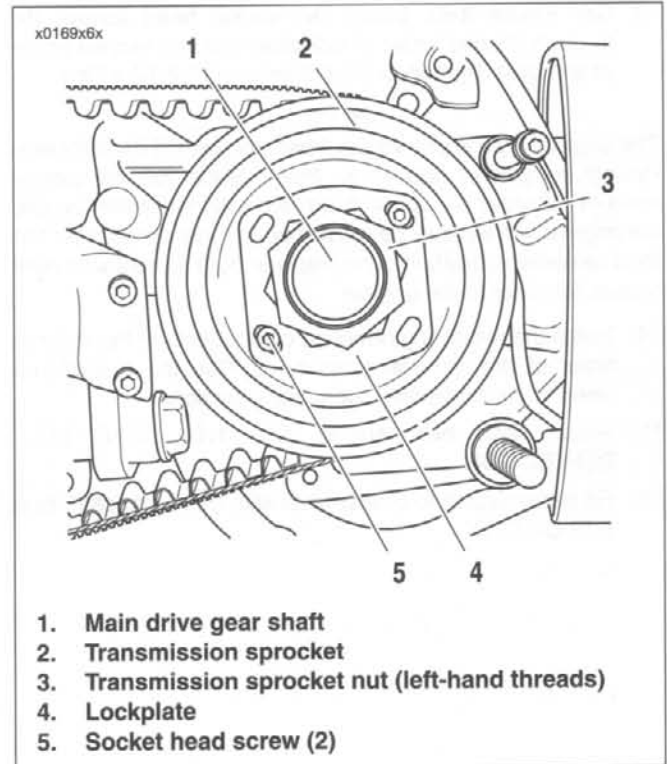


Figure 6-62. Transmission Sprocket

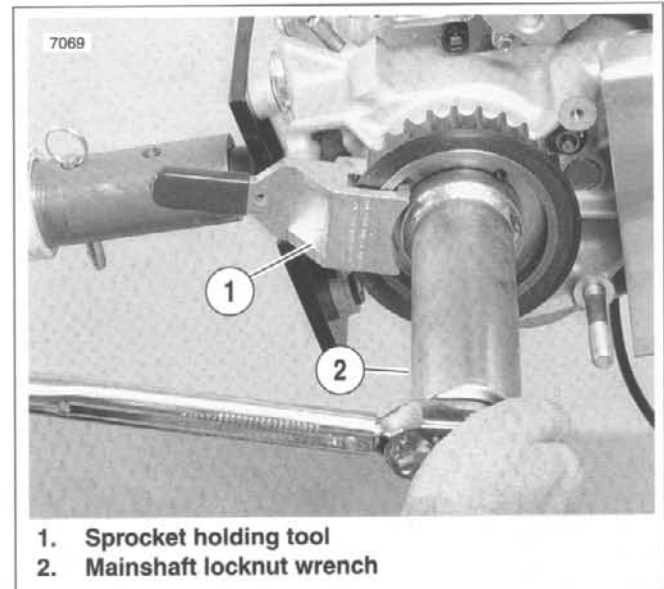


Figure 6-63. Transmission Sprocket Tightening

13. See Figure 6-62. Install two socket head screws (5) through aligned holes of lockplate and into tapped holes of sprocket. Tighten to 90-110 in-lbs (10.2-12.4 Nm).

NOTE

The original equipment socket head screws (5) have thread-locking compound applied to them. Since this compound remains effective for about three removal/installation cycles, the original screws may be reused up to three times. After the third removal/installation cycle, replace both screws with **new** screws identical to the original.

14. Install the remaining removed components in the reverse order of the removal procedures. See the procedures listed in the respective component sections.
15. Adjust drive belt tension. See 1.13 REAR BELT DEFLECTION.
16. Fill transmission to proper level with fresh lubricant. See 1.12 CLUTCH.

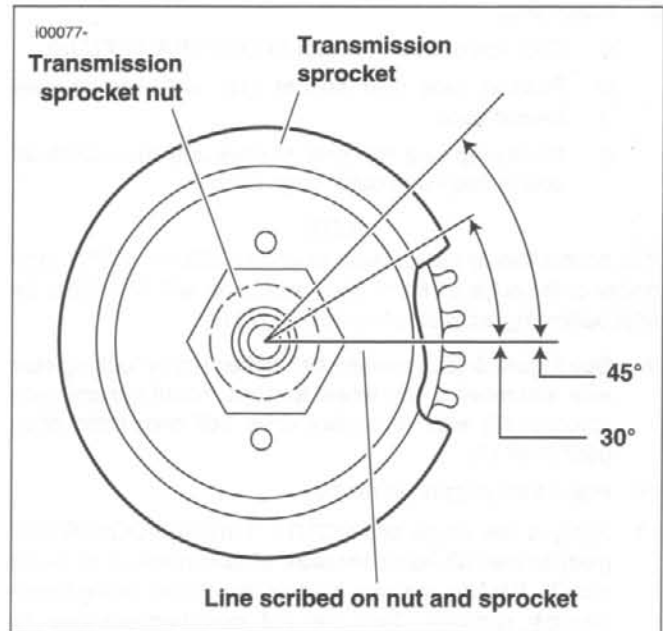


Figure 6-64. Aligning Transmission Sprocket

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SPECIFICATIONS

7.1

BATTERY	
Size	12 VDC
Type	Sealed

REGULATOR	
Voltage output @ 75°F	13.8-15 VDC
Amperes @ 3600 RPM	22 Amps

SPARK PLUGS		
Size	12 mm	
Style	6R12	
Gap	0.038-0.043 in.	0.97-1.09 mm
Torque value	11-18 ft-lbs	14.9-24.4 Nm

IGNITION COIL RESISTANCE	
Primary winding	0.5-0.7 ohms
Secondary winding	5500-7500 ohms

ALTERNATOR	
AC voltage output	19-26 VAC per 1000 engine RPM
Stator coil resistance	0.2-0.4 Ohms

ELECTRICAL SYSTEM	AMPERES
Main circuit breaker	30
Ignition fuse	20
Light fuse	15
Accessory fuse	15
Instrument fuse	15
Odometer fuse	15

BULB CHART		BULBS REQUIRED	WATTS	AMPS	PART NUMBER
Headlamp	High/low replaceable bulb	1	60/55	5.0/4.58	67969-96Y
	Position lamp (European models only)	1	4	0.33	67968-96Y
Marker lamps	Tail/stop lamp	1	5/21	0.42/1.75	68075-94Y
	Turn signal lamp, front and rear (1 bulb each)	4	2.0	0.17	68968-99Y
Indicator lamps on instrument support	High beam indicator	1	2.1	0.15	68024-94
	Turn signal indicator	2	2.1	0.15	68024-94
	Oil pressure indicator	1	2.1	0.15	68024-94
	Neutral indicator	1	2.1	0.15	68024-94
Instruments	Speedometer illumination	1	1.7	0.14	67421-99Y
	Tachometer illumination	1	1.7	0.14	68073-99Y
	Low fuel lamp (tachometer)	1	1.7	0.14	68073-99Y
	Check engine lamp (tachometer)	1	1.7	0.14	68073-99Y

TORQUE VALUES

ITEM	TORQUE		NOTES
Battery cable bolts (1999 Models)	40 in-lbs	4.5 Nm	metric, page 7-26
Battery terminal bolts (2000 Models)	60-96 in-lbs	6.8-10.9 Nm	page 7-32
Dash panel screw	4-5 ft-lbs	5.4-6.8 Nm	page 7-45, page 7-47
Headlamp adjusting screws	6-8 ft-lbs	8.1-10.8 Nm	metric, page 7-35
Neutral indicator switch	3-5 ft-lbs	4.0-6.8 Nm	LOCTITE THREADLOCKER 243 (blue), page 7-56
Rotor mounting bolts	90-110 in-lbs	10.2-10.4 Nm	LOCTITE THREADLOCKER 243 (blue), page 7-22
Spark plugs	11-18 ft-lbs	14.9-24.4 Nm	page 7-1
Stator mounting screws	30-40 in-lbs	3.4-3.5 Nm	T-27 TORX with retaining compound, replace after removal, page 7-22
Switchgear housing screws, left side	25-33 in-lbs	2.8-3.7 Nm	page 7-41
Switchgear housing screws, right side	12-17 in-lbs	1.4-1.9 Nm	page 7-41
Turn signal screws, front	25-28 in-lbs	2.8-3.2 Nm	page 7-37
Turn signal screws, rear	96-120 in-lbs	10.8-13.6 Nm	page 7-38

GENERAL

The vehicle uses a breakerless inductive-discharge ignition system. The system has both a primary and secondary circuit. The primary circuit consists of the battery, ignition switch, primary coil windings, computerized ignition timer and associated wiring. The secondary circuit consists of the secondary coil, spark plugs and associated wiring. See Figure 7-1.

The scan tool can access the information received by and stored in the electronic control module.

The electronic control module (ECM) attaches to the vehicle frame next to the fuse block. The module has three primary functions. First, it computes the spark advance for proper ignition timing based on sensor input. Second, it controls the independent, primary windings of the spark coil and is thus able to provide sequential and independent firing of the spark plugs (non waste spark). Third, it calculates the correct air/fuel ratio based on input from the sensors.

The electronic control module contains all the solid-state components used in the ignition system. The dwell time for the ignition coil is also calculated by the ECM microprocessor and is dependent upon battery voltage. The programmed dwell is an added feature to keep battery drain to a minimum and to adequately charge the coil at all speeds. The ECM has added protection against transient voltages, continuous reverse voltage protection and damage due to jump starts. The ECM is fully enclosed to protect it from vibration, dust, water and oil. The module is not repairable. Replace the unit if it fails.

The ECM uses six different sensors to monitor rider demands and changing engine conditions. These sensors are:

- Throttle Position (TP) Sensor
- Cam Position (CMP) Sensor
- Intake Air Temperature (IAT) Sensor
- Engine Temperature (ET) Sensor
- Oxygen (O₂) Sensor
- Bank Angle Sensor (BAS)

The ECM uses the information provided by the TP and CMP sensors to calculate how much air is entering the engine. The TP Sensor monitors the amount of air entering the engine by how far the throttle is open, whether it is opening or closing and how fast it is opening or closing. The IAT sensor measures the temperature of the air entering the engine, providing the rest of the information necessary to determine the density of the air entering the engine. The ECM also monitors the CMP sensor to determine the exact position of both cylinders in the combustion cycle and the engine speed.

The ET sensor provides the ECM the current engine temperature. Proper fuel and spark delivery are dependent on the temperature of the engine. The ECM will provide a richer fuel mixture on start up and a higher degree of spark advance. As the vehicle warms up to operating temperature the fuel mixture will lean and the spark advance will decrease.

The information provided by the O₂ sensor allows the ECM to ensure a proper air/fuel mixture by monitoring the final combustion efficiency in the exhaust system. This ensures optimum engine performance at any altitude or barometric pressure. The O₂ sensor input to the ECM is required to ensure a stoichiometric (14.6:1) air/fuel ratio during closed loop operation.

The Bank Angle Sensor (BAS) provides input to the ECM on whether the vehicle lean is greater than 55 degrees. As long as lean angle does not exceed 55 degrees fuel supply and ignition operation are unaffected. If the vehicle exceeds a 55 degree lean angle, the BAS will interrupt the operation of the ignition system and fuel supply.

The ECM-controlled ignition coil fires each spark plug independently on the compression stroke of each cylinder (no waste spark). The spark plug in the front cylinder fires at the end of that cylinder's compression stroke, thereby igniting the air/fuel mixture. The same sequence occurs at the end of the rear cylinder's compression stroke (thereby igniting the air/fuel mixture in the rear cylinder).

The rotor and cam position sensor are located in the gearcase cover on the right side of the motorcycle. The Cam position sensor consists of a Hall-effect device, magnet and plate. The plate is mounted over a rotating cup ("rotor cup"). The rotor cup is mounted on the camshaft and operates at one-half crankshaft speed. As the rotor cup turns inside the gearcase, six asymmetrical teeth on the rotor cup sequentially break the magnetic field between the magnet and the Hall-effect device. The edges of these teeth are cut to correspond to specific positions of the camshaft during the engine cycle such as TDC for the front cylinder. The output of the CMP sensor is used by the ECM to not only determine engine position, but also to calculate engine speed. This method of measuring camshaft position provides accurate information on engine position down to zero engine speed.

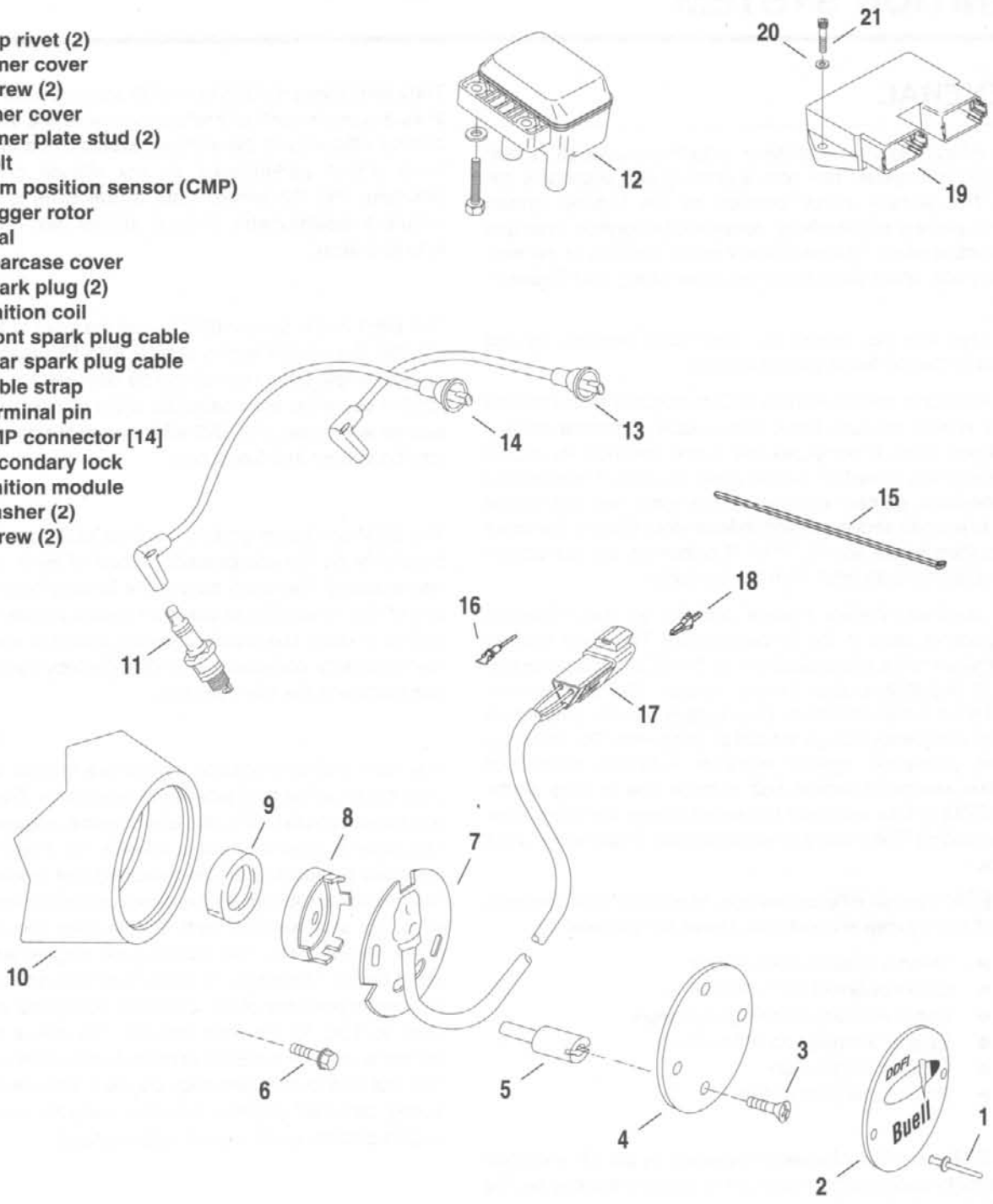
For more information on the sensors used in conjunction with the ECM see Section 4 Fuel System.

See the wiring diagrams at the end of this section for additional information on ignition system circuits.

TROUBLESHOOTING

See Section 4 Fuel System for troubleshooting information.

1. Pop rivet (2)
2. Timer cover
3. Screw (2)
4. Inner cover
5. Timer plate stud (2)
6. Bolt
7. Cam position sensor (CMP)
8. Trigger rotor
9. Seal
10. Gearcase cover
11. Spark plug (2)
12. Ignition coil
13. Front spark plug cable
14. Rear spark plug cable
15. Cable strap
16. Terminal pin
17. CMP connector [14]
18. Secondary lock
19. Ignition module
20. Washer (2)
21. Screw (2)



b0764x7x

Figure 7-1. Ignition System Components

GENERAL

⚠ WARNING

DO NOT modify the ignition/headlamp switch wiring to circumvent the automatic-on headlamp feature. Visibility is a major concern for motorcyclists. Failure to have proper headlamp operation could result in death or serious injury.

See Figure 7-2. The three-position combination ignition/headlamp key switch is not repairable. Replace the unit if it fails.

Switch positions are explained in Table 7-1.

CAUTION

When turning off the ignition, verify that the key is removed in the OFF position and that the lights are not left on. If the rider stops the engine and inadvertently removes the key in the P position, the battery will be drained of its charge if the vehicle is left standing too long.

NOTE

The key locks the ignition system and is removable in both the LOCK and P positions. The P position is located between the OFF and IGNITION positions and allows the rider to remove the key while leaving the lights on. When the key is placed in the P position, several indicator markers are or can be activated. See Table 7-2.

REMOVAL

⚠ WARNING

To avoid accidental start-up of vehicle and possible personal injury, disconnect the battery cables before proceeding. Always disconnect the negative cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion which could result in death or serious injury

1. Disconnect battery cables, negative cable first.
2. Remove four screws and washers to detach windscreen from mounting brackets.
3. Disconnect ignition key switch connector [33] from main wiring harness.
4. See Figure 7-2. Remove ignition switch face nut (2). Remove ignition switch (1) from behind dash panel.

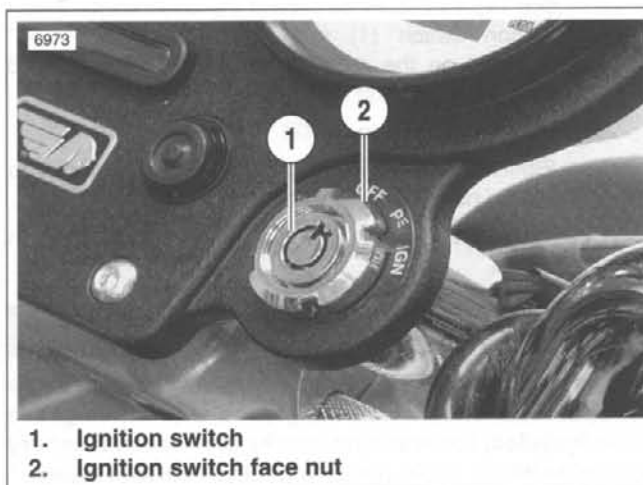


Figure 7-2. Ignition/Headlamp Key Switch

Table 7-1. Ignition Key Switch Positions

LABEL	NAME	IGN.	LAMPS	REMOVE KEY
OFF	locked	off	off	yes
P	markers	off	See note & Table 7-2.	yes
IGN	ignition	on		no

Table 7-2. Indicator Markers

ITEM	P	IGN
Headlamp position marker (European models only)	on	on
Headlamp high/low beam	off	on
Speedometer illumination lamp	on	on
Stop lamp	can be activated	
Front and rear turn signals	can be activated	
Horn	can be activated	

INSTALLATION

1. Install ignition key switch.
 - a. See Figure 7-2. From behind the dash panel, insert ignition switch (1) into hole. The word "TOP" stamped on the switch body should face upward toward the lettering on the switch position decal.
 - b. Loosely install face nut (2).
2. See Figure 7-3. Attach ignition key switch connector to main wiring harness.
3. See Figure 7-2. Tighten face nut to secure switch within dash panel.

WARNING

Always connect the positive battery cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion which could result in death or serious injury.

4. Install battery cables, positive cable first.

WARNING

Check for proper headlamp operation before riding motorcycle. Visibility is a major concern for motorcyclists. Failure to have proper headlamp operation could result in death or serious injury.

5. Check ignition key switch for proper operation. If operation fails, reread procedure and verify that all steps were performed.
6. Install four screws and washers to attach windscreen to mounting brackets.

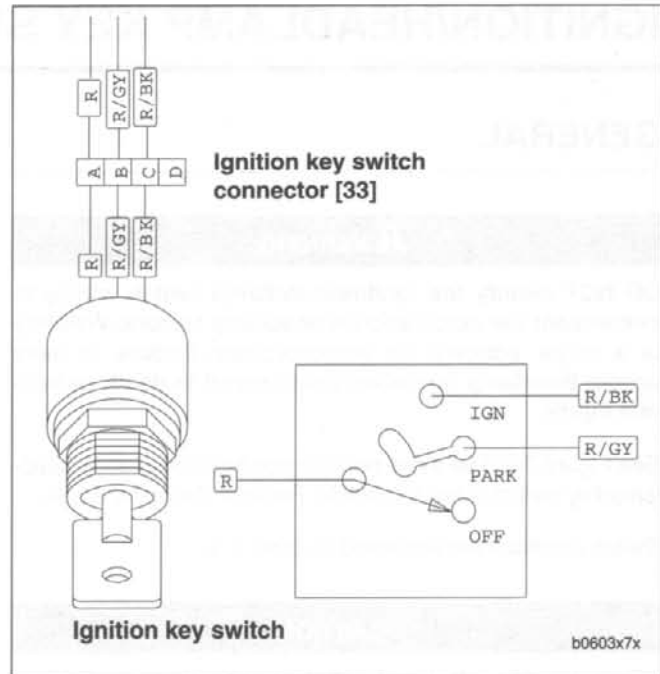


Figure 7-3. Ignition Key Switch Wiring

GENERAL

Resistor-type high-tension spark plug cables have a carbon-impregnated fabric core, instead of solid wire, for radio noise suppression and improved reliability of electronic components. Use the exact replacement cable for best results.

REMOVAL

WARNING

Never disconnect a spark plug cable with the engine running. If you disconnect a spark plug cable with the engine running, you may receive a potentially fatal electric shock from the ignition system which could result in death or serious injury.

CAUTION

When disconnecting each spark plug cable from its spark plug terminal, always grasp and pull on the rubber boot at the end of the cable assembly (as close as possible to the spark plug terminal). Do not pull on the cable portion itself. Pulling on the cable will damage the cable's carbon core.

Disconnect spark plug cables from ignition coil and spark plug terminals. Inspect all removed cables for damage.

INSPECTION

1. Inspect spark plug cables. Replace cables that are worn or damaged.
 - a. Check for cracks or loose terminals.
 - b. Check for loose fit on ignition coil and spark plugs.
2. Check cable boots/caps for cracks or tears. Replace boots/caps that are worn or damaged.
3. See Figure 7-4. Check spark plug cable resistance with an ohmmeter. Replace cables not meeting resistance specifications.
 - a. 4750-11,230 ohms for 19.0 in. (483 mm) cable.
 - b. 1812-4375 ohms for 7.25 in. (184 mm) cable.

INSTALLATION

Connect spark plug cables to ignition coil and spark plugs. Fasten boots/caps securely. Tight connections provide the necessary moisture-proof environment for the ignition coil and spark plug terminals.

NOTE

See 1.20 SPARK PLUGS for spark plug information.

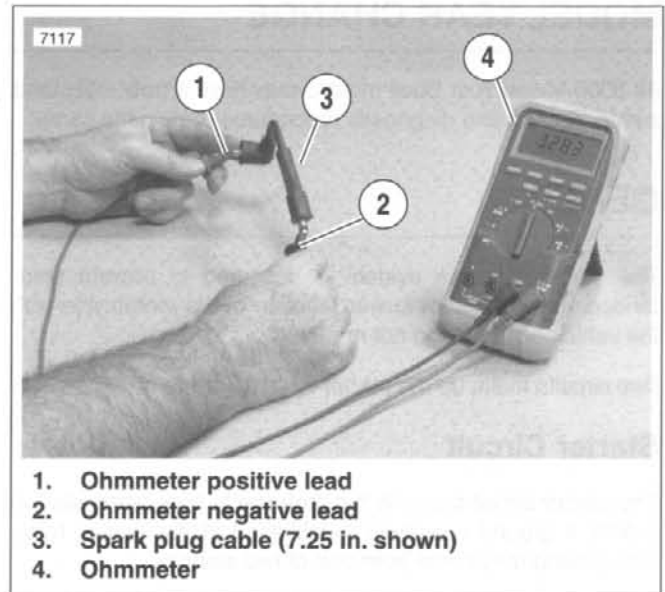


Figure 7-4. Testing Resistance

MODEL YEAR CHANGE

All 2000 Model Year Buell motorcycles have a **new** sidestand switch. Testing and diagnostic procedures remain the same.

GENERAL

The starter interlock system is designed to prevent unintended start-up and/or forward motion of the motorcycle with the vehicle's side stand not retracted.

Two circuits make up the starter interlock system.

Starter Circuit

The starter circuit prevents the motorcycle from being started unless a ground has been established at the starter relay. This ground may come from one of two sources.

- By placing the motorcycle in neutral and grounding through the neutral switch.
- By disengaging the clutch and grounding through the clutch lever switch.

Once the starter circuit is grounded and the starter button pushed, the starter relay can be energized. The energized relay then permits the starter motor to crank the engine.

Ignition Circuit

The ignition circuit prevents the motorcycle from operating unless a ground is established at the ignition relay. If this ground is not established, the ignition system will be not turned on and the motorcycle will not run. Grounds may be established three ways.

- By retracting the side stand and grounding through the side stand switch.
- By placing the motorcycle in neutral and grounding through the neutral switch.
- By disengaging the clutch and grounding through the clutch lever switch.

Note that the ignition circuit allows operation in gear with the side stand extended if the clutch is disengaged. However, if the motorcycle is in gear with the side stand extended, and the clutch is released, the ignition ground is lost and the ignition system is turned off. This system will prevent vehicle operation if forward motion is attempted with the side stand down.

See Figure 7-8.

Table 7-3. Starter Interlock Troubleshooting

PROBLEM	CHECK FOR	CORRECTION
Electric starter will not crank.	Battery problems.	See 7.9 BATTERY (1999 MODELS).
	Inappropriate gear selected.	Place vehicle in neutral.
	Clutch lever not disengaged.	Pull in clutch lever.
	Starter relay problems.	
Follow starter troubleshooting in Section 5.		
Electric starter cranks, but vehicle will not start.	Side stand not retracted.	Retract side stand.
Motorcycle will not start with side stand retracted.	Clutch lever not disengaged.	Pull in clutch lever.
Motorcycle will not start with side stand retracted or clutch disengaged.	Ignition relay problems.	Listen for relay "click". If click is not heard, perform ignition system tests.
Motorcycle will not start after starter relay tests.	No spark at spark plug.	Check for 12 VDC at coil W/BK wire.
		Follow ignition system troubleshooting.

DIAGNOSTICS

The reference numbers below correlate with the circled numbers in the 7.5 STARTER INTERLOCK flow charts.

1. Check diode with an ohmmeter as shown in Figure 7-5.
2. Check diode polarity as shown in Figure 7-6.

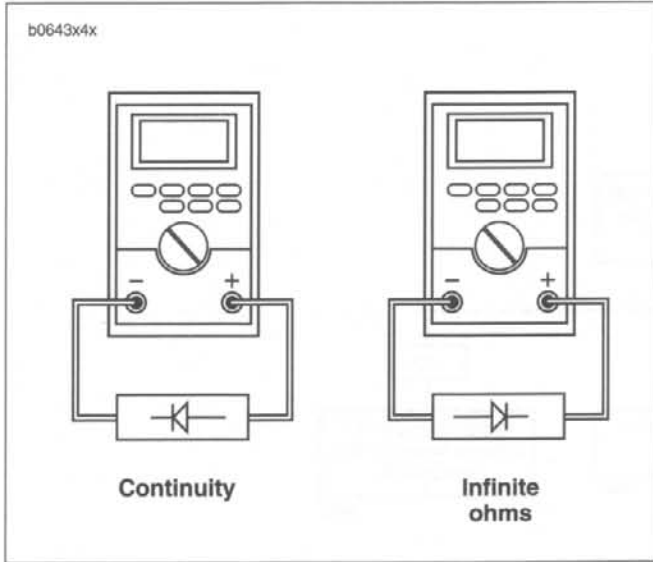


Figure 7-5. Ohmmeter Diode Test

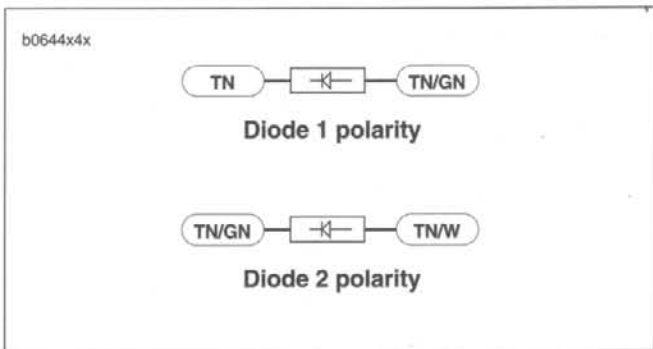


Figure 7-6. Diode Polarity

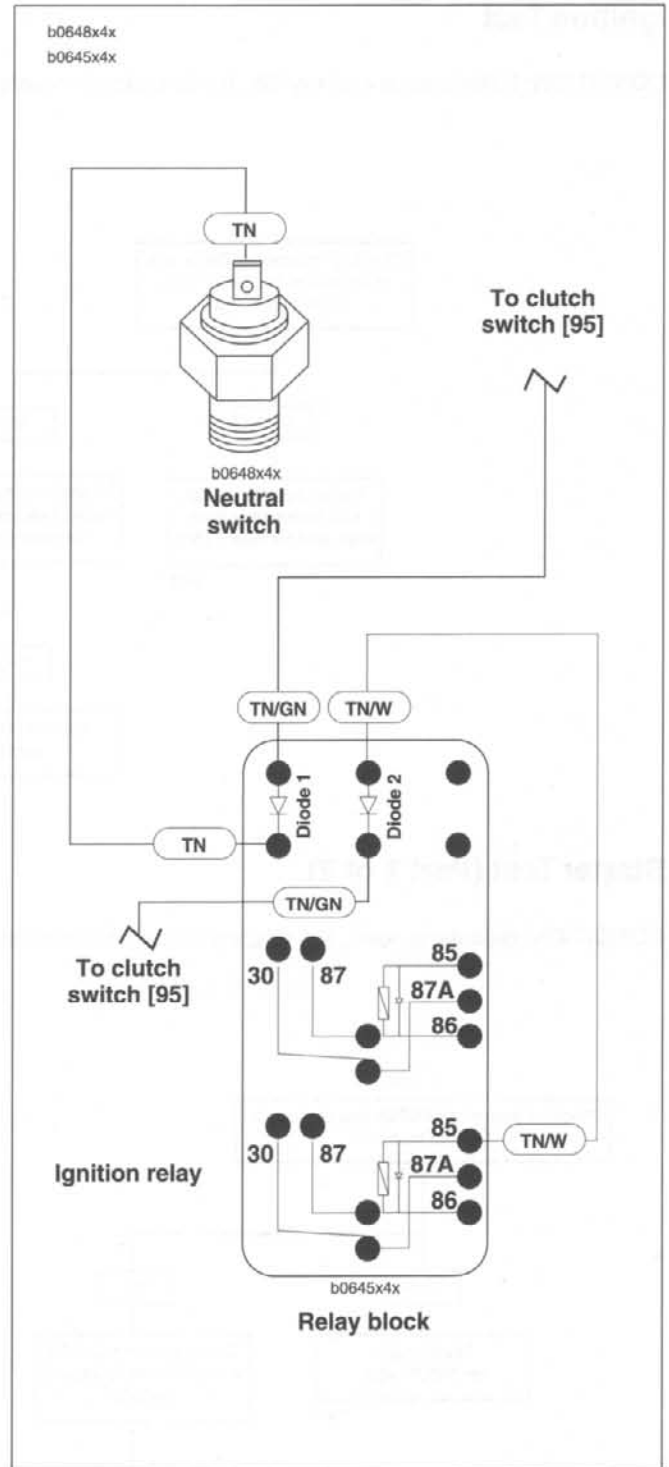
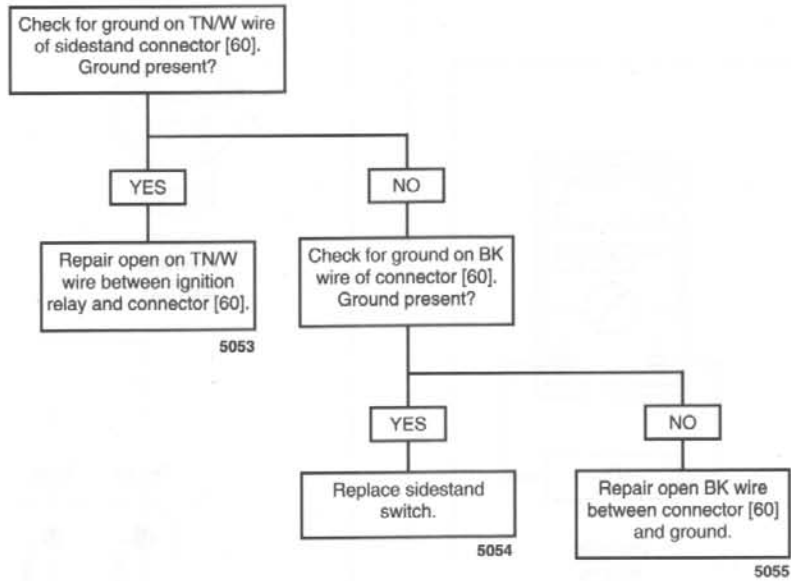


Figure 7-7. Diode Wiring

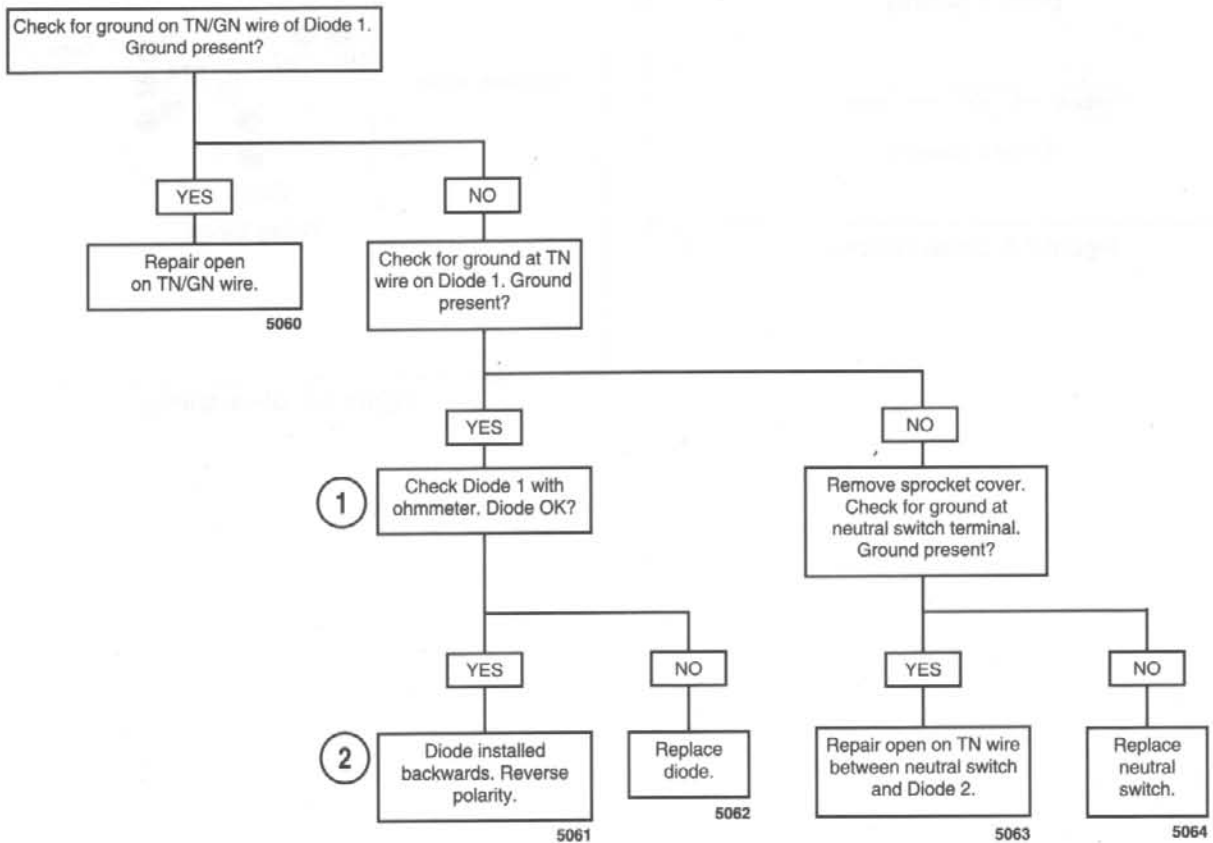
Ignition Test

CONDITION: Sidestand up and key ON, transmission in neutral and clutch engaged



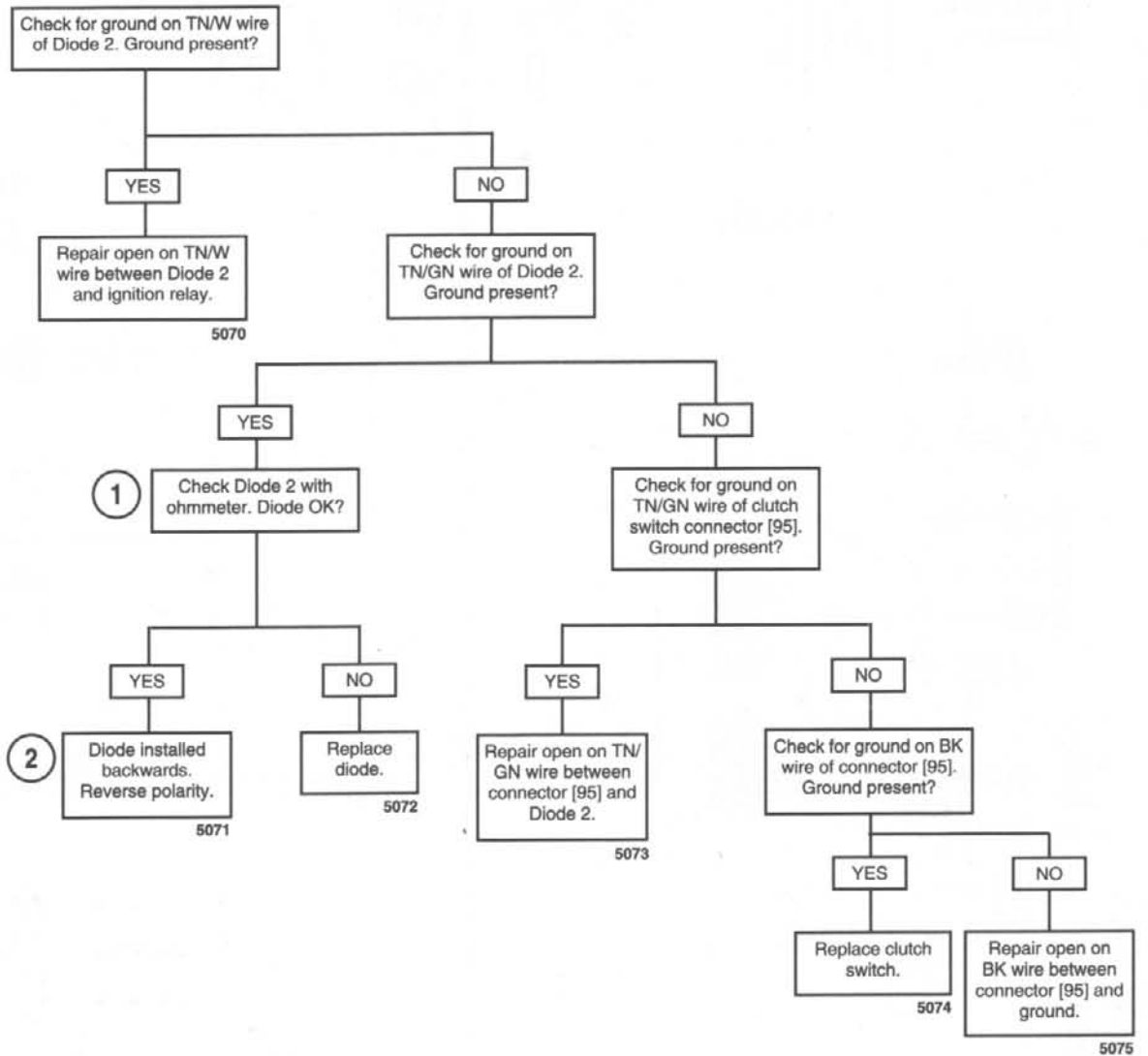
Starter Test (Part 1 of 2)

CONDITION: Sidestand down, key ON, transmission in neutral and clutch engaged



Starter Test (Part 2 of 2)

CONDITION: Sidestand down, key ON, transmission in gear and clutch disengaged



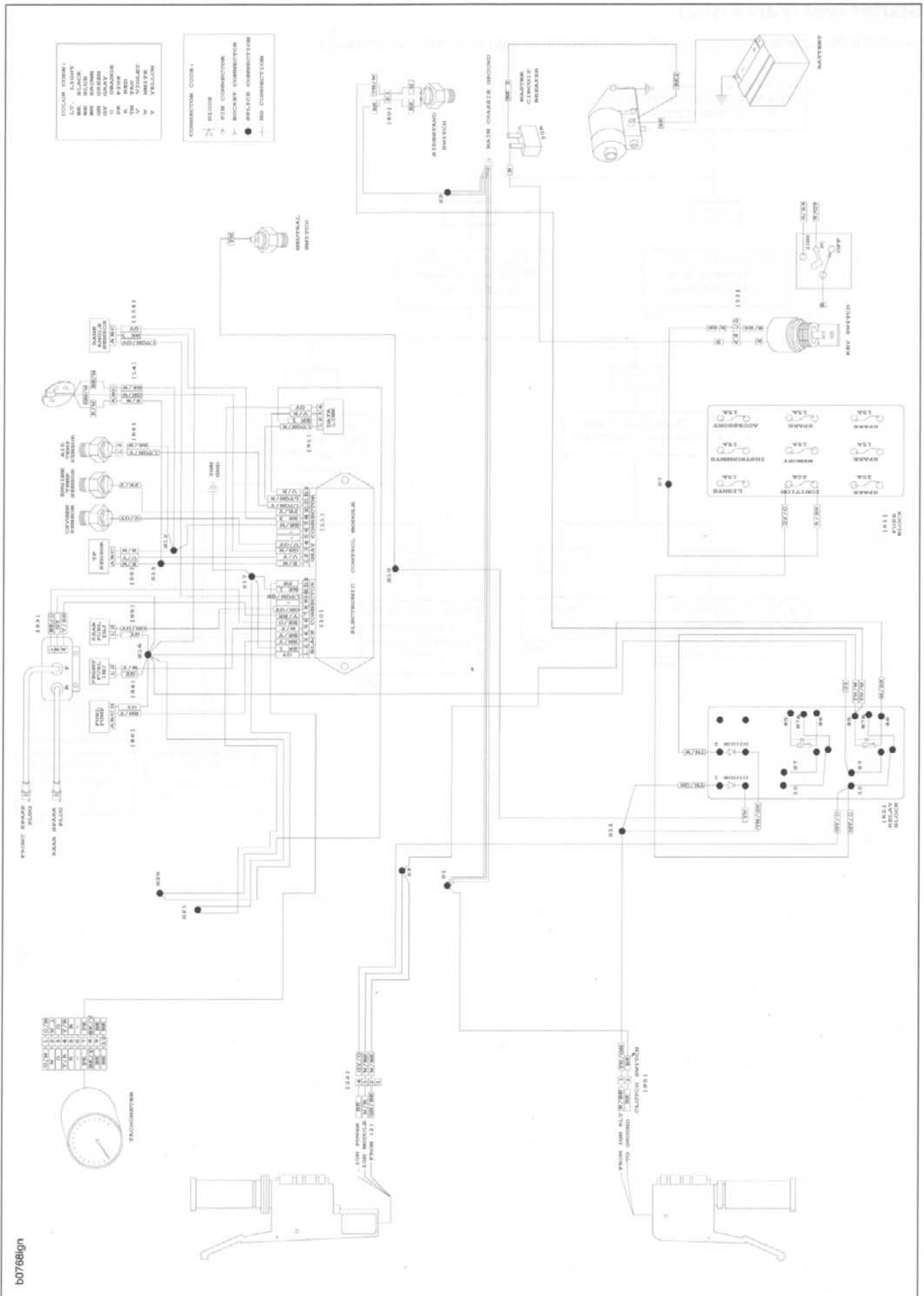


Figure 7-8. Starter/Ignition Interlock System

TESTING/REPLACEMENT

Side Stand Switch

See Figure 7-9. The side stand switch is a simple spring loaded plunger. The switch completes a path to ground for the ignition relay when the side stand is in the retracted position. Test the switch as follows:

1. Unplug the 2-place side stand switch connector [60].
2. Test the switch using an ohmmeter.
 - a. With side stand down (1) (switch open), the switch should show ∞ ohms (infinite ohms).
 - b. With side stand up (2) (switch closed), the switch should show 0 ohms or little resistance.
3. Replace the assembly with a **new** switch if necessary.

1999 Models: Remove side stand switch from frame by turning counterclockwise.

2000 Models: Remove side stand switch from frame by removing two nuts.

Clutch Switch

See Figure 7-10. The clutch switch attaches to the clutch control lever bracket. The switch completes a path to ground for the ignition relay and the starter relay when the clutch is disengaged. Test the switch as follows:

1. Unplug the 2-place clutch switch connector [95].
2. Test the switch using an ohmmeter.
 - a. With clutch engaged (1) (switch open), the switch should show ∞ ohms (infinite ohms).
 - b. With clutch disengaged (2) (switch closed), the switch should show 0 ohms or little resistance.
3. Replace the assembly with a **new** switch if necessary.
 - a. Remove small Phillips screw.
 - b. Depress clutch lever and hold.
 - c. Detach switch by depressing switch trigger button and pulling switch towards the end of the handlebar.
 - d. Install **new** switch.

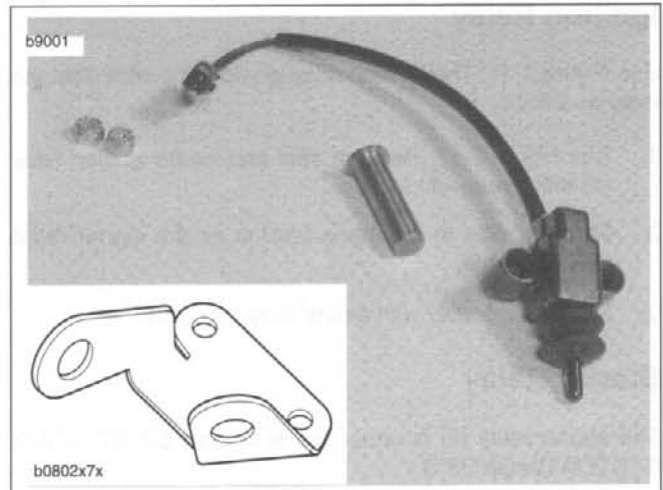


Figure 7-9. Side Stand Switch and Bracket (2000 Models)

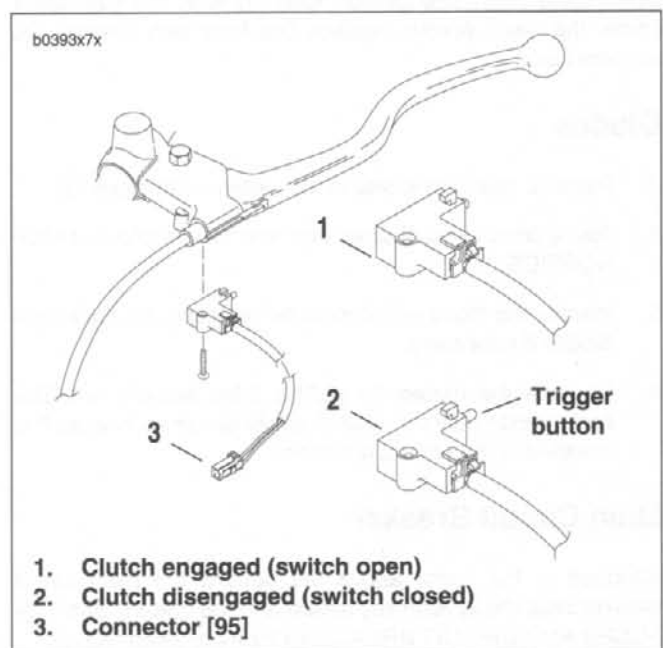


Figure 7-10. Clutch Switch

Ignition Relay

See Figure 7-11. The ignition relay is under the seat. Test the relay as follows:

1. See Figure 7-12. Remove seat and locate ignition relay (1) within relay/diode block.
2. Test the relay in the same fashion as the starter relay. See Section 5.
3. Replace the relay with a **new** relay if necessary.

Starter Relay

The starter relay (2) is under the seat. See 5.3 STARTING SYSTEM DIAGNOSIS.

Ignition Fuse

See Figure 7-11. The ignition fuse (3) is in the fuse block under the seat. Always replace the fuse with another 20 ampere fuse.

Diodes

1. Remove seat and locate diodes within relay block (2).
2. Test diodes using Starter Test flow charts under DIAGNOSTICS.
3. Identify the diode which must be replaced. Replace both diodes if necessary.
4. Replace the diodes by pulling them straight out. The spare diode may be used in either circuit as long as it is installed in the correct direction.

Main Circuit Breaker

Attached to the frame above the battery, the main circuit breaker links the ignition key switch and the battery. See 7.24 FUSES AND CIRCUIT BREAKERS for more information.

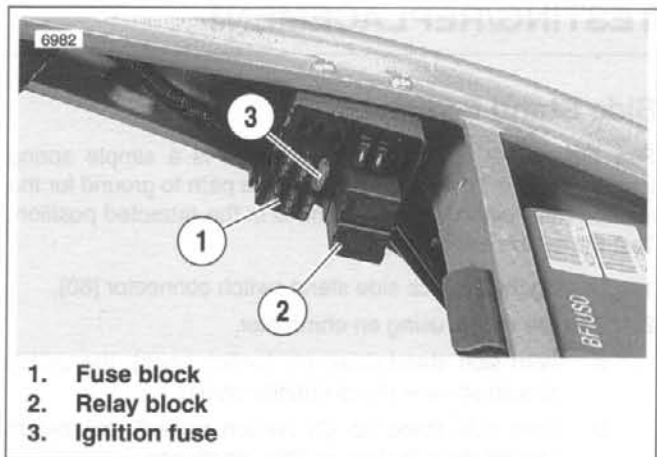


Figure 7-11. Fuse and Relay Blocks

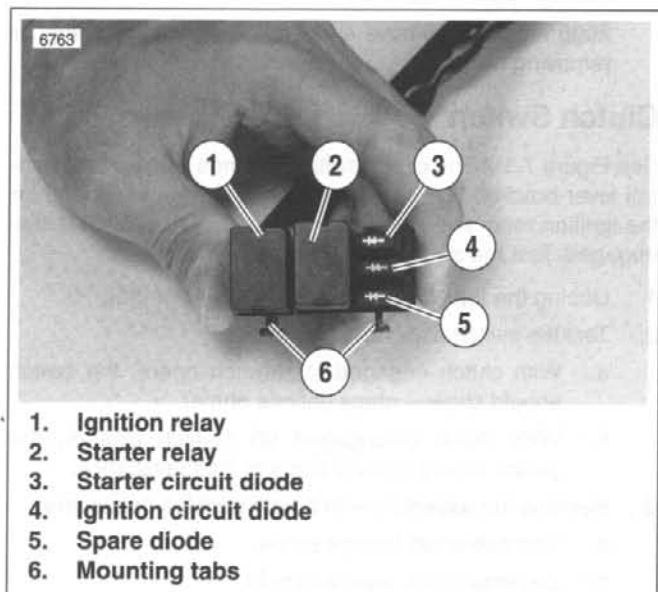


Figure 7-12. Ignition Relay and Diodes

GENERAL

The charging system consists of the alternator and regulator. Charging system circuits are shown in Figure 7-16.

Alternator

The alternator consists of two main components:

- The rotor which mounts to the engine sprocket shaft.
- The stator which bolts to the engine crankcase.

Voltage Regulator

See Figure 7-13. The voltage regulator is a series regulator with shunt control. The circuit combines the functions of rectifying and regulating.

TROUBLESHOOTING

When the charging system fails to charge or does not charge at a satisfactory rate, make the following recommended checks.

Battery

Check for a weak or dead battery. See 7.9 BATTERY (1999 MODELS) or 7.11 BATTERY (2000 MODELS). Battery must be fully charged in order to perform any electrical tests.

Wiring

Check for corroded or loose connections in the charging circuit. See Figure 7-16.

Voltage Regulator Inspection

See Figure 7-13. The voltage regulator base must have a clean, tight connection for proper grounding. Check by using an ohmmeter with one lead on a known good ground, such as battery ground cable, and the other on the regulator base.

See Figure 7-14. Connector plug to stator must be clean and tight.

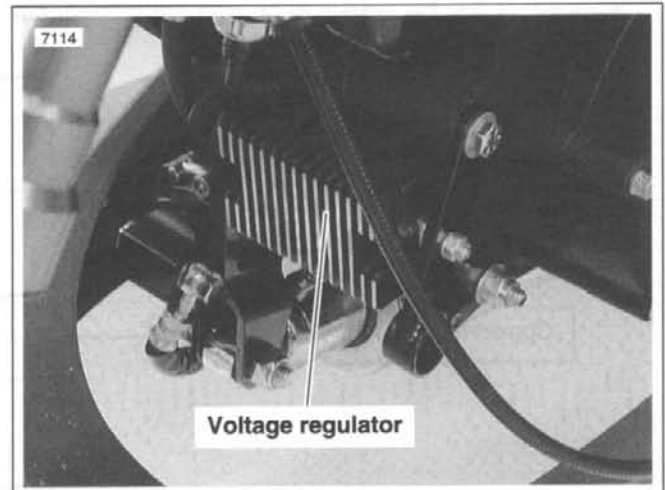


Figure 7-13. Voltage Regulator

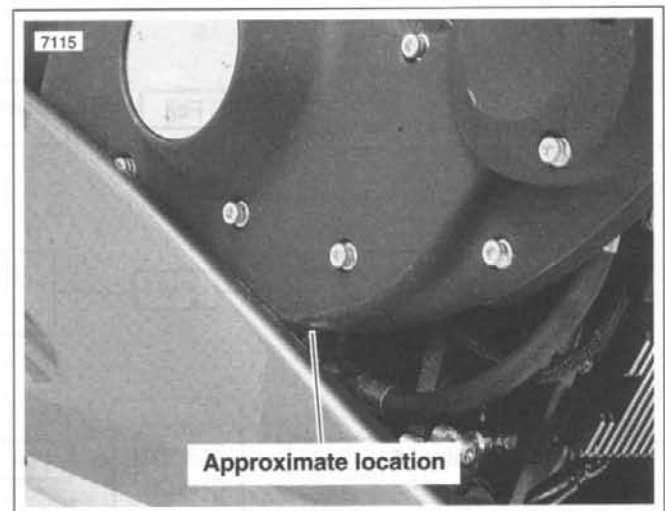


Figure 7-14. Stator Connector

NOTE

Whenever a charging system component fails a test and is replaced, re-test the system to be sure the problem has been corrected.

**SYMPTOM:
BATTERY BECOMES DISCHARGED**

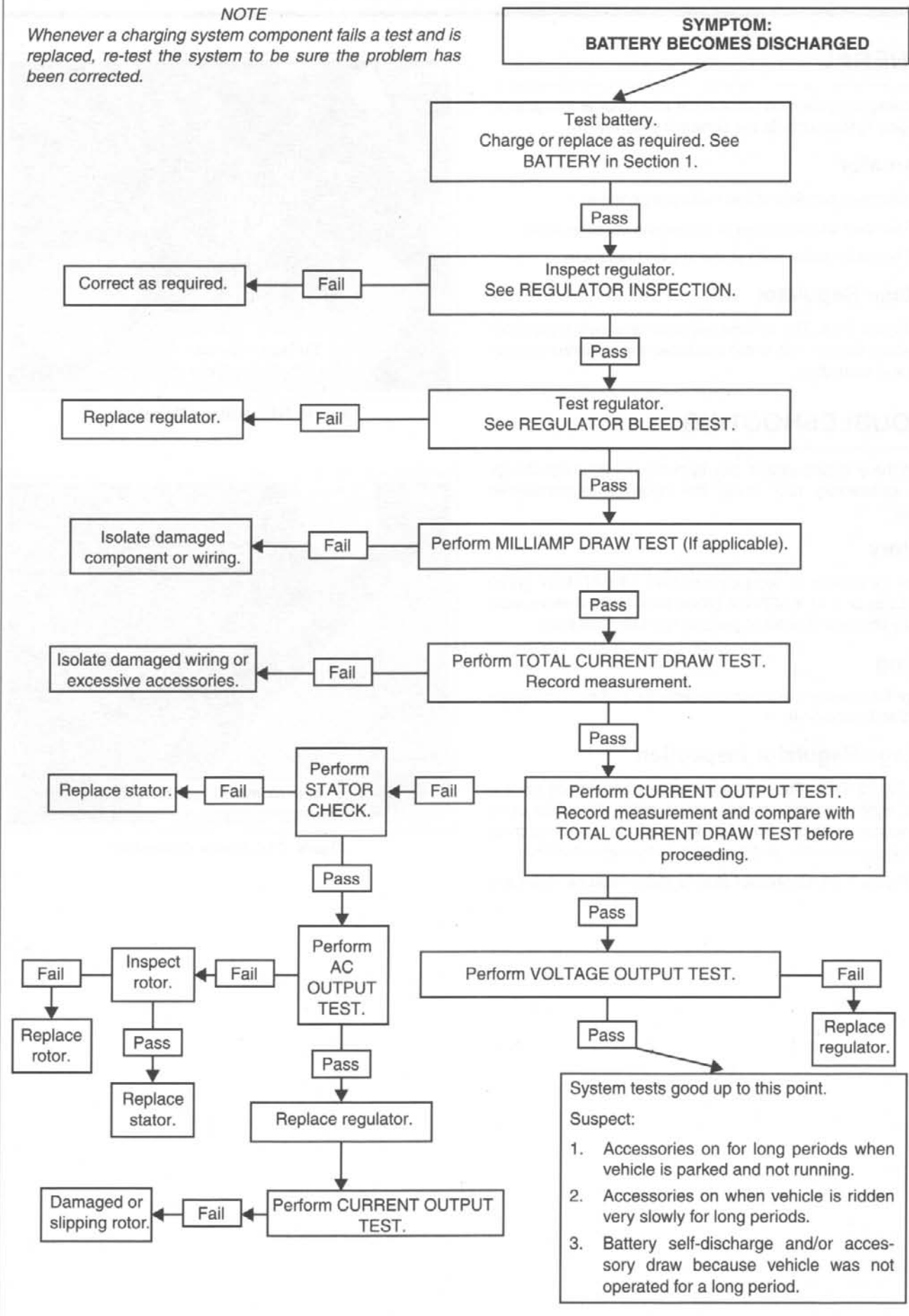


Figure 7-15. Charging System Troubleshooting

b0749chr

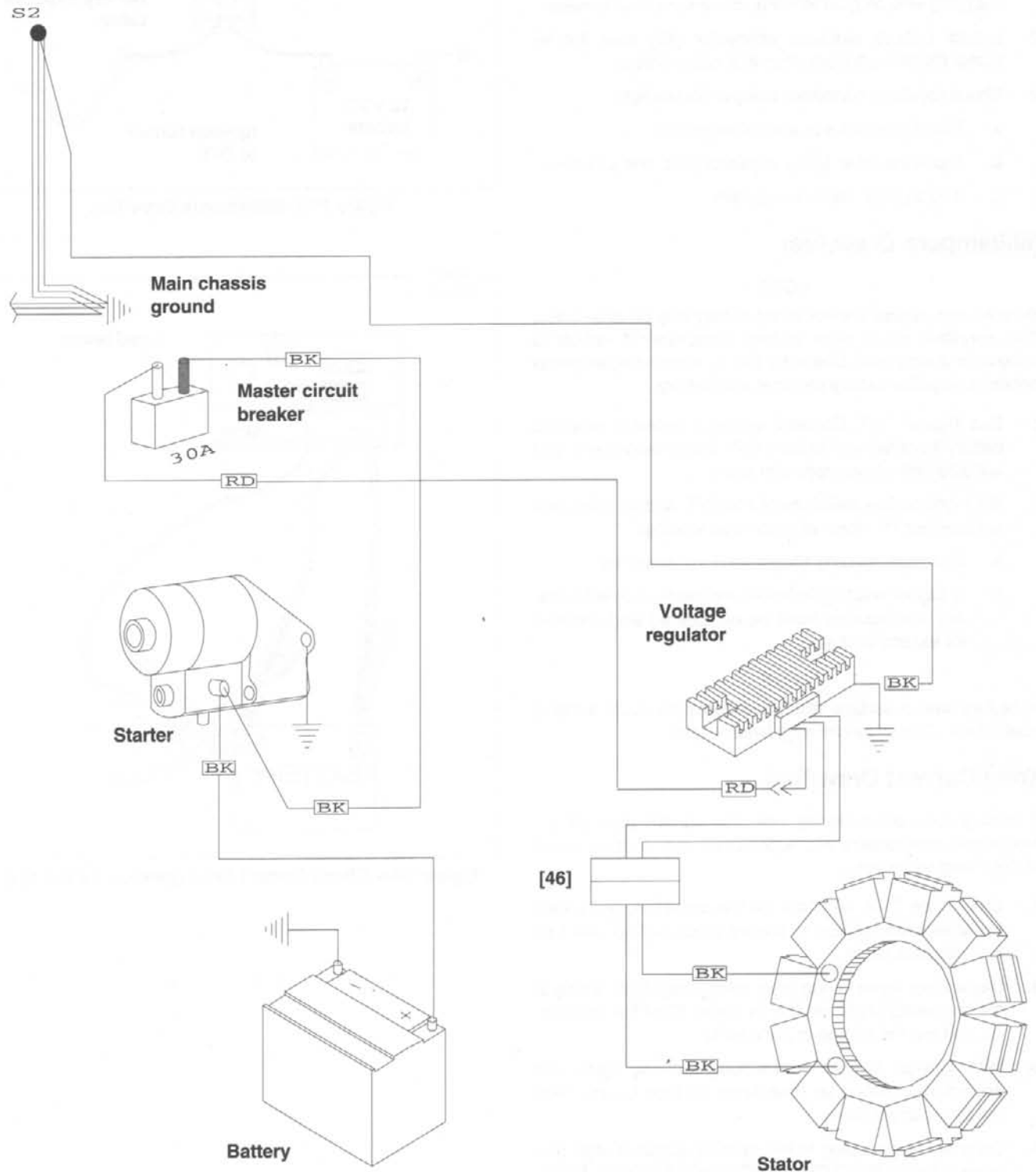


Figure 7-16. Charging System Circuit

TESTING

Voltage Regulator Bleed Test

1. Be sure regulator is connected to battery. Check BK charging wire on gold terminal of master circuit breaker.
2. Locate voltage regulator connector [46] near the oil pump. Disconnect from alternator stator wiring.
3. Check regulator connector using a trouble light.
 - a. Touch one probe to a suitable ground.
 - b. Touch the other to the regulator pins, one at a time.
 - c. If light glows, replace regulator.

Milliampere Draw Test

NOTE

Be sure accessories are not wired so they stay on at all times. This condition could drain battery completely if vehicle is parked for a long time. Check for this by connecting ammeter between negative battery terminal and battery.

1. See Figure 7-17. Connect ammeter between negative battery terminal and battery. With this arrangement, you will also pick up any regulator drain.
2. With ignition key switch turned to OFF and all lights and accessories off, observe amperage reading.
 - a. Maximum reading should be 3 milliamperes.
 - b. A higher reading indicates excessive current draw. Any accessories must be considered and checked for excessive drain.

NOTE

A battery with a surface discharge condition could suffer a static drain. Correct by cleaning battery case.

Total Current Draw Test

If battery runs down during use, the current draw of the motorcycle components and accessories may exceed output of the charging system.

1. See Figure 7-18. To check for this condition, place load tester induction pickup or current probe pickup over battery negative cable.
2. Disconnect stator wiring from voltage regulator wiring at the connector [46] near the oil pump. Start the motorcycle and run the engine at 2000 RPM.
3. With ignition and all continuously running lights and accessories turned on (headlamp on high beam), read the total current draw.
4. Compare this reading to the reading obtained after performing the CURRENT AND VOLTAGE OUTPUT TEST.
 - a. The current output should exceed current draw by 3.5 amps minimum.
 - b. If output does not meet specifications, there may be too many accessories for the charging system to handle.
5. Reconnect regulator after testing.

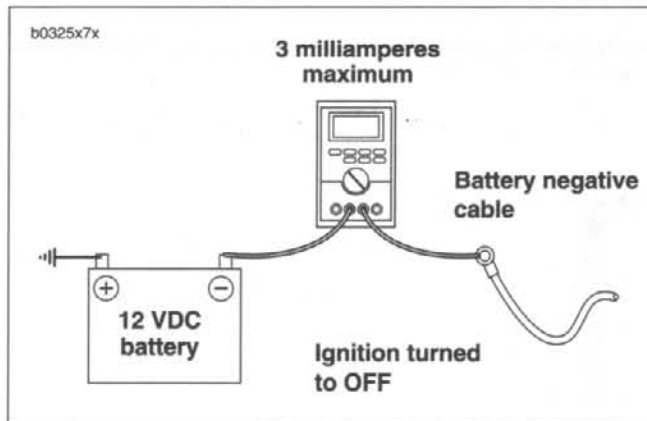


Figure 7-17. Milliampere Draw Test

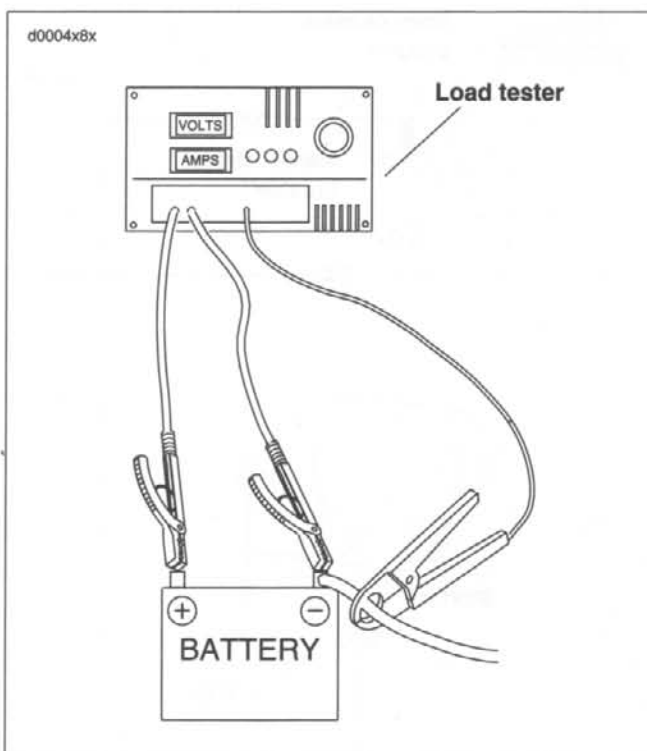


Figure 7-18. Check Current Draw (Ignition Switch On)

Current and Voltage Output Test

1. See Figure 7-19. Connect load tester.
 - a. Connect negative and positive leads to battery terminals.
 - b. Place load tester induction pickup over positive regulator cable.

CAUTION

Do not leave any load switch turned on for more than 20 seconds or overheating and tester damage are possible.

2. Run the engine at 2000 RPM. Increase the load as required to obtain a constant 13.0 VDC.
3. The current output should be 19-23 amps. Make note of measurement for use in TOTAL CURRENT DRAW TEST.

NOTE

Rider's habits may require output test at lower RPM.

Voltage Output Test

1. See Figure 7-19. After removing the load, read the load tester voltage meter.
 - a. If voltage to the battery is not more than 15 VDC, voltage output is within specifications. Investigate other possible problems. See Figure 7-15.
 - b. If voltage is higher, regulator is not functioning properly or connections are loose or dirty.

Stator Check

1. Turn ignition key switch to OFF.
2. See Figure 7-20. Connect an ohmmeter.
 - a. Locate voltage regulator connector [46] near the oil pump. Disconnect from alternator stator wiring.
 - b. Insert one ohmmeter lead into either stator socket.
 - c. Attach the other lead to a suitable ground.
3. Test for continuity with ohmmeter set on the RX1 scale.
 - a. A good stator will show no continuity (∞ ohms) across either stator socket.
 - b. Any other reading indicates a grounded stator which must be replaced.
4. See Figure 7-21. Remove ground lead. Insert lead into the remaining stator socket.
5. Test for resistance with ohmmeter set on the RX1 scale.
 - a. Resistance across the stator sockets should be 0.2-0.4 ohms.
 - b. If the resistance is lower, the stator is damaged and must be replaced.

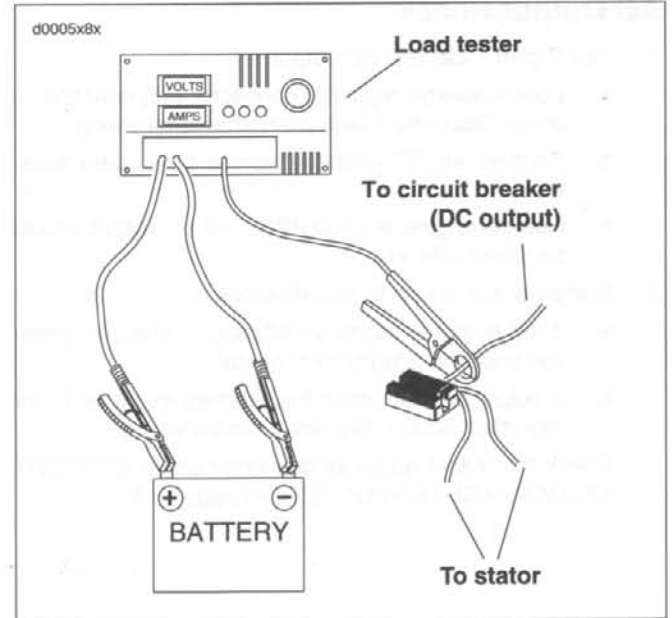


Figure 7-19. Current and Voltage Output Test

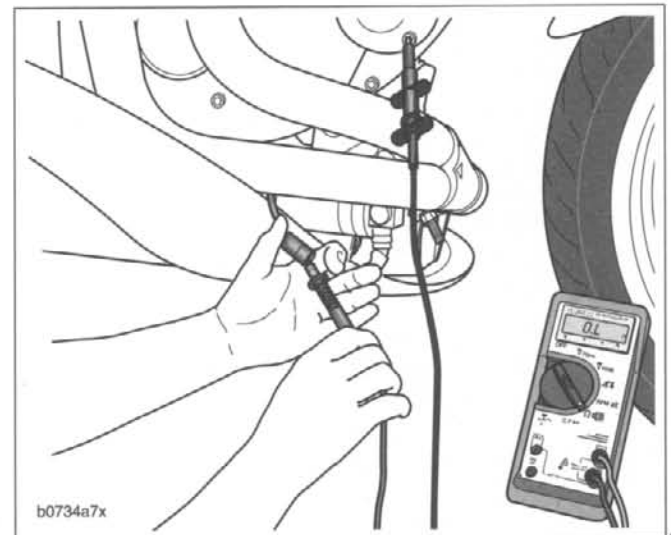


Figure 7-20. Test for Grounded Stator

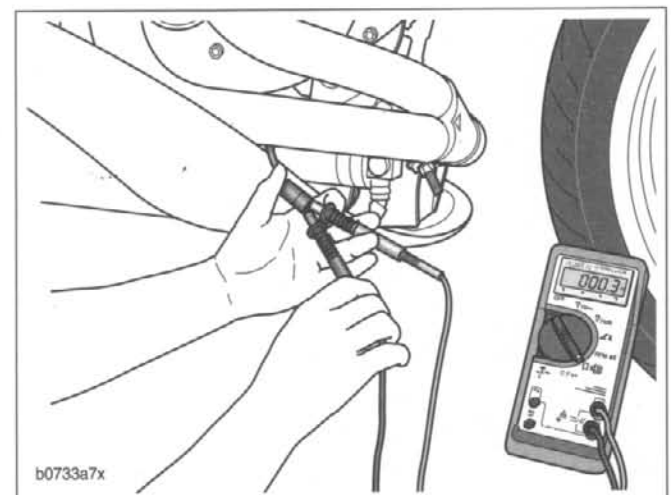


Figure 7-21. Check for Stator Resistance

AC Output Check

1. See Figure 7-22. Test AC output.
 - a. Locate voltage regulator connector [46] near the oil pump. Disconnect from alternator stator wiring.
 - b. Connect an AC voltmeter across both stator sockets.
 - c. Run the engine at 2000 RPM. The AC output should be 38-52 volts AC.
2. Compare test results to specifications.
 - a. If the output is below specifications, charging problem could be a faulty rotor or stator.
 - b. If output is good, charging problem might be faulty regulator/rectifier. Replace as required.
3. Check the output again as described under CURRENT AND VOLTAGE OUTPUT TEST on page 7-19.

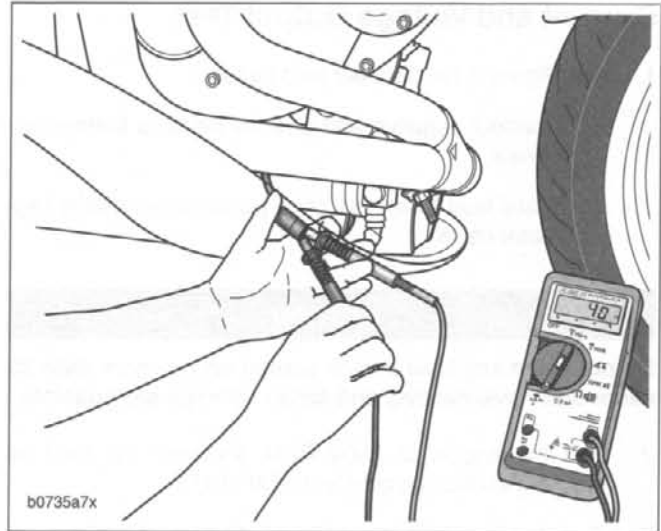


Figure 7-22. Check Stator AC Voltage Output

REMOVAL/DISASSEMBLY

WARNING

To avoid accidental start-up of vehicle and possible personal injury, disconnect the battery cables before proceeding. Always disconnect the negative cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion which could result in death or serious injury.

1. Disconnect battery cables, negative cable first.
2. Remove primary cover. See 6.2 PRIMARY CHAIN.
3. Remove clutch assembly, primary chain and engine sprocket/rotor assembly as a unit. See 6.5 PRIMARY DRIVE/CLUTCH.
4. Remove/disassemble rotor and/or stator, as required. Refer to the following procedures.

Rotor

1. See Figure 7-23. Remove the four bolts which secure alternator rotor to engine sprocket.
2. See Figure 7-24. Position blocking under rotor. Press sprocket free of rotor.

NOTE

Resistance to sprocket/rotor disassembly is due in part to the magnetic force of the permanent rotor magnets.

Stator

1. See Figure 7-25. Disconnect stator wiring (4) from voltage regulator wiring at connector (5) [46] near the oil pump.
2. Remove cable straps holding stator wire to oil filter hose.
3. Withdraw stator wiring (4) from behind the gearcase cover.
4. Remove and discard the four TORX screws (2) which secure stator (1) to left crankcase half.

CAUTION

Stator TORX screws contain a thread locking compound. Do not reuse existing screws. Always use new screws with the proper thread locking compound. Loss of torque on TORX fasteners could result in alternator damage.

5. Remove stator wiring grommet (3) from left crankcase half.
6. Withdraw stator wiring (4) from grommet hole in left crankcase half. Remove stator (1).

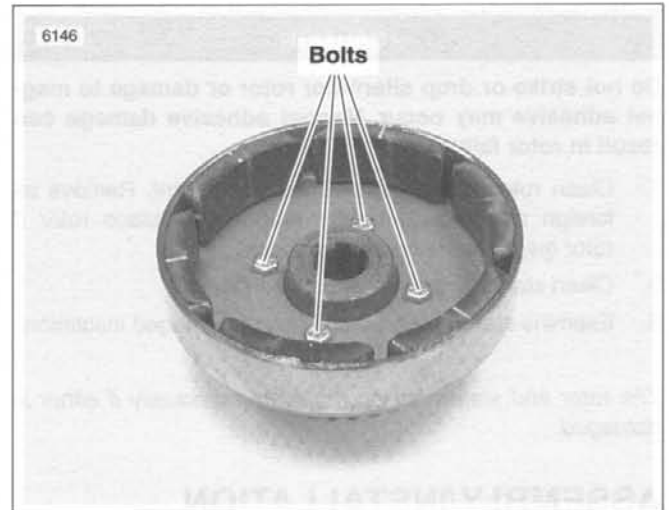


Figure 7-23. Rotor Assembly

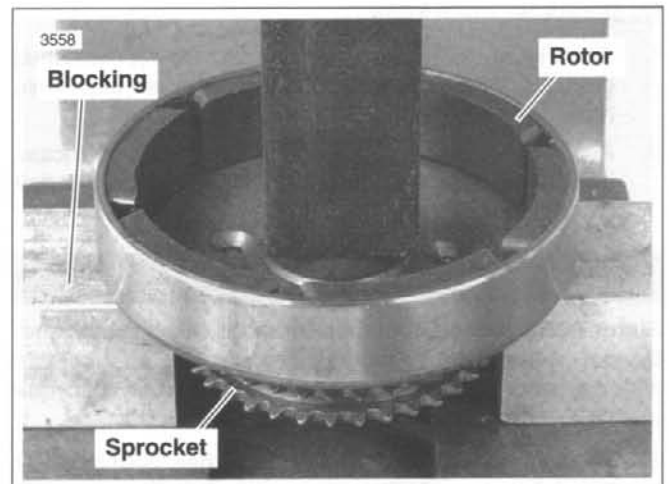


Figure 7-24. Removing Rotor From Sprocket

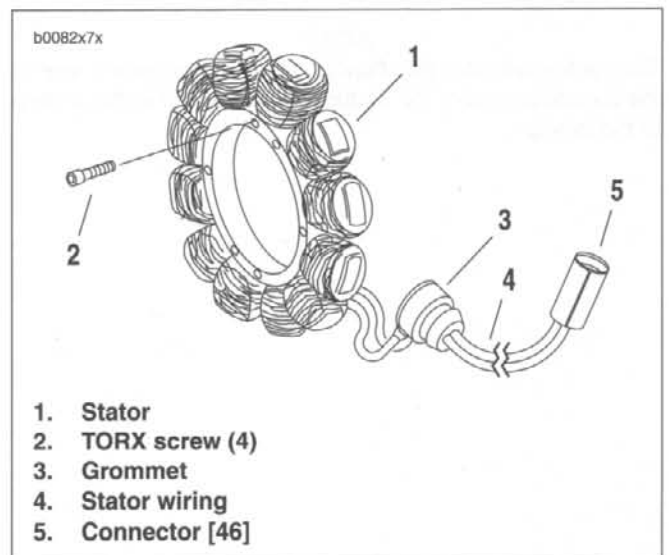


Figure 7-25. Stator Assembly

CLEANING, INSPECTION AND REPAIR

CAUTION

Do not strike or drop alternator rotor or damage to magnet adhesive may occur. Magnet adhesive damage can result in rotor failure.

1. Clean rotor with a petroleum-base solvent. Remove all foreign material from rotor magnets. Replace rotor if rotor magnets are cracked or loose.
2. Clean stator by wiping with a clean cloth.
3. Examine stator leads for cracked or damaged insulation.

NOTE

The rotor and stator can be replaced individually if either is damaged.

ASSEMBLY/INSTALLATION

Depending on whether the rotor, the stator, or both the rotor and stator were removed/disassembled, perform the applicable procedures which follow:

1. See Figure 7-25. Feed stator wiring (4) with attached grommet (3) into open grommet hole in left crankcase half.
2. Apply a light coating of clean engine oil or chaincase lubricant to grommet. Install grommet into hole in left crankcase half.

CAUTION

Stator TORX screws contain a thread locking compound. Do not reuse existing screws. Always use new screws with the proper thread locking compound. Loss of torque on TORX fasteners could result in alternator damage.

3. Position stator (1) on left crankcase half. Secure stator using four new TORX screws (2). Tighten screws to 30-40 in-lbs (3.4-3.5 Nm).
4. Route stator wiring (4) in front of starter, behind gearcase cover and outboard of oil pump.

NOTE

Temporarily attach a thin flexible "feed" or mechanic's wire to the connector end of the stator wiring to assist in the routing of the wiring.

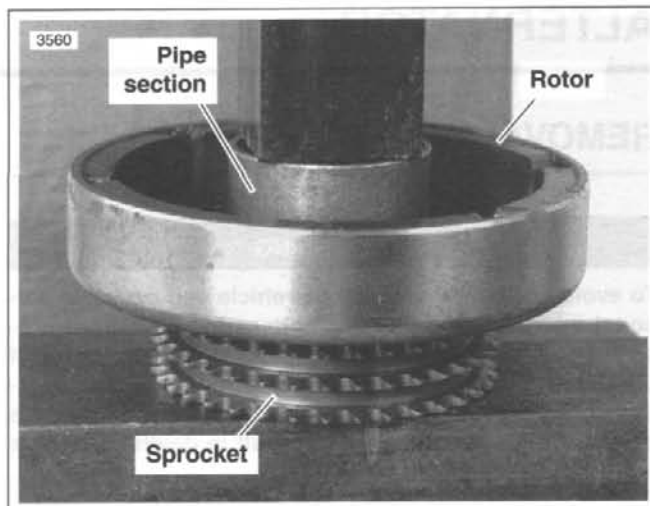


Figure 7-26. Pressing Rotor onto Sprocket

5. Connect alternator stator wiring to voltage regulator connector [46]. Bundle excess wiring in front of oil pump. Secure bundle to oil filter hose using a new cable strap.
6. See Figure 7-26. Attach rotor to sprocket.
 - a. Position rotor on sprocket. Align holes in sprocket with holes in rotor.
 - b. Apply a drop of LOCTITE THREADLOCKER 243 (blue) to threads of each mounting bolt. Insert the four mounting bolts through rotor and start bolts into tapped holes in sprocket.
 - c. Position a section of pipe with an inside diameter larger than the sprocket mounting hub over center of rotor. Press rotor onto sprocket. Tighten bolts to 90-110 in-lbs (10.2-12.4 Nm).
7. Install clutch assembly, primary chain and engine sprocket/rotor assembly as a unit. See 6.5 PRIMARY DRIVE/CLUTCH.
8. Install primary cover. See 6.2 PRIMARY CHAIN.

WARNING

Always connect positive battery cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion which could result in death or serious injury.

9. Connect battery cables, positive cable first.
10. Test charging system. See 7.6 CHARGING SYSTEM.

GENERAL

The voltage regulator is mounted to the front of the crankcase. The voltage regulator is not repairable. Replace the unit if it fails.

REMOVAL

⚠ WARNING

To avoid accidental start-up of vehicle and possible personal injury, disconnect the battery cables before proceeding. Always disconnect the negative cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion which could result in death or serious injury.

1. Disconnect battery cables, negative cable first.

CAUTION

When disconnecting the alternator stator wiring, pull apart the connector by firmly grasping both connector halves. Do not pull on leads or damage to the wires and/or terminals may result.

2. See Figure 7-27. Locate voltage regulator connector [46] near the oil pump. Disconnect from alternator stator wiring. Cut cable straps if necessary.
3. Detach charging wire from main circuit breaker. See 7.24 FUSES AND CIRCUIT BREAKERS.
4. Remove screws (1), washers (2) and lockwasher (4).
5. Remove and discard voltage regulator (3).
6. If necessary, detach mounting bracket (5) by removing screws, washers and nuts.

INSTALLATION

1. See Figure 7-28. Attach **new** voltage regulator (3) using screws (1) and washer (2). Place lockwasher (4) on gearcase cover side of mount.
2. Connect voltage regulator connector [46] to alternator stator wiring. Bundle excess wiring in front of oil pump. Secure bundle to oil pump using a **new** cable strap (6).
3. Route charging wire (8) to gold post on main circuit breaker. Secure wire to frame with **new** cable straps.

⚠ WARNING

Always connect positive battery cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion which could result in death or serious injury.

4. Connect battery cables, positive cable first.
5. Test charging system. See 7.6 CHARGING SYSTEM.

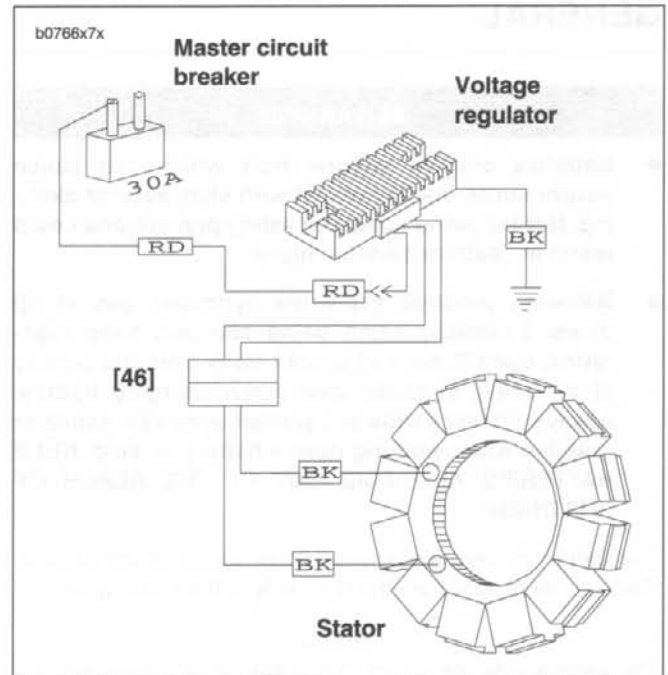


Figure 7-27. Voltage Regulator Connector [46]

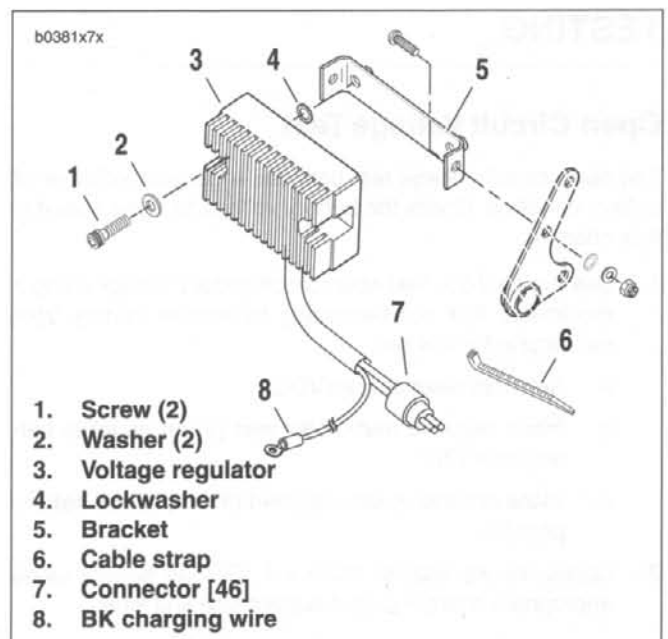


Figure 7-28. Voltage Regulator

GENERAL

⚠ WARNING

- Batteries contain sulfuric acid which can cause severe burns. Avoid contact with skin, eyes or clothing. Not following adequate safety precautions could result in death or serious injury.
- Batteries produce explosive hydrogen gas at all times, especially when being charged. Keep cigarettes, open flame and sparks away from the battery at all times. Ventilate area when charging battery. Always protect hands and protect eyes with shield or goggles when working near a battery or acid. **KEEP BATTERIES AND ACID OUT OF THE REACH OF CHILDREN!**

The battery is below the seat in the center of the vehicle. Remove the battery from the right side of the motorcycle.

NOTE

The battery requires no additional fluid at any time. See 1.4 BATTERY (1999 MODELS) for removal/installation procedures.

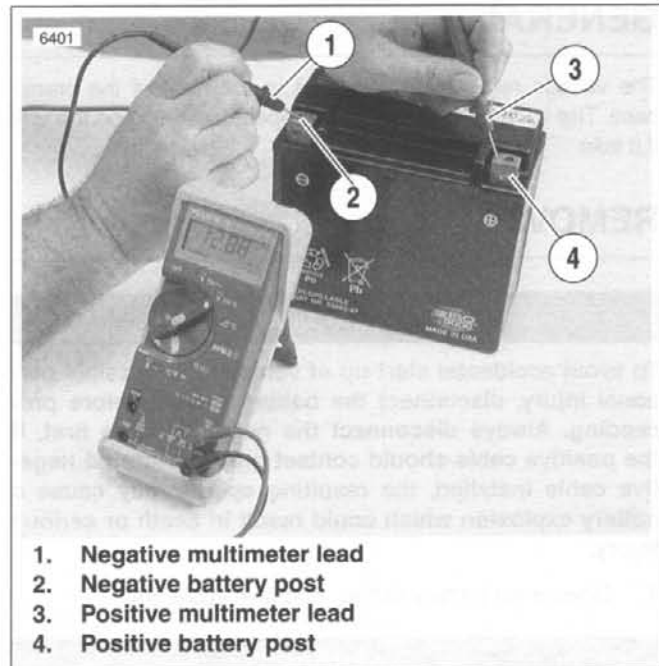


Figure 7-29. Open Circuit Voltage Test

TESTING

Open Circuit Voltage Test

The open circuit voltage test provides a general indicator of battery condition. Check the battery voltage to make sure it is fully charged.

1. See Figure 7-29. Test open circuit battery voltage using a multimeter. It is not necessary to remove battery from motorcycle for this test.
 - a. Set multimeter to read VDC.
 - b. Place negative multimeter lead (1) on negative battery post (2).
 - c. Place positive multimeter lead (3) on positive battery post (4).
2. Check results against Table 7-1. Charge battery using appropriate charger output current rate and time.

NOTE

Charging rates are for a constant current charger @ 1.8 amps. Tapered-rate chargers or trickle chargers will require longer charging times.

If the battery reads below 12.8 VDC after 10 hours of charging using a constant rate charger (set at 1.8 amps), replace the battery.

Table 7-1. Charging Rates

VOLTAGE READING	STATE OF CHARGE	ACTION
13.0 VDC	100%	None
12.8 VDC	75%	Charge 3-5 hours (see note)
12.5 VDC	50%	Charge 4-7 hours (see note)
12.2 VDC	25%	Charge 10 hours (see note)

Load Test

The load test measures battery performance under full current load and is the best indicator of battery condition.

CAUTION

Fully charge the battery before testing. If battery is not fully charged, test readings will be incorrect.

1. Remove battery from motorcycle and fully charge. See CHARGING BATTERY.
2. See Figure 7-31. Connect BATTERY/CHARGING SYSTEM LOAD TESTER (Part No. HD-42376).
 - a. Attach tester leads to battery posts.
 - b. Place induction pickup over negative (black) cable.
3. Load battery to three times amp hour rating. The 18 amp-hour battery should be loaded to three times its amp-hour rating, or 54 amps, for 15 seconds.
4. Observe voltage reading.
 - a. Voltage reading throughout the test should be 9.6 VDC or more at 70°F (21° C).
 - b. If voltage reading is below 9.6 VDC, charge battery.

CHARGING BATTERY

WARNING

Always unplug or turn battery charger OFF before connecting or disconnecting charger clamps from battery. Connecting or disconnecting clamps with charger ON could cause a spark and a possible battery explosion which could result in death or serious injury.

CAUTION

Never add water to the maintenance free battery and never remove the seal strip on top of the battery. Never allow a battery to stand in a discharged condition or damage to the battery will occur.

1. Remove battery from motorcycle and place battery on a level surface. See REMOVAL.

CAUTION

Refer to the charging instructions on the top of the battery. Do not reverse the charger connections described in the next step, or the charging system of the motorcycle could be damaged.

2. With charger turned OFF, attach battery.
 - a. Connect red charger lead to positive terminal.
 - b. Connect black charger lead to negative terminal.
3. Turn battery charger ON. Charge battery for time shown in Table 7-1. Check open circuit battery voltage when battery has finished charging.

NOTE

If battery gets hot, over 110°F (44°C) (warm to the touch), discontinue charging and let battery cool down.

WARNING - EXPLOSIVE GASES

Cigarettes, flames or sparks could cause battery to explode which could result in death or serious injury. Always shield eyes and face from battery. Do not charge without proper instruction and training. Securely connect cables to the proper terminals.

POISON - CAUSES SEVERE BURNS

Contains sulfuric acid. Avoid contact with skin, eyes, and clothing. In event of accident, flush with water and call a physician immediately.

KEEP OUT OF REACH OF CHILDREN

Figure 7-30. Battery Warnings

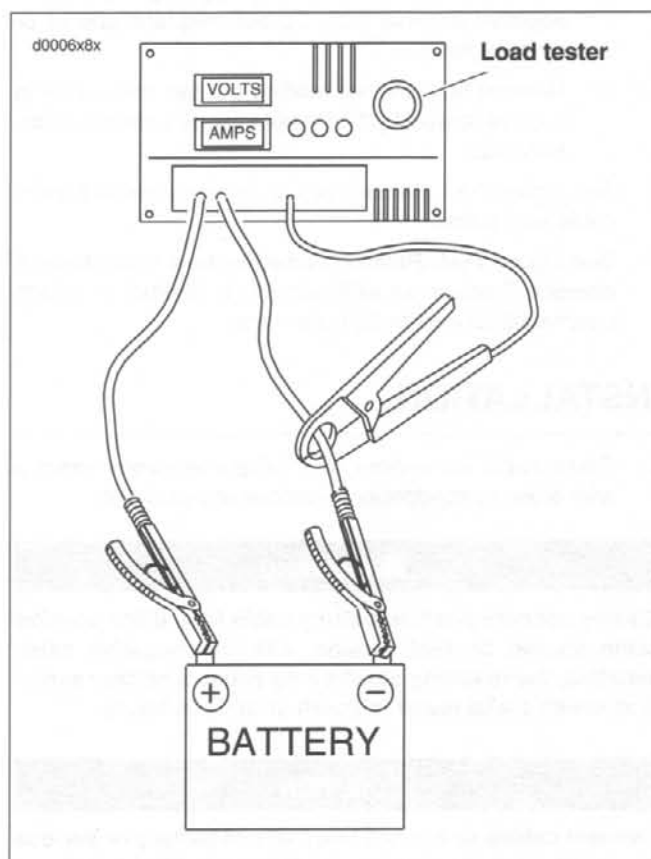


Figure 7-31. Load Test

REMOVAL

⚠ WARNING

To avoid accidental start-up of vehicle and possible personal injury, disconnect the battery cables before proceeding. Always disconnect the negative cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion which could result in death or serious injury.

1. See Figure 7-32. Disconnect cables (5, 10) from battery, negative cable (5) first.
 - a. Remove bolt (metric) holding negative cable (5) to negative terminal (12). Do not misplace spacer or terminal nut.
 - b. Remove bolt (metric) holding positive cable (10) to positive terminal (13). Do not misplace spacer or terminal nut.
2. See Figure 7-33. Remove bolt to detach negative battery cable from frame.
3. See Figure 7-34. Remove protective boot from starter if present. Remove nut with washer (1) (metric) to detach positive battery cable (2) from starter.

INSTALLATION

1. Clean cable connectors and battery terminals using a wire brush or sandpaper to remove any oxidation.

⚠ WARNING

Always connect positive battery cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion which could result in death or serious injury.

CAUTION

Connect cables to correct terminals of battery or serious damage to motorcycle electrical system will occur.

2. Connect cables to battery.
 - a. See Figure 7-32. Positive battery cable (10) runs from starter to positive battery terminal.
 - b. Connect positive cable (10) to positive (+) battery terminal (13) using bolt (metric), spacer and nut.
 - c. Connect negative cable (5) to negative (-) battery terminal (12) using bolt (metric), spacer and nut.
 - d. Tighten bolts to 40 in-lbs (4.5 Nm).

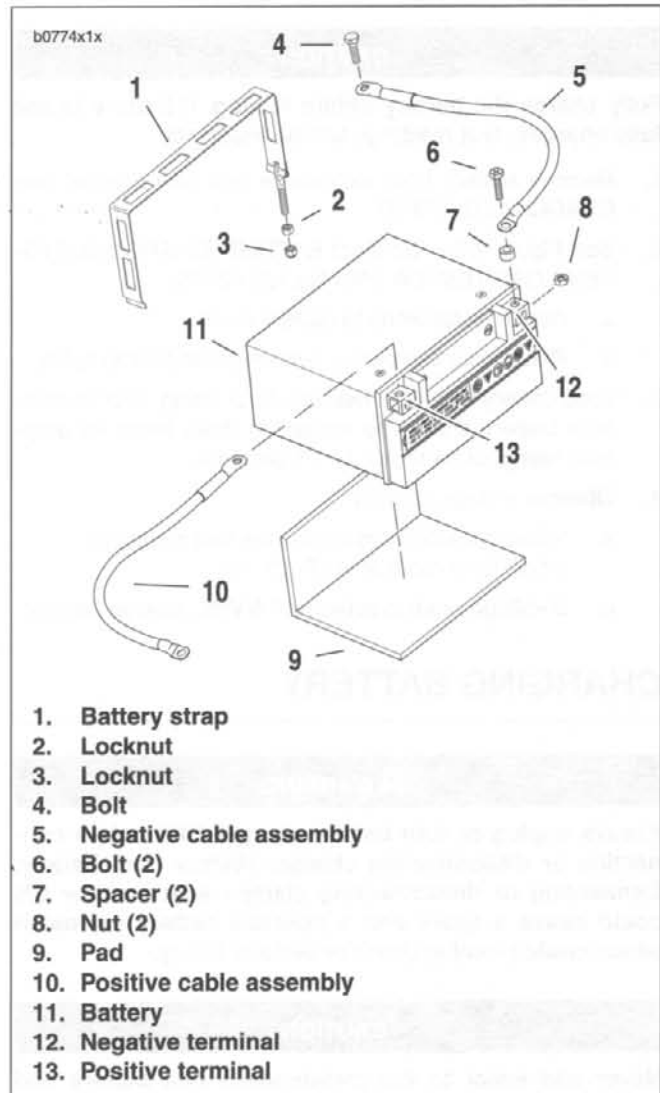


Figure 7-32. Battery

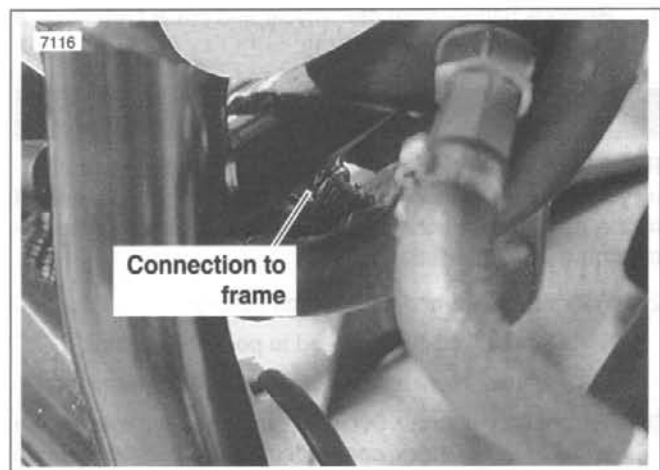
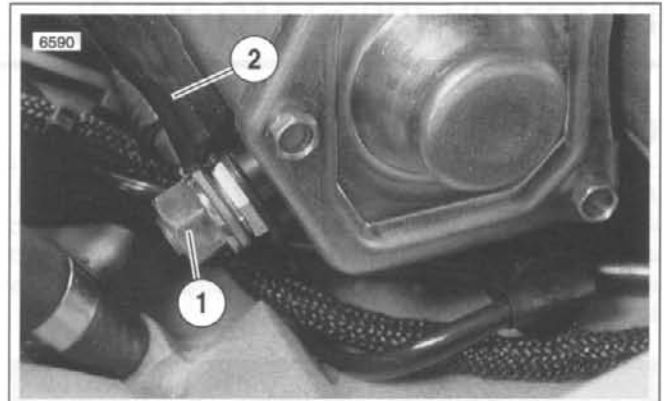


Figure 7-33. Negative Battery Cable

3. Connect cables to frame and starter.
 - a. See Figure 7-34. First, connect positive cable to starter using nut with washer (metric). Tighten to 60-85 **in-lbs** (6.8-9.6 Nm).
 - b. See Figure 7-33. Attach negative cable to frame below oil tank.
4. Apply light coat of petroleum jelly or corrosion-retardant material to both battery terminals.



1. Nut with washer (metric)
2. Positive battery cable

**Figure 7-34. Positive Battery Cable
(Protective Boot Not Shown)**

GENERAL

All 2000 Model Year Buell batteries are permanently sealed, maintenance-free, valve-regulated, lead/calcium and sulfuric acid batteries. The batteries are shipped pre-charged and ready to be put into service. Do not attempt to open these batteries for any reason.

⚠ WARNING

All batteries contain electrolyte. Electrolyte is a sulfuric acid solution that is highly corrosive and can cause severe chemical burns. Avoid contact with skin, eyes, and clothing. Avoid spillage. Always wear protective face shield, rubberized gloves and protective clothing when working with batteries. A warning label is attached to the top of the battery. See Figures 7-34 and 7-35. Never remove warning label from battery. Failure to read and understand all precautions contained in warning label before performing any service on batteries could result in death or serious injury.



Figure 7-34. Maintenance-Free AGM Battery

BATTERY TESTING

Voltmeter Test

See Table 7-5. The voltmeter test provides a general indicator of battery condition. Check the voltage of the battery to verify that it is in a 100% fully charged condition. If the open circuit (disconnected) voltage reading is below 12.6V, charge the battery and then recheck the voltage after the battery has set for one to two hours. If the voltage reading is 12.8V or above, perform the load test described on page 7-30.

ANTIDOTE

- External – Flush with water.
- Internal – Drink large quantities of milk or water, followed by milk of magnesia, vegetable oil or beaten eggs. Call doctor immediately.
- Eyes – Flush with water, get immediate medical attention.

Contents are Corrosive.

Wear Safety Glasses.

Contents are Explosive.

Keep Flames Away.

Read Instructions.

Keep Away From Children.

NON-SPILLABLE
This is a ready filled, activated, SEALED BATTERY. NEVER remove strip. Refer to owner's manual for charging instructions.
If battery is put into service after date shown, charge for minimum of 1 hour at 6-10 amps. (See side of battery for date.)

⚠ DANGER/POISON 3-4425

 SHIELD EYES. EXPLOSIVE GASES CAN CAUSE BLINDNESS OR INJURY.	 NO SPARKS FLAMES SMOKING	 SULFURIC ACID CAN CAUSE BLINDNESS OR SEVERE BURNS.	 FLUSH EYES IMMEDIATELY WITH WATER. GET MEDICAL HELP FAST.
--	------------------------------------	--	--

KEEP OUT OF REACH OF CHILDREN. DO NOT OPEN BATTERY.

Figure 7-35. Battery Warning Label

Table 7-5. Voltmeter Test

BATTERY CHARGE CONDITIONS	
Voltage (OCV)	State of Charge
12.8	100%
12.6	75%
12.3	50%
12.0	25%
11.8	0%

DISCONNECTION AND REMOVAL

1. Remove seat. See SEAT.

WARNING

Always disconnect the negative battery cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion that could result in death or serious injury.

2. Unthread bolt and remove battery negative cable (black) from battery negative (-) terminal.
3. Unthread bolt and remove battery positive cable (red) from battery positive (+) terminal.
4. Remove battery strap locknut (metric). Unhook battery strap from frame near negative terminal.
5. Cut any cable straps holding oxygen sensor connector to battery.
6. Remove battery from right side.

CLEANING AND INSPECTION

1. Battery top must be clean and dry. Dirt and electrolyte on top of the battery can cause battery to self-discharge. Clean battery top with a solution of baking soda (sodium bicarbonate) and water (5 teaspoons baking soda per quart or liter of water). When the solution stops bubbling, rinse off the battery with clean water.
2. Clean cable connectors and battery terminals using a wire brush or sandpaper. Remove any oxidation.
3. Inspect the battery screws, clamps and cables for breakage, loose connections and corrosion. Clean clamps.
4. Check the battery posts for melting or damage caused by overtightening.
5. Inspect the battery for discoloration, raised top or a warped or distorted case, which might indicate that the battery has been frozen, overheated or overcharged.
6. Inspect the battery case for cracks or leaks.

BATTERY CHARGING

Safety Precautions

Never charge a battery without first reviewing the instructions for the charger being used. In addition to the manufacturer's instructions, follow these general safety

precautions:

- Always wear proper eye, face and hand protection.
- Always charge batteries in a well-ventilated area.
- Turn the charger "OFF" before connecting the leads to the battery to avoid dangerous sparks.
- Never try to charge a visibly damaged or frozen battery.
- Connect the charger leads to the battery; red positive (+) lead to the positive (+) terminal and black negative (-) lead to the negative (-) terminal. If the battery is still in the vehicle, connect the negative lead to the chassis ground. Be sure that the ignition and all electrical accessories are turned off.
- Make sure that the charger leads to the battery are not broken, frayed or loose.
- If the battery becomes hot, or if violent gassing or spewing of electrolyte occurs, reduce the charging rate or turn off the charger temporarily.
- Always turn the charger "OFF" before removing charger leads from the battery to avoid dangerous sparks.

Charging Battery

Charge the battery if any of the following conditions exist:

- Vehicle lights appear dim.
- Electric starter sounds weak.
- Battery has not been used for an extended period of time.

WARNING

Charge the battery in a well ventilated area. Explosive hydrogen gas escapes from the battery during charging. Keep open flames, electrical sparks and smoking materials away from the battery at all times. Inadequate safety precautions could result in death or serious injury.

CAUTION

If the battery releases an excessive amount of gas during charging, decrease the charging rate. If the battery gets hotter than 110°F. (43°C) during charging, discontinue charging and allow the battery to cool. Overheating may result in plate distortion, internal shorting, dryout or other damage.

1. Perform a voltmeter test to determine the state of charge. See BATTERY TESTING, VOLTMETER TEST, on the previous page. If battery needs to be charged, proceed to step 2.

CAUTION

Always remove the battery from the motorcycle before charging. Accidental electrolyte leakage will damage motorcycle parts.

Table 7-6. Battery Charging Rates/Times

Battery Amp-Hour	State of Charge		3 Amp Charger	6 Amp Charger	10 Amp Charger	20 Amp Charger
	Voltage Reading	% of Charge				
SPORT 19	12.8 V	100%	-	-	-	-
	12.6 V	75%	1.75 hours	50 minutes	30 minutes	15 minutes
	12.3 V	50%	3.5 hours	1.75 hours	1 hour	30 minutes
	12.0 V	25%	5 hours	2.5 hours	1.5 hours	45 minutes
	11.8 V	0%	6 hours, 40 minutes	3 hours, 20 minutes	2 hours	1 hour

The figures listed above assume that the battery is charging at room temperature. If warmer than room temperature, use a slightly shorter charging time. If colder, use a slightly longer charging time.

The use of constant current chargers to charge sealed maintenance-free batteries is not recommended. Any overcharge will cause dry-out and premature battery failure. If a constant current charger is the only type available, do **not** exceed the charge times listed above and do **not** continue charging the battery if it gets hot. When charging, never exceed 15 volts for more than 30 minutes.

- Remove the battery from the motorcycle. See BATTERY, DISCONNECTION AND REMOVAL. Place the battery on a level surface.
- Perform a load test to determine the condition of the battery. See BATTERY TESTING, LOAD TEST, on this page.

⚠ WARNING

Always unplug or turn OFF the battery charger before connecting the charger clamps to the battery. Connecting clamps with the charger ON could cause a spark resulting in a battery explosion which could result in death or serious injury.

CAUTION

Do not reverse the charger connections described in the following steps or the charging system of the motorcycle could be damaged.

- Connect the red battery charger lead to the positive (+) terminal of the battery.
- Connect the black battery charger lead to the negative (-) terminal of the battery.

NOTE

If the battery is still in the vehicle, connect the negative lead to the chassis ground. Be sure that the ignition and all electrical accessories are turned off.

- Step away from the battery and turn on the charger. See the charging instructions in Table 7-6.

⚠ WARNING

Always unplug or turn OFF the battery charger before disconnecting the charger clamps from the battery. Disconnecting clamps with the charger ON could cause a spark resulting in a battery explosion which could result in death or serious injury.

- After the battery is fully charged, disconnect the black battery charger lead to the negative (-) terminal of the battery.
- Disconnect the red battery charger lead to the positive (+) terminal of the battery.
- Mark the charging date on the battery.

BATTERY TESTING

Load Test

The load test measures battery performance under full current load and is the best indicator of battery condition. To load test the battery, proceed as follows:

CAUTION

Load testing a discharged battery can result in permanent battery damage.

- Always fully charge the battery before testing or test readings will be incorrect. See CHARGING BATTERY. Load testing a discharged battery can also result in permanent battery damage.
- After charging, allow battery to stand for at least one hour before testing.

⚠ WARNING

Always turn the battery load tester OFF before connecting the tester cables to the battery terminals. Connecting tester cables with the load tester ON could cause a spark resulting in a battery explosion which could result in death or serious injury.

- Connect tester leads to battery posts and place induction pickup over negative (black) cable. See Figure 7-36.

CAUTION

To avoid load tester and/or battery damage, do not leave the load tester switch turned ON for more than 20 seconds.

- Referencing Table 7-7, load battery at 50% of CCA rating using the load tester. Voltage reading after 15 seconds should be 9.6V or more at 70°F. (21°C).

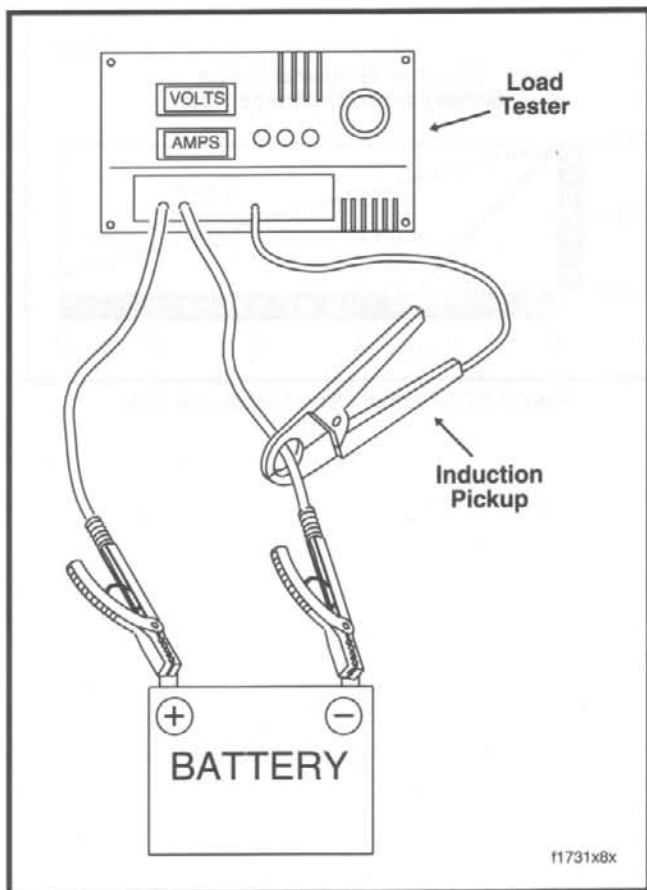


Figure 7-36. Load Test Battery

WARNING

Always turn the battery load tester OFF before disconnecting the tester cables from the battery terminals. Disconnecting tester cables with the load tester ON could cause a spark resulting in a battery explosion which could result in death or serious injury.

5. Install the battery on the motorcycle. See BATTERY, INSTALLATION AND CONNECTION.

Table 7-7. Battery Load Test

COLD CRANKING AMPERAGE (CCA)	100%	50%
SPORT	270	135

BATTERY CABLE ROUTING

Positive battery cable runs from starter post to positive battery terminal. Negative battery cable runs from frame to negative battery terminal. See Figure 7-37.

BATTERY INSTALLATION AND CONNECTION

1. Place the fully charged battery into the battery box, terminal side forward.

CAUTION

Connect the cables to the correct battery terminals or damage to the motorcycle electrical system will occur.

WARNING

Always connect the positive battery cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion that could result in death or serious injury.

CAUTION

Overtightening bolts can damage battery terminals.

2. Insert bolt through battery positive cable (red) into threaded hole of battery positive (+) terminal. Tighten bolt to 60-96 in-lbs (6.8-10.9 Nm).
3. Insert bolt through battery negative cable (black) into threaded hole of battery negative (-) terminal. Tighten bolt to 60-96 in-lbs (6.8-10.9 Nm).
4. Apply a light coat of petroleum jelly or corrosion retardant material to both battery terminals.
5. Install battery strap.
 - a. Insert tab on right side of battery tray. Place battery strap around top side of battery.
 - b. Hook edge of strap into frame tab.
 - c. Insert threaded shaft on strap through frame tab.
 - d. Install battery strap locknut on threaded shaft. Tighten to 40 in-lbs (4.5 Nm).
5. Apply light coat of petroleum jelly or corrosion-retardant material to both battery terminals.
6. Secure oxygen sensor connector with new cable straps.
6. Install seat. See SEAT, INSTALLATION, Section 2.

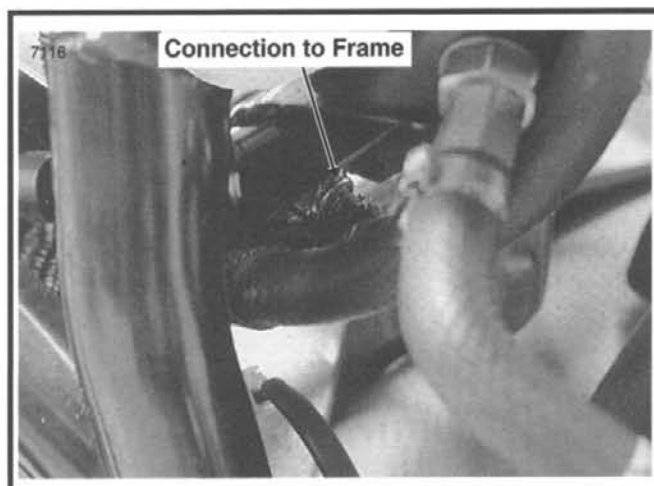


Figure 7-37. Negative Battery Cable

STORAGE

WARNING

Always store batteries where they cannot be reached by children. Contact with the battery's sulfuric acid could result in death or serious injury.

CAUTION

The electrolyte in a discharged battery will freeze if exposed to freezing temperatures. Freezing may crack the battery case and buckle battery plates.

If the motorcycle will not be operated for several months, such as during the winter season, remove the battery from the motorcycle and fully charge. See CHARGING BATTERY.

Self-discharge is a normal condition and occurs continuously at a rate that depends on the ambient temperature and the battery's state of charge. Batteries discharge at a faster rate at higher ambient temperatures. To reduce the self-discharge rate, store battery in a cool (not freezing), dry place. See Figure 7-38.

Charge the battery every month if stored at temperatures below 60° F. (16° C). Charge the battery more frequently if stored in a warm area above 60° F. (16° C).

NOTE

The H-D Battery Tender Automatic Battery Charger (P/N 99863-93TA) may be used to maintain battery charge for extended periods of time without risk of overcharging or boiling.

When returning a battery to service after storage, refer to the instructions under CHARGING BATTERY.

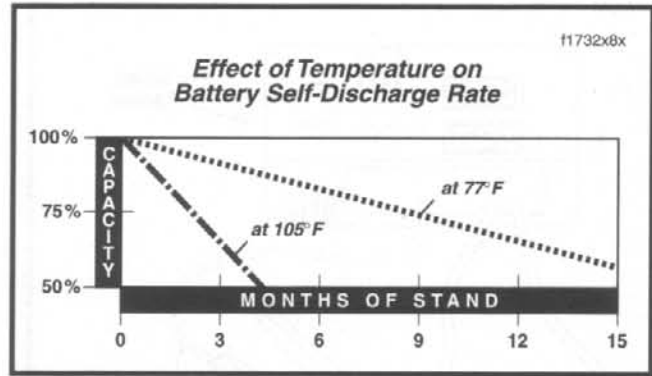


Figure 7-38. Battery Self-Discharge Rate

Battery Stocking and Selling

All Buell dealers should maintain a fresh stock of batteries by rotating and selling them on a "first in, first out" basis. All batteries must be sold within 12 months of the date code which appears on a round sticker below the warranty tag on the left side of the battery (positive terminal side). See Figure 7-39.

The date code sticker consists of both an alpha and numeric character that indicates the date the battery was manufactured. While the alpha character signifies the month, the numeric character indicates the year. Looking at the date code sticker at the bottom of Figure 1, we can see that the battery was manufactured in August, 1999.

BATTERY DATE CODE			
Alpha Character	Month	Numeric Character	Year
A	January	8	1998
B	February	9	1999
C	March	0	2000
D	April	1	2001
E	May	2	2002
F	June		
G	July		
H	August		
J	September		
K	October		
L	November		
M	December		

When a new battery is sold from stock, the battery must also be made to reflect the date of sale. To accomplish this, peel off both the month and year on the right side of the warranty tag.

If the date of sale occurs after the 15th day of the month, advance the date to the next month. For example, if the battery is sold on July 22, peel off the month of August, which is abbreviated on the tag as "AU." To determine the correct number to peel off for the year, just reference the last digit of the current year. Therefore, the number "9" is peeled off to signify the year 1999.

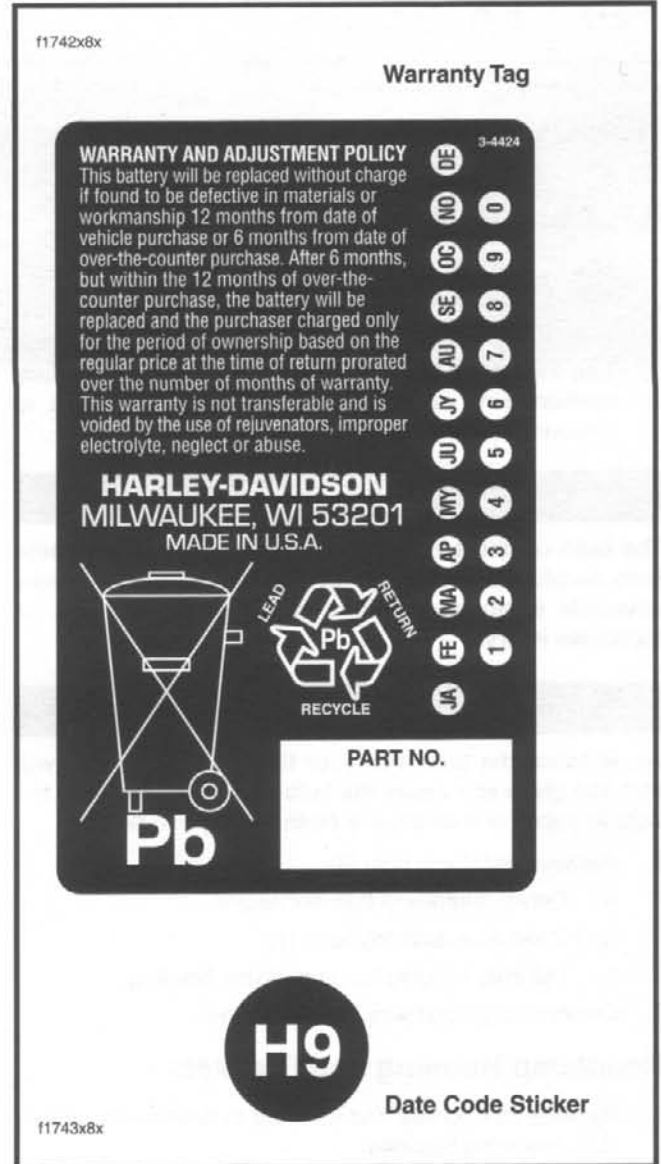


Figure 7-39. Warranty Tag/Date Code Stickers

REMOVAL

Headlamp Bulb

1. See Figure 7-40. Loosen screw (9) at bottom of headlamp.
2. Pry headlamp (8) from headlamp housing (12).
3. See Figure 7-41. Press retaining clip (4) and remove position lamp bulb (3) from headlamp. Twist bulb to remove from harness.

CAUTION

The bulb contains Halogen gas under pressure. Handle bulb careful and wear eye protection. Failure to follow adequate safety precautions could result in minor or moderate injury.

CAUTION

Never touch the bulb with your fingers. Fingerprints will etch the glass and cause the bulb to fail. Always wrap the bulb in paper or a clean, dry cloth during handling.

4. Remove headlamp bulb (6).
 - a. Detach headlamp bulb connector.
 - b. Open wire retaining latch (1).
 - c. Pull bulb housing from headlamp housing.
5. Disconnect ground wire from headlamp.

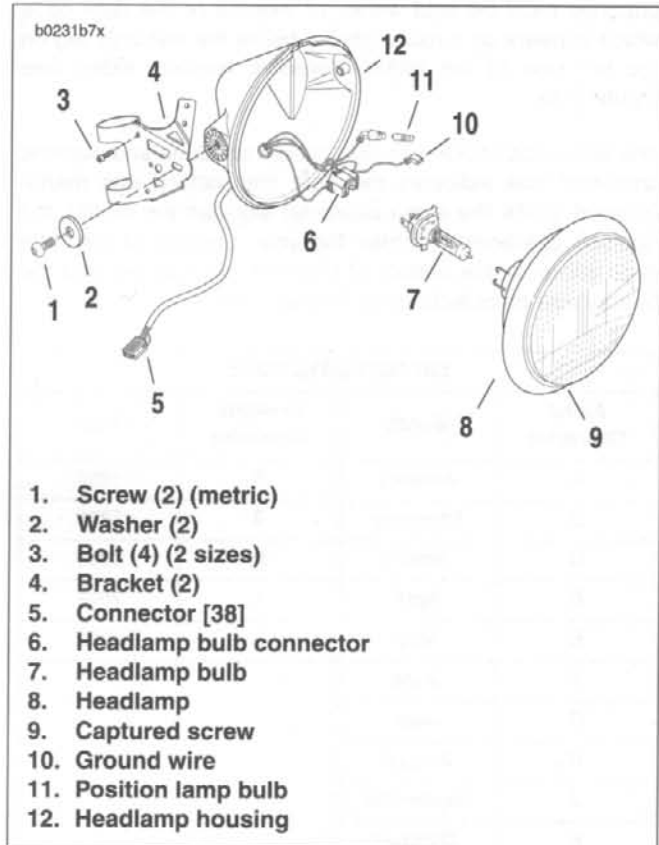
Headlamp Housing and Brackets

1. Remove four screws and washers to detach windscreen from mounting brackets.

WARNING

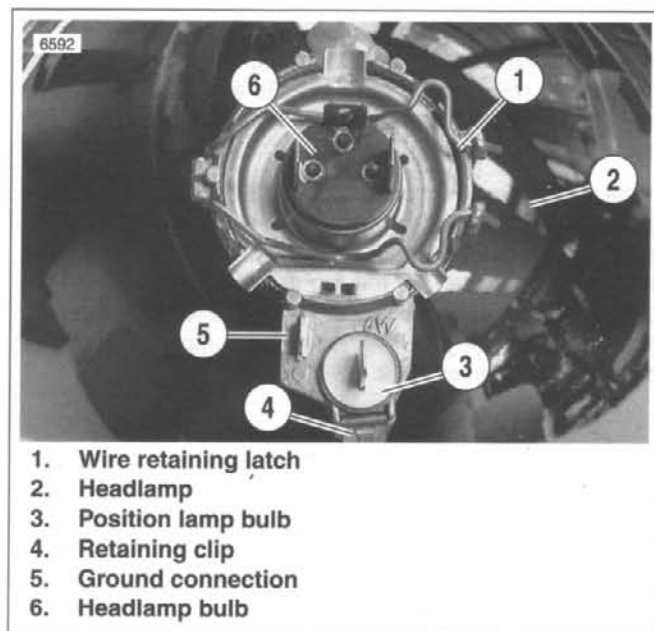
The gasoline in the fuel supply line downstream of the fuel pump is under high pressure (49 psi [338 kPa]). To avoid an uncontrolled discharge or spray of gasoline, always purge the system of high pressure gas before attaching fuel pressure gauge. Gasoline is extremely flammable and highly explosive. Inadequate safety precautions could result in death or serious injury.

2. Purge fuel line and remove fuel tank. See 4.34 FUEL TANK.
3. See Figure 7-42. Cut as many cable straps as necessary to access headlamp connector [38] along right side frame tube. Detach connector [38] from wiring harness.
4. See Figure 7-40. Remove screw (1) (metric) and washer (2) on each side.
5. Remove headlamp housing from vehicle.
6. Remove headlamp brackets.
 - a. Remove front turn signals. See 7.14 TURN SIGNALS.
 - b. Remove four bolts (3) from weldnuts.
 - c. Remove front forks and headlamp brackets (4). See 2.24 FRONT FORK.



1. Screw (2) (metric)
2. Washer (2)
3. Bolt (4) (2 sizes)
4. Bracket (2)
5. Connector [38]
6. Headlamp bulb connector
7. Headlamp bulb
8. Headlamp
9. Captured screw
10. Ground wire
11. Position lamp bulb
12. Headlamp housing

Figure 7-40. Headlamp Assembly



1. Wire retaining latch
2. Headlamp
3. Position lamp bulb
4. Retaining clip
5. Ground connection
6. Headlamp bulb

Figure 7-41. Headlamp Bulbs

INSTALLATION

Headlamp Bulb

CAUTION

The bulb contains Halogen gas under pressure. Handle bulb carefully and wear eye protection. Failure to follow adequate safety precautions could result in minor or moderate injury.

CAUTION

Never touch the bulb with your fingers. Fingerprints will etch the glass and cause the bulb to fail. Always wrap the bulb in paper or a clean, dry cloth during handling.

1. See Figure 7-41. Install headlamp bulb (6).
 - a. Align tabs on bulb housing with tabs on headlamp. Insert bulb.
 - b. Close the wire retaining latch (1).
 - c. Connect the headlamp bulb connector.

NOTE

When replacement is required, see your Buell dealer. Not using the specified bulb may cause charging system problems.

2. Insert position lamp bulb (3).
3. Connect ground wire (5).
4. See Figure 7-40. Place headlamp assembly in housing (12). Tighten screw (9).

WARNING

Check for proper headlamp operation before riding motorcycle. Visibility is a major concern for motorcyclists. Failure to have proper headlamp operation could result in death or serious injury.

5. Check headlamp for proper operation. If operation fails, reread procedure and verify that all steps were performed.
 - a. Turn ignition key switch to IGN.
 - b. See Figure 7-43. Check headlamp LOW (2) and HIGH beam (1) settings.
 - c. Set headlamp to LOW beam (2). Press passing lamp switch (3). Headlamp should flash HIGH beam for as long as the switch is pressed.
 - d. Turn ignition key switch to OFF.
6. Align headlamp. See 1.25 HEADLAMP.

Headlamp Housing and Brackets

1. Install headlamp brackets.
 - a. Install front forks through triple clamps and headlamp brackets. See 2.24 FRONT FORK.
 - b. See Figure 7-40. Install four bolts (3).
 - c. Attach front turn signals. See 7.14 TURN SIGNALS.
2. See Figure 7-42. Route headlamp wire harness between front forks and along right side frame tube. Attach connector [38] to wiring harness. Fasten wiring harness to frame with **new** cable straps.

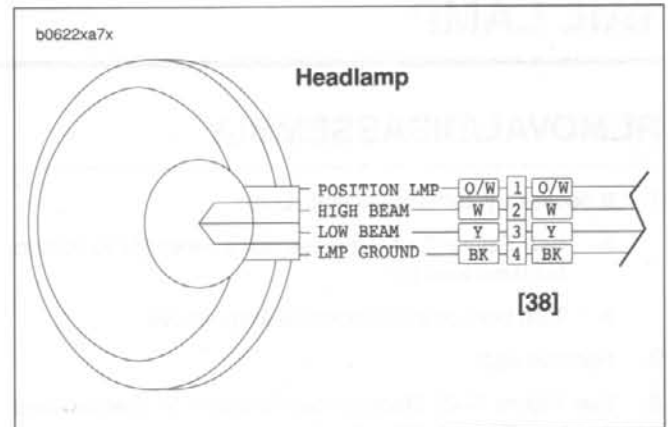


Figure 7-42. Headlamp Connector [38]

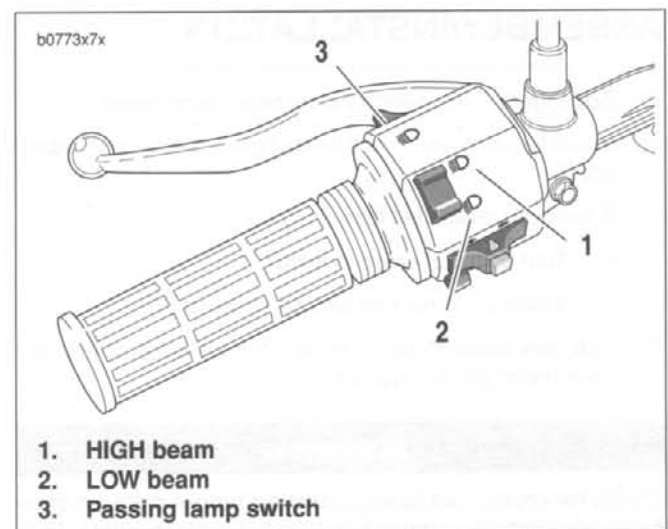


Figure 7-43. Headlamp Controls

3. See Figure 7-40. Install headlamp housing using two screws (1) (metric) and washers (2). Tighten to 6-8 ft-lbs (8.1-10.8 Nm).

WARNING

Check for proper headlamp operation before riding motorcycle. Visibility is a major concern for motorcyclists. Failure to have proper headlamp operation could result in death or serious injury.

4. Check headlamp for proper operation. If operation fails, reread procedure and verify that all steps were performed.

WARNING

After installing seat, pull upward on front of seat to be sure it is locked in position. If seat is loose, it could shift during vehicle operation and startle the rider, causing loss of control which could result in death or serious injury.

5. Install fuel tank and seat.
6. Align headlamp. See 1.25 HEADLAMP.

REMOVAL/DISASSEMBLY

1. If necessary, remove tail lamp bulb.
 - a. See Figure 7-44. Remove two screws (1) to detach tail lamp lens (2).
 - b. Turn bulb counterclockwise and remove.
2. Remove seat.
3. See Figure 7-45. Remove two locknuts (6) (metric) and washers (5) from within trunk.
4. Disconnect the three terminals and remove tail lamp.

ASSEMBLY/INSTALLATION

1. See Figure 7-45. Attach the three tail lamp wires.
2. Install tail lamp using two locknuts (6) (metric) and washers (5).
3. If removed, install tail lamp bulb (3).
 - a. Turn bulb clockwise to install.
 - b. Install tail lamp lens with two screws (1).
4. Use **new** cable straps to bundle the tail lamp wiring harness under the tail section.

WARNING

Check for proper tail lamp operation before riding motorcycle. Visibility is a major concern for motorcyclists. Failure to have proper lamp operation could result in death or serious injury.

5. Check tail lamp for proper operation. If operation fails, reread procedure and verify that all steps were performed.
 - a. Turn ignition key switch to IGN.
 - b. Check for tail lamp illumination.
 - c. Squeeze front brake hand lever. Check for brake lamp illumination. Release front brake hand lever.
 - d. Press rear brake pedal. Check for brake lamp illumination. Release rear brake pedal.
 - e. Turn ignition key switch to OFF.

WARNING

After installing seat, pull upward on front of seat to be sure it is locked in position. If seat is loose, it could shift during vehicle operation and startle the rider, causing loss of control which could result in death or serious injury.

6. Install seat.

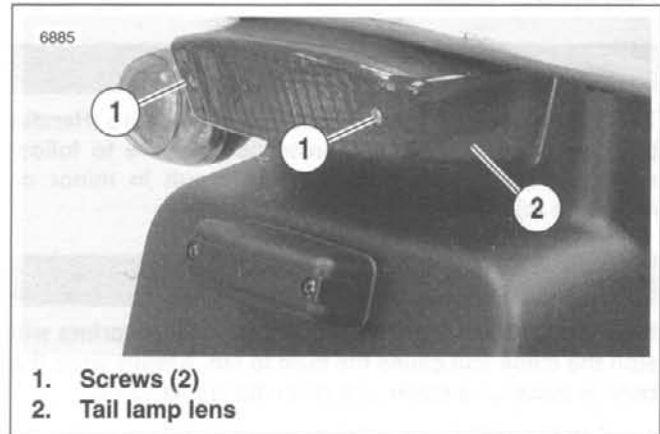


Figure 7-44. Turn Signal Lens

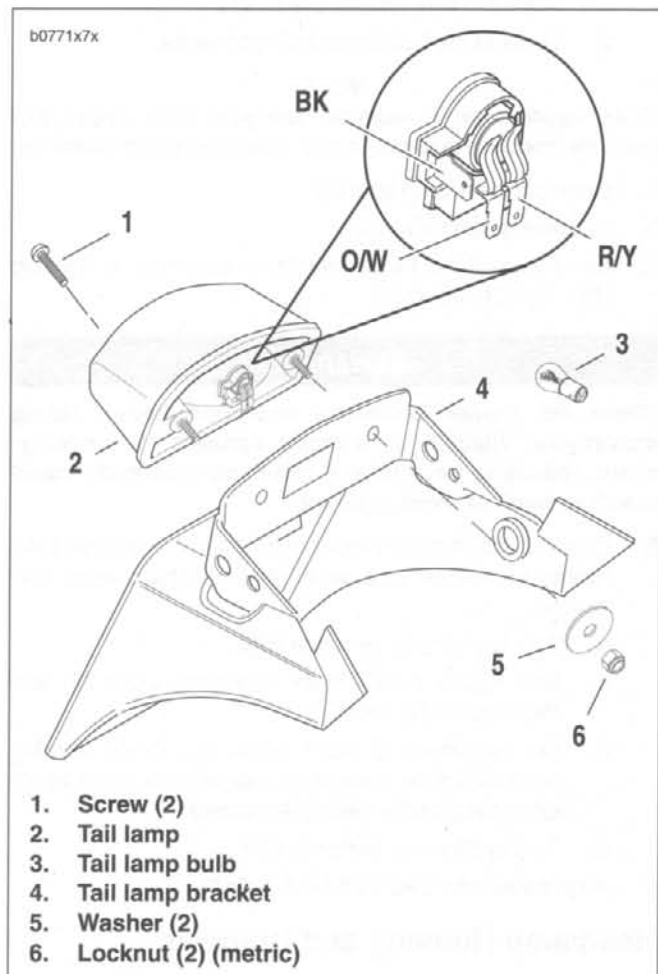


Figure 7-45. Tail Lamp

REMOVAL

Bulbs

Remove screw on back of housing to access turn signal bulbs.

Front

1. Remove windscreen and headlamp. See 7.12 HEADLAMP.
2. See Figure 7-46. Disconnect bullet connectors on turn signal wires.
3. See Figure 7-47. Remove nut (1) and lockwasher (2) from mounting bracket (3).
4. Remove turn signals (4) and standoffs (5).
5. Pull bullet connectors (6) and wiring through hole in mounting bracket (3).

Rear

1. Remove trunk. See 2.45 TRUNK.
2. Cut cable straps to access bullet connectors under tail section.
3. See Figure 7-48. Disconnect bullet connectors on turn signal wires.
4. See Figure 7-49. Remove nut (1) and lockwasher (2).
5. Remove turn signal (3) from outside of trunk.

INSTALLATION

Front

1. See Figure 7-47. Insert bullet connectors (6) through hole in mounting bracket (3).
2. Install turn signal (4) and standoffs (5) using lockwasher (2) and nut (1). Tighten to 25-28 **in-lbs** (2.8-3.2 Nm).
3. Attach bullet connectors on turn signal wires as shown in Figure 7-46.
4. Install and align headlamp. See 7.12 HEADLAMP.

⚠ WARNING

Check for proper turn signal operation before riding motorcycle. Visibility is a major concern for motorcyclists. Failure to have proper turn signal operation could result in death or serious injury.

5. Check turn signals for proper operation. If operation fails, reread procedure and verify that all steps were performed.
 - a. Turn ignition key switch to IGN.
 - b. Activate left turn signals using switch on left handlebar. Front and rear left turn signals must flash.
 - c. Activate right turn signals using switch on left handlebar. Front and rear right turn signals must flash.
 - d. Turn ignition key switch to OFF.

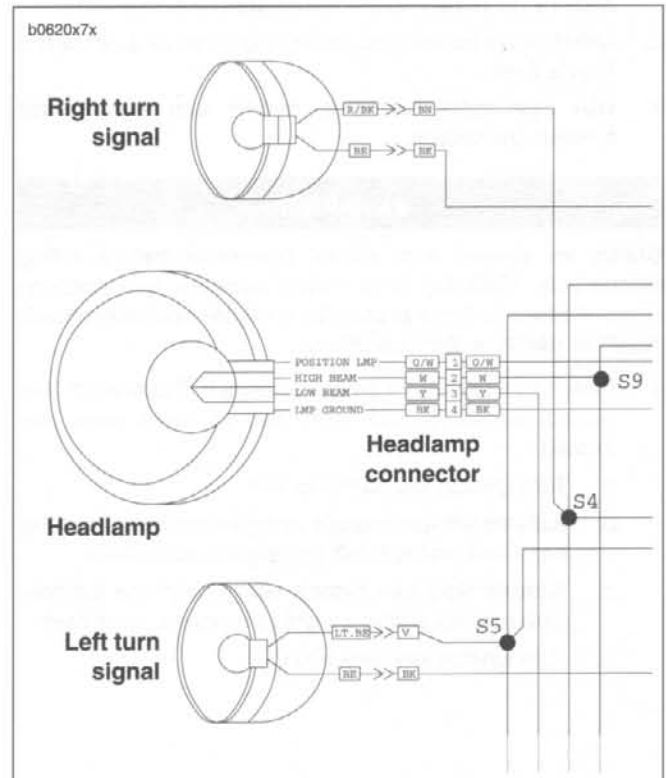


Figure 7-46. Front Turn Signal Connections

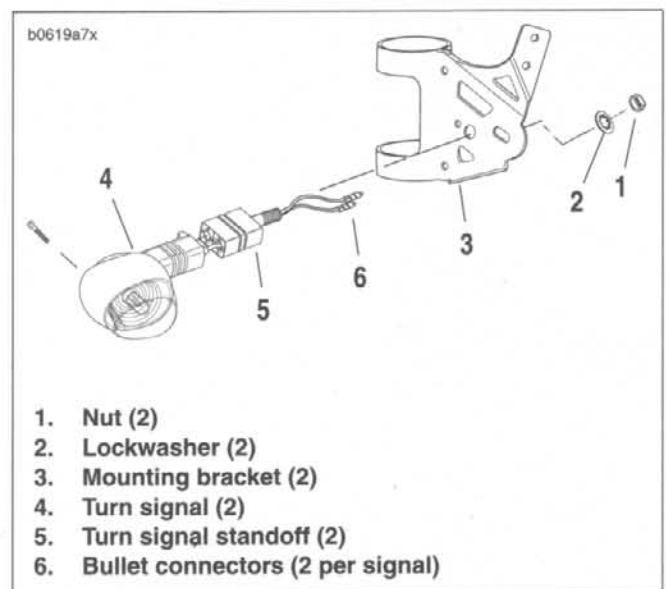


Figure 7-47. Front Turn Signals

Rear

1. See Figure 7-49. Insert bullet connectors through rear hole in trunk. Attach turn signal (3) using lockwasher (2) and nut (1). Tighten to 96-120 **in-lbs** (10.8-13.6 Nm).
2. Attach bullet connectors on turn signal wires as shown in Figure 7-48.
3. Use **new** cable straps to bundle turn signal wires beneath tail section.

WARNING

Check for proper turn signal operation before riding motorcycle. Visibility is a major concern for motorcyclists. Failure to have proper turn signal operation could result in death or serious injury.

4. Check turn signals for proper operation. If operation fails, reread procedure and verify that all steps were performed.
 - a. Turn ignition key switch to IGN.
 - b. Activate left turn signals using switch on left handlebar. Front and rear left turn signals must flash.
 - c. Activate right turn signals using switch on left handlebar. Front and rear right turn signals must flash.
 - d. Turn ignition key switch to OFF.

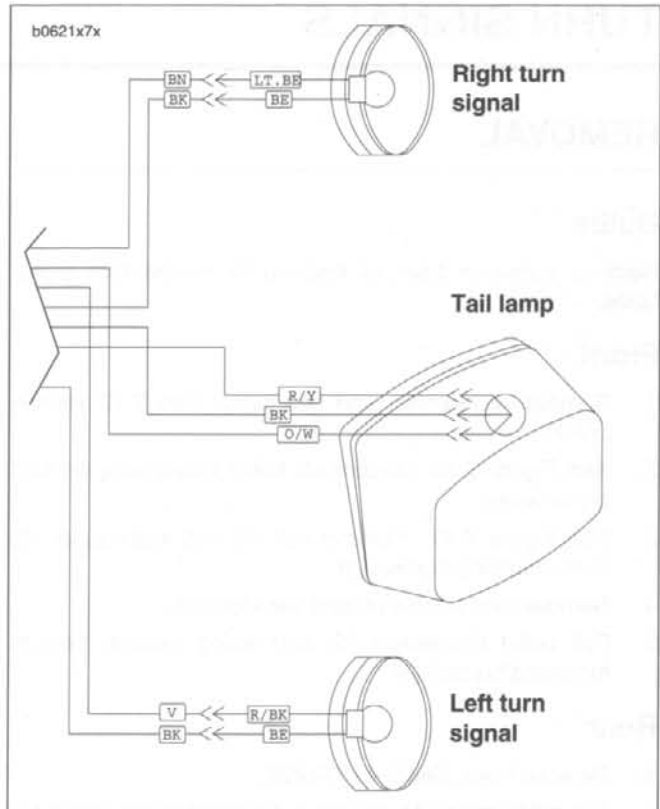


Figure 7-48. Rear Turn Signal Connections

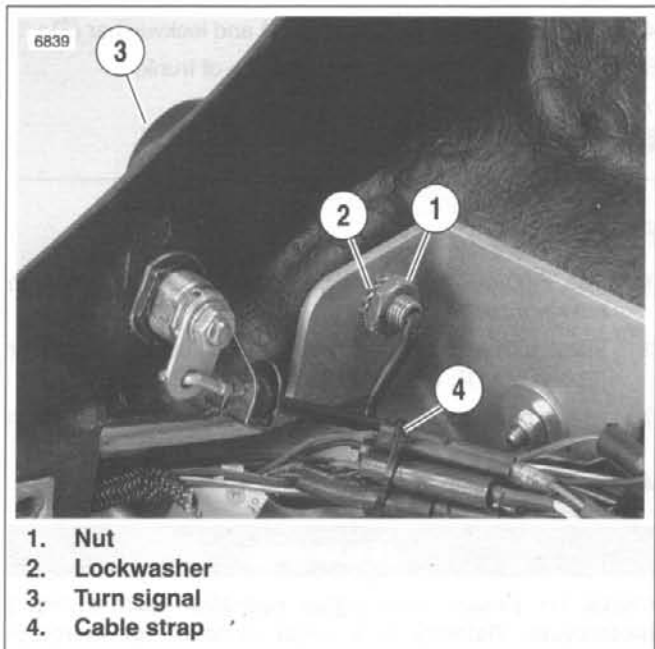


Figure 7-49. Rear Turn Signals

MODEL YEAR CHANGE

The turn signal flasher has been relocated under the seat on all 2000 Model Buell X1 motorcycles.

REMOVAL

NOTE

The turn signal flasher is not repairable. Replace flasher upon failure.

1. See Figure 7-50. Remove nut (1) to free flasher (2) from bottom of ECM bracket.
2. Detach 3-place connector (3) [30] from flasher body.

INSTALLATION

1. See Figure 7-50. Attach 3-place connector (3) [30] to flasher.
2. Install nut (1) to secure flasher (2) to bottom of ECM bracket.

WARNING

Check for proper turn signal operation before riding motorcycle. Visibility is a major concern for motorcyclists. Failure to have proper turn signal operation could result in death or serious injury.

3. Check turn signals for proper operation. If operation fails, reread procedure and verify that all steps were performed.
 - a. Turn ignition key switch to IGN.
 - b. See Figure 7-51. Activate left turn signals using switch on left handlebar. Front and rear left turn signals must flash.
 - c. Activate right turn signals using switch on left handlebar. Front and rear right turn signals must flash.
 - d. Turn ignition key switch to OFF.

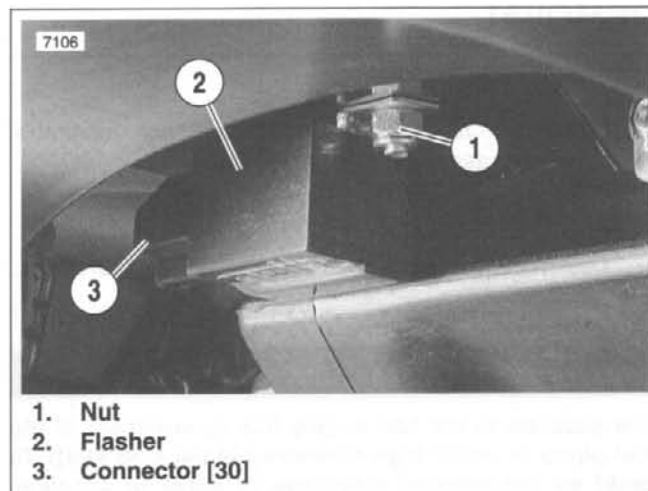


Figure 7-50. Turn Signal Flasher (1999 Shown)

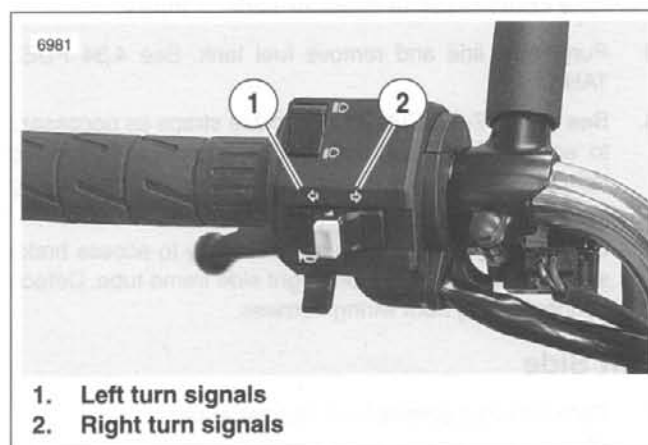


Figure 7-51. Turn Signal Controls

REMOVAL

NOTE

The individual handlebar switches are not repairable. Replace switch assembly upon switch failure.

Right Side

1. Detach throttle cables. See 2.31 THROTTLE CONTROL.
2. Remove seat.

WARNING

The gasoline in the fuel supply line downstream of the fuel pump is under high pressure (49 psi [338 kPa]). To avoid an uncontrolled discharge or spray of gasoline, always purge the system of high pressure gas before attaching fuel pressure gauge. Gasoline is extremely flammable and highly explosive. Inadequate safety precautions could result in death or serious injury.

3. Purge fuel line and remove fuel tank. See 4.34 FUEL TANK.
4. See Figure 7-52. Cut as many cable straps as necessary to access right handlebar switch connector [22] along right side frame tube. Detach connector [22] from wiring harness.
5. Cut as many cable straps as necessary to access brake switch connector [21] along right side frame tube. Detach connector [21] from wiring harness.

Left Side

1. Remove three screws from handlebar switch.
2. Separate switch housings and remove from handlebar.
3. Remove seat.

WARNING

The gasoline in the fuel supply line downstream of the fuel pump is under high pressure (49 psi [338 kPa]). To avoid an uncontrolled discharge or spray of gasoline, always purge the system of high pressure gas before attaching fuel pressure gauge. Gasoline is extremely flammable and highly explosive. Inadequate safety precautions could result in death or serious injury.

4. Purge fuel line and remove fuel tank. See 4.34 FUEL TANK.
5. See Figure 7-54. Cut as many cable straps as necessary to access left handlebar switch connector [24] along right side frame tube. Detach connector [24] from wiring harness.
6. Cut as many cable straps as necessary to access clutch switch connector [95] along right side frame tube. Detach connector [95] from wiring harness.

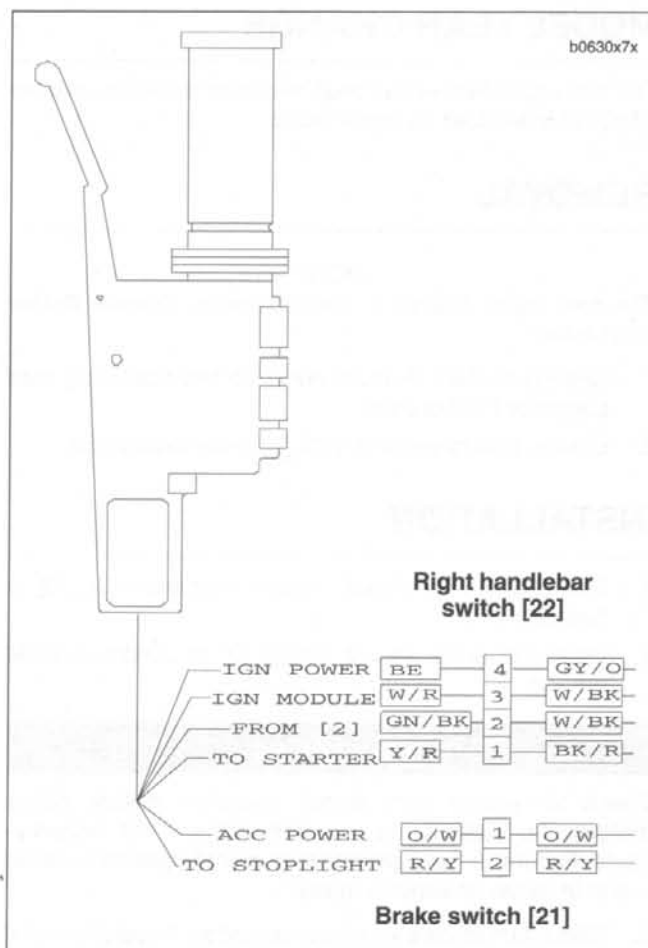


Figure 7-52. Right Handlebar Switch Connection

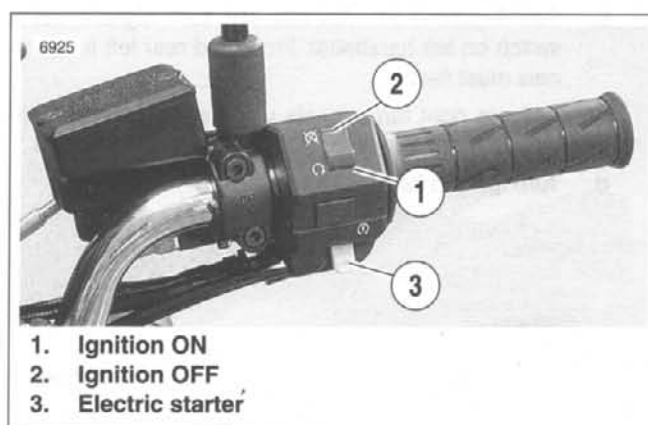


Figure 7-53. Right Handlebar Switches

INSTALLATION

Right Side

1. Attach throttle cables to hand control. See 2.31 THROTTLE CONTROL.
2. Position housings on right handlebar by engaging locating pin on front housing with hole in handlebar. Attach housings with two screws (1, 6), installing longer screw on bottom. Tighten to 12-17 in-lbs (1.4-1.9 Nm).
3. See Figure 7-56. Route switch housing wiring harness between front forks and along right side frame tube. Attach connector [22] and, if necessary, connector [21] to wiring harness. Fasten wiring harness to frame with **new** cable straps.
4. Install fuel tank. See 4.34 FUEL TANK.

WARNING

After installing seat, pull upward on front of seat to be sure it is locked in position. If seat is loose, it could shift during vehicle operation and startle the rider, causing loss of control which could result in death or serious injury.

5. Install seat.
6. Adjust throttle cables. See 1.22 THROTTLE CABLES.

WARNING

Check all handlebar switch operations before riding motorcycle. Visibility is a major concern for motorcyclists. Handlebar switches not operating properly could result in death or serious injury.

7. Check handlebar switch for proper operation. If operation fails, reread procedure and verify that all steps were performed.
 - a. Turn ignition key switch to IGN.
 - b. Start motorcycle.
 - c. Turn ignition key switch to OFF.

Left Side

1. Attach switch housing to handlebar with three screws. Tighten to 25-33 in-lbs (2.8-3.7 Nm).
2. See Figure 7-57. Route switch housing wiring harness between front forks and along right side frame tube. Attach connector [24] and, if necessary, connector [95] to wiring harness. Fasten wiring harness to frame with **new** cable straps.
3. Install fuel tank. See 4.34 FUEL TANK

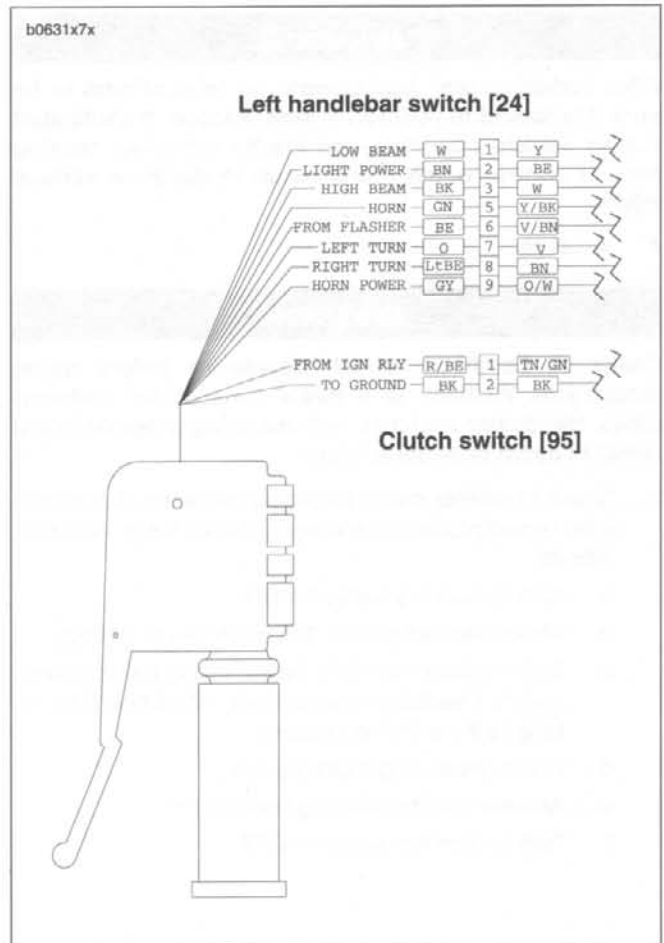


Figure 7-54. Left Handlebar Switch Connection

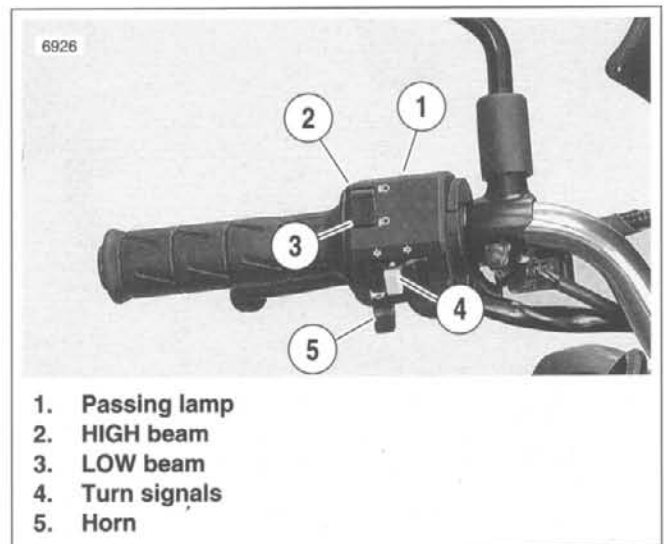


Figure 7-55. Left Handlebar Switches

WARNING

After installing seat, pull upward on front of seat to be sure it is locked in position. If seat is loose, it could shift during vehicle operation and startle the rider, causing loss of control which could result in death or serious injury.

4. Install seat.

WARNING

Check all handlebar switch operations before riding motorcycle. Visibility is a major concern for motorcyclists. Handlebar switches not operating properly could result in death or serious injury.

5. Check handlebar switch for proper operation. If operation fails, reread procedure and verify that all steps were performed.
 - a. Turn ignition key switch to IGN.
 - b. Check headlamp LOW and HIGH beam settings.
 - c. Set headlamp to LOW beam. Press passing lamp switch. Headlamp should flash HIGH beam for as long as the switch is pressed.
 - d. Check left and right turn signals.
 - e. Activate horn by pressing horn switch.
 - f. Turn ignition key switch to OFF.

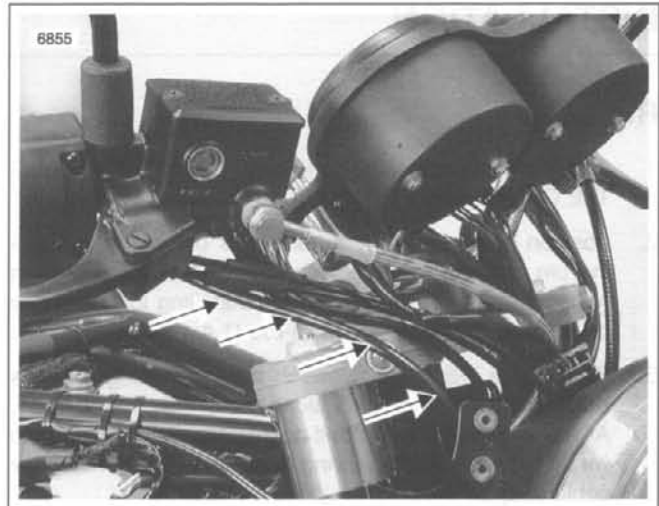


Figure 7-56. Routing Handlebar Wires, Right



Figure 7-57. Routing Handlebar Wires, Left

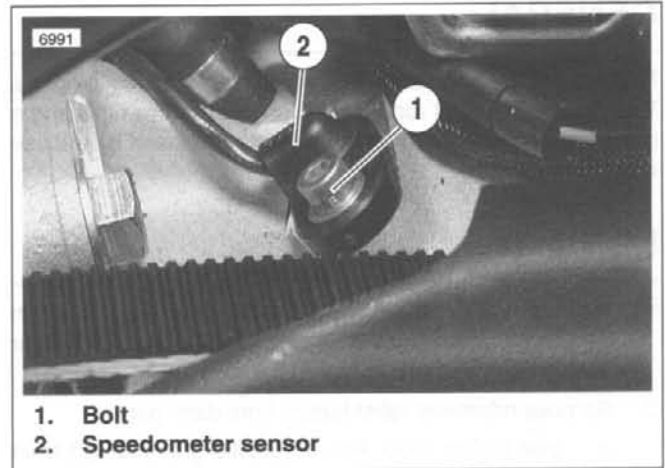
SPEEDOMETER SENSOR

REMOVAL

1. See Figure 7-58. Remove bolt (1) to detach speedometer sensor (2) from crankcase.
2. See Figure 7-59. Disconnect 3-place Deutsch connector [65] under battery tray.

INSTALLATION

1. See Figure 7-58. Install bolt (1) to attach speedometer sensor (2) to crankcase.
2. Connect speedometer sensor connector [65] to wiring harness.



1. Bolt
2. Speedometer sensor

Figure 7-58. Speedometer Sensor

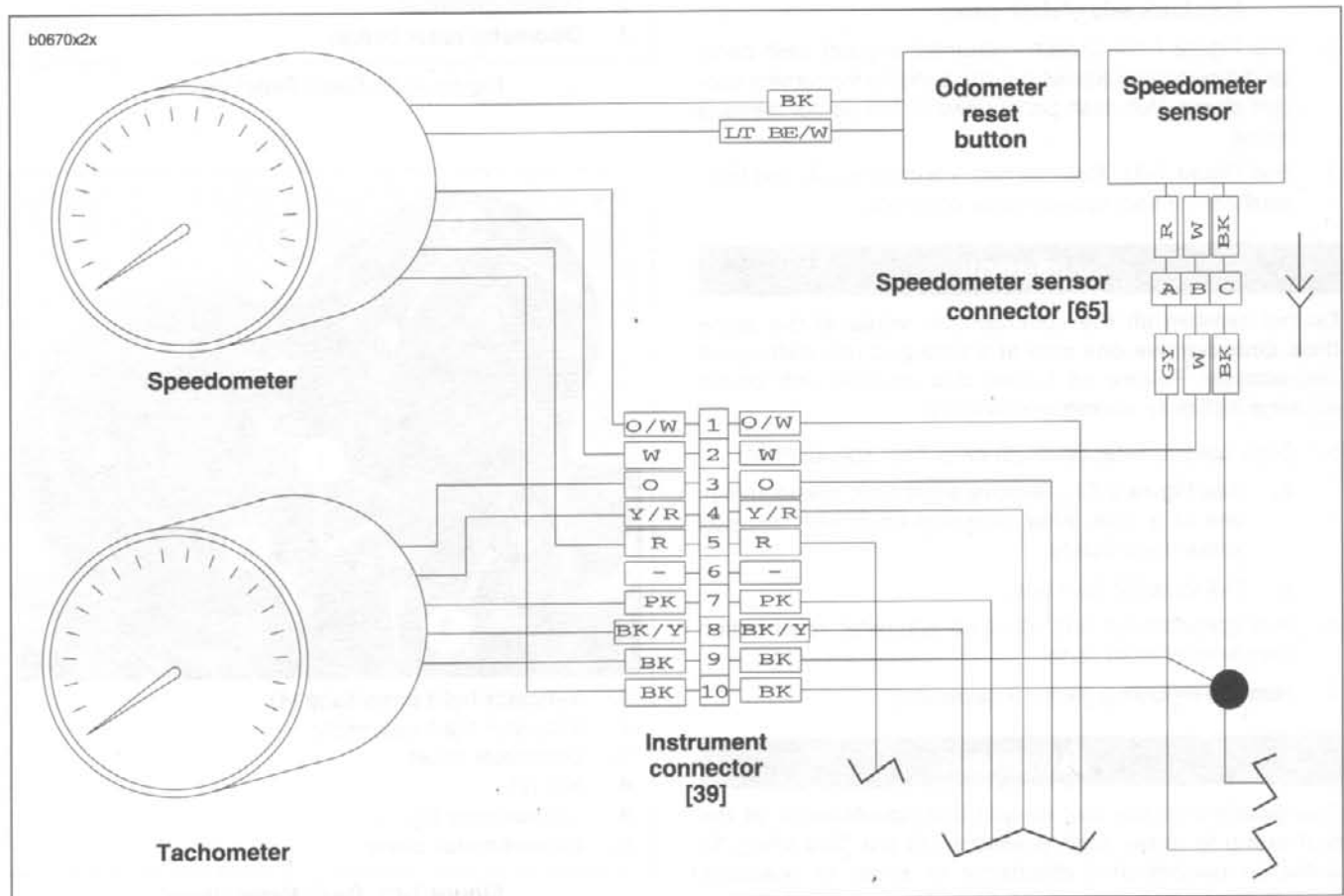


Figure 7-59. Speedometer Sensor Wiring

GENERAL

Replace the speedometer if the unit is not working properly. The instrument is not repairable. However, before replacing a component, check that the problem is not caused by a loose wire connection.

REMOVAL

1. Gain access to the back side of the dash panel. Detach windscreen from mounting brackets by removing four screws and washers.
2. Remove odometer reset button from dash panel.
 - a. See Figure 7-60. Pry off plastic grommet (2) from front of odometer reset button (3).
 - b. See Figure 7-61. Remove odometer reset button (3) from back side of dash panel.
3. See Figure 7-60. Detach instrument support dash panel by removing two screws holding panel to instrument support clamp. Pull dash panel upward, but do not damage wiring.
4. See Figure 7-61. Remove two nuts (metric) (4) and lockwashers (5) from speedometer cover (6).

CAUTION

Do not remove all the speedometer wires at the same time. Only remove one wire at a time and reinstall screw immediately. Failure to follow this caution will cause extreme difficulty during reassembly.

5. Slide speedometer cover (6) away from speedometer.
 - a. See Figure 2-62. Remove wires from speedometer, one at a time. After removing each wire, reinstall screw immediately.
 - b. Pull lamp (5) from bore.
6. Pull speedometer and attached odometer reset button from front of dash panel.
7. Remove mounting gasket if necessary.

WARNING

The gasoline in the fuel supply line downstream of the fuel pump is under high pressure (49 psi [338 kPa]). To avoid an uncontrolled discharge or spray of gasoline, always purge the system of high pressure gas before attaching fuel pressure gauge. Gasoline is extremely flammable and highly explosive. Inadequate safety precautions could result in death or serious injury.

8. If necessary, replace speedometer wiring.
 - a. Purge fuel line and remove fuel tank. See 4.34 FUEL TANK.
 - b. Cut cable straps on wiring harness. Detach wires at plug connector.

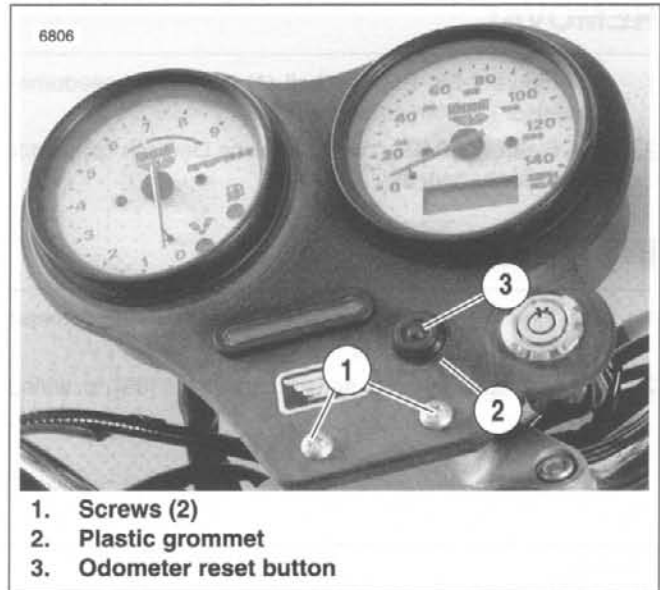


Figure 7-60. Dash Panel (Front)

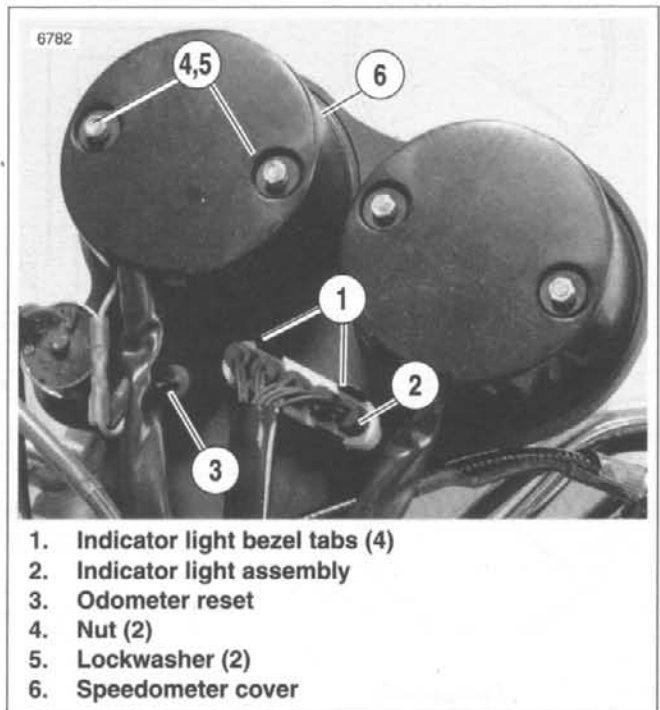


Figure 7-61. Dash Panel (Back)

NOTE

Tachometer and speedometer wiring share a common connector [39] on the wiring harness.

INSTALLATION

1. If replacing speedometer wiring:
 - a. See Figure 2-63. Attach wires at plug connector.
 - b. Feed wiring through to dash panel and secure with ties on electrical cabling.
 - c. Install fuel tank. See 4.34 FUEL TANK.
2. Install odometer reset.
 - d. See Figure 7-61. Install odometer reset button (3) from back side of dash panel.
 - e. See Figure 7-60. Secure odometer reset button (3) on front of dash panel with plastic grommet (2).
3. Install rubber mounting gasket if removed.
 - a. Apply 2 drops of adhesive (Permabond 105) at each end of notches in gasket.
 - b. Apply 1 drop of adhesive (Permabond 105) at top of gasket and bottom of gasket.
 - c. Position mounting gasket in dash panel.
4. Install speedometer in dash panel.
 - a. Feed wires through opening in speedometer cover.
 - b. Slide speedometer into rubber mounting gasket.
 - c. See Figure 2-62. Insert lamp (5).
 - d. Attach wires to speedometer as shown.
5. See Figure 7-61. Install speedometer cover (6).
 - a. Place speedometer cover over speedometer. Align posts on back of speedometer with holes in cover. Drain hole must be at the bottom of cover.
 - b. Apply LOCTITE THREADLOCKER 243 (blue) to both nuts (metric) (4).
 - c. Fasten cover (6) to speedometer using two nuts (metric) (4) and lockwashers (5).
6. See Figure 7-60. Position dash panel on instrument support clamp.
 - a. Attach dash panel using two screws (1) to hold panel to clamp.
 - b. Tighten screws to 4-5 ft-lbs (5.4-6.8 Nm).
 - c. Attach windscreen to mounting brackets using four screws and washers.

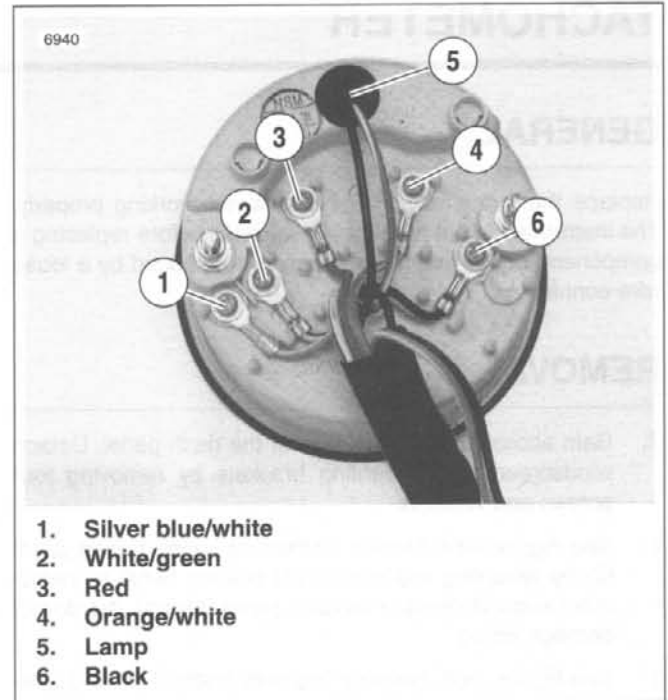


Figure 2-62. Speedometer Wiring

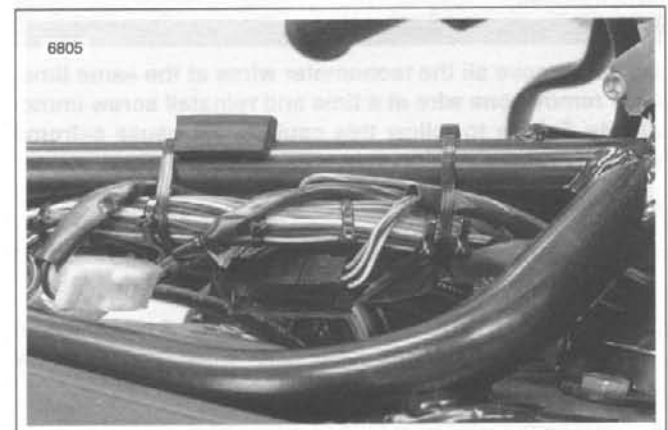


Figure 2-63. Speedometer Wiring Connector Locations (Approximate)

GENERAL

Replace the tachometer if the unit is not working properly. The instrument is not repairable. However, before replacing a component, check that the problem is not caused by a loose wire connection.

REMOVAL

1. Gain access to the back side of the dash panel. Detach windscreen from mounting brackets by removing four screws and washers.
2. See Figure 7-64. Detach instrument support dash panel (2) by removing two screws (1) holding panel to instrument support clamp. Pull dash panel upward, but do not damage wiring.
3. See Figure 7-65. Remove two nuts (metric) (3) and lock-washers (4) from tachometer cover (5).
4. Slide tachometer cover (5) away from tachometer.

CAUTION

Do not remove all the tachometer wires at the same time. Only remove one wire at a time and reinstall screw immediately. Failure to follow this caution will cause extreme difficulty during reassembly.

5. See Figure 7-66. Remove wires from tachometer.
 - a. Remove three lamps (1, 2, and 3) and attached wires.
 - b. Loosen screws and remove wires (4, 5 and 6) one at a time. After removing each wire, reinstall screw immediately.
6. Pull tachometer from front of dash panel.
7. Remove rubber mounting gasket if necessary.

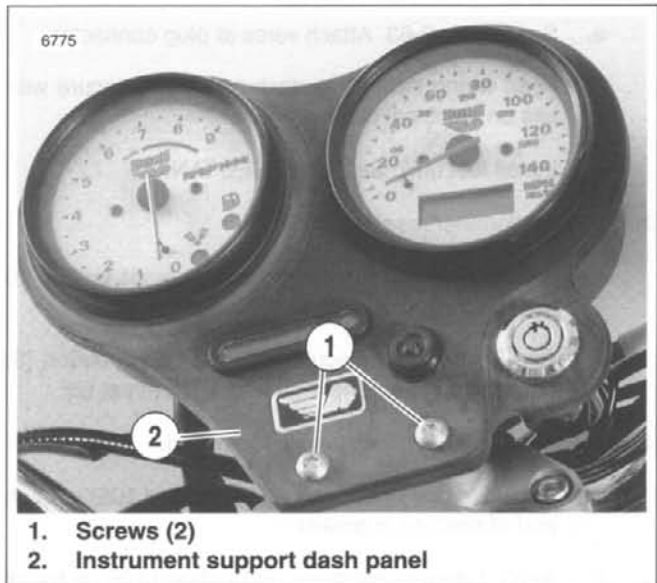
WARNING

The gasoline in the fuel supply line downstream of the fuel pump is under high pressure (49 psi [338 kPa]). To avoid an uncontrolled discharge or spray of gasoline, always purge the system of high pressure gas before attaching fuel pressure gauge. Gasoline is extremely flammable and highly explosive. Inadequate safety precautions could result in death or serious injury.

8. If necessary, replace tachometer wiring.
 - a. Purge fuel line and remove fuel tank. See 4.34 FUEL TANK.
 - b. Cut cable straps on wiring harness. See Figure 7-67. Detach wires at plug connector.

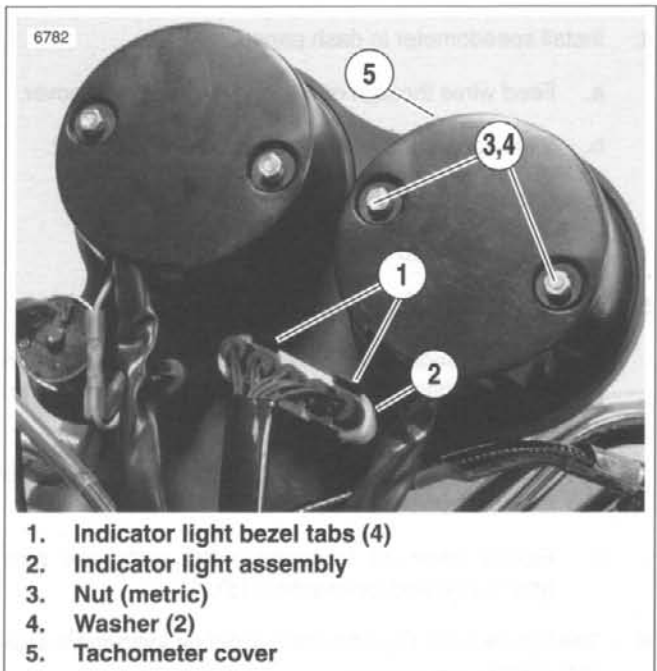
NOTE

Tachometer and speedometer wiring share a common connector [39] on the wiring harness.



1. Screws (2)
2. Instrument support dash panel

Figure 7-64. Front Dash Panel



1. Indicator light bezel tabs (4)
2. Indicator light assembly
3. Nut (metric)
4. Washer (2)
5. Tachometer cover

Figure 7-65. Back Dash Panel

INSTALLATION

1. If replacing tachometer wiring:
 - a. See Figure 7-67. Attach wires at plug connector.
 - b. Feed wiring through wiring harness to dash panel and secure with ties on electrical cabling.
 - c. Install fuel tank. See 4.34 FUEL TANK.
2. Install rubber mounting gasket if removed.
 - a. Apply 2 drops of adhesive (Permabond 105) at each end of notches in gasket.
 - b. Apply 1 drop of adhesive (Permabond 105) at top of gasket and bottom of gasket.
 - c. Position mounting gasket in dash panel.
3. Install tachometer in dash panel.
 - a. Feed wires through opening in tachometer cover.
 - b. Slide tachometer into rubber mounting gasket.
 - c. See Figure 7-66. Insert lamps (1, 2 and 3) into their appropriate bores.
 - d. Attach wires (4, 5 and 6) to tachometer as shown.
4. See Figure 7-66. Install tachometer cover (5).
 - a. Place tachometer cover over tachometer. Align posts on back of tachometer with holes in tachometer cover. Drain hole must be at the bottom of cover.
 - b. Apply LOCTITE THREADLOCKER 243 (blue) to both nuts (metric) (3).
 - c. Fasten cover (5) to tachometer using two nuts (metric) (3) and lockwashers (4).
5. See Figure 7-64. Position dash panel on instrument support clamp.
 - a. Attach dash panel using two screws (1) to hold panel to clamp.
 - b. Tighten screws to 4-5 ft-lbs (5.4-6.8 Nm).
 - c. Attach windscreen to mounting brackets using four screws and washers.

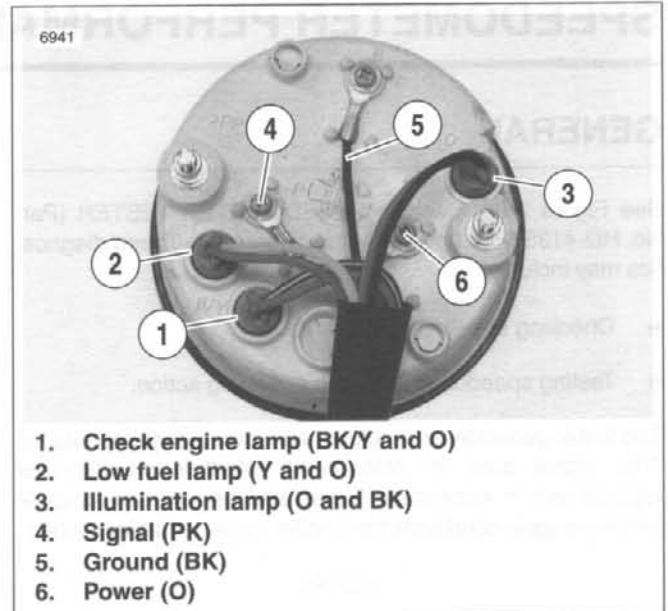


Figure 7-66. Tachometer Wiring

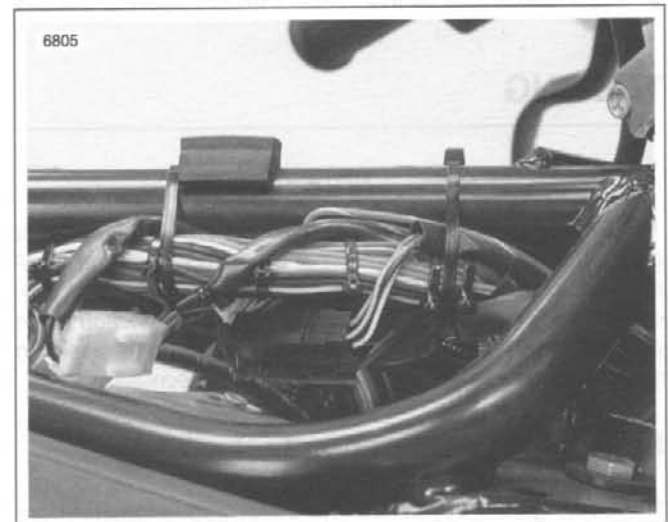


Figure 7-67. Tachometer Wiring Connector Locations (Approximate)

GENERAL

See Figure 7-68. Use the SPEEDOMETER TESTER (Part No. HD-41354) for speedometer diagnostics. These diagnostics may include:

- Checking speedometer operation.
- Testing speedometer needle sweeping action.

The tester generates a simulated speedometer sensor signal. This signal aids in determining whether speedometer replacement is necessary. It can also be used to simulate running engine conditions for ignition system troubleshooting.

NOTES

- Use the following procedures in conjunction with the manual supplied with the speedometer tester.
- Test results may be inaccurate if tester battery is low.

TESTING

NOTE

The SPEEDOMETER TESTER (Part No. HD-41354) cannot be used to verify the calibration of a speedometer and it will not verify the speedometer's function to support legal proceedings. Its purpose is to verify speedometer function when performing service diagnosis or repair. It can also assist in determining if speedometer replacement is necessary.

Speedometer Operation Test

1. See Figure 7-69. Locate the 3-place speedometer connector [65] under the battery tray and disconnect. Attach speedometer tester connector.
2. Place speedometer tester power switch in the ON position. Place signal switch in the OUT position.
3. Turn vehicle ignition switch ON.
4. Begin test.
 - a. Press ENTER on the tester keypad.
 - b. Enter a frequency from Table 7-2. Note that different markets use different frequencies.
 - c. Verify that speedometer display reads the corresponding speed. To change the test frequency, press CLEAR to cancel and enter the new frequency. Press ENTER to begin and reverify.

NOTE

The speedometer should be accurate within 0-4 MPH (0-6.5 KPH).

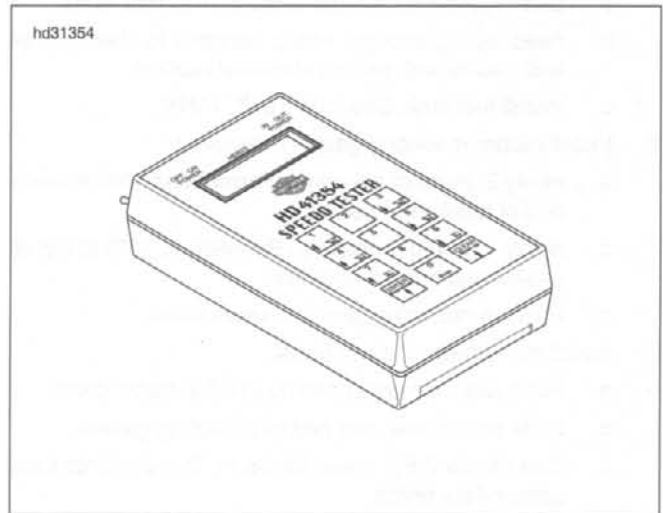


Figure 7-68. Speedometer Tester



Figure 7-69. Speedometer Sensor Connector (Battery Removed For Illustration Purposes Only)

Table 7-2. Speedometer Test Frequency in Hertz (Hz)

MARKET	20 MPH (30 KPH)	40 MPH (60 KPH)	60 MPH (100 KPH)	80 MPH (130 KPH)
USA	432	864	1296	1728
ENG	362	725	1088	1454
AUS, EUR	340	680	1134	1474
CAN, JPN, NZ	405	810	1350	1755

Speedometer Needle Sweep Test

The tester's sweep function moves the speedometer needle through the full range of movement. This allows for testing the smoothness of operation and checking for hesitancy or a stuck needle.

1. See Figure 7-69. Disconnect speedometer sensor connector. Attach speedometer tester connector to speedometer sensor connector.
2. Place speedometer tester power switch in the ON position. Place signal switch in the OUT position.
3. Turn vehicle ignition switch ON.
4. Begin test by pressing 0 on the tester keypad, then pressing ENTER. The tester will scan for two seconds, then the tester will put out a 1 Hz signal.
5. Select a test range.
 - a. Press 2 to select LO range (1-20 Hz).
 - b. Press 5 to select CEN range (21-999 Hz).
 - c. Press 8 to select HI range (1000-20,000 Hz).
6. After selecting a range, use the corresponding arrow keys to accelerate through the range. As you move through the speed range, check for smooth needle movement.
 - a. If testing LO range, press 1 or 3.
 - b. If testing CEN range, press 4 or 6.
 - c. If testing HI range, press 7 or 9.

Speedometer Sensor Test

If the speedometer is inoperative, but backlighting and odometer work, the speedometer sensor may not be working.

See Figure 7-70. Fabricate a test harness using the following parts. This harness can also be used to test the tachometer.

- Two Deutsch 3-place socket housings (Part No. 72113-94BK) and six socket terminals (Part No. 72191-94).
- Deutsch 3-place pin housing (Part No. 72103-94BK) and three pin terminals (Part No. 72080-99Y).
- Six lengths of 18 gauge wire, each 6.0 in. (15 cm) long.

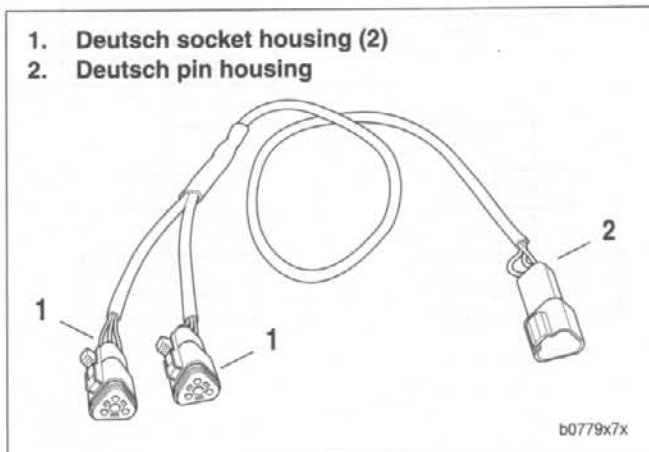


Figure 7-70. Test Harness

Before attempting the actual speedometer sensor check, two system checks must be made. Install the test harness at the cam position sensor connector [14]. See Figure 7-71.

- Test for voltage to sensor by checking for 8-12 VDC on red wire in connector [65].
 - Then check for continuity to ground on black wire in connector [65].
1. Raise rear wheel off floor using REAR WHEEL SUPPORT STAND (Part No. B-41174).
 2. Install the test harness between the speedometer sensor connectors.
 3. Place speedometer tester power switch in the ON position. Place signal switch in the IN position.
 4. Plug the speedometer tester into the test harness. Turn vehicle ignition switch ON.
 5. Press ENTER on the tester keypad.
 6. Rotate the motorcycle's rear wheel.
 - a. If reading on speedometer tester changes as wheel is rotated, speedometer sensor is OK.
 - b. If reading does not change, speedometer sensor is suspect. Install a known, good speedometer sensor and test again.

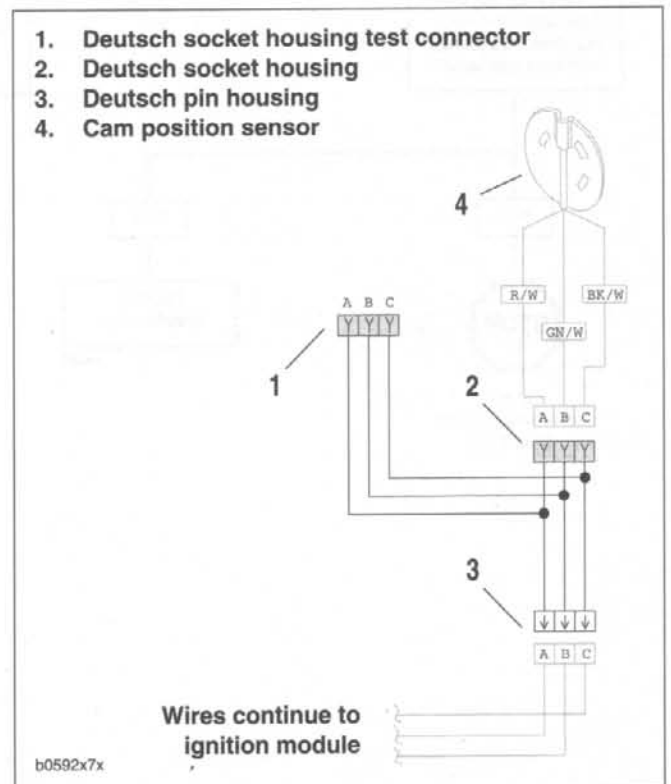
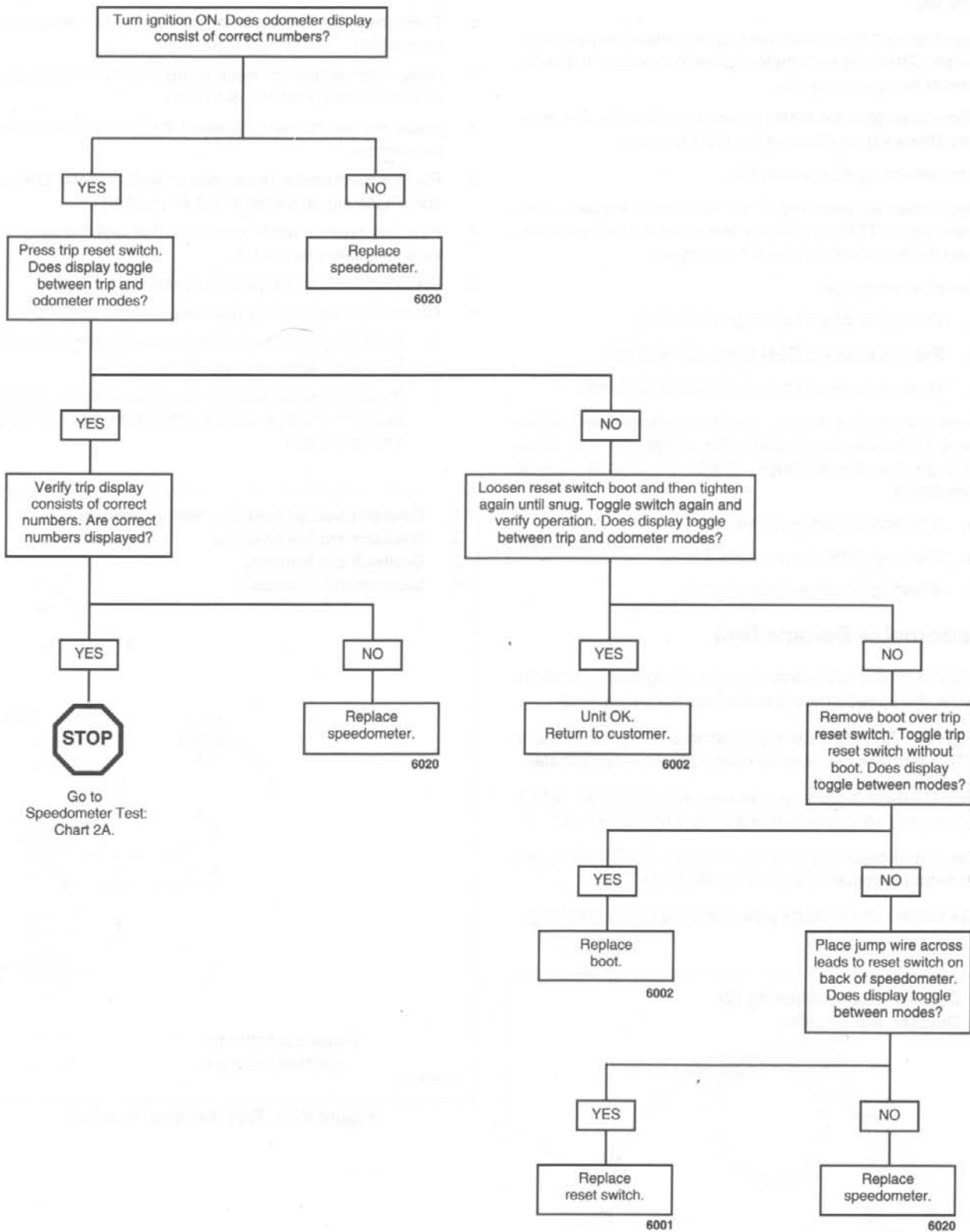


Figure 7-71. Test Harness Installed

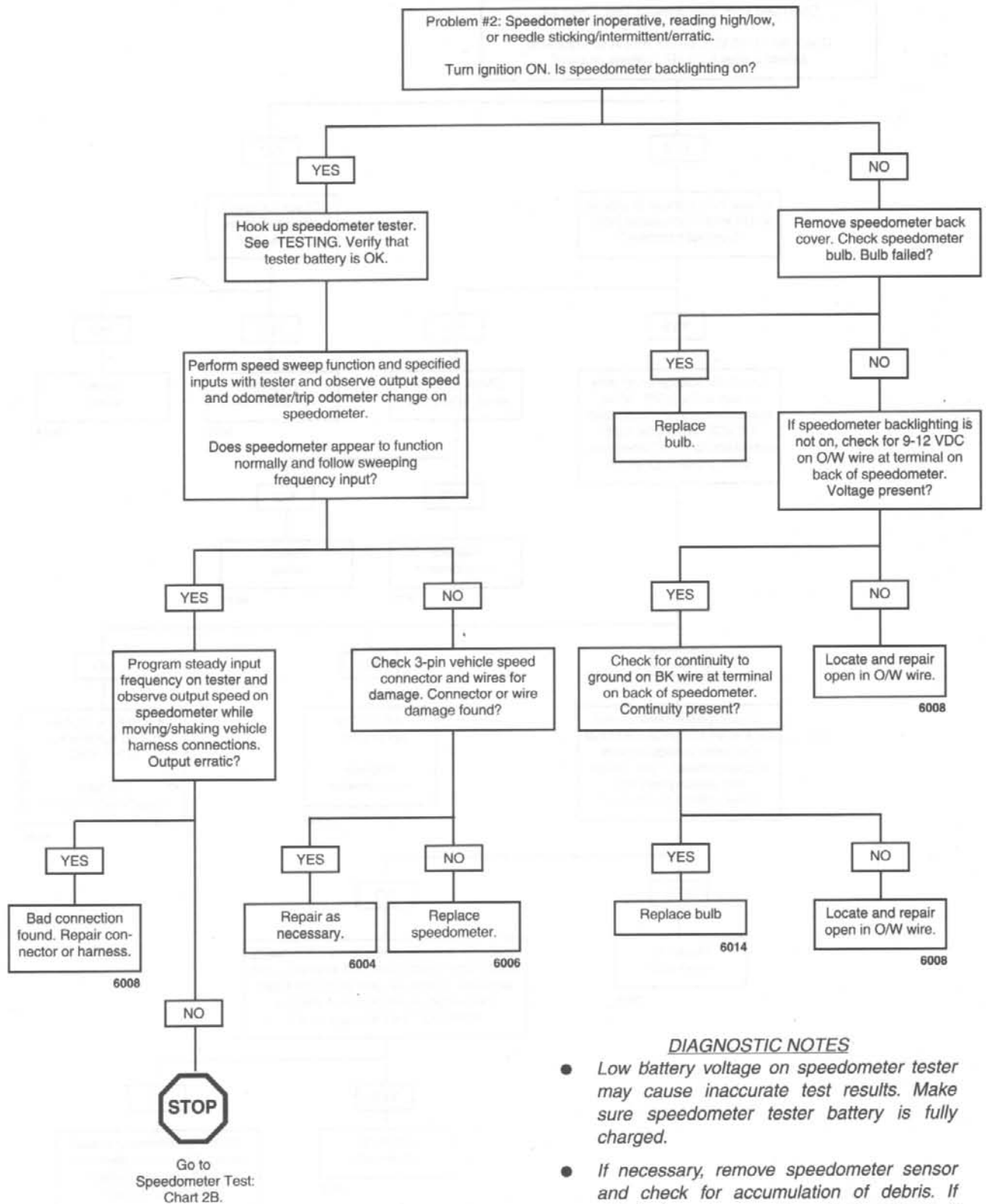
Speedometer Test: Chart 1

ODOMETER, TRIP ODOMETER AND RESET SWITCH TESTING



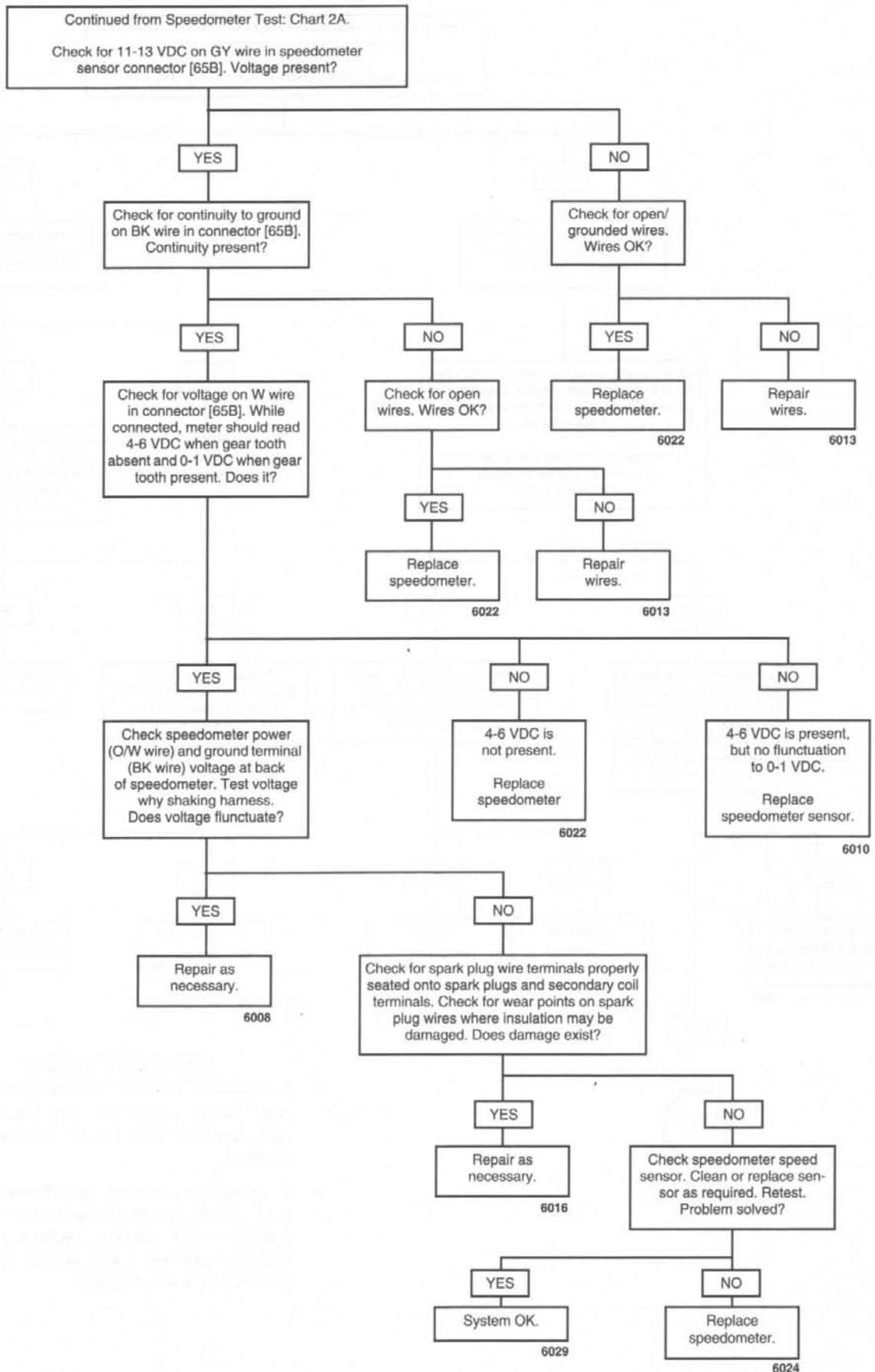
Speedometer Test: Chart 2A

INOPERATIVE, INACCURATE OR ERRATIC SPEEDOMETER



Speedometer Test: Chart 2B

INOPERATIVE, INACCURATE OR ERRATIC SPEEDOMETER



GENERAL

See Figure 7-68. Use the SPEEDOMETER TESTER (Part No. HD-41354) for tachometer diagnostics. These diagnostics may include:

- Checking tachometer operation.
- Testing tachometer needle sweeping action.

The tester can be connected to the vehicle's cam position sensor connector. This connection introduces a signal to the ignition module that simulates the signal from the cam position sensor. The ignition module will use this simulated signal to open and close circuits to fire the spark plugs. This allows you to simulate the engine running and therefore generate tachometer readings.

TESTING

Operation Test

1. See Figure 7-72. Connect the speedometer tester to the cam position sensor Deutsch socket housing.
2. Convert the desired test RPM to a tester frequency in Hertz. Several conversions are listed in Table 7-2.
 - a. Select a desired tachometer reading for testing. This example will use 2000 RPM.
 - b. Divide the desired tachometer reading by 60. For example, $2000/60=33.3$.
3. Enter the result (33.3 for 2000 RPM) into the speedometer tester.
 - a. The tachometer should respond by moving its needle to the desired RPM.
 - b. Test the tachometer at several different RPM readings to verify proper operation.

Table 7-3. Tachometer Accuracy Tolerances and Conversions

READING	2000 RPM	4000 RPM	6000 RPM	7500 RPM
Tolerance (+/- RPM)	100	120	210	320
Conversion factor	33.3	66.7	100	125

NOTE

All tachometer accuracy tolerances were taken at 68°-77° F (20-25° C).

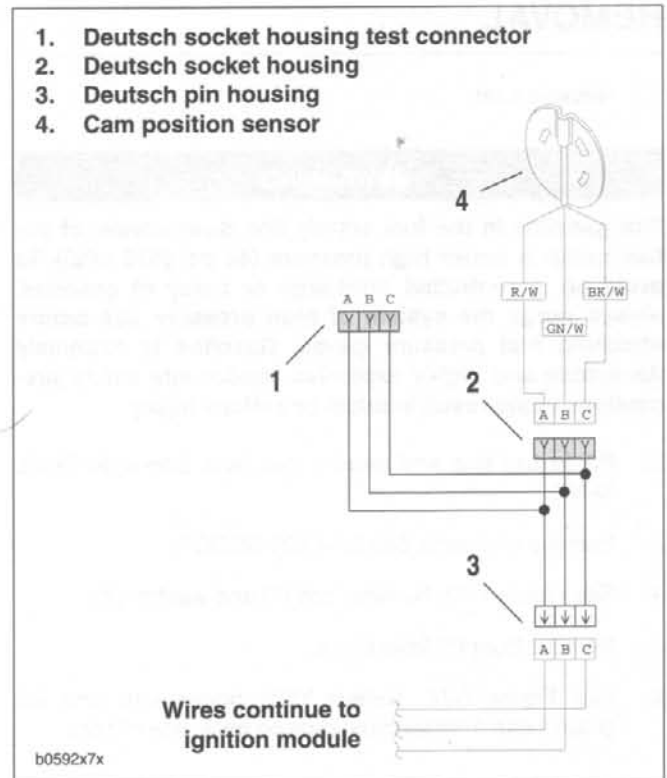


Figure 7-72. Testing Tachometer

Sweep Test

1. See Figure 7-72. Connect the speedometer tester to the cam position sensor Deutsch socket housing.
2. Place speedometer tester power switch in the ON position. Place signal switch in the OUT position.
3. Turn vehicle ignition switch ON.
4. Begin test by pressing 0 on the tester keypad, then pressing ENTER. The tester will scan for two seconds, then the tester will put out a 1 Hz signal.
5. Select a test range.
 - a. Press 2 to select LO range.
 - b. Press 5 to select CEN range.
 - c. Press 8 to select HI range.
6. After selecting a range, use the corresponding arrow keys to accelerate through the range. As you move through the speed range, check for smooth needle movement.
 - a. If testing LO range, press 1 or 3.
 - b. If testing CEN range, press 4 or 6.
 - c. If testing HI range, press 7 or 9.

REMOVAL

1. Remove seat.

WARNING

The gasoline in the fuel supply line downstream of the fuel pump is under high pressure (49 psi [338 kPa]). To avoid an uncontrolled discharge or spray of gasoline, always purge the system of high pressure gas before attaching fuel pressure gauge. Gasoline is extremely flammable and highly explosive. Inadequate safety precautions could result in death or serious injury.

2. Purge fuel line and remove fuel tank. See 4.34 FUEL TANK.
3. Remove air scoop. See 2.44 AIR SCOOP.
4. See Figure 7-73. Remove bolt (1) and washer (2).
5. Remove horn (3) from frame.
6. See Figure 7-74. Detach Y/BK power wire and BK ground wire from terminal clips on back side of horn.

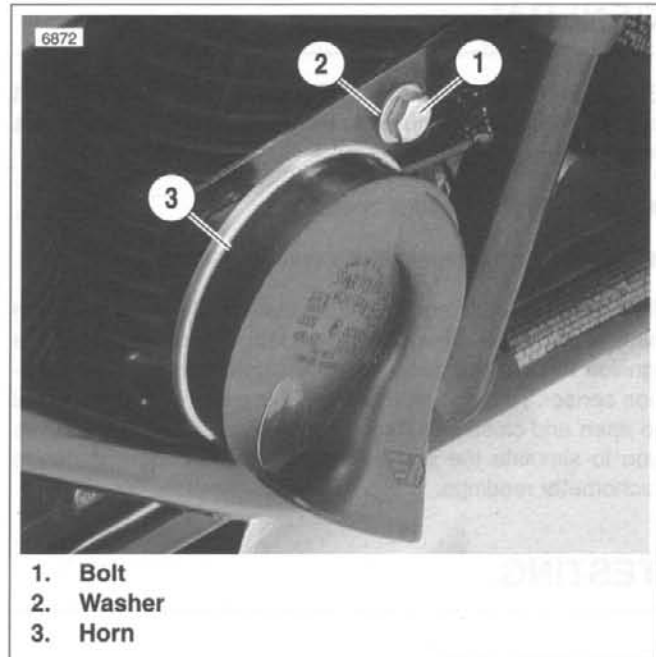


Figure 7-73. Horn Assembly

INSTALLATION

1. See Figure 7-74. Connect Y/BK power wire and BK ground wire to terminal clips on back side of horn.
2. See Figure 7-73. Attach horn (3) to frame using bolt (1) and washer (2).
3. Check horn operation. If horn does not sound or fails to function satisfactorily, see TROUBLESHOOTING.
 - a. Turn ignition key switch to IGN.
 - b. Press horn switch to activate horn.
 - c. Turn ignition key switch to OFF.
4. Install air scoop. See 2.44 AIR SCOOP.
5. Install fuel tank. See 4.34 FUEL TANK.

WARNING

After installing seat, pull upward on front of seat to be sure it is locked in position. If seat is loose, it could shift during vehicle operation and startle the rider, causing loss of control. These events could result in death or serious injury.

6. Install seat.

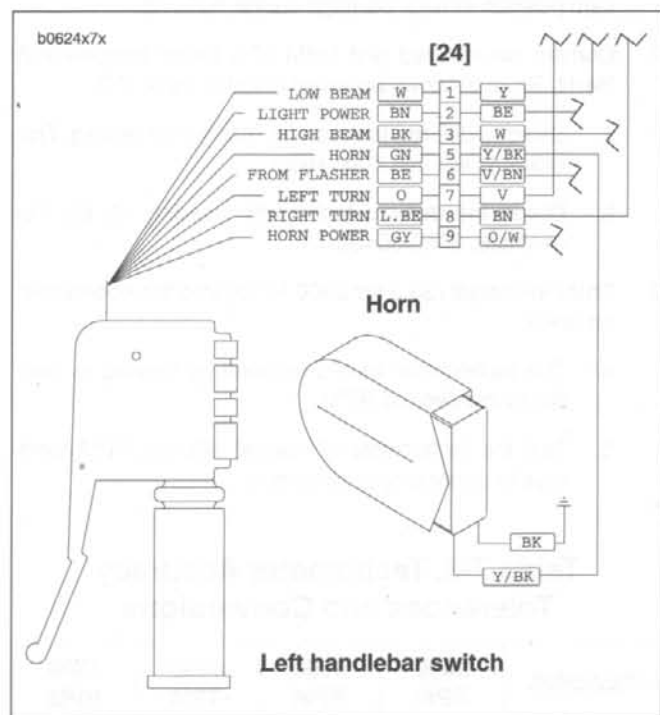


Figure 7-74. Horn Wiring

TROUBLESHOOTING

1. If the horn does not sound or fails to function satisfactorily, check for the following conditions:
 - a. Discharged battery.
 - b. Loose, frayed or damaged wiring leading to horn terminal.
2. If battery has a satisfactory charge and wiring appears to be in good condition, test horn grounds and switch using voltmeter.
 - a. See Figure 7-74. Remove Y/BK power and BK ground wires from terminal clips.
 - b. Connect voltmeter positive (+) lead to Y/BK wire.
 - c. Connect voltmeter negative (-) lead to ground.
 - d. Turn ignition key switch to IGN.
3. See Figure 7-75. Depress horn switch and observe voltmeter reading.
 - a. If battery voltage is present, horn or horn grounding is faulty. If horn is faulty, replace unit as an assembly. The horn is not repairable.
 - b. If battery voltage is not present, either horn switch or wiring to horn is faulty. If horn switch is faulty, replace left handlebar switch. See 7.16 HANDLEBAR SWITCHES.



Figure 7-75. Horn Switch

GENERAL

See Figure 7-76. The neutral indicator switch (1) is threaded into the transmission portion of the right crankcase half (2); it is immediately forward of the main drive gear shaft (3). The sprocket cover must be removed to test the switch. If switch requires replacement, secondary drive belt and transmission sprocket must also be removed; there is not enough clearance to allow the removal of the switch without first removing the transmission sprocket.

A pin on the shifter drum contacts the neutral indicator switch plunger, completing the neutral indicator circuit. The switch is not repairable. Replace the switch if it malfunctions.

TESTING

1. Remove sprocket cover. See 2.38 SPROCKET COVER.
2. See Figure 7-76. Disconnect wire lead from neutral indicator switch (1).
3. Turn ignition key switch to IGN. Touch the neutral indicator wire lead to a suitable ground.
 - a. If indicator lamp lights, then problem is at indicator switch. Replace switch.
 - b. If indicator lamp does not light, then problem is elsewhere in circuit. Check for loose connections, burned out indicator lamps or faulty wiring.
 - c. After testing and repair, connect wire lead to indicator switch.
4. Install sprocket cover. See 2.38 SPROCKET COVER.

REMOVAL/INSTALLATION

1. Verify that the ignition key switch is turned to OFF.
2. Remove sprocket cover. See 2.38 SPROCKET COVER.
3. See Figure 7-76. Place transmission in first gear. Remove two socket head screws (7) and lockplate (6).

CAUTION

Transmission sprocket nut has left-hand threads. Turn nut clockwise to loosen and remove from main drive gear shaft. Transmission sprocket nut will be damaged if turned counterclockwise to remove.

4. Remove transmission sprocket nut (5) from main drive gear shaft (3). See 6.7 TRANSMISSION CASE.

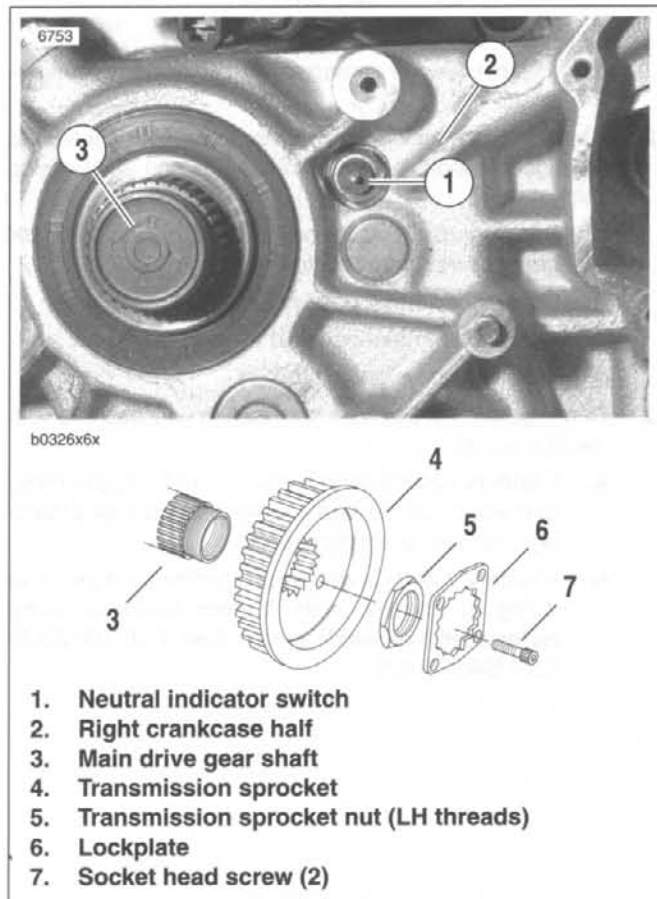


Figure 7-76. Neutral Indicator Switch

5. Decrease secondary drive belt tension by loosening axle adjusting nuts. See 1.13 REAR BELT DEFLECTION. Remove transmission sprocket (4) (with secondary drive belt) from main drive gear shaft (3).
6. Remove wire lead from neutral indicator switch (1). Remove switch from right crankcase half (2).
7. Install **new** neutral indicator switch.
 - a. Apply a light coating of LOCTITE THREADLOCKER 243 (blue) to **new** neutral indicator switch (1) threads.
 - b. Install switch in crankcase. Tighten to 3-5 ft-lbs (4.0-6.8 Nm).
 - c. Connect wire lead to switch.
8. Install transmission sprocket (4) (with secondary drive belt) onto main drive gear shaft (3). See 6.13 TRANSMISSION INSTALLATION AND SHIFTER PAWL ADJUSTMENT.
9. Install sprocket cover. See 2.38 SPROCKET COVER.
10. Adjust secondary drive belt tension. See 1.13 REAR BELT DEFLECTION.

GENERAL

Buell motorcycles feature two components which protect the electrical system.

Fuse

The fuse block is in the trunk, under the seat.

See Figure 7-77. The ignition (4) fuse is rated at 20 amps. Fuses for the odometer (5), lights (7), and instruments (8) and accessories (9) are each rated at 15 amps.

Always investigate the cause of blown fuses before replacing them. See your Buell dealer for more information.

Master Circuit Breaker

See Figure 7-78. The 30 amp main circuit breaker is on the frame beneath the fuel tank.

⚠ WARNING

To avoid accidental start-up of vehicle and possible personal injury, disconnect the battery cables before servicing motorcycle. Always disconnect the negative cable first. If the positive cable should contact ground with the negative cable installed, the resulting sparks may cause a battery explosion which could result in death or serious injury.

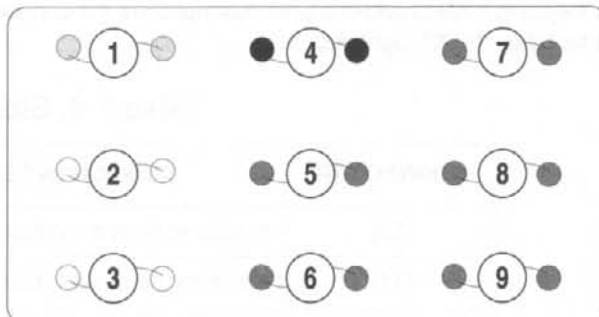
1. Disconnect battery cables, negative cable first.

⚠ WARNING

The gasoline in the fuel supply line downstream of the fuel pump is under high pressure (49 psi [338 kPa]). To avoid an uncontrolled discharge or spray of gasoline, always purge the system of high pressure gas before removing fuel tank. Gasoline is extremely flammable and highly explosive. Inadequate safety precautions could result in death or serious injury.

2. Purge fuel line and remove fuel tank. See 4.34 FUEL TANK.
3. Remove battery negative cable from frame.
4. See Figure 7-78. Loosen nut (2) on frame to free circuit breaker (3) from clip (1).
5. Remove nuts (5), star washers (4) and wire leads (6, 7 and 8) from circuit breaker studs.
6. Install in the reverse order.
 - a. BK wire connects to gold post.
 - b. All red wires connect to silver post.

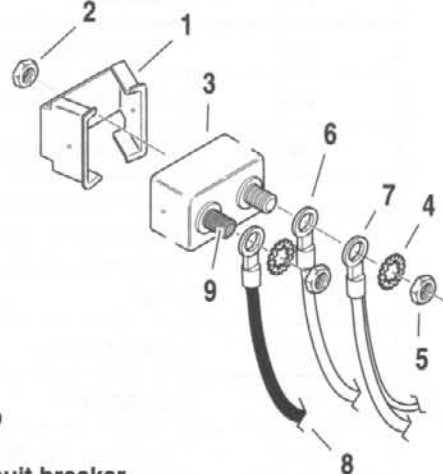
b0769x7x



1. Factory installed spare (15 or 20 amp)
2. Empty
3. Empty
4. Ignition (20 amp)
5. Odometer (15 amp)
6. Factory installed spare (15 amp)
7. Lights (15 amp)
8. Instruments (15 amp)
9. Accessory (15 amp)

Figure 7-77. Fuse Block

b0772x7x



1. Clip
2. Nut
3. Circuit breaker
4. Star washer (2)
5. Nut (2)
6. R wire from voltage regulator
7. R wires from key switch/fuse block
8. BK wire from starter
9. Circuit breaker gold post

Figure 7-78. Circuit Breaker

GENERAL

Connector numbers are listed in [brackets] in this manual.

The following table provides a brief description of the connectors found on the X1 Lightning.

Table 7-4. Electrical Connectors

CONNECTOR	COMPONENT(S)	DESCRIPTION
[10]	electronic control module (Black)	12-place Deutsch
[11]	electronic control module (Gray)	12-place Deutsch
[14]	cam position sensor	3-place Deutsch
[21]	front brake switch	2-place Amp Multilock
[21]	indicator lamps	12-place Amp Multilock
[22]	right handlebar switch housing-ignition power, module and starter	4-place connector
[24]	left handlebar switch housing-horn, turn signals, lights	9-place connector
[30]	flasher relay	3-place relay connector
[33]	ignition/headlamp switch	4-place Packard
[38]	headlamp	4-place Amp Multilock
[39]	speedometer and tachometer	10-place connector
[46]	voltage regulator/stator	2-place plug
[60]	side stand switch	2-place Amp Multilock
[61]	four 15 amp fuses for odometer, instruments, lights and accessories and one 20 amp fuse for ignition	5-slot fuse block
[65]	speed sensor	3-place Deutsch
[83]	ignition coil	3-place Packard
[84]	front fuel injector	2-place connector
[85]	rear fuel injector	2-place connector
[86]	fuel pump	4-place connector
[88]	throttle position sensor	3-place connector
[89]	intake air temperature sensor	2-place connector
[91]	data link	4-place Deutsch
[95]	clutch switch	2-place Amp Multilock
[96]	clock	4-place plug
[134]	bank angle sensor	3-place connector

GENERAL

The Deutsch Connector features a superior seal to protect electrical contacts from dirt and moisture in harsh environments. The connector also provides better pin retention than previous connectors.

Three and eight pin connectors are of similar construction with one exception: eight pin connectors use two external latches on the socket side.

NOTE

Use the *DEUTSCH TERMINAL CRIMP TOOL* (Part No. HD-39965) to install Deutsch pin and socket terminals on wires. If **new** terminals must be installed, follow the instructions included with the crimping tool or see *CRIMPING INSTRUCTIONS*.

REMOVING/INSTALLING SOCKETS

1. See Figure 7-79. Remove the secondary locking wedge (6). Insert the blade of a small screwdriver between the socket housing and locking wedge inline with the groove (inline with the pin holes if the groove is absent). Turn the screwdriver 90° to pop the wedge up.
2. Gently depress terminal latches inside socket housing (3) and back out socket terminals (1) through holes in rear wire seal (2).
3. Fit rear wire seal (2) into back of socket housing, if removed. Grasp socket terminal approximately 1.0 in. (25.4 mm) behind the contact barrel. Gently push sockets through holes in wire seal into their respective chambers. Feed socket into chamber until it "clicks" in place. Verify that socket will not back out of chamber; a slight tug on the wire will confirm that it is properly locked in place.
4. Install internal seal (5) on lip of socket housing, if removed. Insert tapered end of secondary locking wedge (6) into socket housing and press down until it snaps in place. The wedge fits into the center groove within the socket housing and holds the terminal latches tightly closed.

NOTE

- The conical secondary locking wedge of the 3-pin connector must be installed with the arrow pointing toward the external latch. See Figure 7-80.
- If the secondary locking wedge does not slide into the installed position easily, verify that all terminals are fully installed in the socket housing. The lock indicates when terminals are not properly installed by not entering its fully installed position.

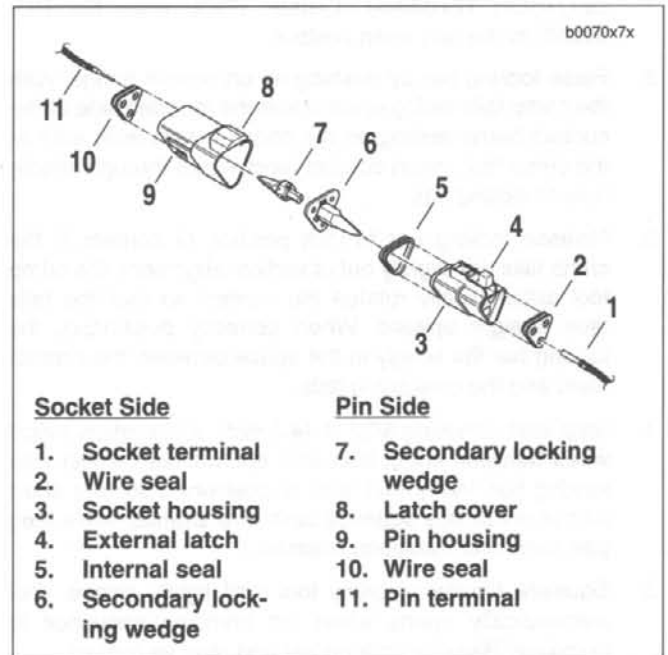


Figure 7-79. 3-Pin Connector

REMOVING/INSTALLING PINS

1. See Figure 7-79. Remove the secondary locking wedge (7). Use the hooked end of a stiff piece of mechanic's wire or a needle nose pliers, whichever is most suitable.
2. Gently depress terminal latches inside pin housing (9) and back out pin terminals (11) through holes in wire seal (10).
3. Fit wire seal (10) into back of pin housing (9). Grasp crimped pin approximately 1.0 in. (25.4 mm) behind the contact barrel. Gently push pins through holes in wire seal into their respective numbered locations. Feed pin into chamber until it "clicks" in place. Verify that pin will not back out of chamber; a slight tug on the wire will confirm that it is properly locked in place.
4. Insert tapered end of secondary locking wedge (7) into pin housing (9) and press down until it snaps in place. The wedge fits in the center groove within the pin housing and holds the terminal latches tightly closed.

ASSEMBLY/INSTALLATION

Insert socket housing (3) into pin housing (9) until it snaps in place. To fit the halves of the connector together, the latch (4) on the socket side must be aligned with the latch cover (8) on the pin side.

CRIMPING INSTRUCTIONS

1. See Figure 7-81. Squeeze the handles to cycle the DEUTSCH TERMINAL CRIMP TOOL (Part No. HD-39965) to the fully open position.
2. Raise locking bar by pushing up on bottom flange. With the crimp tails facing upward and the rounded side of the contact barrel resting on the concave split level area of the crimp tool, insert contact (socket/pin) through middle hole of locking bar.
3. Release locking bar to lock position of contact. If the crimp tails are slightly out of vertical alignment, the crimp tool automatically rotates the contact so that the tails face straight upward. When correctly positioned, the locking bar fits snugly in the space between the contact band and the core crimp tails.
4. Strip lead removing $5/32$ in. (4.0 mm) of insulation. Insert wires between crimp tails until ends make contact with locking bar. Verify that wire is positioned so that short pair of crimp tails squeeze bare wire strands, while long pair folds over insulation material.
5. Squeeze handle of crimp tool until tightly closed. Tool automatically opens when the crimping sequence is complete. Raise up locking bar and remove contact.

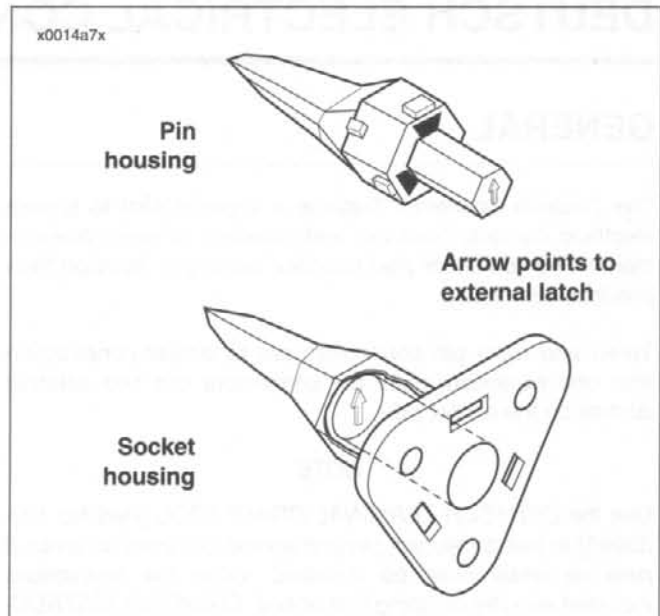


Figure 7-80. 3-pin Locking Wedge Orientation

NOTE

Inspect the quality of the core and insulation crimps. Distortion should be minimal.

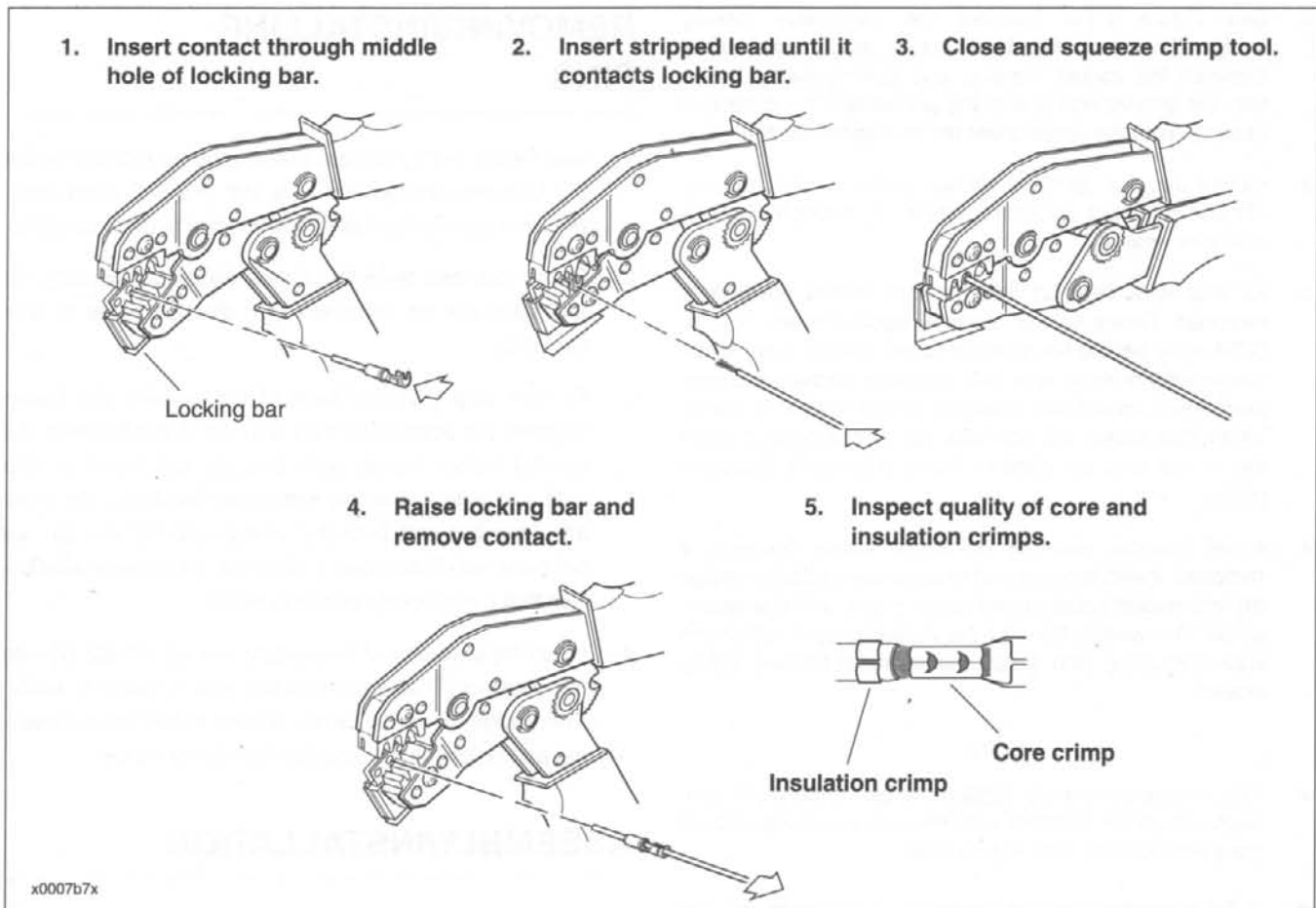


Figure 7-81. Deutsch Crimping Procedure

REMOVING SOCKET/PIN TERMINALS

1. If necessary, cut any surrounding cable straps to gain access to the connector.
2. See Figure 7-82. Depress the button (5) on the socket housing (3).
3. Pull apart the pin and socket halves.
4. Bend back the latch slightly and free one side of secondary lock, then repeat the step to release the other side.
5. Rotate the secondary lock outward on hinge to access terminals in chambers of connector housing.
6. Looking in the terminal side of the connector (opposite the secondary lock), take note of the cavity next to each terminal.
7. Remove socket terminal (Figure 7-84.) or pin terminal (Figure 7-85.)
 - a. With the flat edge against the terminal, insert the pick (Snap-On TT600-3) into the cavity until it stops.
 - b. Pivot the end of the pick away from the terminal to release the tang.
 - c. Gently tug on wire to pull terminal from chamber. Do not tug on the wire until the tang is released or the terminal will be difficult to remove. A "click" is heard if the tang is engaged but then inadvertently released. Repeat the steps without releasing the tang.

NOTE

An AMP TERMINAL CRIMP TOOL (Part No. HD-41609) is used to install Amp Multilock pin and socket terminals on wires. If **new** terminals must be installed, see CRIMPING INSTRUCTIONS.

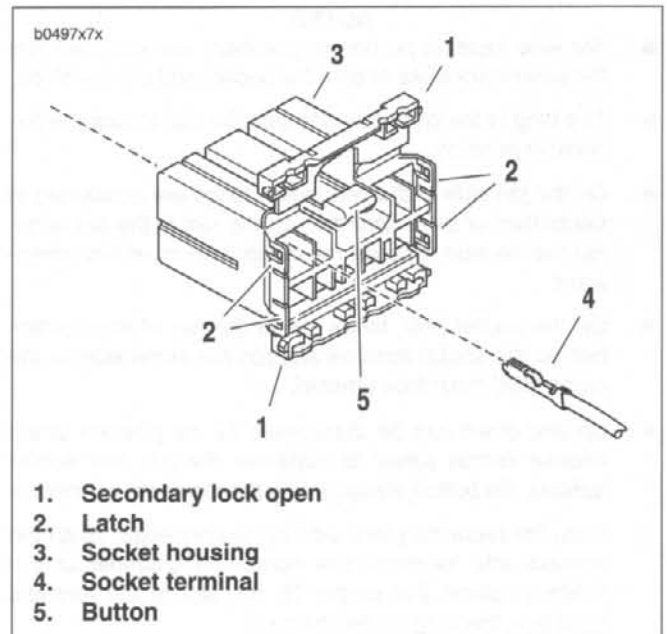


Figure 7-82. Socket Housing

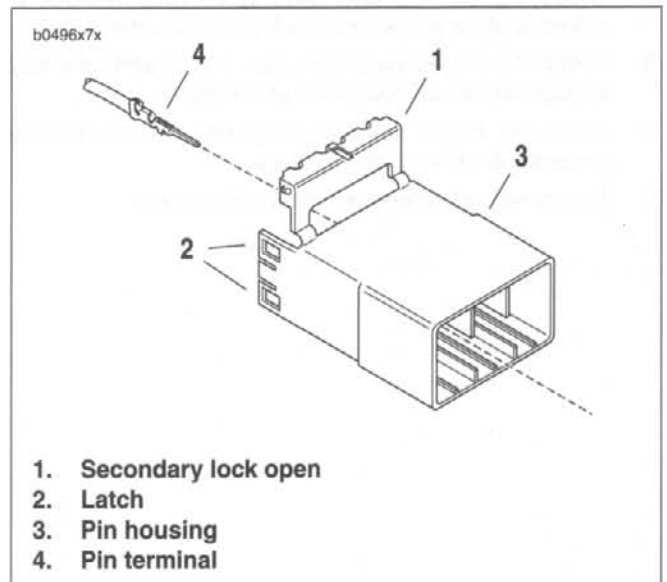


Figure 7-83. Pin Housing

INSTALLING SOCKET/PIN TERMINALS

NOTES

- For wire location purposes, numbers are stamped into the secondary locks of both the socket and pin housings.
- The tang in the chamber engages the slot to lock the terminal in position.
- On the pin side of the connector, tangs are positioned at the bottom of each chamber, so the slot in the pin terminal (on the side opposite the crimp tails) must face downward.
- On the socket side, tangs are at the top of each chamber, so the socket terminal slot (on the same side as the crimp tails) must face upward.
- Up and down can be determined by the position of the release button (used to separate the pin and socket halves), the button always being the top of the connector.

1. From the secondary lock side of the connector, insert the terminal into its respective numbered chamber until it snaps in place. For proper fit, the slot in the terminal must face the tang in the chamber.
 - a. If installing socket terminals, see Figure 7-84.
 - b. If installing pin terminals, see Figure 7-85.
2. Gently tug on wire end to verify that the terminal is locked in place and will not back out of chamber.
3. Rotate the hinged secondary lock inward until tabs fully engage latches on both sides of connector.
4. Insert the socket housing (plug) into the pin housing (receptacle) until it snaps in place.
5. Secure wiring harness with **new** cable straps.

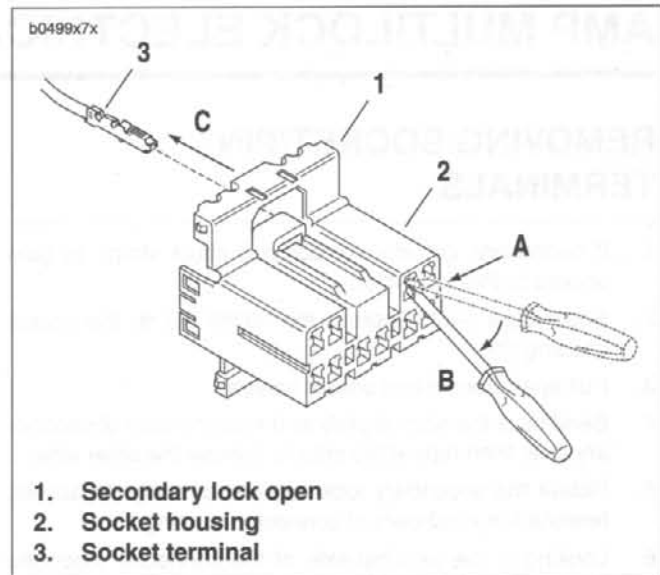


Figure 7-84. Socket Terminals

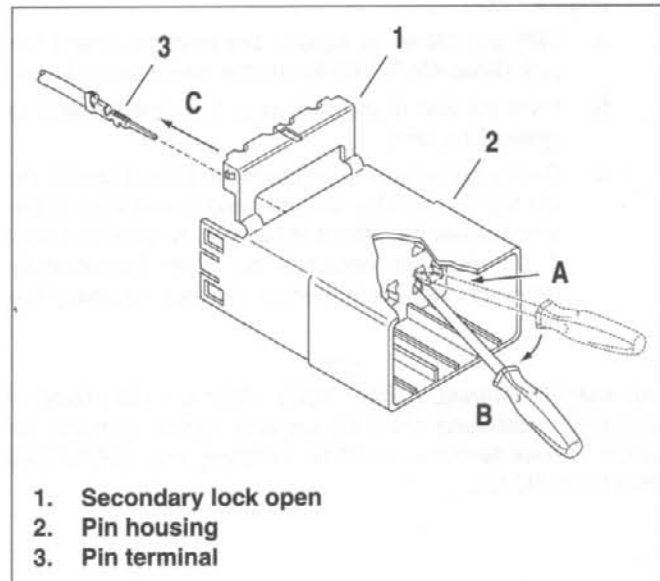


Figure 7-85. Pin Terminals

CRIMPING INSTRUCTIONS

1. See Figure 7-87. Squeeze the handles to cycle the AMP TERMINAL CRIMP TOOL (Part No. HD-41609) to the fully open position.
2. Raise locking bar by pushing up on bottom flange. With the crimp tails facing upward, insert contact (socket/pin) through locking bar, so that the closed side of the contact rests on the nest (concave split level area) of the crimp tool. Use the front nest for 20 gauge wire, the middle for 16 gauge and the rear for 18 gauge.
3. Release locking bar to lock position of contact. When correctly positioned, the locking bar fits snugly in the space at the front of the core crimp tails.
4. Strip lead removing 5/32 in. (4.0 mm) of insulation. Insert wires between crimp tails until ends make contact with locking bar. Verify that wire is positioned so that short pair of crimp tails squeeze bare wire strands, while long pair folds over insulation material.
5. Squeeze handle of crimp tool until tightly closed. Tool automatically opens when the crimping sequence is complete. Raise up locking bar and remove contact.
6. See Figure 7-86. Inspect the quality of the core and insulation crimps. Distortion should be minimal.

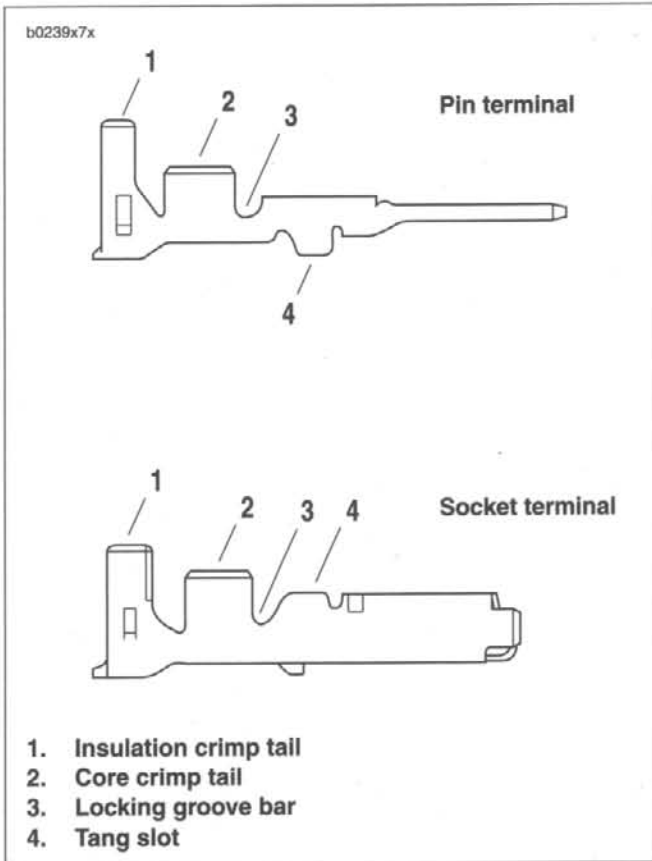


Figure 7-86. Crimps

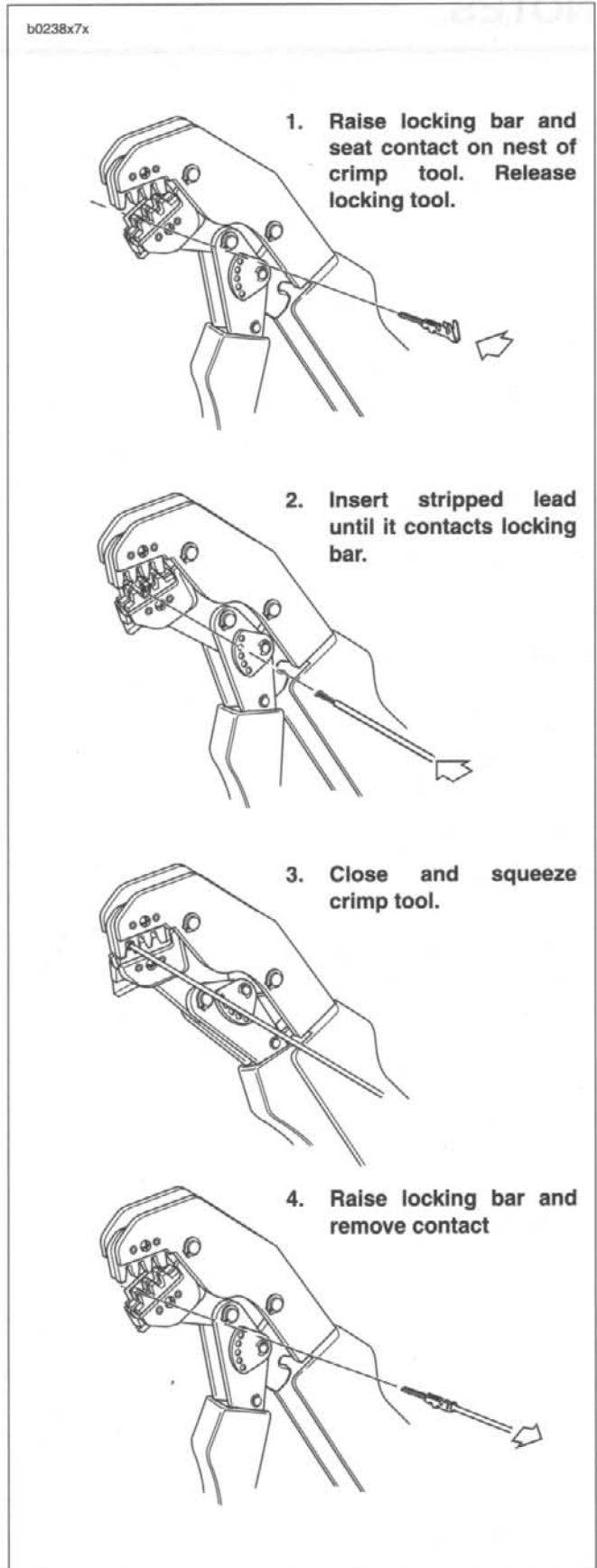


Figure 7-87. Amp Multilock Crimping Procedure

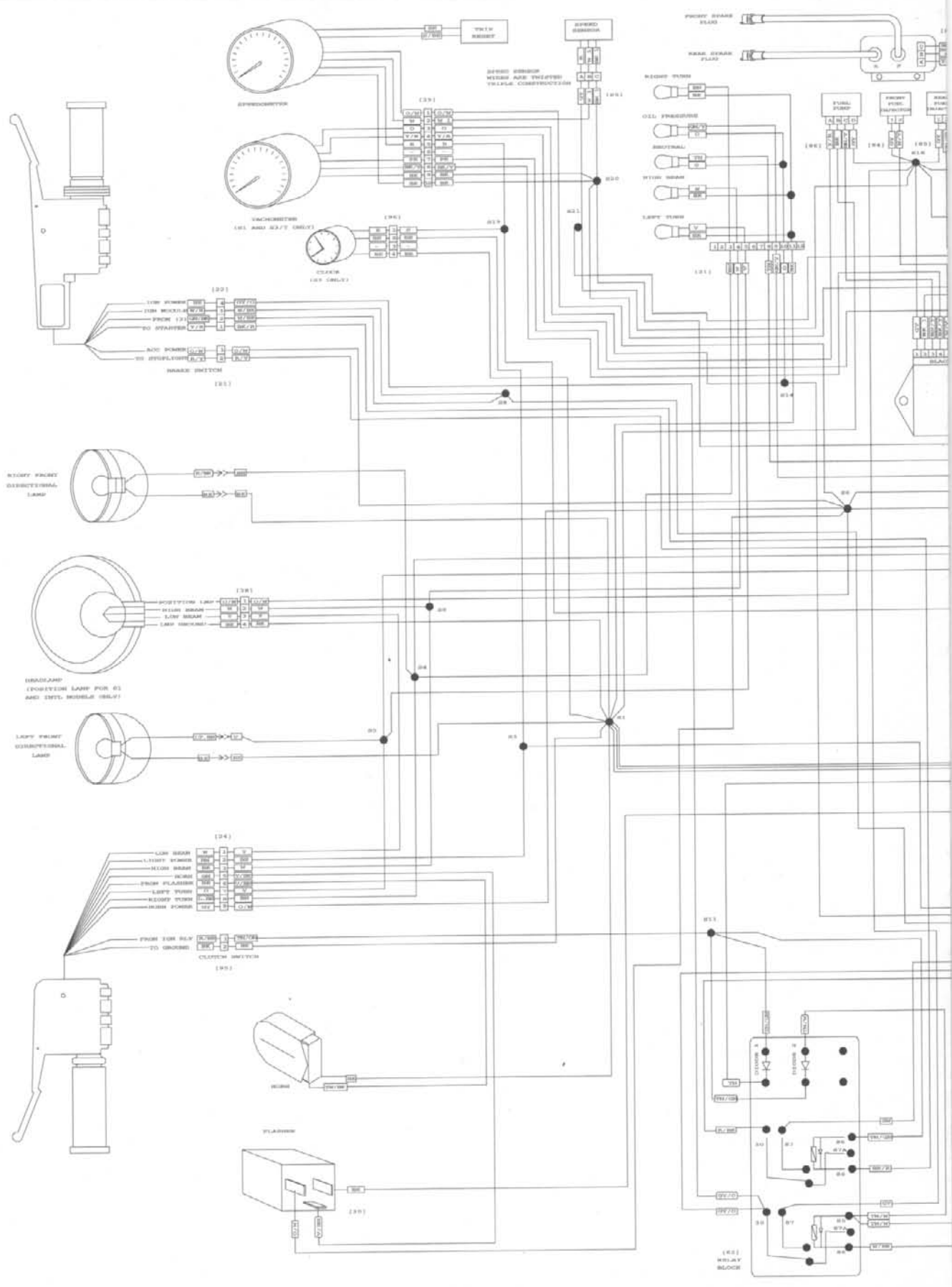
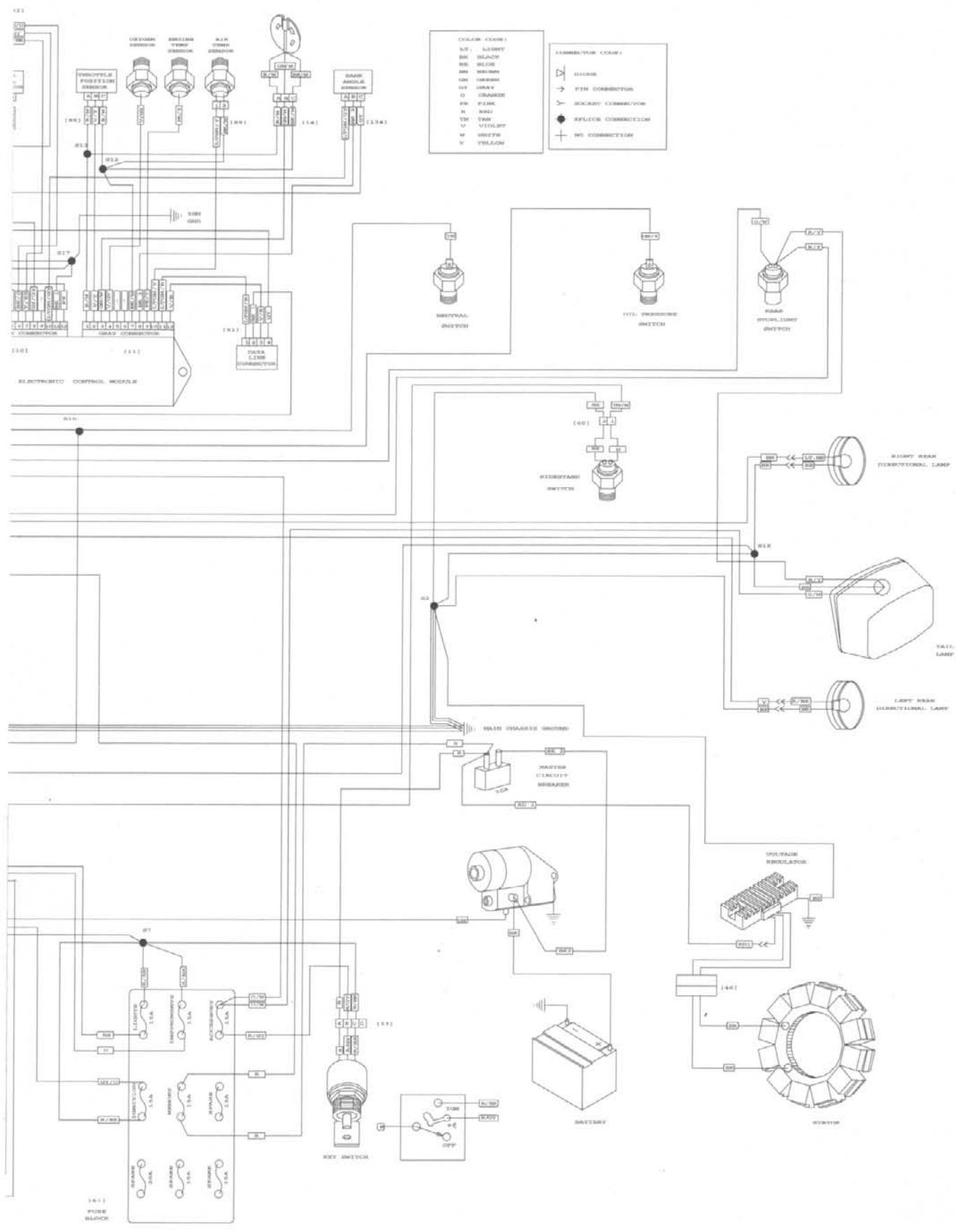


Figure 7-88. 1999 and 20



00 X1 Wiring Diagram

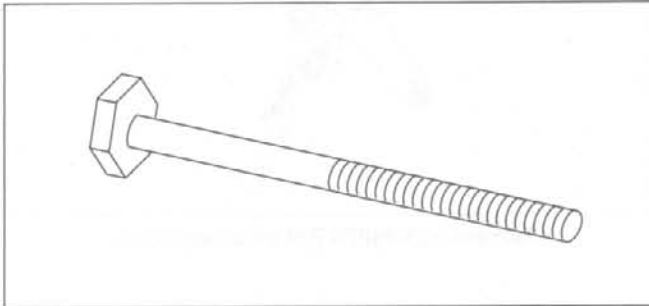
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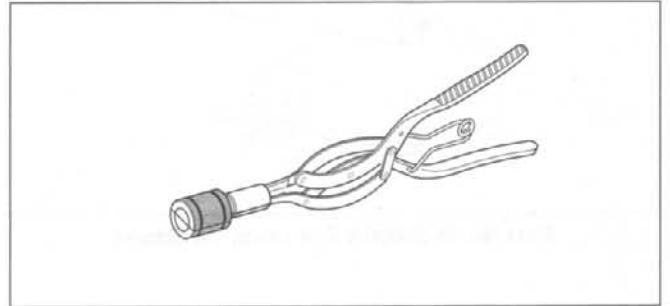
Appendix A-Tools	A-1
Appendix B-Metric Conversions	B-1

APPENDIX

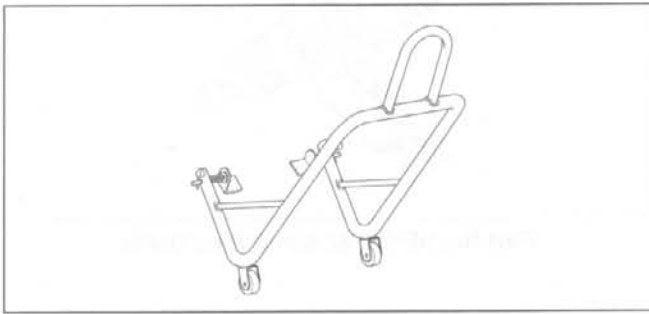
APPENDIX A-TOOLS



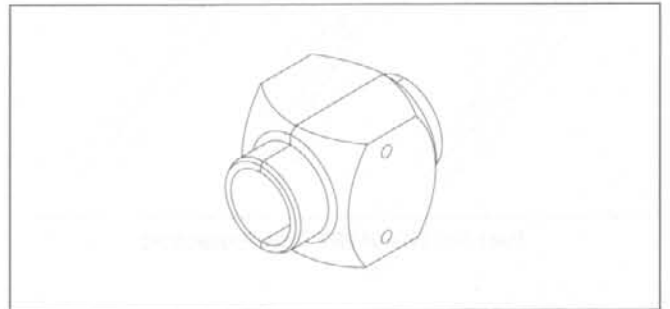
Part No. B-35316-5 12 Inch Bolt.
Used with Part No. HD-39302.



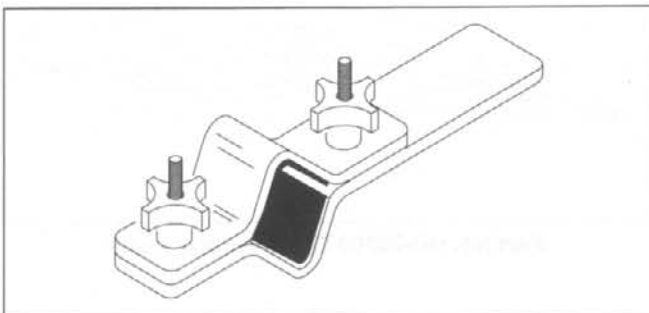
Part No. B-42887 Brake Caliper Piston Remover



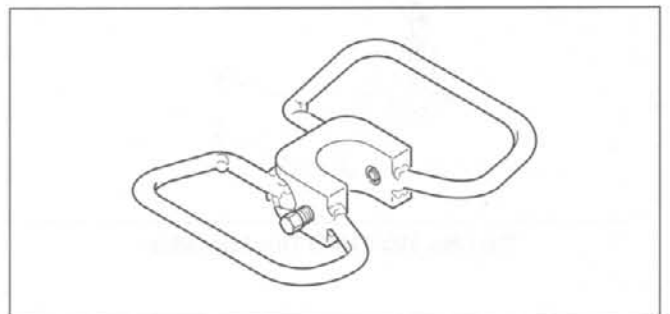
**Part No. B-41174 Rear Wheel Support Stand and
Part No. B-41174-2 Replacement Pad**



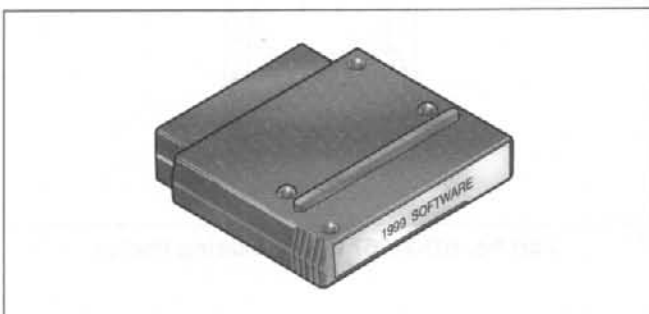
Part No. B-43721 Front Fork Seal Driver



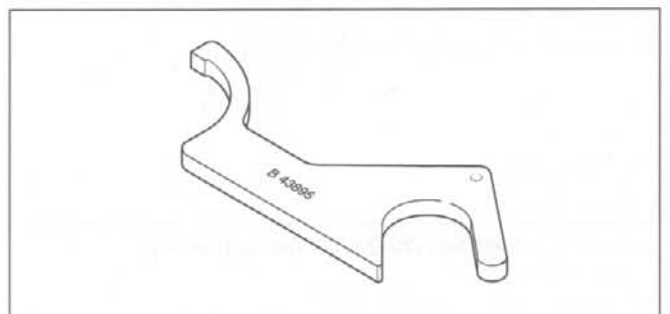
Part No. B-41177 Front Fork Holding Tool



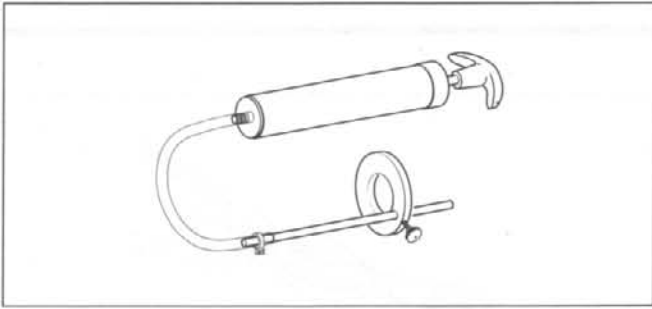
Part No. B-43875 Fork Spring Compressor



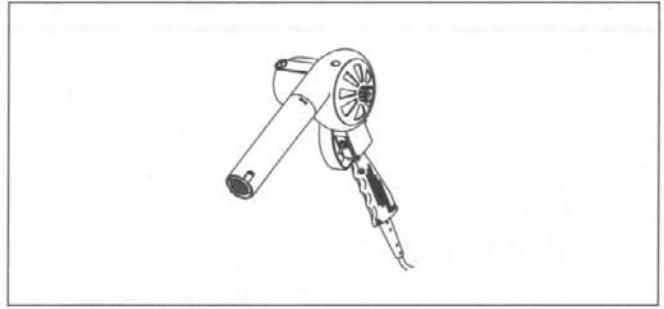
Part No. B-41325-99 Scanalyzer Software Cartridge



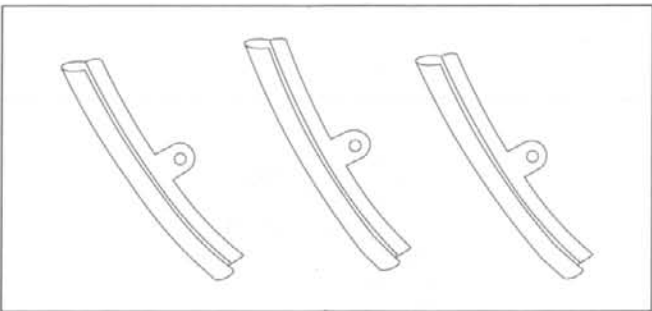
Part No. B-43895 Rear Shock Preload Spanner



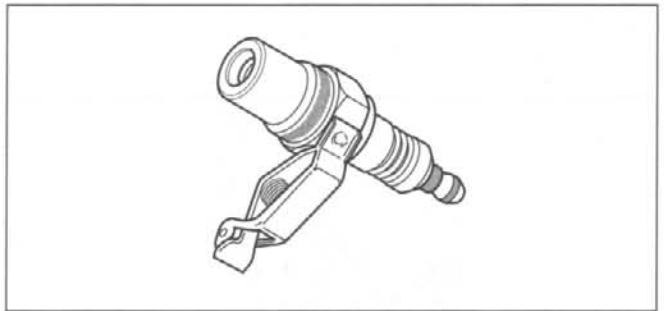
Part No. B-59000A Pro Level Oil Gauge



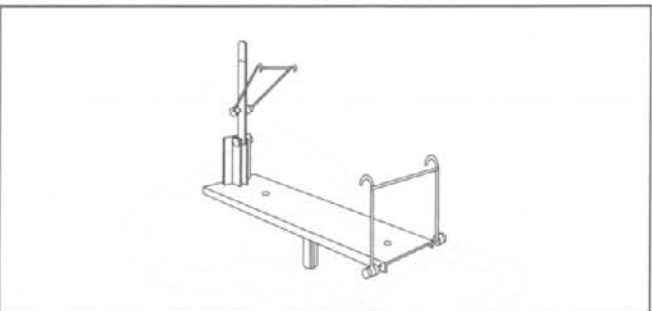
Part No. HD-25070 Robinair Heat Gun



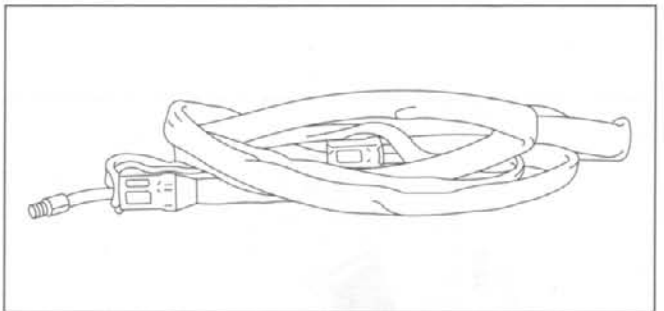
Part No. HD-01289 Rim Protectors



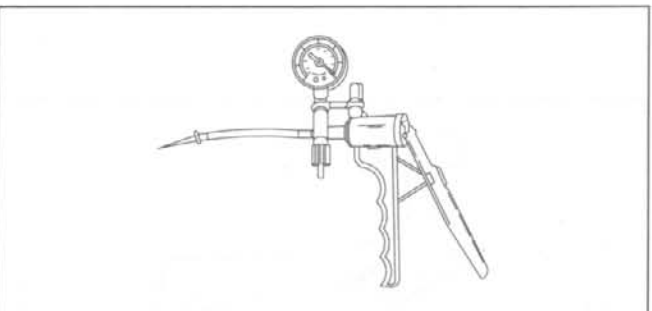
Part No. HD-26792 Spark Plug Tester



Part No. HD-21000 Tire Spreader



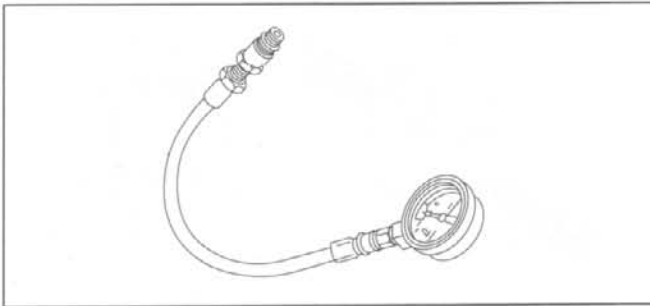
Part No. HD-28700 Tire Bead Expander



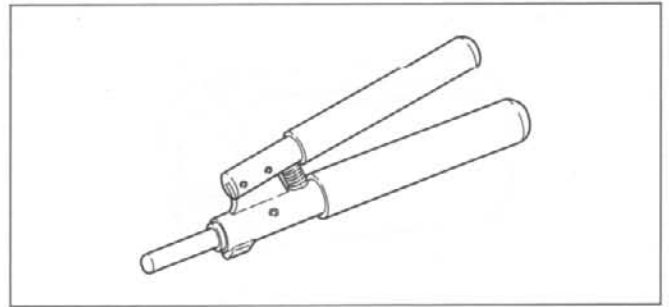
Part No. HD-23738 Vacuum Pump



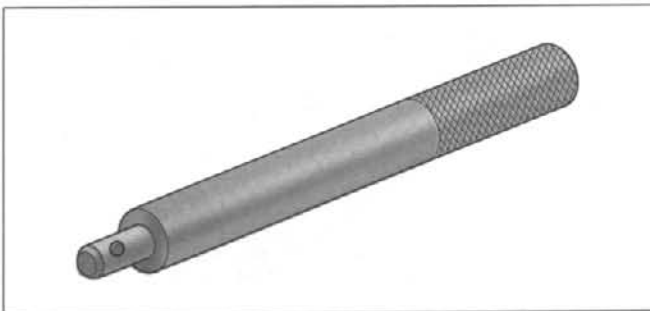
Part No. HD-33067 Wheel Bearing Packer



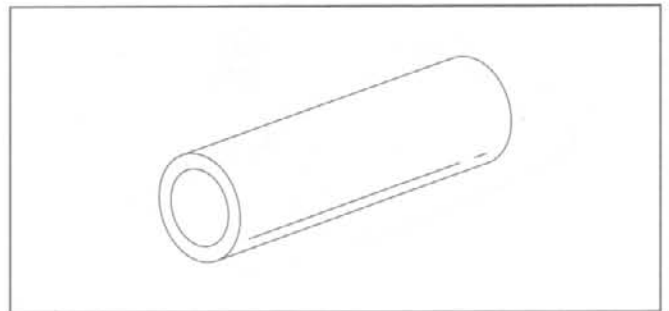
Part No. HD-33223-1 Cylinder Compression Gauge



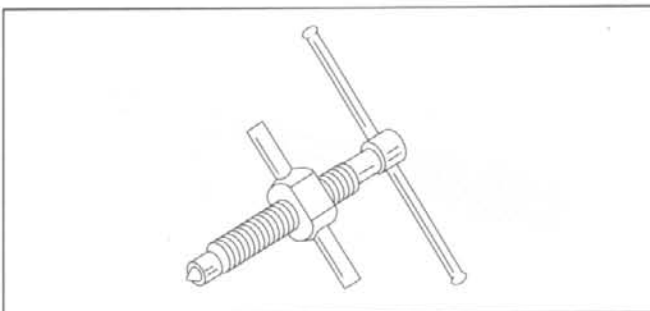
Part No. HD-34623B Piston Pin Retaining Ring Installer/Remover



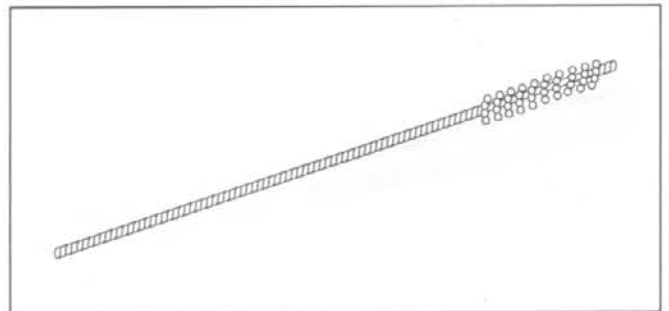
Part No. HD-33416 Universal Driver Handle



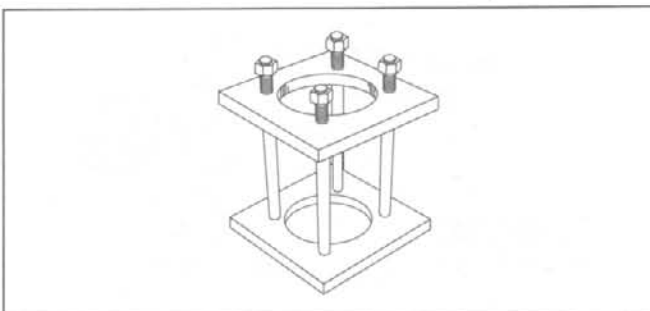
Part No. HD-34643A Shoulderless Valve Guide Seal Installer



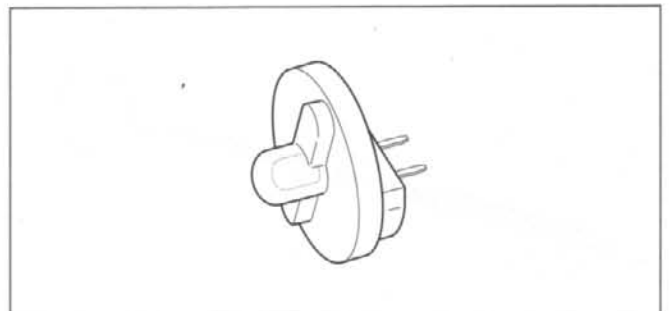
Part No. HD-33418 Universal Puller Forcing Screw



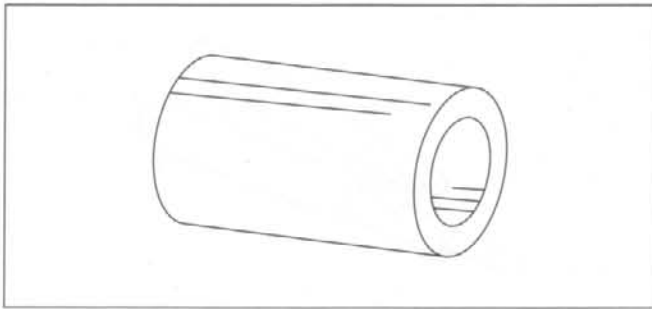
Part No. HD-34723 Valve Guide Hone (8 mm)



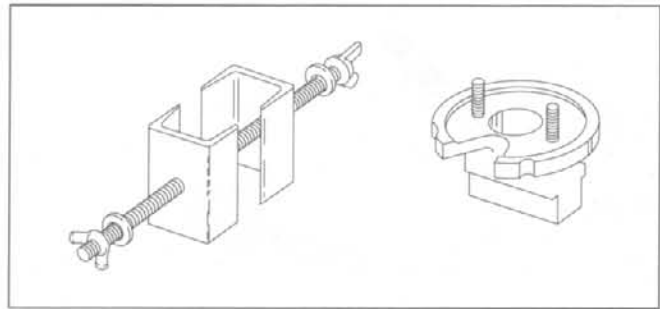
Part No. HD-33446A Cylinder Torque Plates and Torque Plate Bolts Part No. HD-33446-86



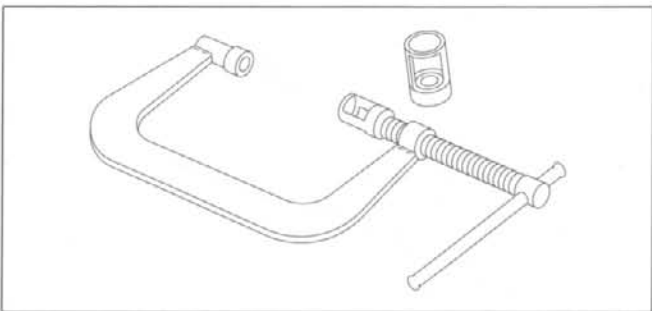
Part No. HD-34730-2C Fuel Injector Test Lamp



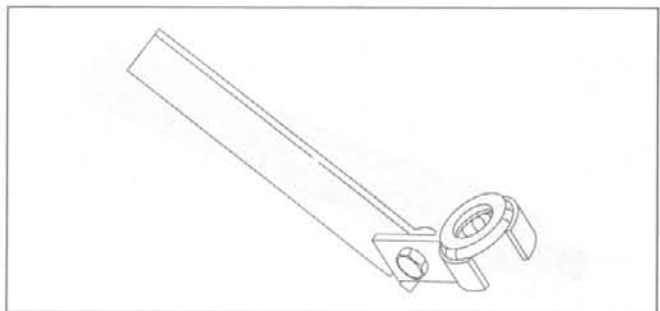
Part No. HD-34731 Shoulderless Valve Guide Installation Tool



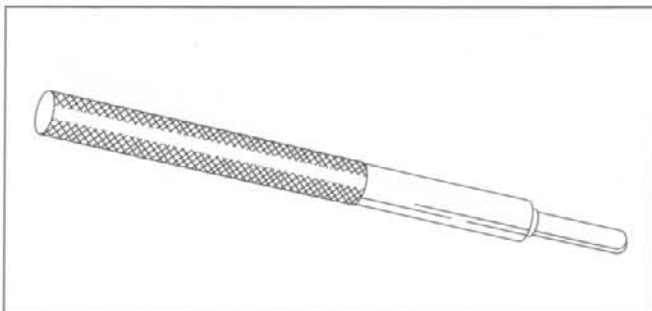
Part No. HD-34813 Rowe Flywheel Rebuilding Jig



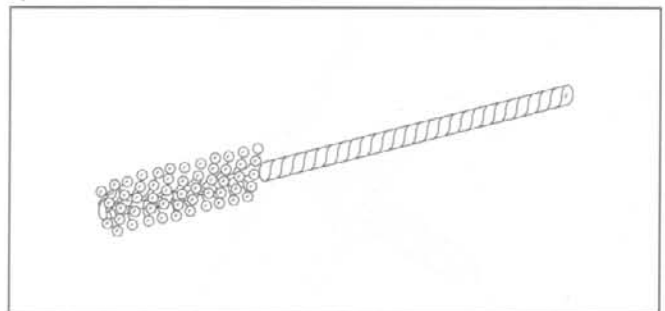
Part No. HD-34736B Valve Spring Compressor



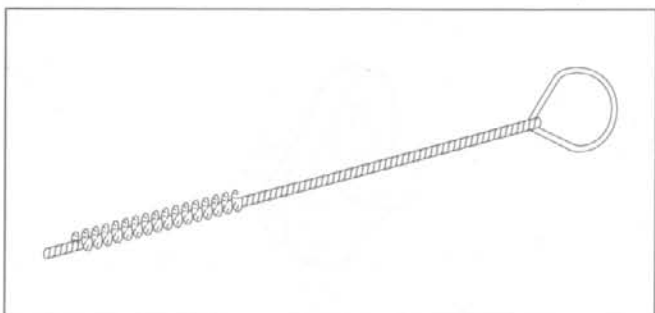
Part No. HD-34816 Oil Pressure Switch Wrench



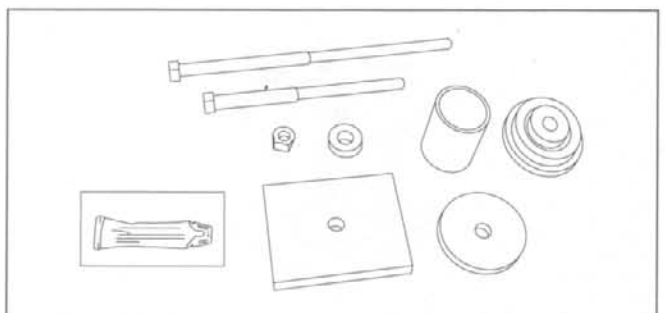
Part No. HD-34740 Driver Handle and Remover. Used with HD-34643A and HD-34731.



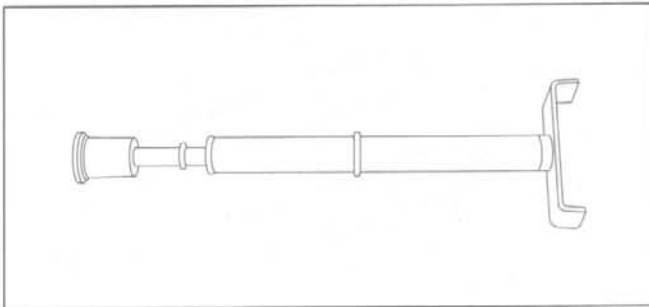
Part No. HD-35102 Wrist Pin Bushing Hone (20 mm)



Part No. HD-34751 Nylon Valve Guide Brush



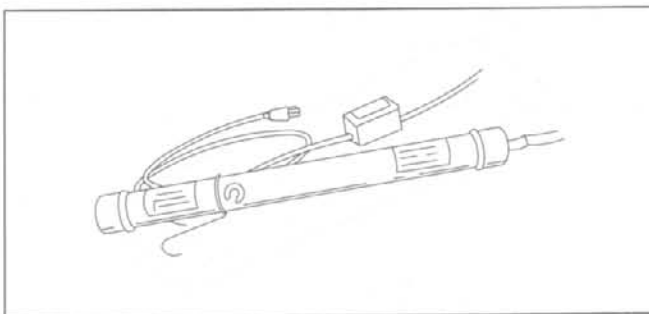
Part No. HD-35316-A Main Drive Gear Remover/Installer and Main Drive Gear Bearing Installer



Part No. HD-35381 Belt Tension Gauge



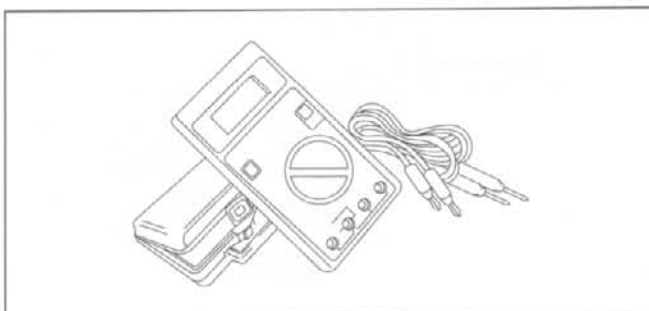
Part No. HD-35667A Cylinder Leakdown Tester



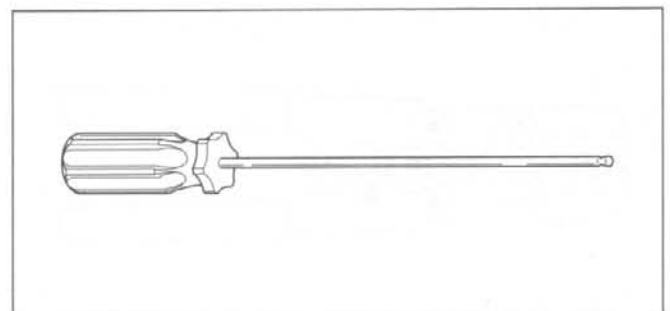
Part No. HD-35457 Black Light Leak Detector



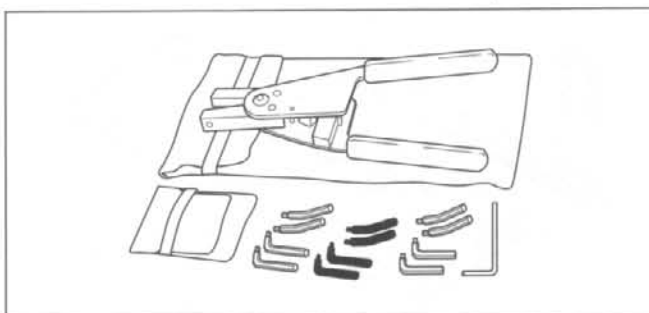
Part No. HD-35758A Neway Valve Seat Cutter Set



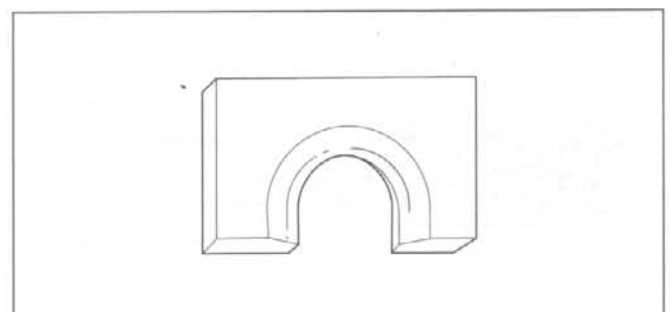
Part No. HD-35500A Digital Multi-Meter (FLUKE 23)



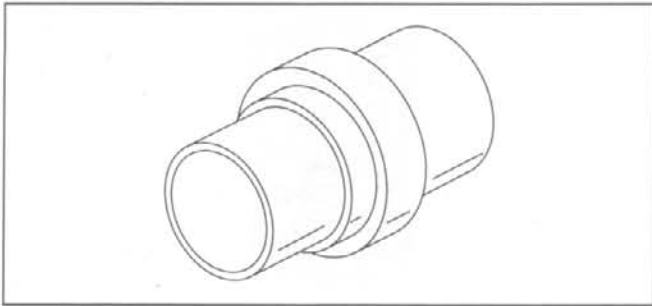
Part No. HD-35801 Intake Manifold Screw Wrench



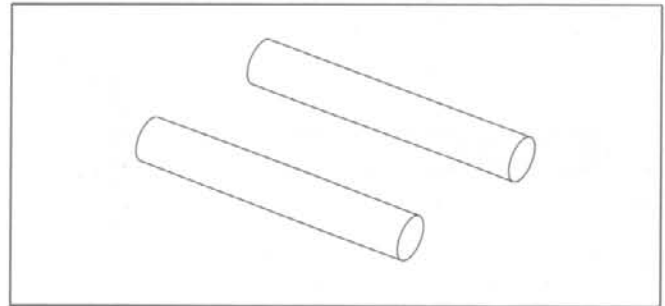
Part No. HD-35518 Internal/External Retaining Ring Pliers



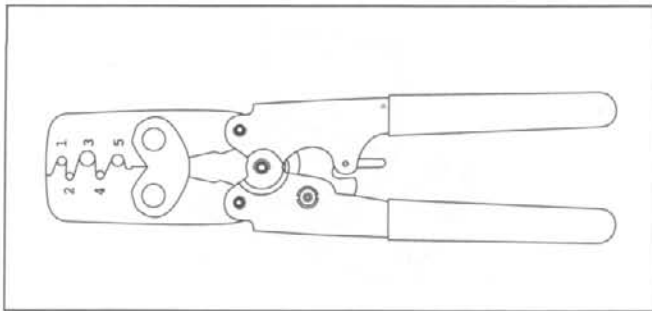
Part No. HD-37404 Countershaft Gear Support Plate



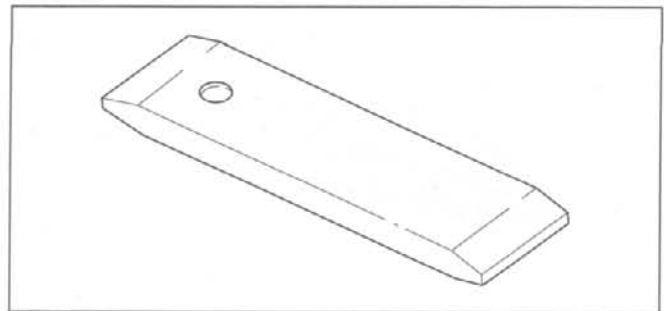
Part No. HD-37842A Inner/Outer Main Drive Gear Needle Bearing Installer



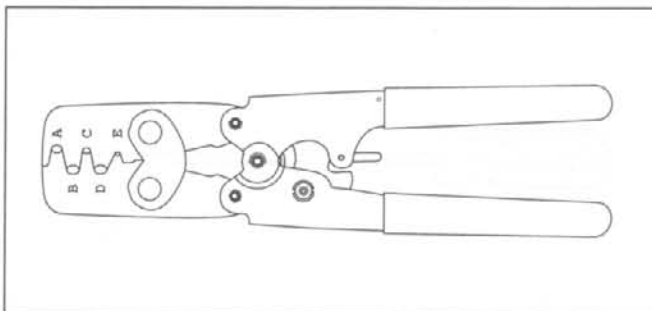
Part No. HD-38361 Cam Gear Gauge Pin Set (0.108 in. (2.74 mm) Diameter)



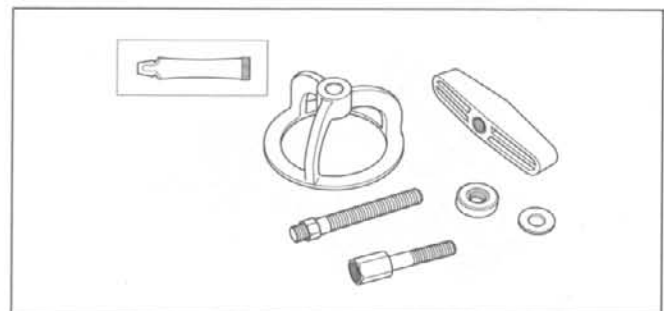
Part No. HD-38125-6 Packard Terminal Crimp Tool (Sealed and non-sealed connectors)



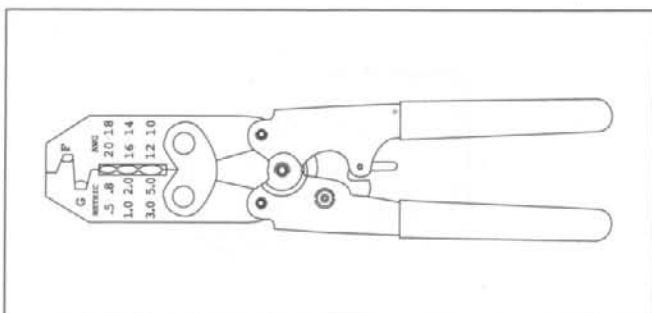
Part No. HD-38362 Sprocket Locking Link



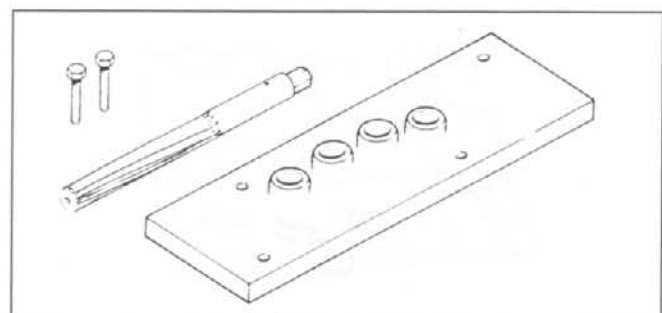
Part No. HD-38125-7 Packard Terminal Crimp Tool (Sealed connectors)



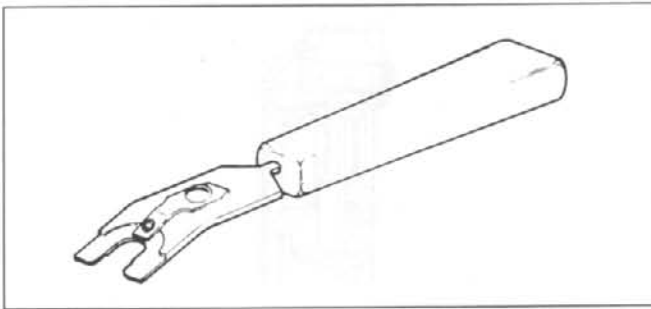
Part No. HD-38515-A Clutch Spring Compressing Tool and Part No. HD-38515-91 Forcing Screw



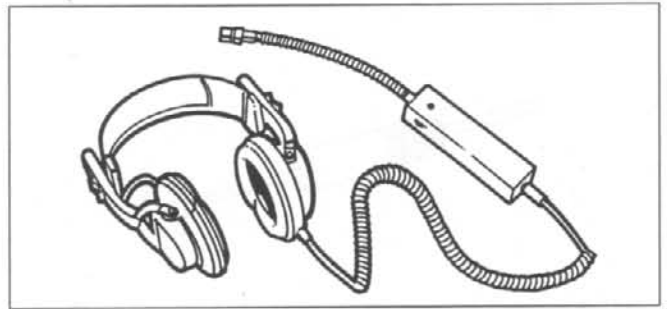
Part No. HD-38125-8 Packard Terminal Crimp Tool



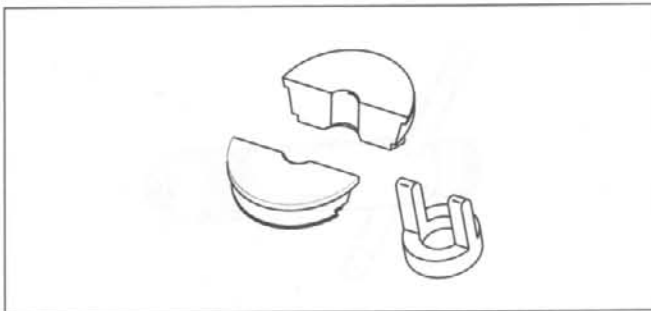
Part No. HD-38871 Camshaft Bushing Plate Pilot and Reamer



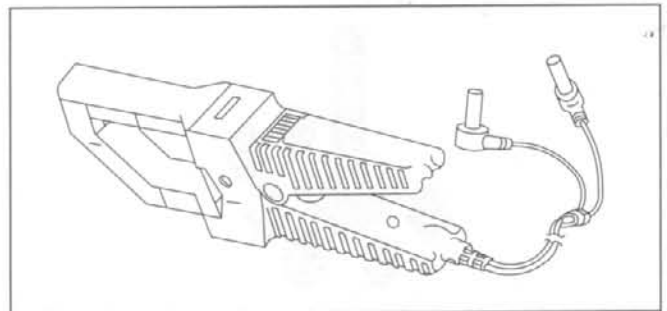
Part No. HD-39151 Shift Drum Retaining Ring Installer



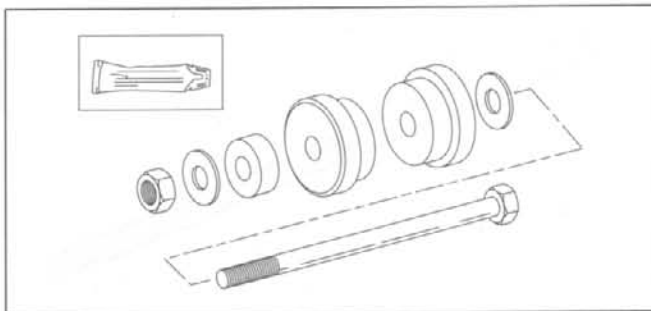
Part No. HD-39565 Engine Sound Probe



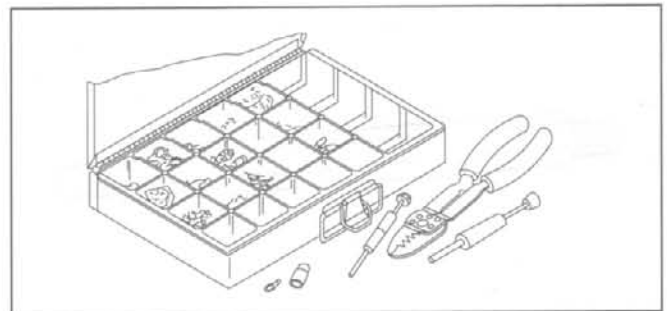
Part No. HD-39301A Steering Head Bearing Race Remover



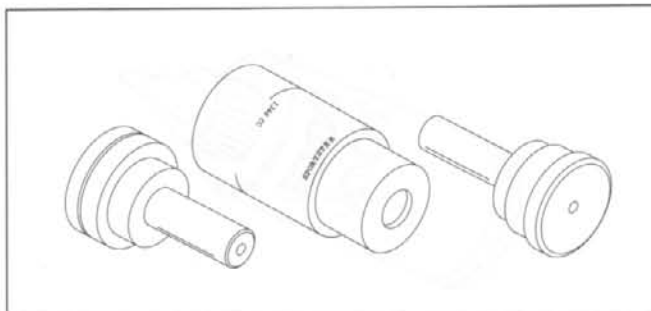
**Part No. HD-39617 Inductive Amp Probe.
Use with HD-35500A.**



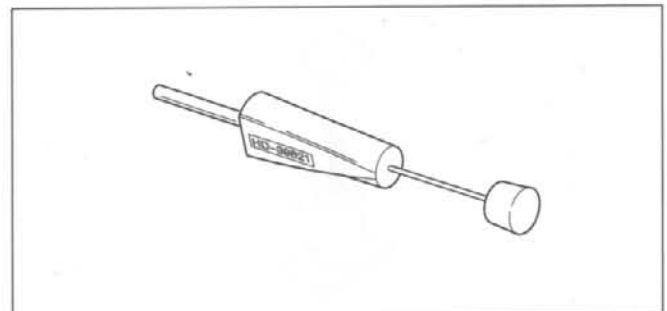
Part No. HD-39302 Steering Head Bearing Race Installer



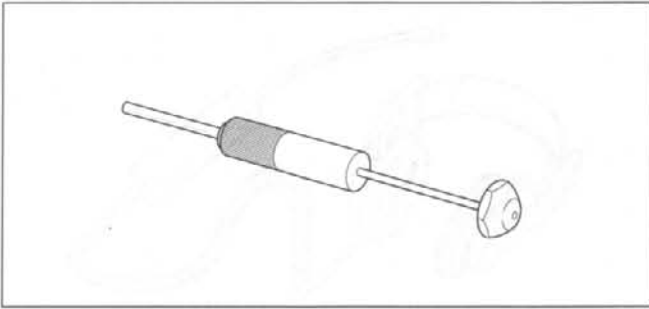
Part No. HD-39621 Electrical Terminal Repair Kit



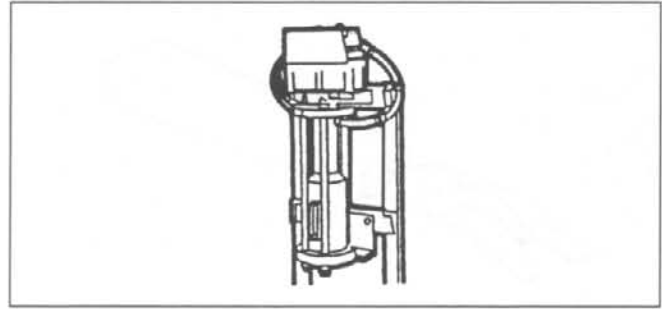
Part No. HD-39458 Sprocket Shaft Bearing Outer Race Installer



Part No. HD-39621-27 Socket Terminal Remover



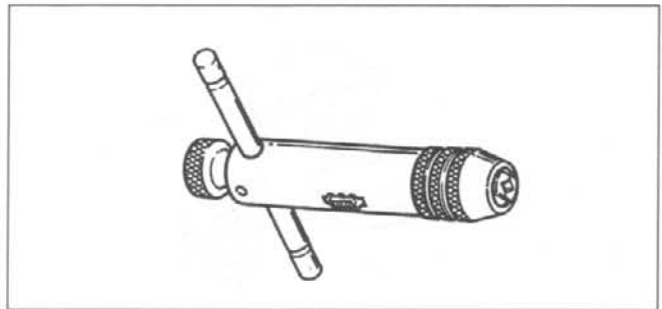
Part No. HD-39621-28 Pin Terminal Remover



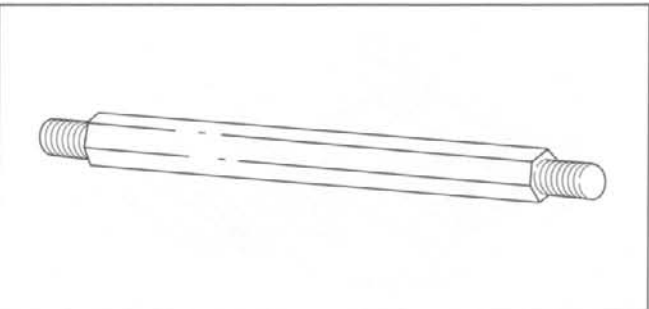
Part No. HD-39823 Oil Filter Crusher, Large



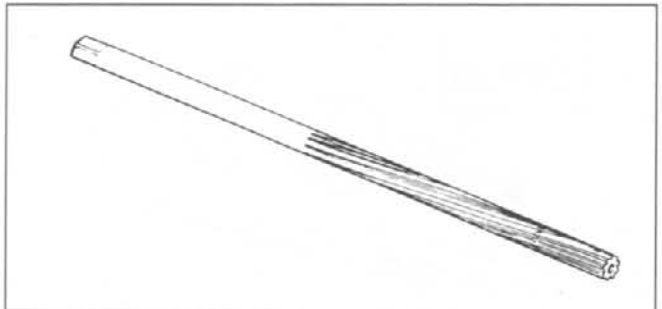
Part No. HD-39782 Cylinder Head Support



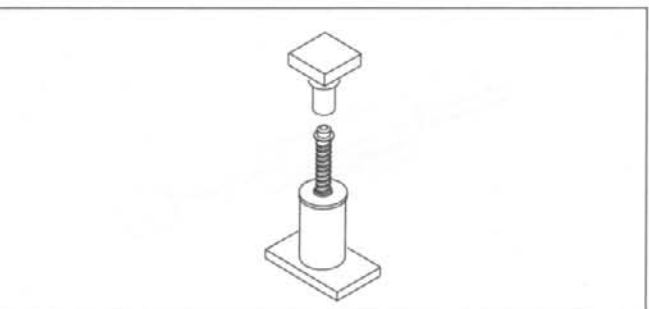
Part No. HD-39847 Universal Ratcheting Tap/
Reamer Handle



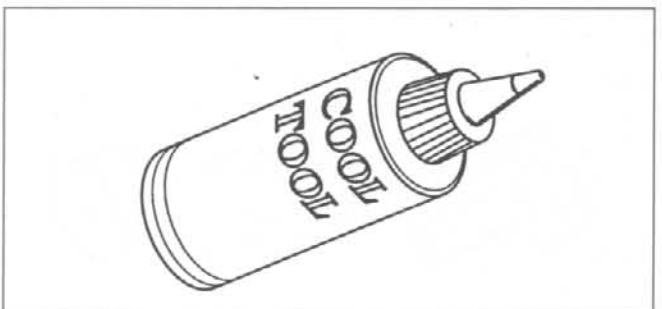
Part No. HD-39786 Cylinder Head Holding Fixture



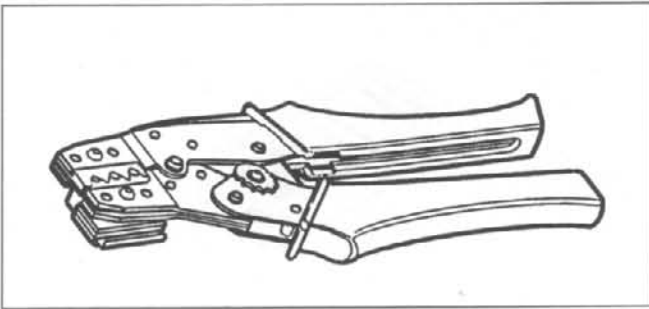
Part No. HD-39932 (Steel) or HD-39932-CAR (Carbide)
Intake and Exhaust Valve Guide Reamer



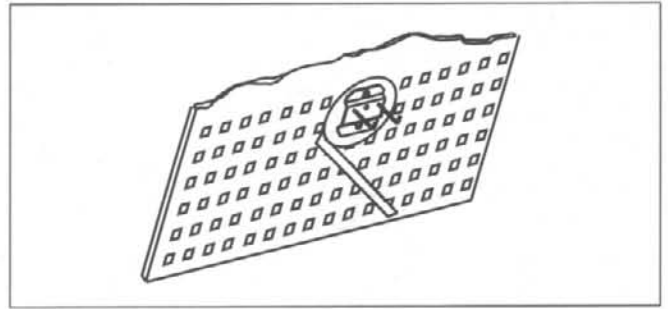
Part No. HD-39800 Oil Filter Crusher, Small



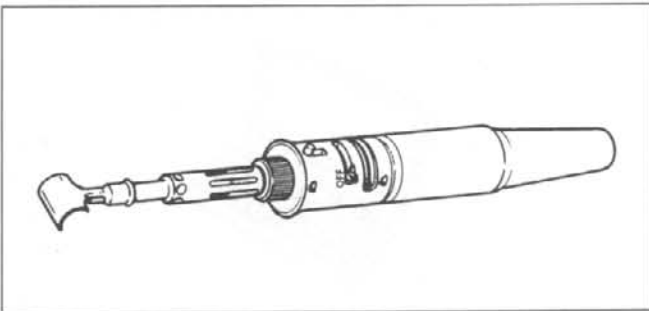
Part No. HD-39964 Reamer Lubricant (Cool Tool)



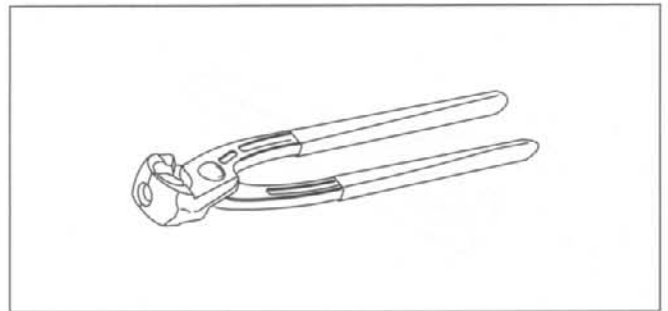
Part No. HD-39965 Deutsch Terminal Crimp Tool



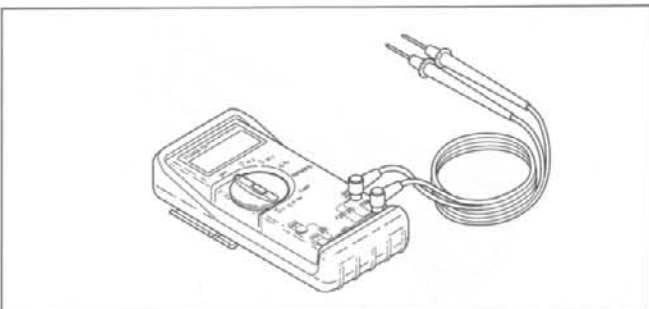
Part No. HD-41025 Tool Organizational System



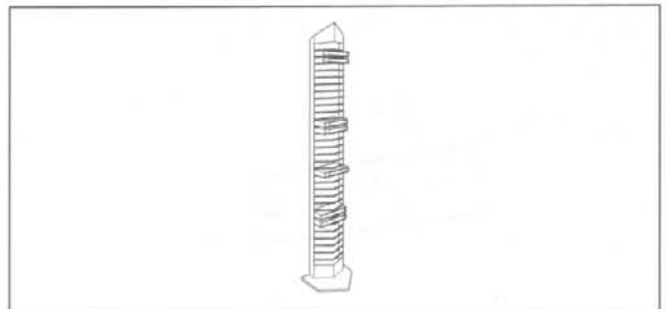
Part No. HD-39969 Ultra-Torch UT-100



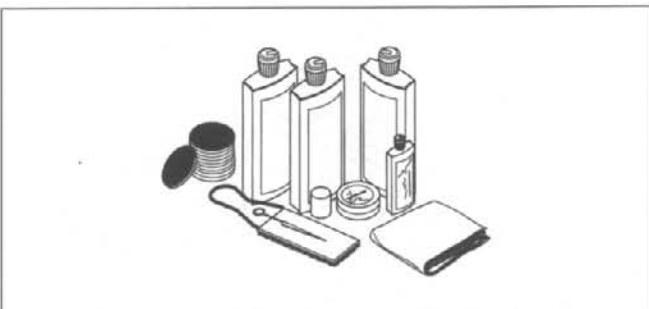
Part No. HD-41137 Hose Clamp Pliers



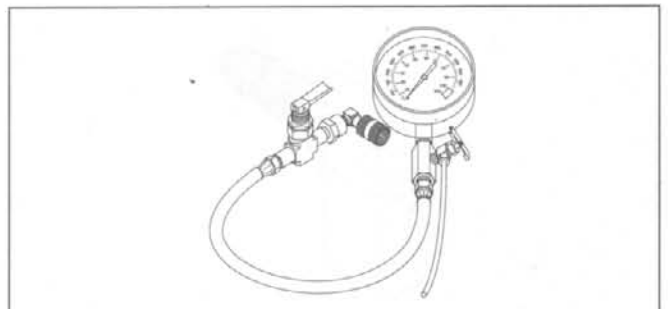
Part No. HD-39978 Fluke 78 Multimeter (DVOM)



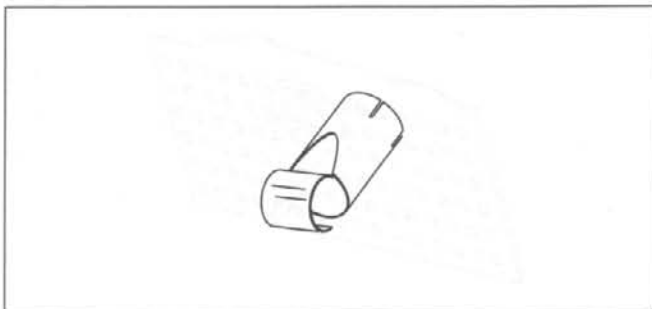
Part No. HD-41155 VHS Video Shelf



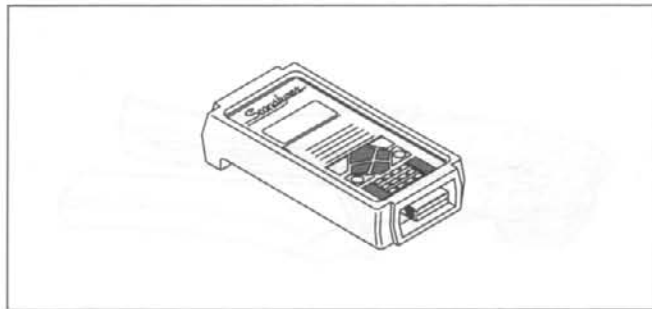
Part No. HD-39994 Paint Repair Kit



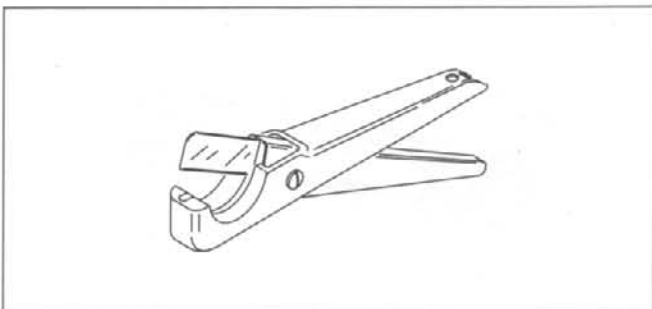
Part No. HD-41182 Fuel Pressure Gauge



Part No. HD-41183 Heat Shield Attachment
Use with Part No. HD-25070.



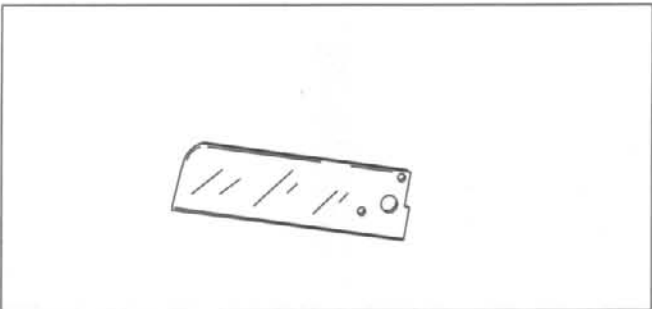
Part No. HD-41325 Scanalyzer



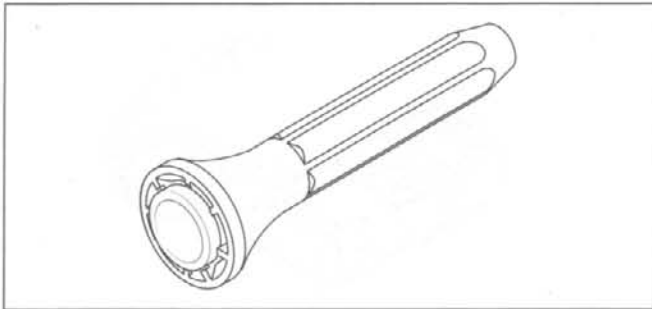
Part No. HD-41185 Hose Cutting Tool



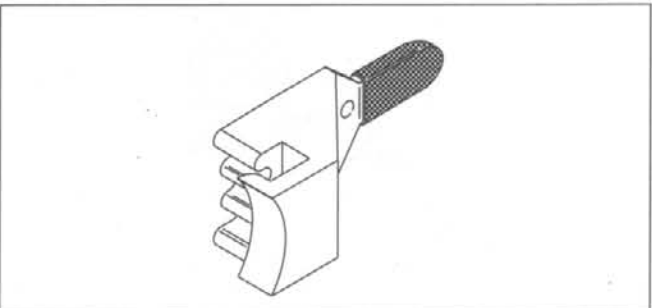
Part No. HD-41404 Test Connector Kit



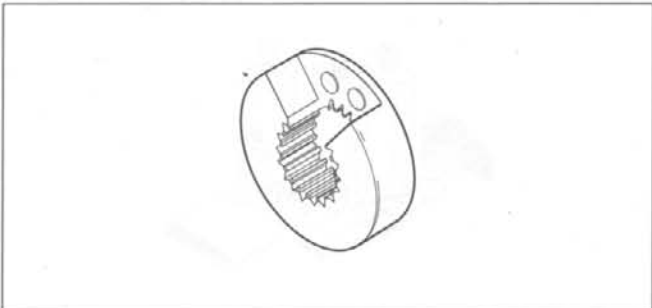
Part No. HD-41185-1 Oil Hose Cutter



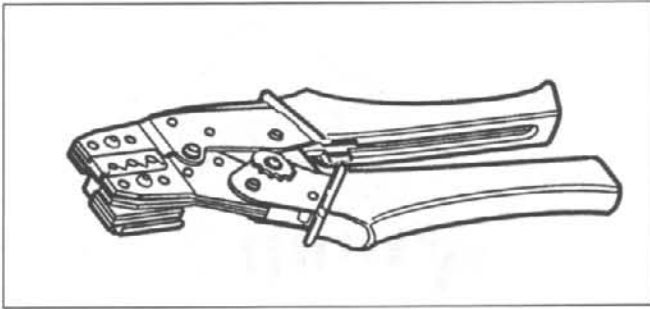
Part No. HD-41496 Main Drive Gear Seal Installer



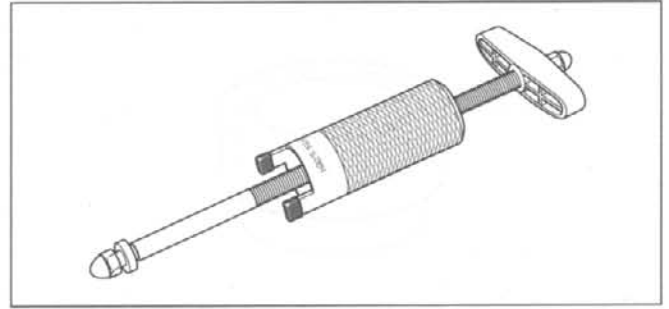
Part No. HD-41321 Sprocket Holding Tool



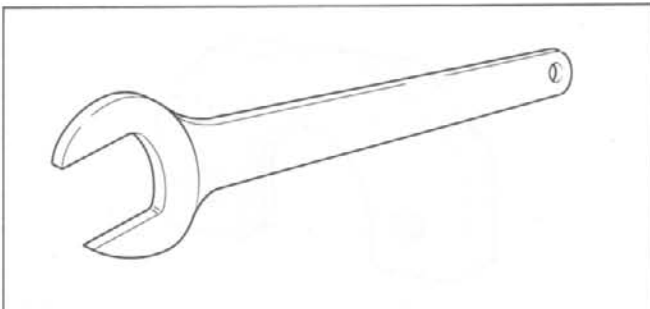
Part No. HD-41506 Crankshaft Locking Tool



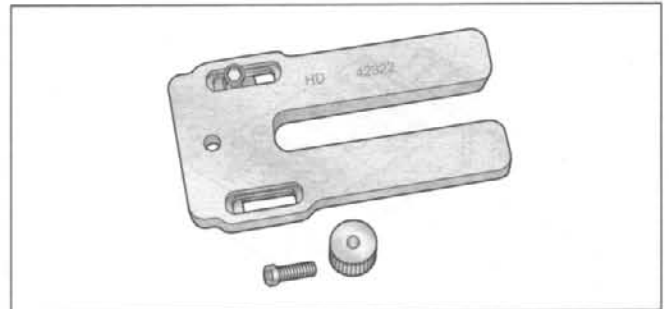
Part No. HD-41609 Amp Terminal Crimp Tool



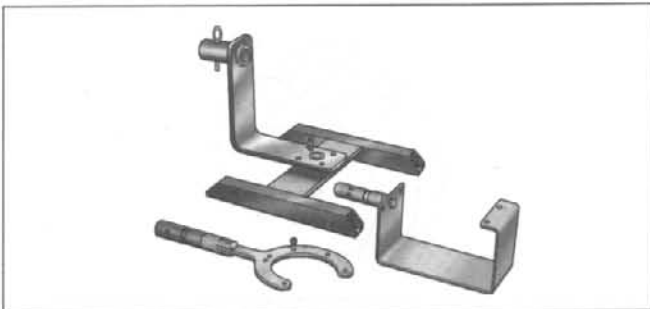
Part No. HD-42320 Piston Pin Remover/Installer



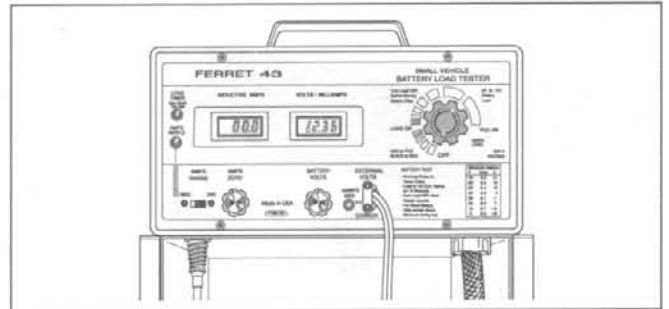
Part No. HD-41675 Oil Pressure Sending Unit Wrench



Part No. HD-42322 Piston Support Plate



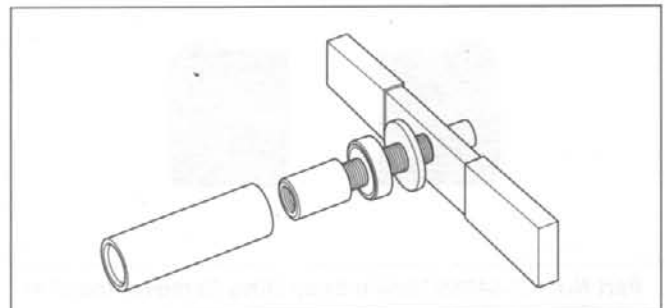
Part No. HD-42310 Engine/Transmission Stand



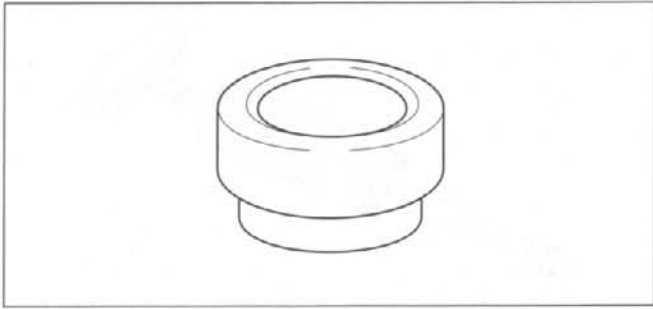
Part No. HD-42376 Battery/Charging System Load Tester



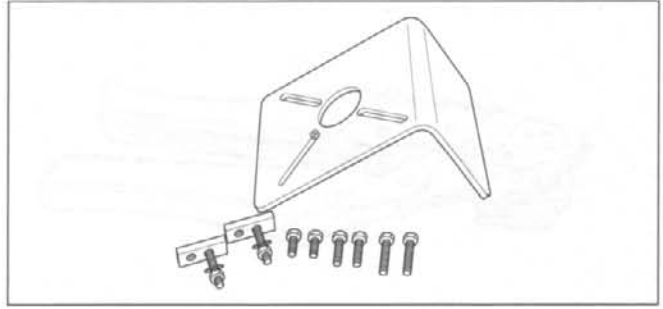
Part No. HD-42311 Oil Filter Wrench



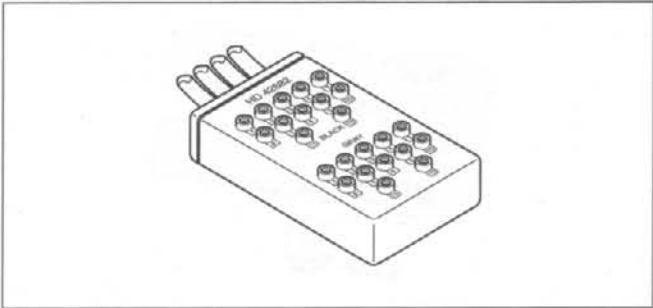
Part No. HD-42579 Sprocket Bearing/Seal Installer



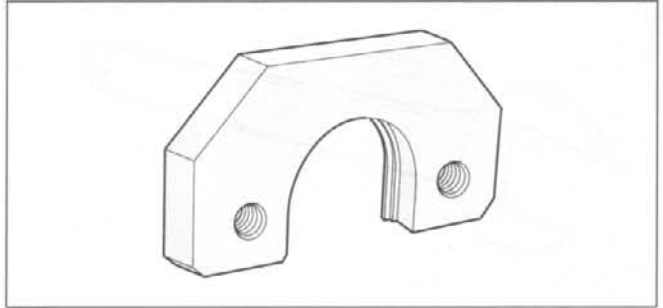
Part No. HD-42774 Sprocket Shaft Seal Installer



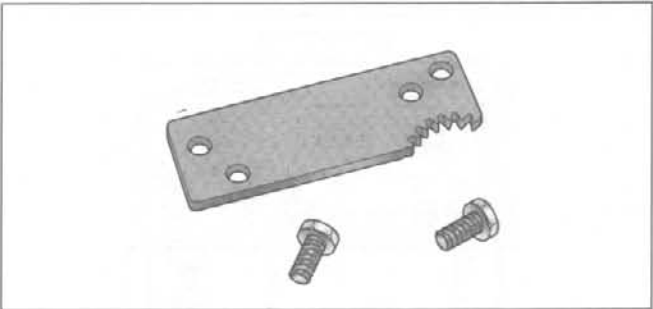
Part No. HD-44358 Flywheel Fixture (2000 Models)



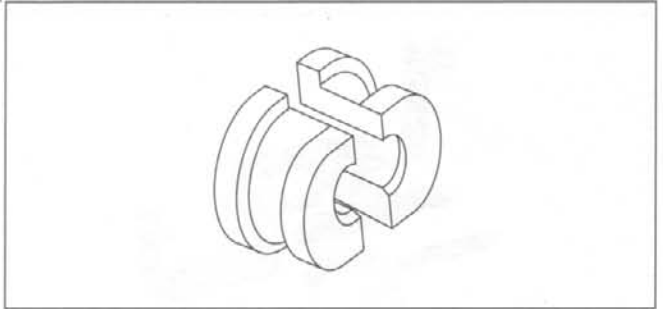
Part No. HD-42682 Breakout Box



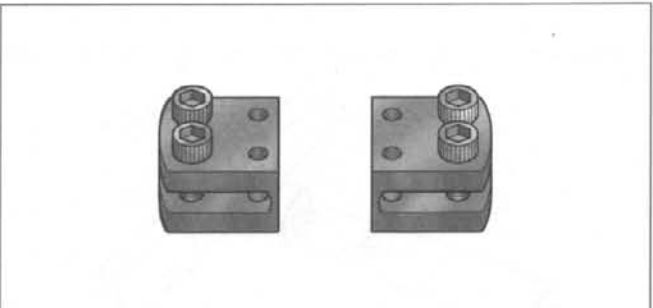
Part No. HD-44404 Sprocket Shaft Inner Timkin Bearing Remover



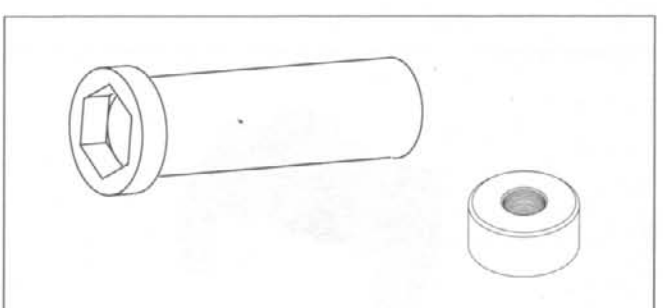
Part No. HD-43984 Crankshaft Locking Tool



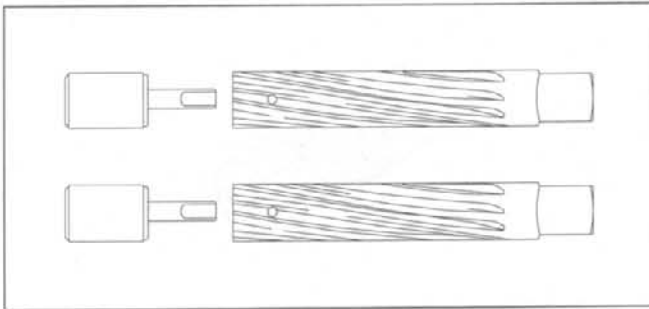
Part No. HD-94547-101 Crankshaft Bearing Outer Race Remover/Installer



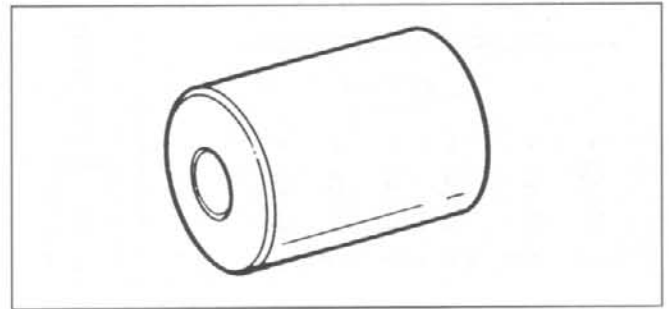
Part No. HD-44069 Timkin Snap Ring Remover/Installer



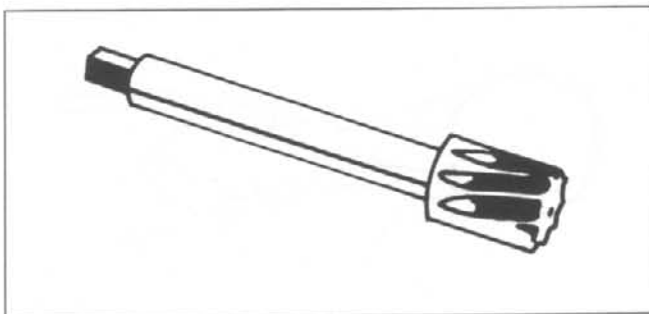
Part No. HD-94660-37B Mainshaft Locknut Wrench



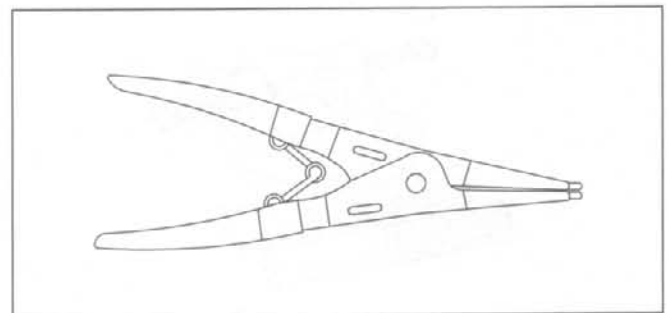
Part No. HD-94800-26A Connecting Rod Bushing Reamers and Pilots



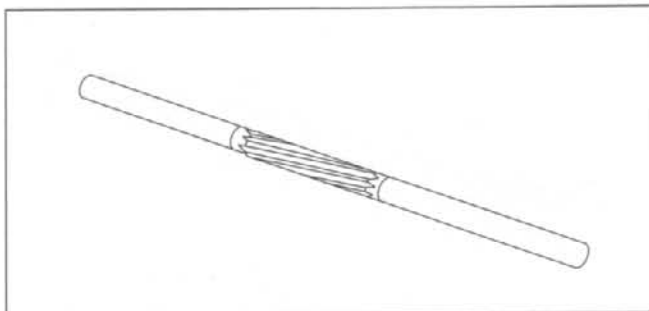
**Part No. HD-94812-87 Pinion Shaft Reamer Pilot.
Use with HD-94812-1.**



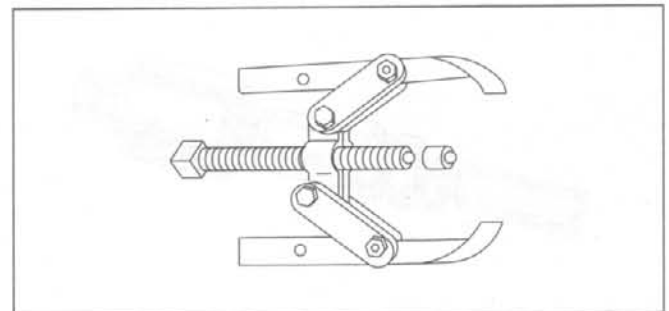
Part No. HD-94803-67 Rear Intake Camshaft Bushing Reamer



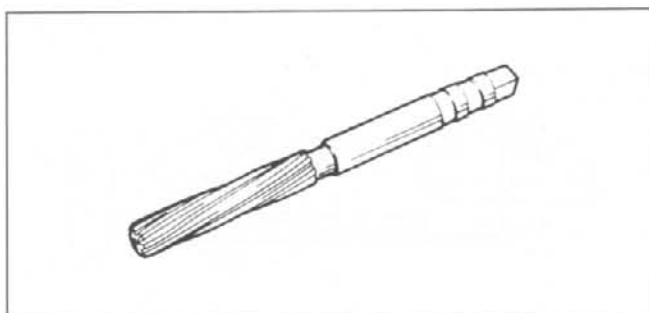
Part No. HD-95017-61 Large External Retaining Ring Pliers



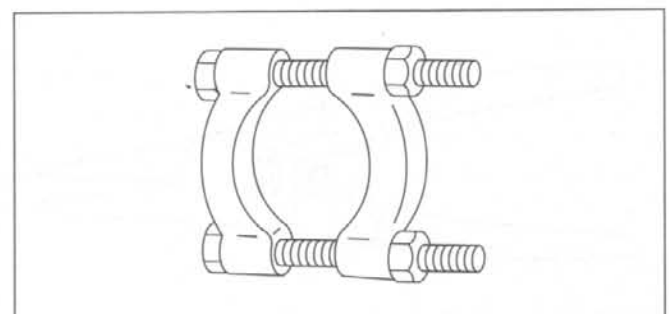
Part No. HD-94804-57 Rocker Arm Bushing Reamer



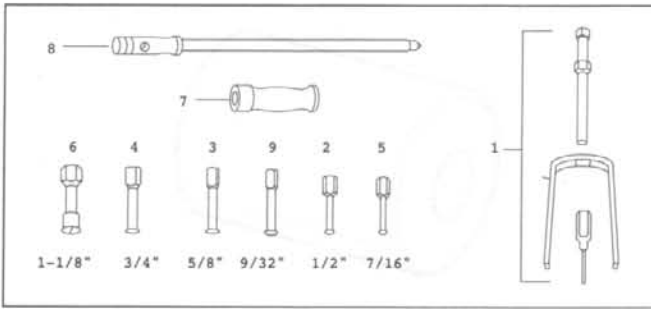
Part No. HD-95635-46 All-Purpose Claw Puller



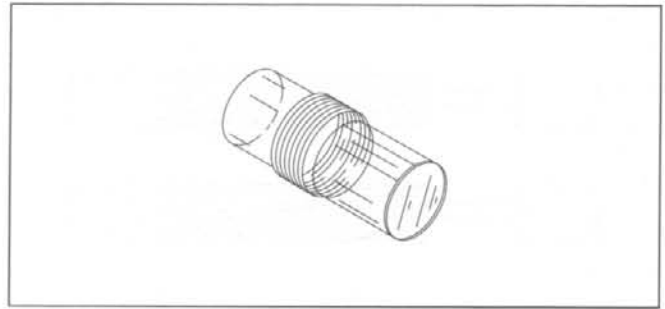
**Part No. HD-94812-1 Pinion Shaft Bushing Reamer.
Use with HD-94812-87.**



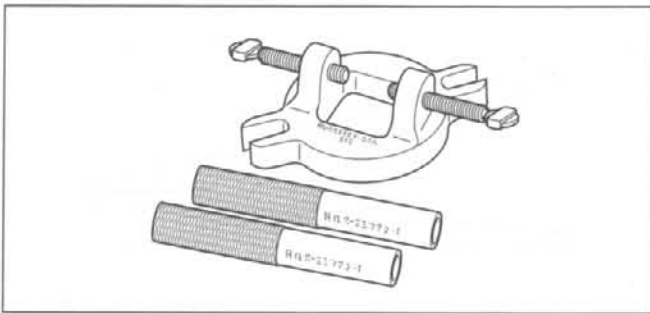
Part No. HD-95637-46A Wedge Attachment for Claw Puller. Use with HD-95635-46.



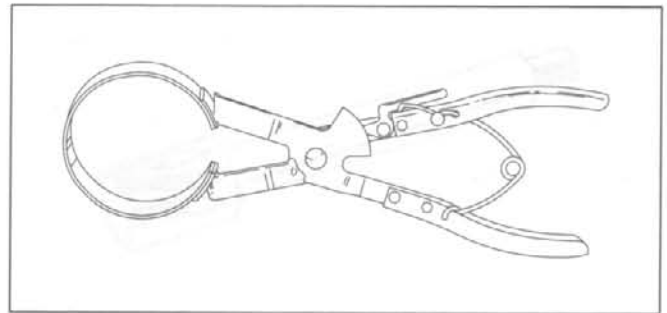
Part No. HD-95760-69A Bushing/Bearing Puller Tool Set.
Set includes items 1-7. Items 8 (HD-95769-69), 9 (HD-95770-69) and 10 (HD-95771-69) are optional.



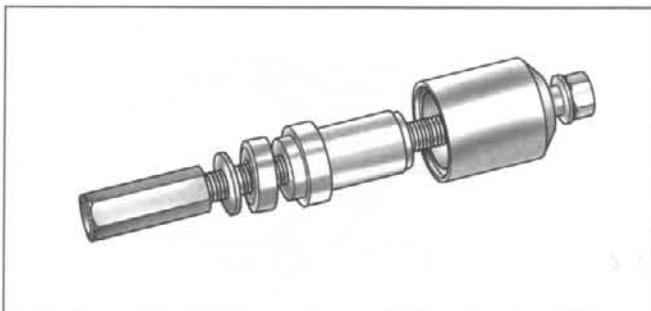
Part No. HD-96295-65D Timing Mark View Plug.
Use with HD-33813.



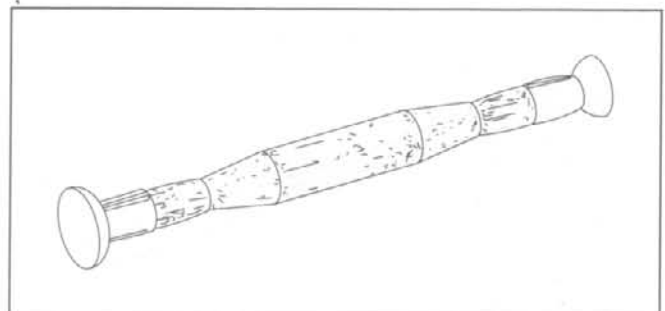
Part No. HD-95952-33B Connecting Rod Clamping Tool



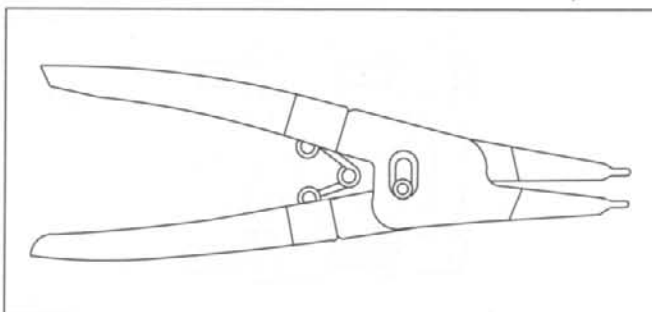
Part No. HD-96333-51C Piston Ring Compressor



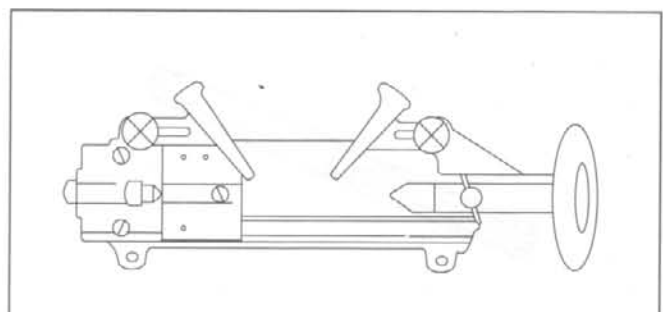
Part No. HD-95970-32D Piston Pin Bushing Tool



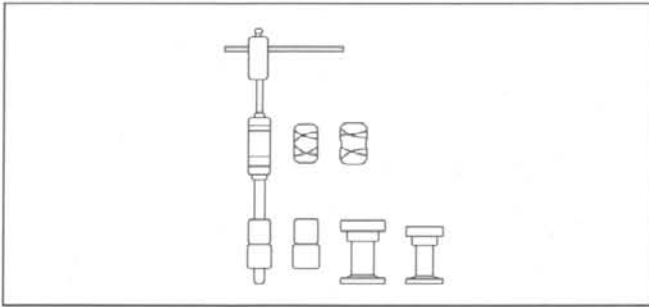
Part No. HD-96550-36A Valve Lapping Tool



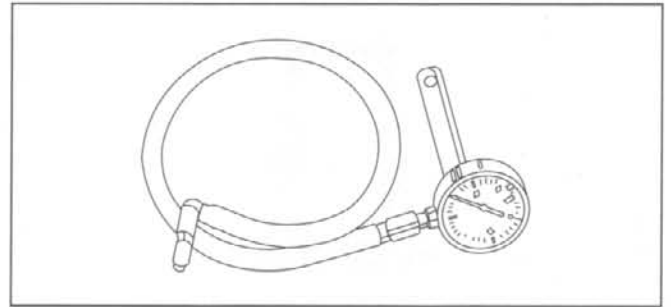
Part No. HD-96215-49 Small Internal Retaining Ring Pliers



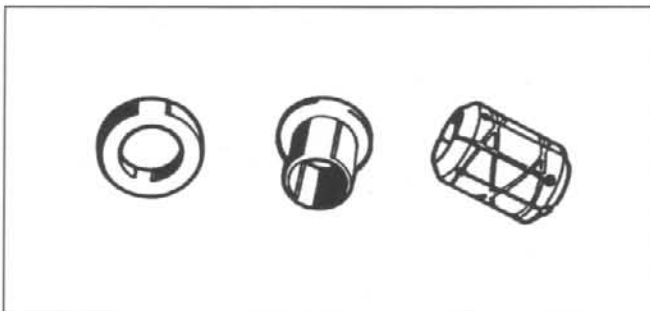
Part No. HD-96650-80 Flywheel Truing Stand



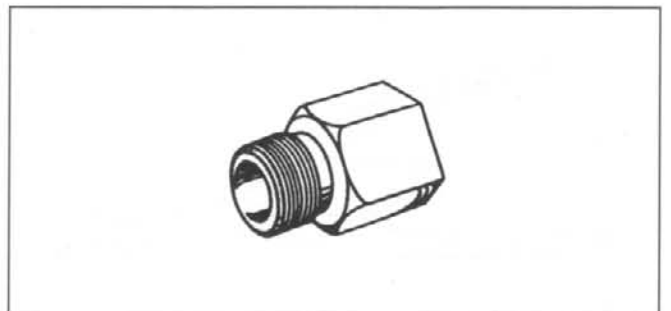
Part No. HD-96710-40B Crankcase Main Bearing Lapping Tool



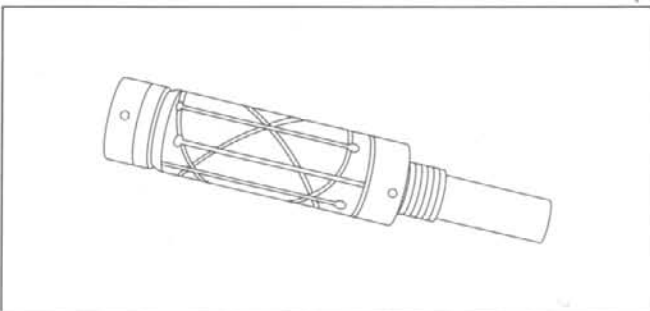
Part No. HD-96921-52A Oil Pressure Gauge



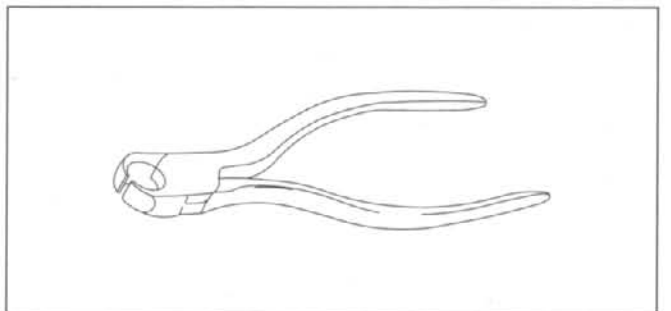
Part No. HD-96718-87 Pinion Bearing Outer Race Lapping Kit



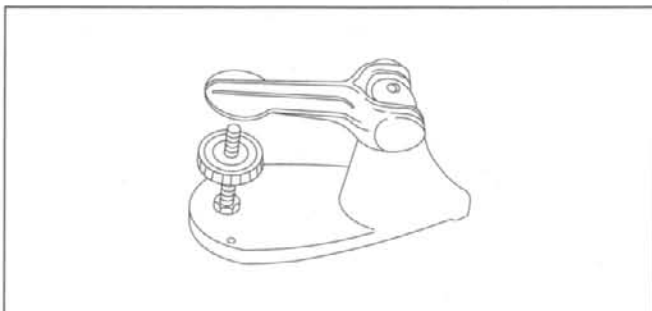
**Part No. HD-96940-52A Oil Pressure Gauge Adapter.
Use with HD-96921-52A.**



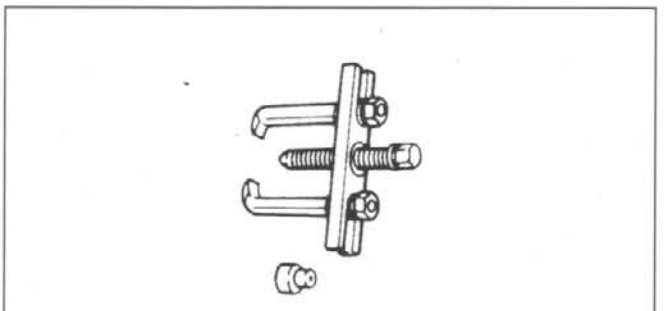
Part No. HD-96740-36 Connecting Rod Lapping Arbor



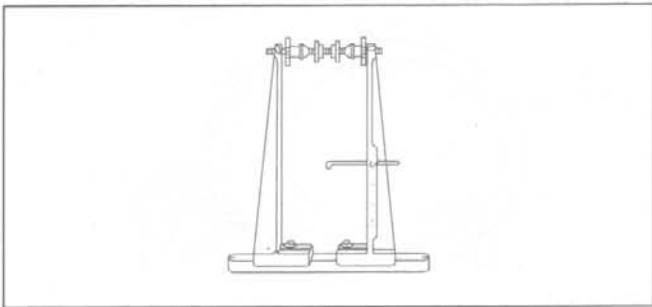
Part No. HD-97087-65B Hose Clamp Pliers



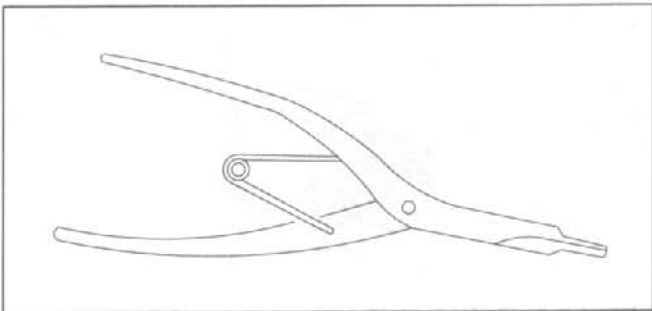
Part No. HD-96796-47 Valve Spring Tester



Part No. HD-97292-61 Two Claw Puller



**Part No. HD-99500-80 Wheel Truing
and Balancing Stand**



**Part No. J-5586 Transmission Shaft
Retaining Ring Pliers**

APPENDIX B—METRIC CONVERSIONS

Table B-1. Metric Conversions

MILLIMETERS to INCHES (mm x 0.03937 = inches)								INCHES to MILLIMETERS (inches x 25.40 = mm)							
mm	in.	mm	in.	mm	in.	mm	in.	in.	mm	in.	mm	in.	mm	in.	mm
.1	.0039	25	.9842	58	2.283	91	3.582	.001	.025	.6	15.240	1 15/16	49.21	3 5/16	84.14
.2	.0078	26	1.024	59	2.323	92	3.622	.002	.051	5/8	15.875	2	50.80	3 3/8	85.72
.3	.0118	27	1.063	60	2.362	93	3.661	.003	.076	11/16	17.462	2 1/16	52.39	3.4	86.36
.4	.0157	28	1.102	61	2.401	94	3.701	.004	.102	.7	17.780	2.1	53.34	3 7/16	87.31
.5	.0197	29	1.142	62	2.441	95	3.740	.005	.127	3/4	19.050	2 1/8	53.97	3 1/2	88.90
.6	.0236	30	1.181	63	2.480	96	3.779	.006	.152	.8	20.320	2 3/16	55.56	3 9/16	90.49
.7	.0275	31	1.220	64	2.519	97	3.819	.007	.178	13/16	20.638	2.2	55.88	3.6	91.44
.8	.0315	32	1.260	65	2.559	98	3.858	.008	.203	7/8	22.225	2 1/4	57.15	3 5/8	92.07
.9	.0354	33	1.299	66	2.598	99	3.897	.009	.229	.9	22.860	2.3	58.42	3 11/16	93.66
1	.0394	34	1.338	67	2.638	100	3.937	.010	.254	15/16	23.812	2 5/16	58.74	3.7	93.98
2	.0787	35	1.378	68	2.677	101	3.976	1/64	.397	1	25.40	2 3/8	60.32	3 3/4	95.25
3	.1181	36	1.417	69	2.716	102	4.016	.020	.508	1 1/16	26.99	2.4	60.96	3.8	96.52
4	.1575	37	1.456	70	2.756	103	4.055	.030	.762	1.1	27.94	2 7/16	61.91	3 13/16	96.84
5	.1968	38	1.496	71	2.795	104	4.094	1/32	.794	1 1/8	28.57	2 1/2	63.50	3 7/8	98.42
6	.2362	39	1.535	72	2.834	105	4.134	.040	1.016	1 3/16	30.16	2 9/16	65.09	3.9	99.06
7	.2756	40	1.575	73	2.874	106	4.173	.050	1.270	1.2	30.48	2.6	66.04	3 15/16	100.01
8	.3149	41	1.614	74	2.913	107	4.212	.060	1.524	1 1/4	31.75	2 5/8	66.67	4	101.6
9	.3543	42	1.653	75	2.953	108	4.252	1/16	1.588	1.3	33.02	2 11/16	68.26	4 1/16	102.19
10	.3937	43	1.693	76	2.992	109	4.291	.070	1.778	1 5/16	33.34	2.7	68.58	4.1	104.14
11	.4331	44	1.732	77	3.031	110	4.331	.080	2.032	1 3/8	34.92	2 3/4	69.85	4 1/8	104.77
12	.4724	45	1.772	78	3.071	111	4.370	.090	2.286	1.4	35.56	2.8	71.12	4 3/16	106.36
13	.5118	46	1.811	79	3.110	112	4.409	.1	2.540	1 7/16	36.51	2 13/16	71.44	4.2	106.68
14	.5512	47	1.850	80	3.149	113	4.449	1/8	3.175	1 1/2	38.10	2 7/8	73.02	4 1/4	107.95
15	.5905	48	1.890	81	3.189	114	4.488	3/16	4.762	1 9/16	39.69	2.9	73.66	4.3	109.22
16	.6299	49	1.929	82	3.228	115	4.527	.2	5.080	1.6	40.64	2 15/16	74.61	4 5/16	109.54
17	.6693	50	1.968	83	3.268	116	4.567	1/4	6.350	1 5/8	41.27	3	76.20	4 3/8	111.12
18	.7086	51	2.008	84	3.307	117	4.606	.3	7.620	1 11/16	42.86	3 1/16	77.79	4.4	111.76
19	.7480	52	2.047	85	3.346	118	4.645	5/16	7.938	1.7	43.18	3.1	78.74	4 7/16	112.71
20	.7874	53	2.086	86	3.386	119	4.685	3/8	9.525	1 3/4	44.45	3 1/8	79.37	4 1/2	114.30
21	.8268	54	2.126	87	3.425	120	4.724	.4	10.160	1.8	45.72	3 3/16	80.96	4 9/16	115.89
22	.8661	55	2.165	88	3.464	121	4.764	7/16	11.112	1 13/16	46.04	3.2	81.28	4.6	116.84
23	.9055	56	2.205	89	3.504	122	4.803	1/2	12.700	1 7/8	47.62	3 1/4	82.55	4 5/8	117.47
24	.9449	57	2.244	90	3.543	123	4.842	9/16	14.288	1.9	48.26	3.3	83.82	4 11/16	119.06








FASTENER TORQUE VALUES

Torque specifications for specific components are listed in each section at the point of use. When converting to Newton-meters, use the formulas given under the metric chart. For all other steel fasteners, use the values listed in one of the tables below. In the English table, torque figures are listed in ft-lbs, except those marked with an asterisk (*), which are listed in in-lbs. In the metric table, figures are listed in Newton-meters.

WARNING








The quality fasteners used on Buell motorcycles have specific strength, finish and type requirements to perform properly in the assembly and the operating environment. Use only genuine Buell replacement fasteners tightened to the proper torque. Substitution could cause fastener failure, which could result in death or serious injury.

Table B-2. English Torque Values

FASTENER	TYPE	MINIMUM TENSILE STRENGTH	MATERIAL	BODY SIZE OR OUTSIDE DIAMETER																	
				# (number)						in. (inches)											
				2	3	4	5	6	8	10	1/4	5/16	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1	
	SAE 2 STEEL	74,000 PSI	LOW CARBON									6	12	20	32	47	69	96	155	206	310
	SAE 5 STEEL	120,000 PSI	MEDIUM CARBON HEAT TREAT						14*	22*		10	19	33	54	78	114	154	257	382	587
	SAE 7 STEEL	133,000 PSI	MEDIUM CARBON ALLOY									13	25	44	71	110	154	215	360	570	840
	SAE 8 STEEL	150,000 PSI	MEDIUM CARBON ALLOY									14	29	47	78	119	169	230	380	600	900
	SAE 8 STEEL	150,000 PSI	MEDIUM CARBON ALLOY									14	29	47	78	119	169	230	380	600	900
	SOCKET SET SCREW	212,000 PSI	HIGH CARBON QUENCHED TEMPERED					9*	16*	30*	70*	140*	18	29	43	63	100	146			
	STUDS			Use SAE 2, 5 and 8 values when grade is known, with nut of sufficient strength.																	

*Torque values in in-lbs.

Table B-3. Metric Torque Values

FASTENER	TYPE	MINIMUM TENSILE STRENGTH	MATERIAL	BODY SIZE OR OUTSIDE DIAMETER																		
				# (number)						mm (millimeters)												
				2	3	4	5	6	8	10	6.4	7.9	9.5	11.1	12.7	14.3	15.9	19.1	22.2	25.4		
	SAE 2 STEEL	5,202 kg/cm ²	LOW CARBON										8.3	16.6	27.7	44.3	65.0	95.4	132.8	214.4	283.5	428.7
	SAE 5 STEEL	8,436 kg/cm ²	MEDIUM CARBON HEAT TREAT						1.6	2.5		13.8	26.3	45.6	74.7	107.9	157.7	213.0	355.4	528.3	811.8	
	SAE 7 STEEL	9,350 kg/cm ²	MEDIUM CARBON ALLOY									18.0	34.6	60.8	98.2	152.1	213.0	297.3	497.9	788.3	1161.7	
	SAE 8 STEEL	10,545 kg/cm ²	MEDIUM CARBON ALLOY									19.4	40.1	65.0	107.9	164.6	233.7	318.1	525.5	829.8	1220.0	
	SAE 8 STEEL	10,545 kg/cm ²	MEDIUM CARBON ALLOY									19.4	40.1	65.0	107.9	164.6	233.7	318.1	525.5	829.8	1220.0	
	SOCKET SET SCREW	14,904 kg/cm ²	HIGH CARBON QUENCHED TEMPERED					1.0	1.8	3.4	8.1	16.1	24.9	40.1	59.5	87.1	138.3	201.9				
	STUDS			Use SAE 2, 5 and 8 values when grade is known, with nut of sufficient strength.																		

foot-pounds (ft-lbs) x 1.356 = Newton-meters (Nm)

inch-pounds (in-lbs) x 0.113 = Newton-meters (Nm)

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