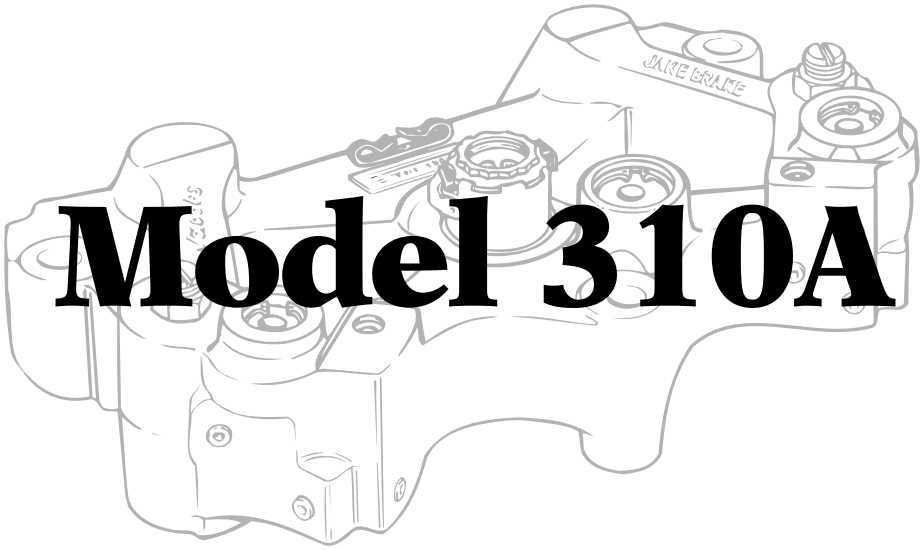
INSTALLATION



Model 310A

The Model 310A Engine Brake is designed and approved for use on all 1994 Caterpillar Series 3176B engines. This engine can be identified by an engine serial number prefix of 9CK. The Model 310A replaces the Model 310, which is discontinued.

Jacobs Service Letters should be consulted for additional applications and updated information.

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Safety Precautions

The following symbols in this manual signal potentially dangerous conditions to the mechanic or equipment. Read this manual carefully. Know when these conditions can exist. Then, take necessary steps to protect personnel as well as equipment.

⚠ WARNING

THIS SYMBOL WARNS OF POSSIBLE PERSONAL INJURY.

⚠ CAUTION

THIS SYMBOL REFERS TO POSSIBLE EQUIPMENT DAMAGE.

NOTE:

INDICATES AN OPERATION, PROCEDURE OR INSTRUCTION THAT IS IMPORTANT FOR CORRECT SERVICE.

Fuels, electrical equipment, exhaust gases and moving engine parts present potential hazards that could result in personal injury. Take care when installing an engine brake. Always use correct tools and proper procedures as outlined in this manual.

⚠ WARNING

SEE JACOBS DRIVER'S MANUAL FOR PROPER ENGINE BRAKE DRIVER TECHNIQUES.

THE JAKE BRAKE RETARDER IS A VEHICLE SLOWING DEVICE, NOT A VEHICLE STOPPING DEVICE. IT IS NOT A SUBSTITUTE FOR THE SERVICE BRAKING SYSTEM. THE VEHICLE'S SERVICE BRAKES MUST BE USED TO BRING THE VEHICLE TO A COMPLETE STOP.

Section 1: Introduction

Housing Identification

The housing serial number is stamped on the flat surface of the housing near the control valve. The engine brake model number, housing part number and slave lash are printed on a nameplate located on the top surface of the housing.

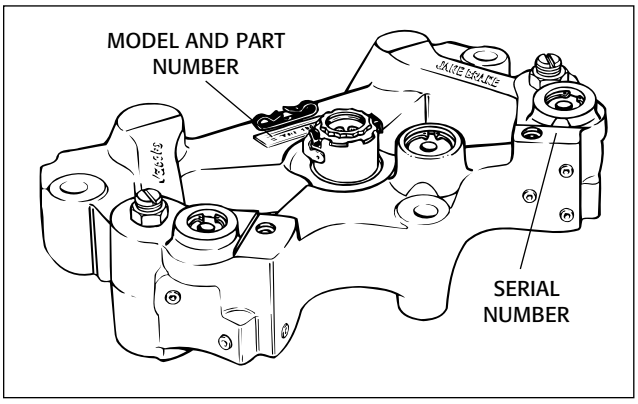

FIG. 1

Engine Identification

Engine serial number prefix "9CK" indicates a 1994 model year 3176B engine. See page 7 for slave piston adjustment procedures.

Electrical control systems are engine and vehicle integrated. Control system installation information should be obtained from Caterpillar or appropriate vehicle manufacturer.

Engine serial number information is printed on the nameplate located on the left rear side of the engine block.

Tools Needed

There are no special tools required for installation of the Model 310A Jake Brake® engine retarder. However, the Caterpillar Series 3176B engine and the Model 310A Jake Brake are of metric design and will require the use of metric hand tools.

Recommended Torque Values

Jacobs Parts

Cylinder head bolt	203 lbft. (275 N•m)
Brake mounting study assembly	70 lbft. (95 N•m)
Housing hold-down nuts	59 lbft. (80 N•m)
Housing bolts, 70 mm long	41 lbft. (55 N•m)
Slave piston adjusting screw locknut	25 lbft. (35 N•m)
Spacer bolts (cover)	5 lbft. (7 N•m)
Solenoid valve	5 lbft. (7 N•m)

Caterpillar Parts

Ex. rocker arm adjusting screw locknut	18 lbft. (25 N•m)
Injector rocker arm adjusting screw	41 lbft. (55 N•m)

NOTE:

UNLESS OTHERWISE SPECIFIED, THE TORQUE VALUES LISTED HERE AND IN THE TEXT ARE DIRECT VALUES USING NO TORQUE WRENCH ADAPTERS OR EXTENSIONS. WHEN ADAPTERS OR EXTENSIONS ARE USED WITH A TORQUE WRENCH, THE TORQUE VALUES MUST BE ADJUSTED. FOLLOW THE MANUFACTURER'S RECOMMENDED PROCEDURES FOR THE TORQUE WRENCH AND ADAPTER BEING USED.

Section 2: Engine Preparation

Valve Cover Base

The photographs in this manual show the valve cover base in place during engine brake installation. Production engines will be equipped with a cover base (1) that includes three support brackets (2) for containment of the injector wire harnesses (see Fig. 2).

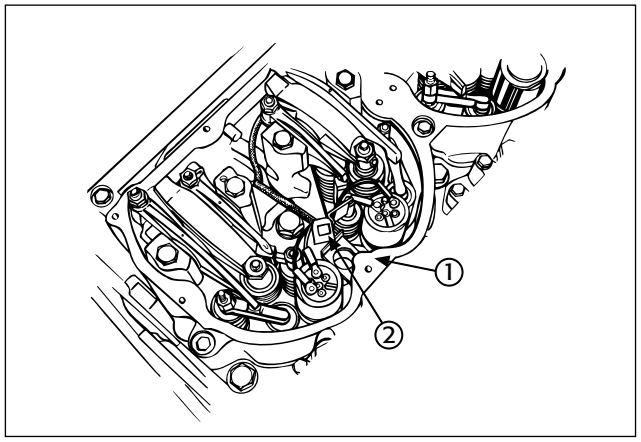

FIG. 2

The support brackets may prevent access to the three cylinder head bolts which must be removed for the installation of three Jacobs bolts. Because the injector harness support brackets are difficult to remove with the cover base in place, **it may be necessary to remove the valve cover base to permit access to the cylinder head bolts**.

Exhaust Valve Bridge Adjusting Screw Replacement

Remove all accessory equipment that is necessary to remove the rocker covers.

Remove the rocker covers. Note the valve arrangement shown in Fig. 3.

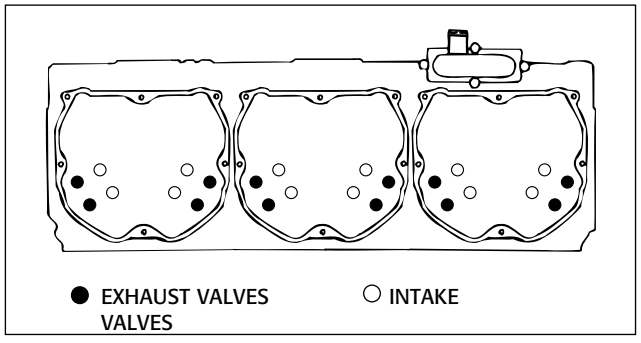

FIG. 3

Refer to Fig. 4. Loosen the locknut (2) and the adjusting screw (1) on the exhaust rocker arm (3).

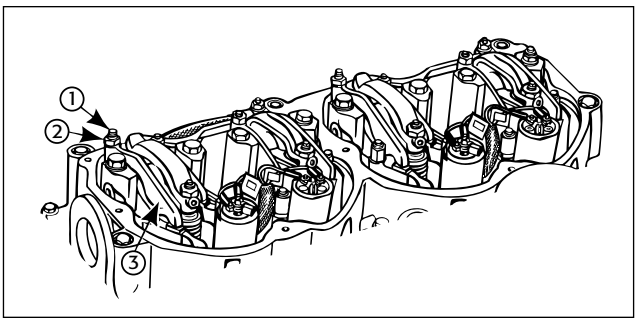

FIG. 4

Loosen the locknut on the exhaust valve bridge adjusting screw.

Move the exhaust valve push rod aside to permit the rocker arm to be rotated.

Remove the Caterpillar exhaust valve bridge (1) (see Fig. 5).

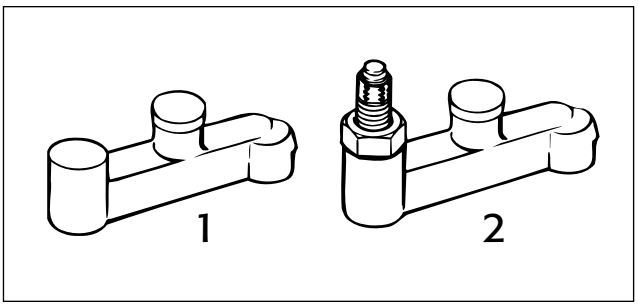

FIG. 5

Valve Bridge Installation

Lubricate the Jacobs' bridge, top pad and screw and pin assembly with clean lube oil.

Install the Caterpillar bridge assembly used for Jacobs' screw and pin assembly (2) (see Fig. 5) on bridge dowel with the adjusting screw toward the rocker shaft as shown in Fig. 6. This is 180° from the original position.

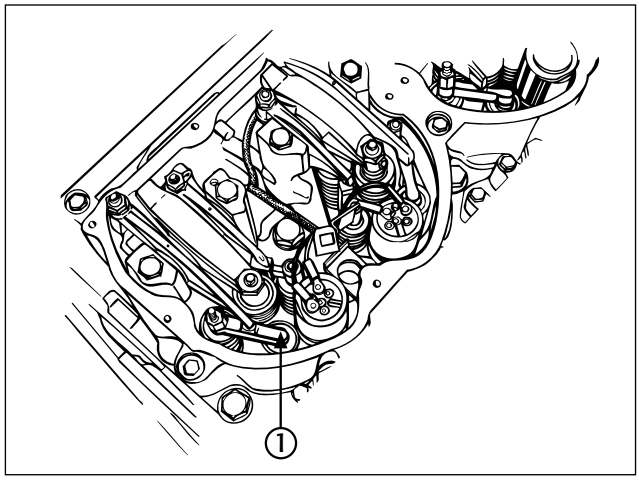

FIG. 6

⚠ CAUTION

DO NOT DISASSEMBLE THE JACOBS' BRIDGE ASSEMBLY AS THIS WILL CHANGE THE POSITION OF THE LEVELING SCREW. IMPROPER LEVELING OF THE BRIDGE COULD RESULT IN SERIOUS ENGINE DAMAGE.

⚠ CAUTION

BE SURE THE EXHAUST VALVE BRIDGE IS PROPERLY LOCATED ON THE EXHAUST VALVE STEM. THE VALVE STEM MUST FIT IN THE COUNTERBORE OF THE BRIDGE ON THE SIDE WITHOUT THE ADJUSTING SCREW. FAILURE TO DO SO WILL RESULT IN SERIOUS ENGINE DAMAGE.

Refer to Fig. 7 to determine the cylinder head bolts (1) and rocker shaft bolts (2) to be removed.

NOTE:

REPLACE THE THREE CYLINDER HEAD BOLTS WITH THE JACOBS' BOLTS ONE AT A TIME. THIS WILL PREVENT CYLINDER HEAD DISTORTION.

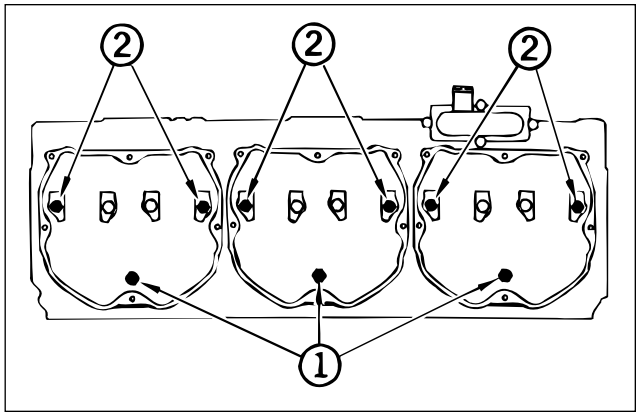

FIG. 7

Remove the cylinder head bolt and washer closest to the intake manifold, one per brake housing.

Using a blow gun nozzle with an extension, remove the oil from the cylinder head bolt hole.

⚠ WARNING

WEAR EYE PROTECTION AND COVER THE CYLINDER HEAD BOLT HOLE WITH TOWELS TO MINIMIZE OIL SPRAY AND HELP PREVENT PERSONAL INJURY.

Coat head bolt threads (2) and both faces of the related washers (1) with a moly lube (6V4876 or G-N metal assembly paste) prior to assembly.

Refer to Fig. 8 to install the Caterpillar washer (1) on the Jacobs' cylinder head bolt (2) and install the bolt into the hole. Tighten the bolt to 203 lbft. (275 N•m).

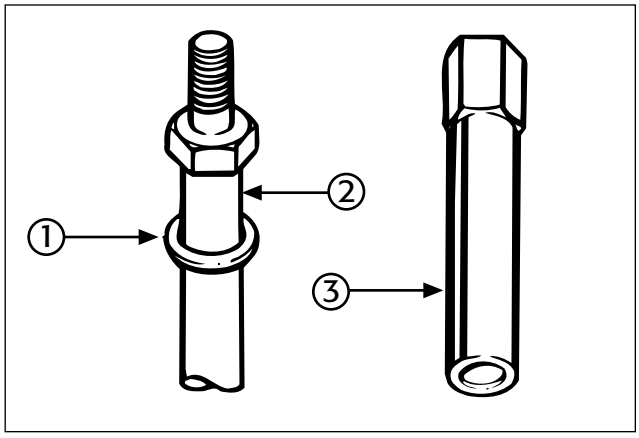

FIG. 8

Repeat the above procedure for the remaining two cylinder head bolts, one at a time.

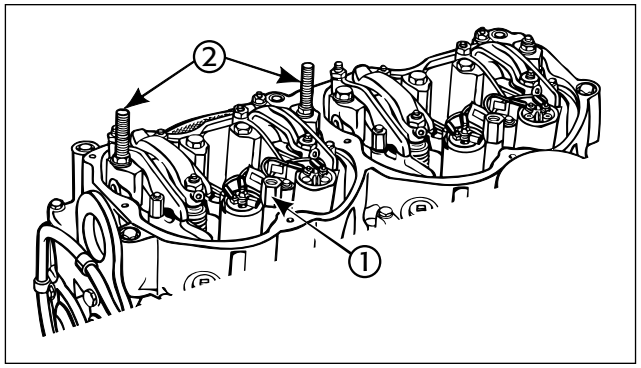

FIG. 9

Install the cylinder head bolt spacers (3, Fig. 8) on the cylinder head bolts and hand tighten only (1, Fig. 9).

Remove the rocker lever bolts at the six locations next to the exhaust rocker levers. Install the mounting stud assemblies (2) and torque to 70 lbft. (95 N•m) (see Fig. 9).

Valve and Injector Adjustments

NOTE:

EXHAUST VALVE CLEARANCE ADJUSTMENT IS REQUIRED. ADJUSTMENTS OF THE INTAKE VALVE CLEARANCE AND THE INJECTORS WILL BE REQUIRED ONLY ACCORDING TO VEHICLE MILEAGE OR ENGINE SERVICE INTERVALS.

Make all adjustments with the engine stopped and cold. Follow the sequence in the following table:

Set Engine	Set Intake Valve No.	Set Exhaust Valve No.	Set Injector
Cyl. #1 TC Compression	1, 2, 4	1, 3, 5	3, 5, 6
Cyl. #6 TC Compression	3, 5, 6	2, 4, 6	1, 2, 4

Set intake valves to 0.015″ (0.38 mm).

Set exhaust valves to 0.025″ (0.64 mm).

Set unit injectors to zero clearance plus 1/2 turn (180°).

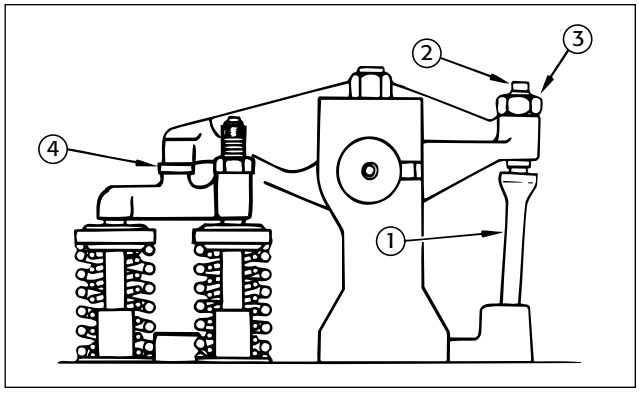

FIG. 10

Valve Clearance Adjustment

Locate the exhaust rocker arm adjusting screw in the socket of the exhaust valve push rod (1). Insert the feeler gage between the rocker arm and valve bridge. Turn the rocker arm adjusting screw (2) clockwise until the proper clearance (4) is set. Hold the adjusting screw and torque the locknut (3) to 18 lbft. (25 N•m).

Adjust the intake and exhaust valves using the same procedure. Set the intake valve to 0.015″ (0.38 mm). Set the exhaust valves to 0.025″ (0.64 mm).

Injector Adjustment

Turn the injector adjusting screw (1) clockwise until contact is made with the injector (3). Turn the adjusting screw clockwise an additional 1/2 turn (180°). Hold the adjusting screw in this position and tighten the locknut (2) to 41 lbft. (55 N•m).

NOTE:

ROTATE THE ENGINE 360° IN THE DIRECTION OF ROTATION AND ADJUSTING THE REMAINING VALVES AND INJECTORS FOLLOWING THE SEQUENCE IN THE ABOVE TABLE.

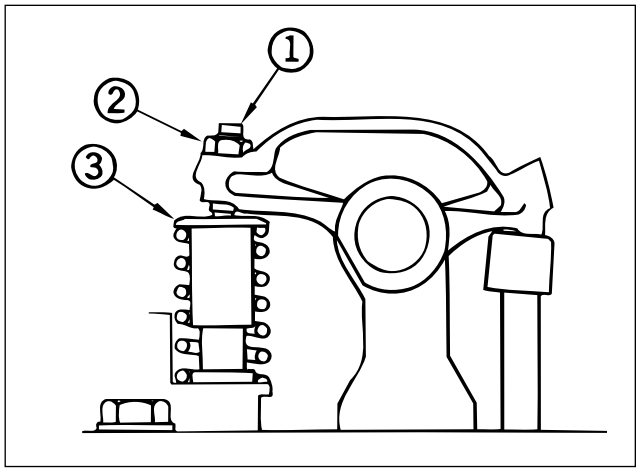

FIG. 11

Section 3: Brake Housing Installation

Housing Installation

Position the engine brake housings on the mounting stud nuts and install the Jacobs hold-down nuts (1) on the brake mounting studs Torque to 59 lbft. (80 N•m) (see Fig. 12).

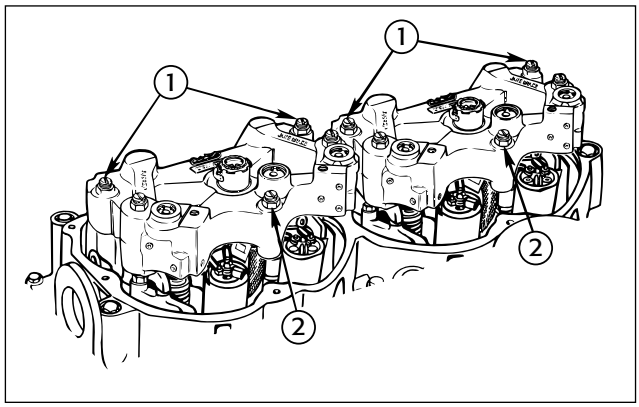

FIG. 12

Refer to Fig. 9 on page 6. Unscrew the cylinder head bolt spacer (1) until it contacts the bottom of the housing.

Refer to Fig. 12. Install the 70 mm bolts (2) through the housing into the spacer (one per housing) and torque to 41 lbft. (55 N•m).

Be sure the slave piston foot (1) is aligned squarely over the bridge screw and pin assembly (2) to insure full contact of exhaust valve stem. Reposition the housing if necessary (see Fig. 13).

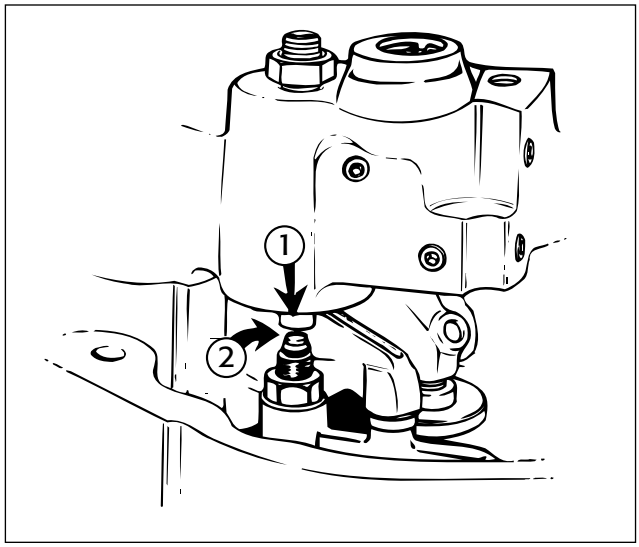

FIG. 13

Slave Piston Adjustment

Slave Piston Adjustment Sequence

Set Engine	Set Slave Piston No.
Cyl. #1 TC Compression	1, 3, 5
Cyl. #6 TC Compression	2, 4, 6

Slave Piston Clearance Setting

Engine	Model Year	Clearance	Gage P/N
3176B	1994	0.020" (1.14 mm)	018424

With the exhaust valves closed on the cylinder to be adjusted, insert the proper Jacobs feeler gage (2) between the slave piston and the actuating pin (3) in the valve bridge adjusting screw.

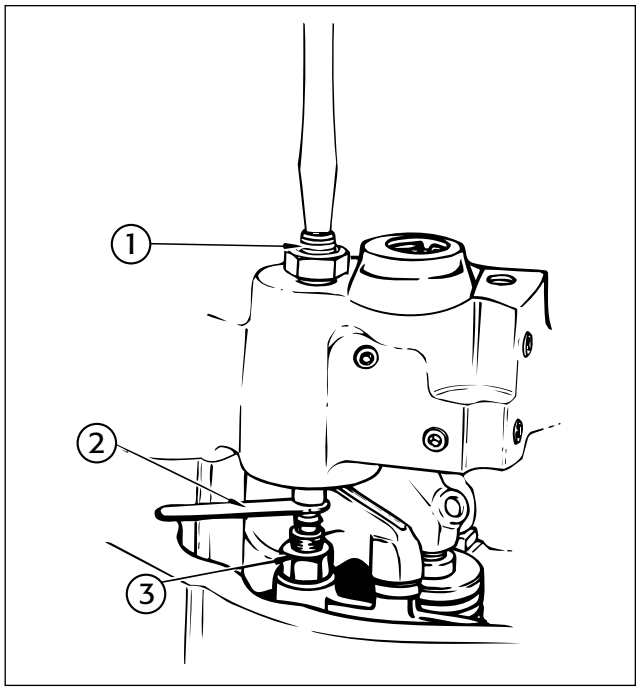

FIG. 14

Turn the slave piston adjusting screw (1) in until a slight drag is felt on the feeler gage.

Hold the adjusting screw in this position and tighten the locknut to 25 lbft. (35 N•m).

Rotate the engine 360° and set the clearance on the remaining slave pistons.

Spacer Installation

Be sure the seal is seated in the groove at the bottom surface of the Jacobs' spacer (see Fig. 15).

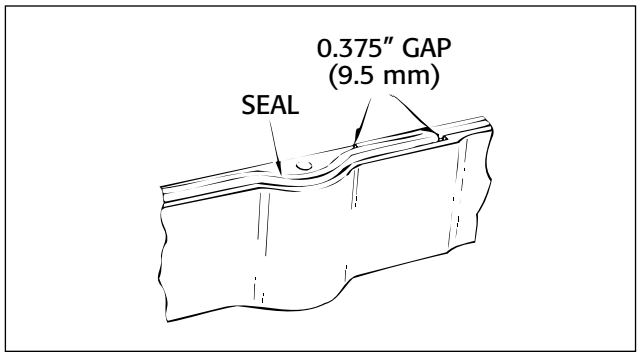

FIG. 15

NOTE:

A 0.375" (9.5 MM) GAP SHOULD BE LEFT BETWEEN EACH END OF THE GASKET AND THE SPACER.

Connect both solenoid lead wires (1) to the terminal lead outs (2) on the solenoids (see Fig. 16).

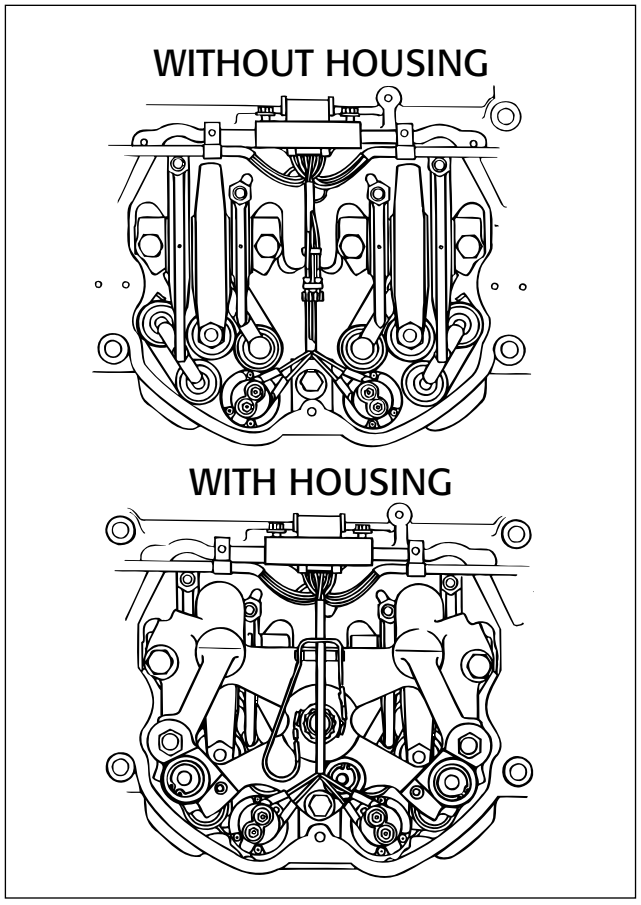

FIG. 16

NOTE:

THE SOLENOID LEAD WIRES ARE NOT POLARITY SENSITIVE AND MAY BE CONNECTED IN EITHER DIRECTION.

Install the three Jacobs spacers on the valve cover base (see Fig. 17, only 2 shown for clarity).

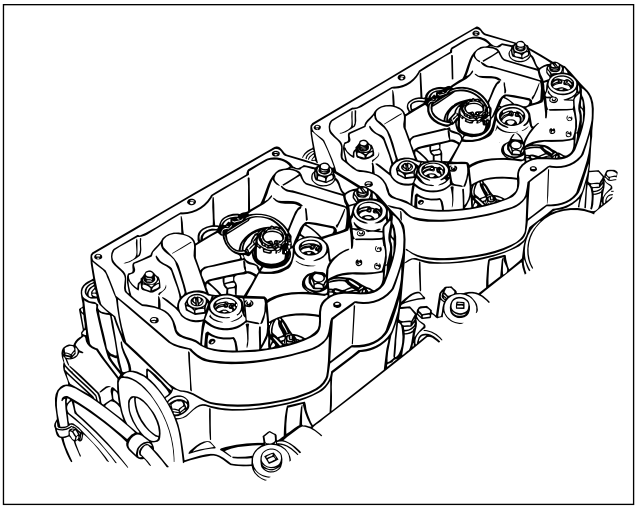

FIG. 17

Section 4: Engine Brake Operation Check

Bleed Engine Brake Housings

⚠ WARNING

WEAR EYE PROTECTION AND DO NOT EXPOSE YOUR FACE OVER THE ENGINE AREA. TAKE PRECAUTIONS TO PREVENT OIL LEAKAGE ONTO THE ENGINE.

WHENEVER THE ENGINE IS RUNNING WITH THE VALVE COVERS REMOVED, OIL SPLASHING IN THE ENGINE AREA COULD CAUSE PERSONAL INJURY.

1. Start the engine and allow to run for a few minutes.
2. Depress and release the engine brake solenoid disc several times to allow the housing to be filled with oil (see Fig. 18).

NOTE:

PLACE RAG OVER CONTROL VALVE AND ACCUMULATOR COVERS TO REDUCE OIL SPRAY.

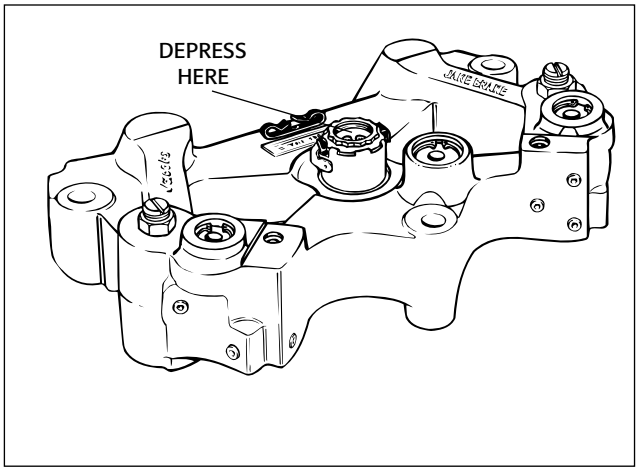

FIG. 18

3. Watch the master piston to be sure it is moving down onto the injector rocker arm pad.
4. Watch the slave piston assembly. It should move down to contact the pin in the exhaust valve screw.
5. Check each housing to be sure they are functioning.
6. Shut down engine. Clean the gasket surface for the cover.

Rocker Cover Installation

Be sure the seal is located in the groove of the cover (Fig. 19) and install the cover on the spacer. Install the Jacobs' bolts, six per cover. Torque to 5 lbft. (7 N•m). Tighten in steps to assure uniform compression of the seals.

⚠ CAUTION

BE SURE TO TIGHTEN ALL ROCKER COVER BOLTS EVENLY. EXCESSIVE OR UNEVEN TIGHTENING MAY CAUSE THE ROCKER COVER TO CRACK.

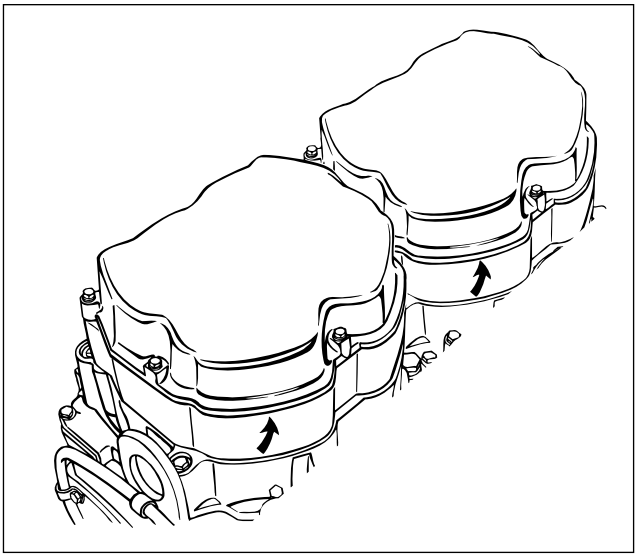

FIG. 19

Chassis Wiring

Consult vehicle manufacturer's wiring diagrams to locate engine brake switch location and wire coding.

NOTE:

1994 MODEL TRUCKS SHOULD HAVE ENGINE BRAKE CONTROL WIRING LOCATED BEHIND THE DASH. LOCATE THE APPROPRIATE WIRES AND CONNECT TO CORRECT VEHICLE MANUFACTURER'S SWITCH. SWITCH MAY NEED TO BE PROCURED FROM VEHICLE MANUFACTURER.

Jacobs does not provide controls for 1994 model year products as these controls are integrated into the engine chassis.

Section 5: Engine Brake Maintenance

Theory of Operation

Energizing the engine brake effectively converts a power-producing diesel engine into a power-absorbing air compressor. This is accomplished by opening the cylinder exhaust valves near the top of the normal compression stroke, releasing the compressed cylinder charge to exhaust.

The blowdown of compressed air to atmosphere prevents the return of energy to the engine piston on the expansion stroke. The effect is a net energy loss, since the work done in compressing the cylinder charge is not returned during the expansion process.

Exhaust blowdown of the braking cylinder is accomplished by utilizing the injector arm motion of that cylinder.

Energizing the solenoid valve permits engine lube oil to flow under pressure through the control valve to both the master piston, slave piston and accumulator.

Oil pressure causes the master piston to move down, coming to rest on the corresponding injector rocker arm.

The injector rocker arm moves up (as in normal injector cycle), forcing the master piston upward and creating a high pressure oil flow to the slave piston of the braking cylinder. The ball check valve in the control valve traps high pressure oil in the master/slave piston system.

Under the influence of the high pressure oil flow, the slave piston moves down, momentarily opening the exhaust valves at a pre-determined amount of slave stroke. The Power-Lash™ uncovers a passageway in the slave piston, thus allowing oil to flow back to the undersides of the control valve and accumulator piston, where it is stored for the next cycle. Prior to top dead center position, the exhaust valve is forced open, releasing the compressed cylinder air to the exhaust manifold.

Compressed air escapes into the atmosphere, completing a compression braking cycle.

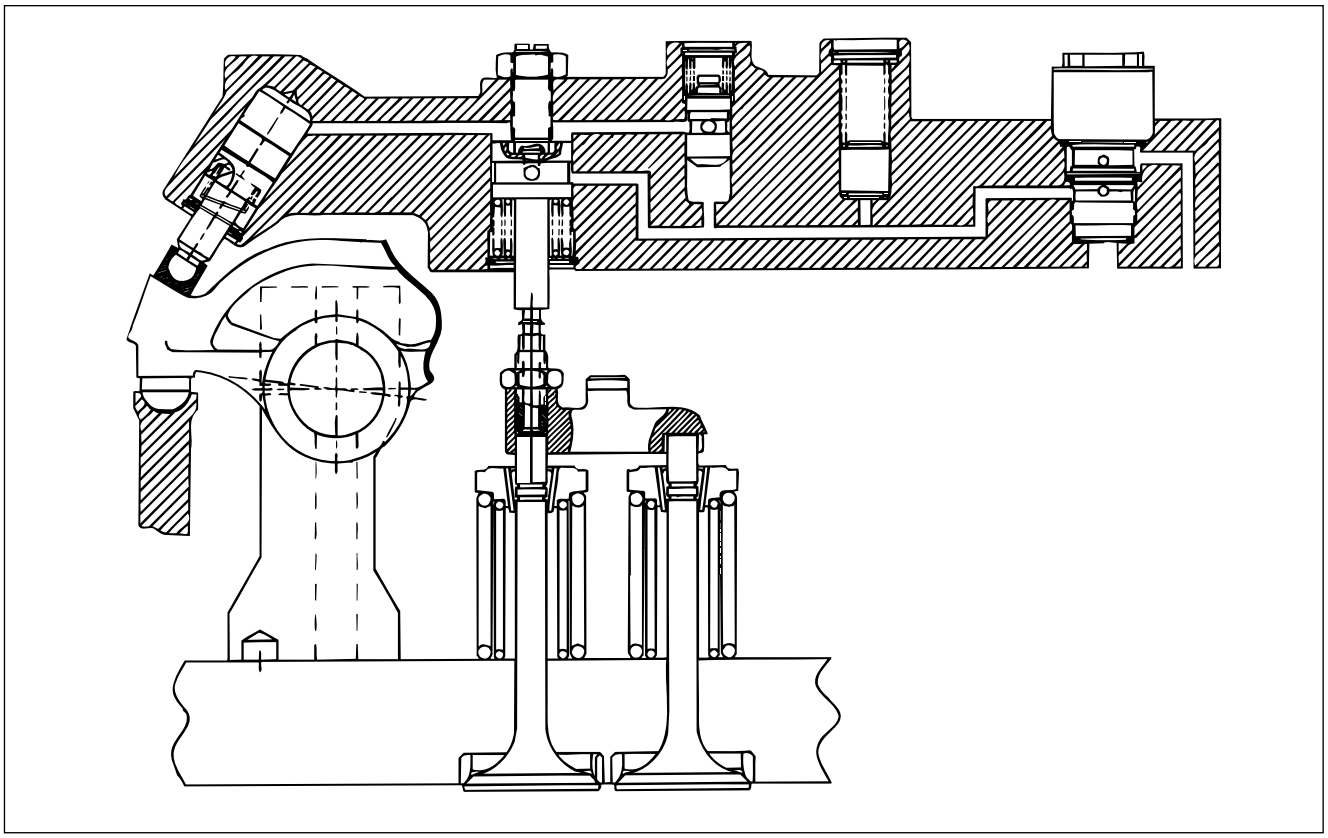

FIG. 20

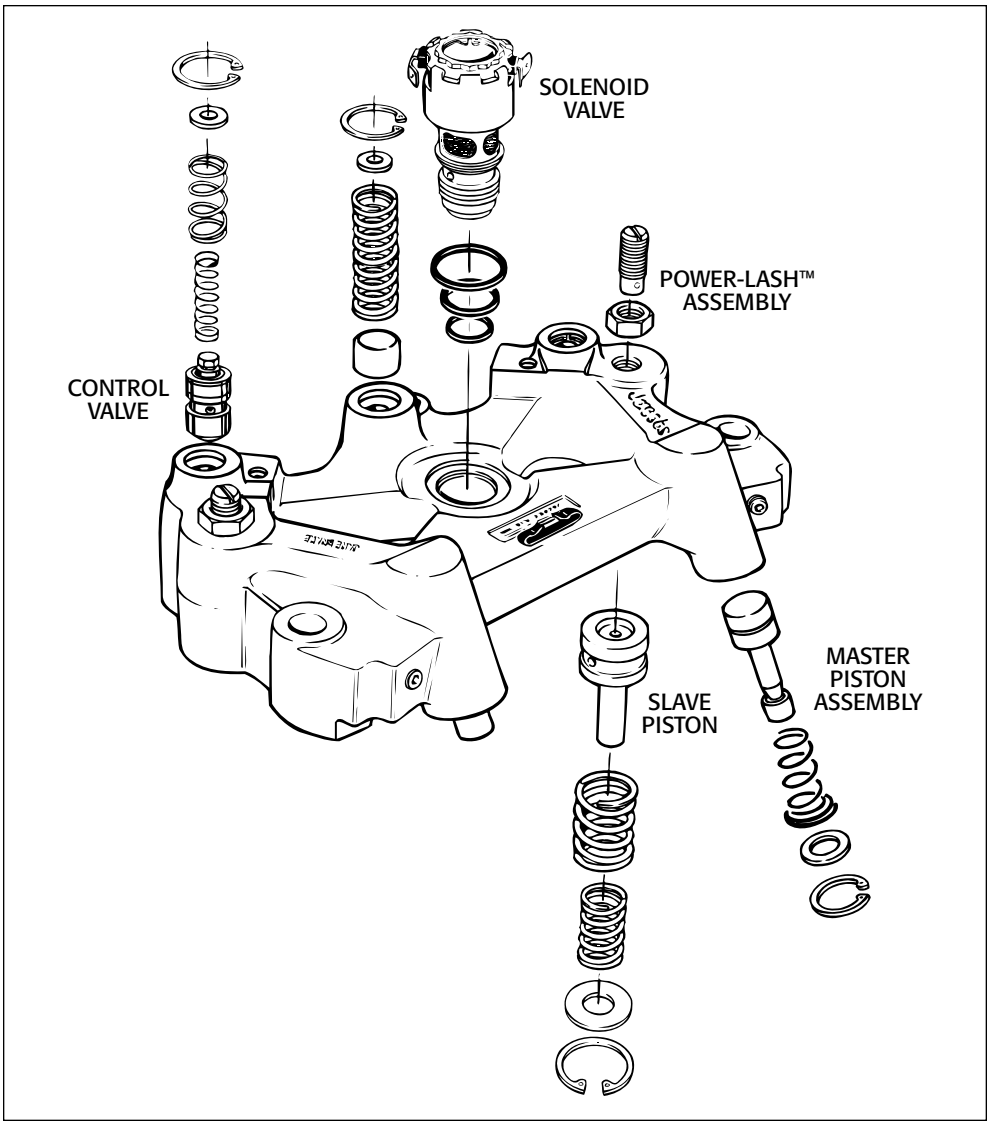

FIG. 21

⚠ WARNING

NEVER REMOVE ANY ENGINE BRAKE COMPONENT WITH ENGINE RUNNING. PERSONAL INJURY MAY RESULT.

The Jacobs Engine Brake is a relatively trouble-free device. However, inspections and routine maintenance are necessary to assure proper operation. Use the following procedures to keep the engine brake in top condition.

This section will cover how to properly remove, clean and reinstall engine brake components. Use an OSHA-approved cleaning solvent when washing parts. Be sure to coat parts with clean engine oil when reinstalling them

Solenoid Valve

⚠ WARNING

DO NOT DISASSEMBLE OR TAMPER WITH THE SOLENOID VALVE. ENGINE DAMAGE COULD RESULT. THE SOLENOID VALVE IS NOT FIELD SERVICEABLE.

1. Disconnect solenoid harness. Using 7/8″ socket and extension, unscrew solenoid valve.
2. Remove and discard the three rubber seal rings (see Fig. 22). If the lower ring stays in the bottom of the housing solenoid bore, remove with a seal pick.

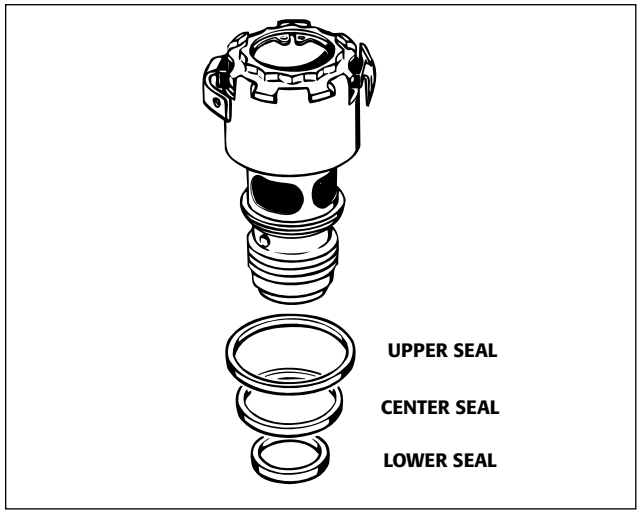

FIG. 22

3. Wash out the solenoid valve with approved cleaning solvent. Use a brush to clean the oil screen. When clean, dry the valve with compressed air.
4. Clean out the solenoid valve bore in the housing. Use clean paper towels. Never use rags as they may leave lint and residue which can plug the oil passageways.
5. Using new solenoid seal rings, coat them with clean lube oil. Install the upper and center seal rings on the solenoid body and the lower seal ring into the bottom of the solenoid bore in the housing (see Fig. 23).
6. Be sure the seals are seated properly and carefully screw the solenoid into the housing without unseating the seals. Torque the valve to 5 lbft. (7 N•m). Be careful not to twist the seals while installing.

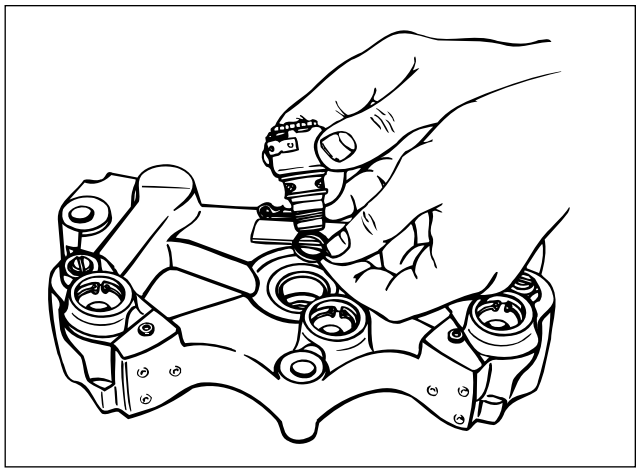

FIG. 23

Control Valve

⚠ WARNING

REMOVE CONTROL VALVE COVERS CAREFULLY TO AVOID PERSONAL INJURY. CONTROL VALVE COVERS ARE UNDER LOAD FROM THE CONTROL VALVE SPRINGS.

1. Apply pressure on the control valve cover (1). Remove retaining ring (2) using retaining ring pliers (see Fig. 24).

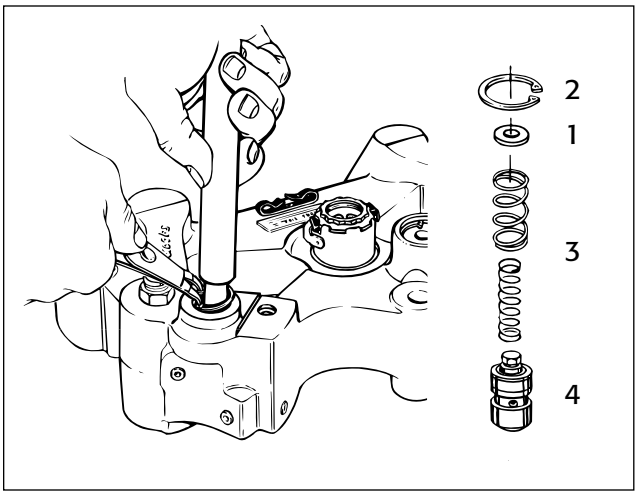

FIG. 24

2. Slowly remove cover until spring pressure ceases, then remove the two control valve springs (3).
3. Using needle-nose pliers, reach into the bore and grasp the stem of the control valve (4) (see Fig. 24). Remove the control valve.
4. Wash the control valves with approved cleaning solvent. Push a wire into the hole in the base of the valve to the distance required to insure that the ball check is free. The ball should lift with light pressure on the wire. If the ball is stuck, replace the control valve. Dry the valve with compressed air and wipe clean with a paper towel.
5. Thoroughly clean the control valve bore in the housing using clean paper towels.
6. Reassemble parts reversing the removal procedure.

Accumulator

⚠ WARNING

THE ACCUMULATOR SPRING IS UNDER STRONG COMPRESSION. USE CAUTION WHEN REMOVING THE RETAINING RING AND COVER. WEAR SAFETY GLASSES. IF THE SPRING IS ACCIDENTALLY DISCHARGED, PERSONAL INJURY MAY RESULT.

1. Push down on the accumulator cover using the appropriate diameter rod and remove the retaining ring (see Fig. 25).

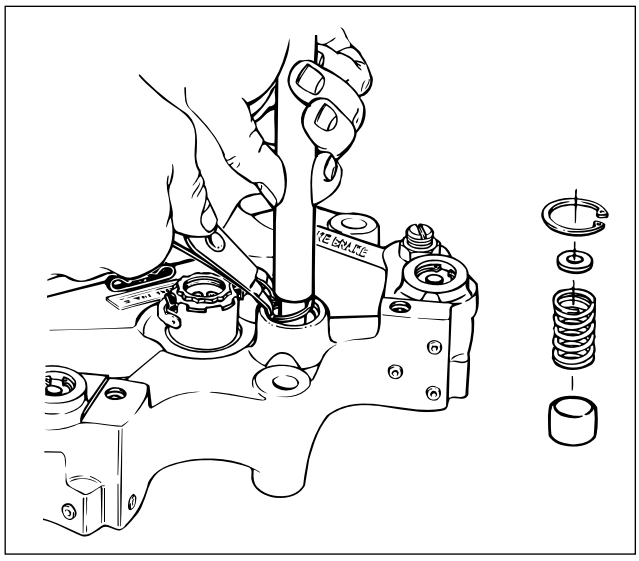

FIG. 25

2. Relieve pressure on the accumulator cover; remove the cover and spring.
3. Use a magnet to remove the piston from the accumulator bore.
4. Inspect the parts for wear or damage; replace if needed.
5. Reassemble by installing the piston, spring, cover and retaining ring.

Slave Piston Adjusting Screw (Power-Lash™)

1. Loosen the slave piston adjusting screw locknut and remove the adjusting screw from housing (see Fig. 26).

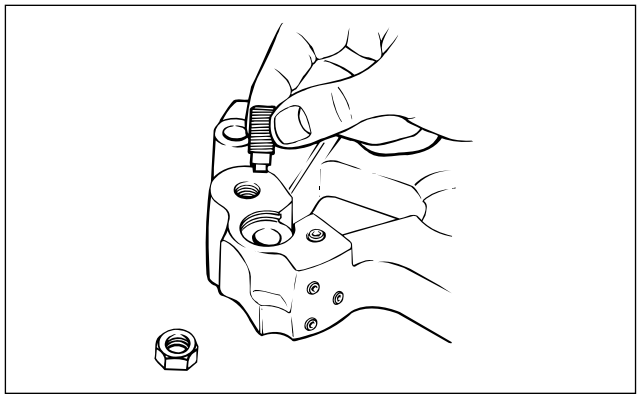

FIG. 26

NOTE:

THE PART NUMBER FOR THE SCREW IS LOCATED AT THE TOP OF THE SCREW NEXT TO THE SCREWDRIVER SLOT. REFER TO THE PARTS MANUAL FOR PART NUMBER IDENTIFICATION.

⚠ CAUTION

DO NOT ADJUST OR TAMPER WITH THE ADJUSTING SCREW ASSEMBLY. ENGINE DAMAGE COULD RESULT.

2. Clean in an approved cleaning solvent.
3. Inspect the slave piston adjusting screw. The plunger should protrude from the bottom of the screw, have light spring pressure apparent when depressed and should move freely (see Fig. 27). Replace the entire screw assembly if any defect is found.

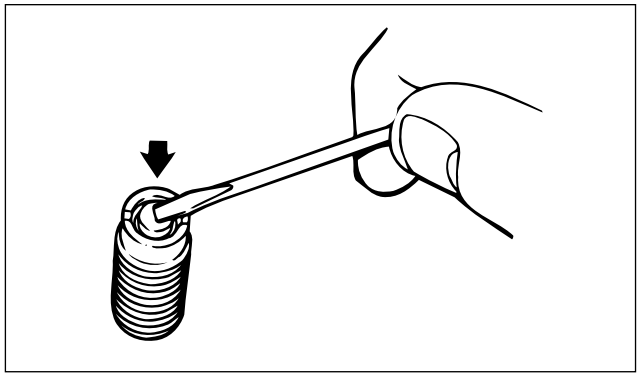

FIG. 27

Master Piston

1. Press down on the master piston retaining washer to relieve the spring force. While holding the washer, use a pair of snap ring pliers to remove the retaining ring from the groove. Carefully release the retainer and remove it along with the old spring.
2. Remove master piston from bore. Clean in approved solvent and inspect for wear on the piston and foot. Also inspect the bore.
3. Install a new master piston return spring by inserting the small end into the bore. The large coil, identified by **WHITE** paint, **should be facing out**.
4. Place the retaining washer and snap ring over the foot of the master piston and compress them into the bore. Using snap ring pliers, replace the snap ring in the groove to retain the master piston.

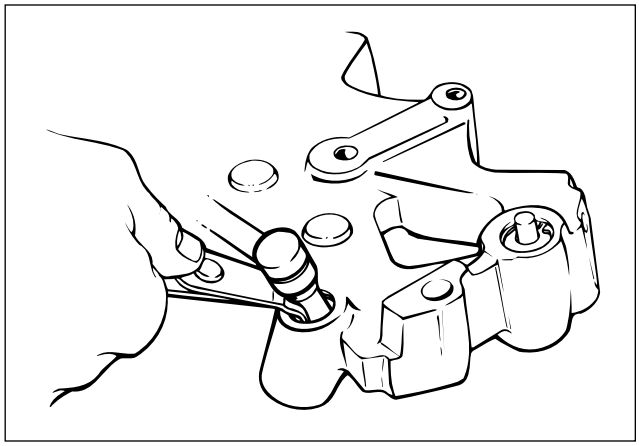

FIG. 28

5. Ensure the snap ring is properly engaged in the groove by gently grasping the master piston foot and pulling out until the master piston bottoms on the retaining washer. Release the master piston. If the assembly is correct, all parts should return to their original position.
6. Repeat this procedure on the remaining 5 locations.

NOTE:

AFTER THE NEW SPRING IS INSTALLED WITHIN THE RETAINING WASHER AND SNAP RING, IT IS NORMAL TO BE ABLE TO SEE THE SPRING IN THE BORE AROUND THE RETAINING WASHER.

Slave Piston

⚠ WARNING

WEAR SAFETY GLASSES.

THE SLAVE PISTON IS RETAINED BY SPRINGS THAT ARE UNDER HEAVY COMPRESSION. IF THE FOLLOWING INSTRUCTIONS ARE NOT FOLLOWED AND PROPER TOOLS NOT USED, THE SPRINGS WILL BE DISCHARGED WITH ENOUGH FORCE TO CAUSE PERSONAL INJURY.

1. Remove the locknut (3) on the slave piston adjusting screw (1). Back out the adjusting screw until the slave piston is fully retracted (screw is loose).
2. Place the hole in the clamp fixture (2) over the slave piston adjusting screw (see Fig. 29).

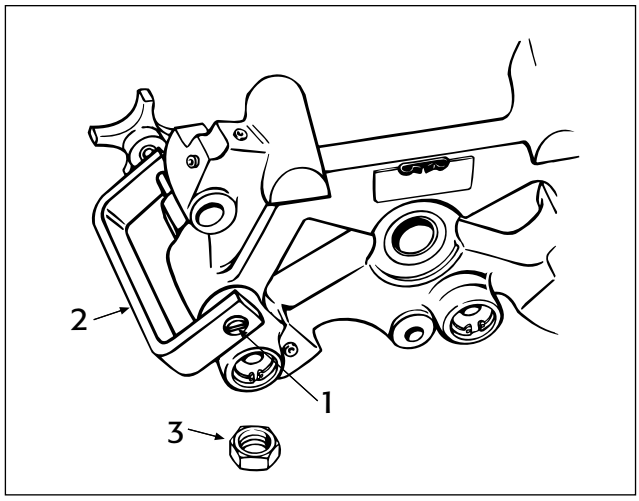

FIG. 29

3. While holding the fixture in position, screw holder down over the slave piston (4) until the spring retainer (7) is contacted.
4. Turn the handle slowly until the retainer is depressed to about 1/32" (1 mm), relieving pressure against the retaining ring (8).
5. Remove the retaining ring using retaining ring pliers. Back out the holder until the springs (5 and 6) are loose. Remove the fixture.
6. Remove all components, ensuring there is no binding or burrs. Clean in an approved cleaning solvent. Inspect parts and replace as necessary.

NOTE:

BE SURE COMPONENTS ARE REASSEMBLED IN PROPER ORDER (SEE FIG. 30).

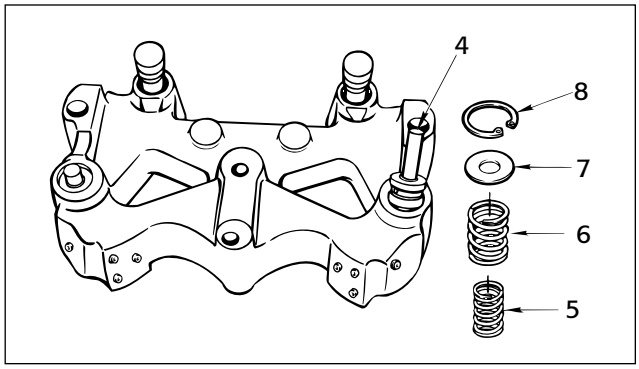

FIG. 30

7. Use the clamp fixture to reinstall piston and springs. Be sure retaining ring is placed on the retainer before screwing the clamp-holder down over the slave piston.
8. Compress the slave piston springs down until the retainer is about 0.040" (1 mm) below the retaining ring groove. Reinstall the retaining ring. Be sure the retaining ring is fully seated in the groove.
9. Remove the clamp fixture slowly to insure proper seating of retaining ring.

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