

CBRAKE By *Jacobs*™

Installation Manual For ISM/ISM02/ISM07 M11/M11 Plus Engines

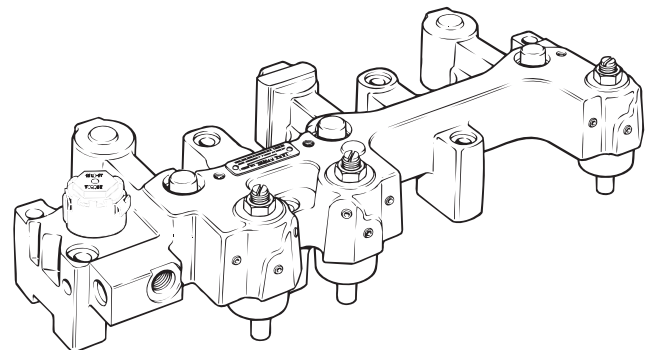


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Safety Precautions

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.



THIS SYMBOL WARNS OF POSSIBLE PERSONAL INJURY.



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.



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

THE C BRAKE BY JACOBS™ ENGINE BRAKE 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

Model 411/411C/D/E Aftermarket Kits

P/N	Engine	Brake Model	Description
3804584	M11/M11+	411	12 VDC, S/L kit
3804585	M11/M11+	411	24 VDC, S/L kit
3804586	M11/M11+	411	24 VDC, D/L kit
3800765	ISM	411C	12 VDC, D/L kit
4089395	ISM02/04	411D	12 VDC, S/L kit
4955458	ISM07	411E	12 VDC, S/L kit

*See Application Guide, P/N 3401804, for specific engine model application information.

Housing Identification

A nameplate attached to the top surface of the engine brake housing identifies the model number, part number, front or rear housing and slave piston lash setting.

The housing serial number is stamped on the top surface of the center master piston boss or on the nameplate.

For housing part number and other replacement part information, refer to Cummins Bulletin No. 3698826, Jacobs Parts Manual, P/N 021475.

Engine Identification

Prior to engine brake installation, verify that engine is an ISM, 2002 ISM, 2007 ISM, M11 or M11 Plus. The engine identification is on the serial number plate located on the fuel pump side below the rocker cover.

Special Tools

The following special tools should be available for the installation:

1. Injector adjusting tool: Torque wrench, Cummins P/N 3376592
2. Crowfoot: Cummins P/N 3823820
3. Feeler gage/slave piston:
Cummins P/N 3871428, (0.015")
Cummins P/N 3163172, (0.027")



UNLESS OTHERWISE SPECIFIED, THE TORQUE VALUES LISTED 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 FOR THE SPECIFIC TOOLS BEING USED. FOLLOW THE MANUFACTURER'S RECOMMENDED PROCEDURES FOR THE TORQUE WRENCH AND ADAPTER BEING USED.

Automatic Transmissions



PRIOR TO INSTALLATION OF THE ENGINE BRAKE ON VEHICLES WITH AUTOMATIC TRANSMISSIONS, WE RECOMMEND THAT THE TRANSMISSION MANUFACTURER REPRESENTATIVE (DEALER) BE CONSULTED TO BE SURE OF THE COMPATIBILITY OF THE ENGINE BRAKE WITH THE SPECIFIC AUTOMATIC TRANSMISSION BEING USED.

Section 2: Engine Preparation

Clean engine thoroughly. Remove engine valve cover and gasket. Retain all parts.

NOTE:

REFER TO CUMMINS TROUBLESHOOTING & REPAIR MANUAL, SECTION 003-004 FOR OVERHEAD SET INFORMATION.

Crosshead and Adjusting Screws

Cylinder 1, 3 and 5 Exhaust Valve Crosshead Replacement and Injector Rocker Lever Adjusting Screws:

1. Rotate crankshaft by turning accessory drive shaft in direction of rotation (clockwise, see Fig. 1). Align the "A" valve set mark on the accessory drive pulley with the pointer on the gear cover. Check the intake and exhaust valves of cylinder No. 1. All valves must be closed (both crossheads loose) to make adjustments. If the valves are not closed, rotate the engine one complete revolution. The engine is now ready for valve and injector adjustments that will be made later.
2. Loosen locknuts and adjusting screws on injector and exhaust valve rocker levers on cylinders 1, 3 and 5.

NOTES:

THE ROCKER LEVER FOR THE EXHAUST VALVE CROSSHEAD IS THE LONGEST OF THE THREE ROCKER LEVERS IN EACH CYLINDER.

ALL M11 AND ISM ENGINES USE GUIDELESS CROSSHEADS (SEE FIG. 2).

3. Remove the Cummins guideless **exhaust** valve crosshead from cylinders 1, 3 and 5 (see Fig. 3).



DO NOT DISASSEMBLE THE ACTUATOR PIN FROM THE JACOBS CROSSHEAD. THE ASSEMBLY IS NOT SERVICEABLE IN THE FIELD.

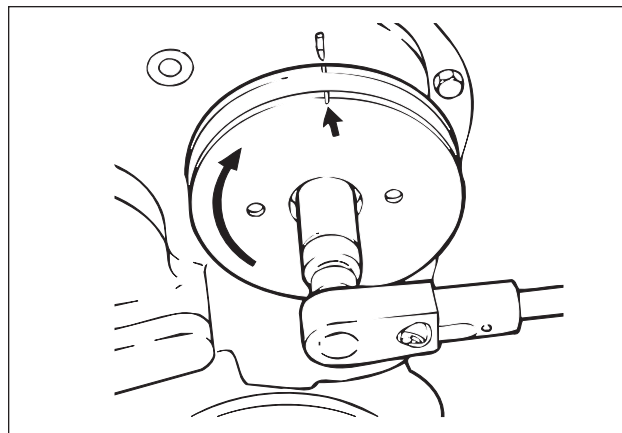


FIG. 1

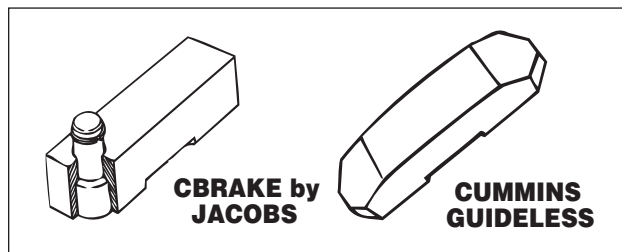


FIG. 2

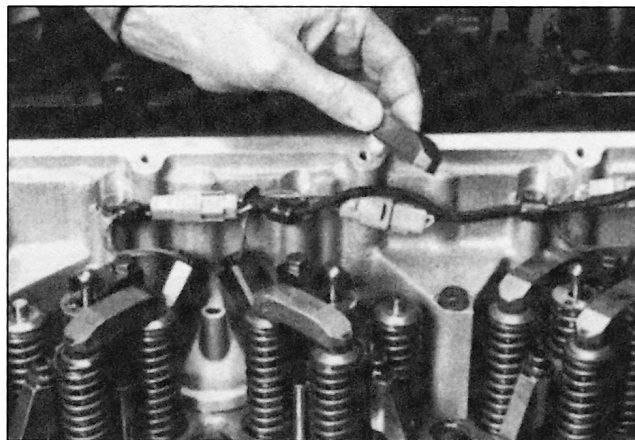


FIG. 3

4. Lubricate the actuator pins and valve stems with clean lube oil and install the CBrake by Jacobs™ crossheads over the exhaust valves. Locate the actuator pins on the exhaust valves closest to the push rod side of the engine (see Fig. 4).
5. The crosshead should move freely from side to side pivoting on the side without the actuator pin. No leveling adjustment is required with guideless crossheads.
6. Remove the Cummins injector rocker lever adjusting screws and install the CBrake by Jacobs™ injector rocker lever adjusting screws and hex jam nut on cylinders 1, 3 and 5 (see Fig. 5).
7. Repeat steps 1 through 6 above for cylinders 2, 4 and 6.

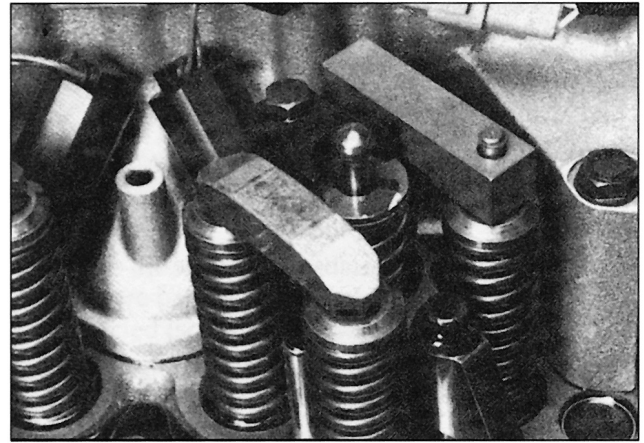


FIG. 4

Exhaust Valve and Injector Adjustment

NOTE:

OVERHEAD ADJUSTMENTS MUST BE MADE WHEN THE ENGINE IS COLD: STABILIZED COOLANT TEMPERATURE 140° F. (60° C.) OR BELOW.

1. Refer to Fig. 6 to determine the correct order to set the exhaust valve and injector adjustment.
2. Rotate the engine crankshaft clockwise to the desired pulley position.

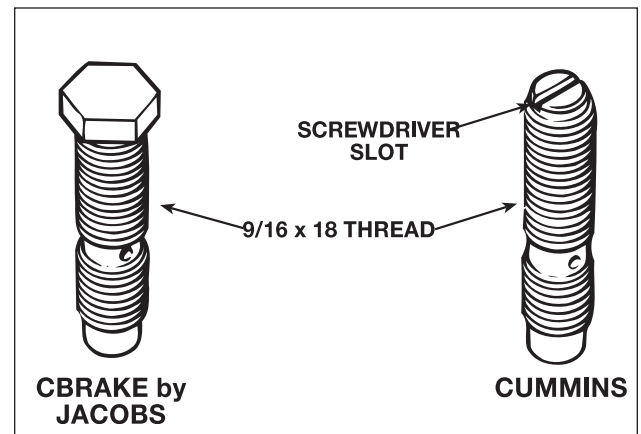


FIG. 5

Bar Engine Dir. of Rotation	Pulley Position	Set Valves Cyl. No.	Set Inj. Cyl. No.
Start	A	1	1
Advance to	B	5	5
Advance to	C	3	3
Advance to	A	6	6
Advance to	B	2	2
Advance to	C	4	4

FIG. 6

3. Place a 0.027" (0.68 mm) feeler gage between the rocker lever and the crosshead of the exhaust valve (see Fig. 7). Tighten the adjusting screw until a light drag can be felt on the feeler gage. Hold the adjusting screw and tighten the locknut to 45 lb.-ft. (61 N•m).
4. Turn the injector adjusting screw in and bottom the injector plunger 3 to 4 times to remove fuel.
5. Bottom injector adjusting screw with a screwdriver.
6. Back out screw two flats (120°).
7. Hold screw and torque lock nut to 45 lb.-ft. (61 N•m).
8. Adjust valves and injectors in the same cylinder following the procedures in 1 through 7 above.



FIG. 7

Spacer Installation

1. **MODEL 411 ONLY:** Install two (2) electrical lead out assemblies into spacer and torque to 10 lb.-ft. (14 N•m) (see Fig. 8).
2. Install bulkhead fitting with seal into hole in spacer as shown in Fig. 9. Seal must be located on the outside of the spacer. Install nut and torque to 25 lb.-ft. (34 N•m).
3. Clean rocker housing. Cummins recommends the use of RTV (Cummins P/N 3823494) between the rocker housing and the spacer. If, however, you wish to use a gasket instead of the RTV, a gasket is included with the kit.
4. Starting from the center and proceeding outward on both sides torque the capscrews to 15 lb.-ft. (20 N•m) following the sequences shown in Fig. 10.

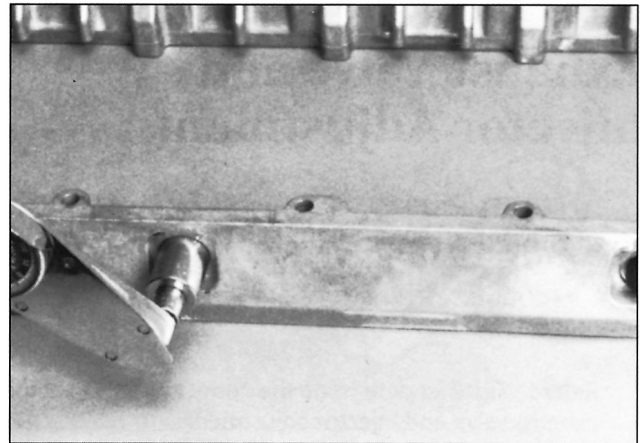


FIG. 8

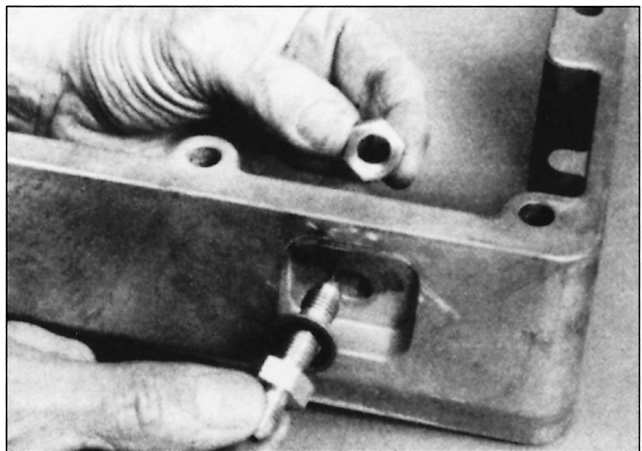


FIG. 9

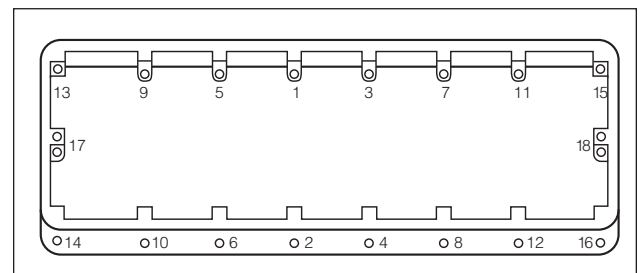


FIG. 10

Section 3: Brake Installation

Housing Installation

NOTE:

ALSO REFERENCE CUMMINS TROUBLESHOOTING & REPAIR MANUAL, SECTION 020-024 FOR ENGINE BRAKE FOR CLEANING, REMOVING, INSPECTING, INSTALLATION AND ADJUSTMENT.

Oil Supply Tube

1. Lubricate O-rings on oil supply tube and install into oil supply hole in rear housing. Push tube in all the way (see Fig. 11).
2. Install the O-ring adaptor into the front housing in the location shown in Figure 12. Tighten the O-ring adaptor as follows:

411	24 lb.-ft	33 N•m
411C	27 lb.-ft	37 N•m
411D	27 lb.-ft	37 N•m
411E	27 lb.-ft	37 N•m
3. Make sure the slave piston adjusting screws on both housings are backed out so all slave pistons are fully retracted (screw is loose).
4. Place rear brake housing on rocker shaft supports for cylinders 4, 5 and 6.
5. Install front housing so that the oil supply tube fits into the oil supply hole of the front housing.

NOTE:

NO WASHERS ARE USED WITH THE CBRAKE BY JACOBS™ CAPSCREWS.

6. Lubricate threads and underside of Jacobs hold-down capscrews with clean lube oil.
7. Install the capscrews in the sixteen (16) locations and hand tighten following the sequence in Fig. 13. Complete the sequence by tightening the capscrews to 60 lb.-ft. (81 N•m).

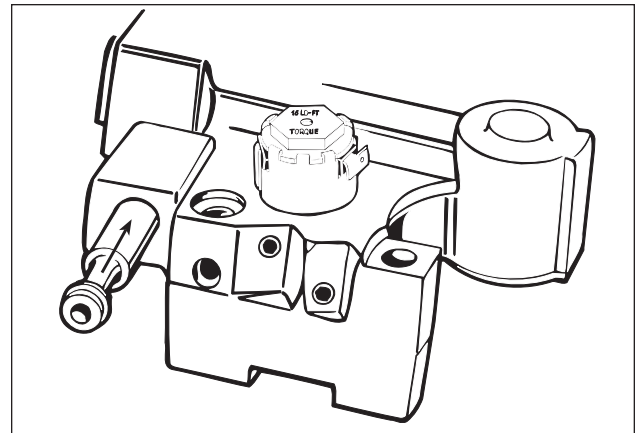


FIG. 11

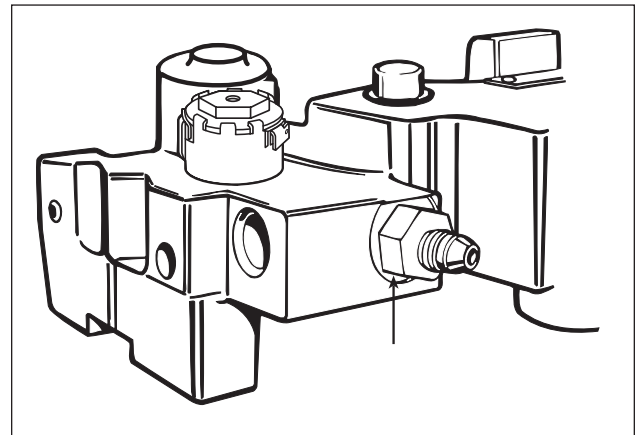


FIG. 12

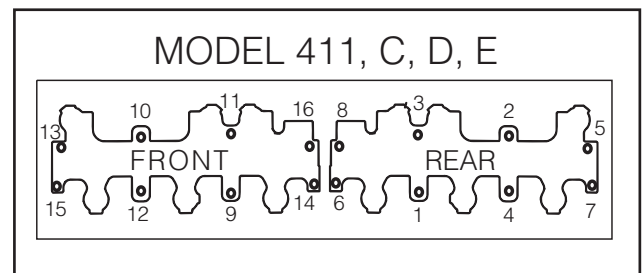


FIG. 13

Slave Piston Adjustment



PAY SPECIAL ATTENTION TO THIS ADJUSTMENT. TO ENSURE MAXIMUM BRAKE OPERATING EFFICIENCY AND TO PREVENT ENGINE DAMAGE, FOLLOW INSTRUCTIONS CAREFULLY.

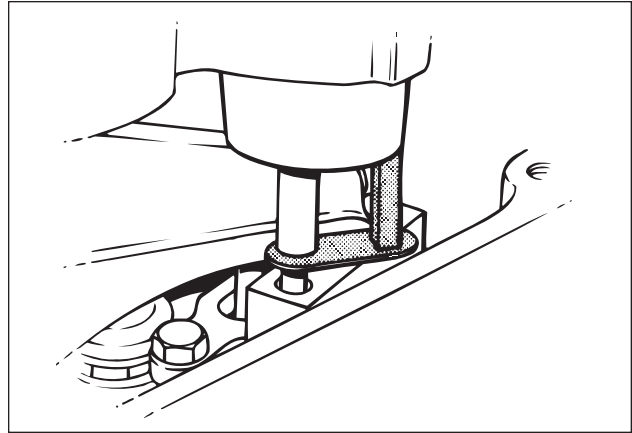


FIG. 14

Slave Piston Lash Settings

Model	Engine	Setting
411	M11	0.015"
411	M11 Plus	0.015"
411C	ISM	0.015"
411D	2002 ISM	0.015"
411E	2007 ISM	0.027"

1. Slave piston lash setting is printed on the housing nameplate.
2. Slave piston adjustment must be made with the engine stopped and cold (stabilized water temperature of 140° F., 60° C., or below).
3. Exhaust valves on the cylinder to be adjusted must be closed.
4. Install the appropriate feeler gage (.027" for 411E, .015" for all others) between the slave piston and the actuating pin in the crosshead (see Fig. 14). Turn the slave piston adjusting screw until a slight drag on the feeler gage can be felt.
5. Hold screw in position with a screwdriver (see Fig. 15) (Model 411E ONLY - Hold screw in position with wrench on hex head - See Fig. 15A). Torque locknut to 25 lb.-ft. (34 N•m)

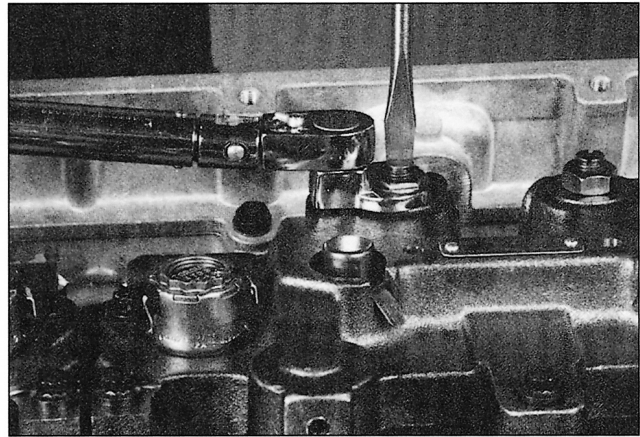


FIG. 15



OVERTORQUING LOCKNUT COULD SEIZE RESET MECHANISM IN SLAVE PISTON ADJUSTING SCREW. THIS WILL RESULT IN POOR ENGINE BRAKE PERFORMANCE. (SEE NOTE ON PAGE 3).

NOTE:

AFTER TORQUING THE SLAVE PISTON ADJUSTING SCREW LOCKNUT, CHECK THE CLEARANCE WITH THE FEELER GAGE. READJUST IF NECESSARY.

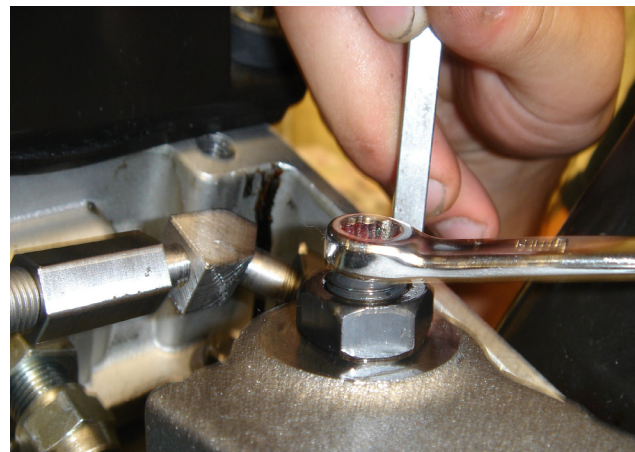


FIG. 15 A

Installation of Oil Supply



DO NOT CONNECT THE ENGINE BRAKE OIL SUPPLY TO THE SAME LOCATION USED FOR THE TURBOCHARGER OIL SUPPLY. SERIOUS ENGINE DAMAGE MAY RESULT.

1. Remove the plug from the rear, inboard filter head location and install the new fitting with seal ring. Tighten the fitting to 27 lb.-ft. (37N•m) (Fig.16).

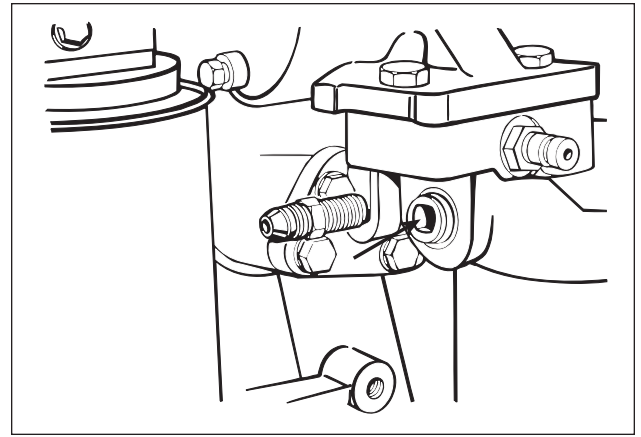


FIG. 16



KEEP HOSE CLEAR OF ALL POTENTIAL HOT ENGINE COMPONENTS AND FREE FROM RUBBING ON ENGINE OR CHASSIS. A RUPTURED HOSE WILL SPRAY HOT OIL AND COULD CAUSE HEAVY SMOKE OR FIRE UPON HITTING HOT ENGINE COMPONENTS.

2. Connect the external hose to the bulkhead fitting in the spacer. Install the hose clamps and attach to the bolt in the intake manifold (Fig.17).

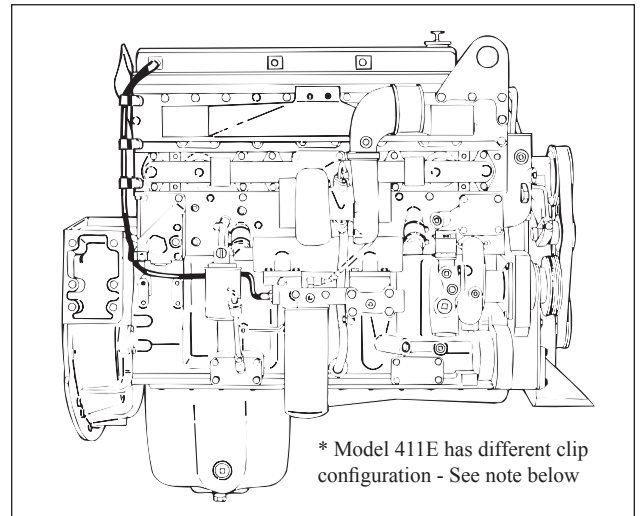


FIG. 17

NOTE: 411E HAS 3 CLIPS INSTEAD OF 4 AS PREVIOUS MODELS. HOLDING THOSE 3 CLIPS ARE TWO NEW SCREWS

3821783	15 lb.-ft
3036230	35 lb.-ft
3818060	40 lb.-ft *
already exists on engine	

3. Route the hose behind the coolant filter and connect to the O-ring adapter as follows:

411	12 lb.-ft	16 N•m
411C	19 lb.-ft	26 N•m
411D	19 lb.-ft	26 N•m
411E	19 lb.-ft	26 N•m

4. Install short hose between housing adaptor and bulkhead fitting. Torque fitting nuts as follows: (Fig.18)

411	12 lb.-ft	16 N•m
411C	19 lb.-ft	26 N•m
411D	19 lb.-ft	26 N•m
411E	19 lb.-ft	26 N•m

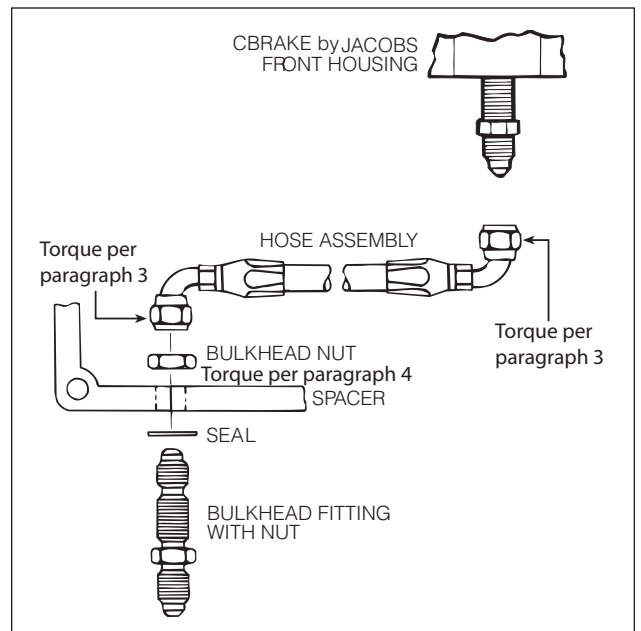


FIG. 18

Section 4: Electrical Installation

M11 CELECT™ Wiring Installation

NOTE:

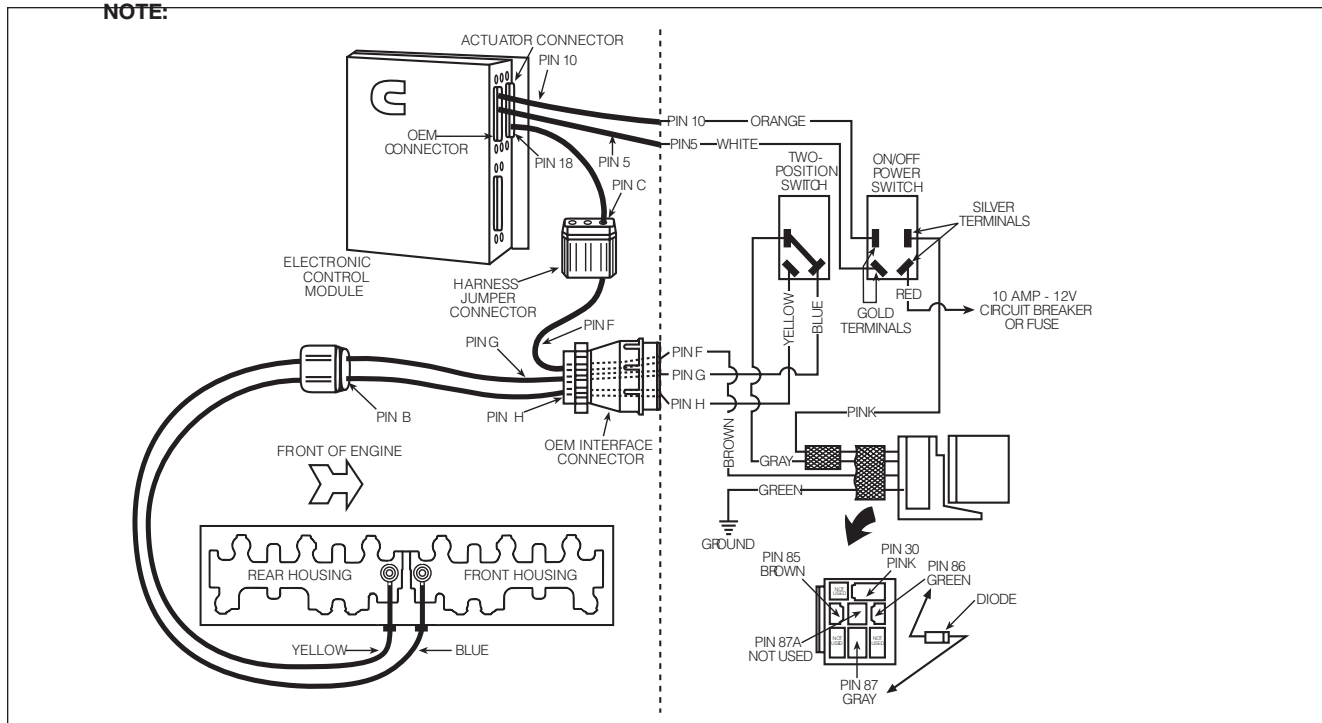


FIG. 19

ALL CUMMINS M11 ENGINES HAVE ELEC-
TRONIC CONTROLS (CELECT™).

Install the relay base under the dash at a convenient location
in order to make the following wiring connections:



IT IS EXTREMELY IMPORTANT THAT A
SECURE GROUND CONNECTION IS MADE.
FAILURE TO DO SO WILL RESULT IN POOR
ENGINE BRAKE OPERATION.

1. Connect the GREEN wire to a good engine ground.
2. Connect the PINK wire to the output side of the ON/
OFF brake switch.
3. Connect the GRAY wire to the input side of the selector
switch.
4. Connect the BROWN wire to the Cummins interface
connector, pin "F".

Additional electrical connections (wiring to be provided by
the installer):

1. Connect the RED wire from the input terminal (silver
coated) to a 10-amp, 12-volt circuit breaker electrical
source.
2. The BLUE wire should be connected from the output
side of the selector switch as shown in the diagram,
to pin "G" of the Cummins interface connector.
3. Connect the YELLOW wire from the output side of the
selector switch to pin "H" of the Cummins interface
connector.
4. The ORANGE wire is connected from the output side of
the on/off switch (gold plated terminal) to pin 10 of the
Cummins electronic control module.
5. Connect the WHITE wire from the input side of the
ON/OFF switch (gold plated terminal) to pin 5 of the
Cummins electronic control module.

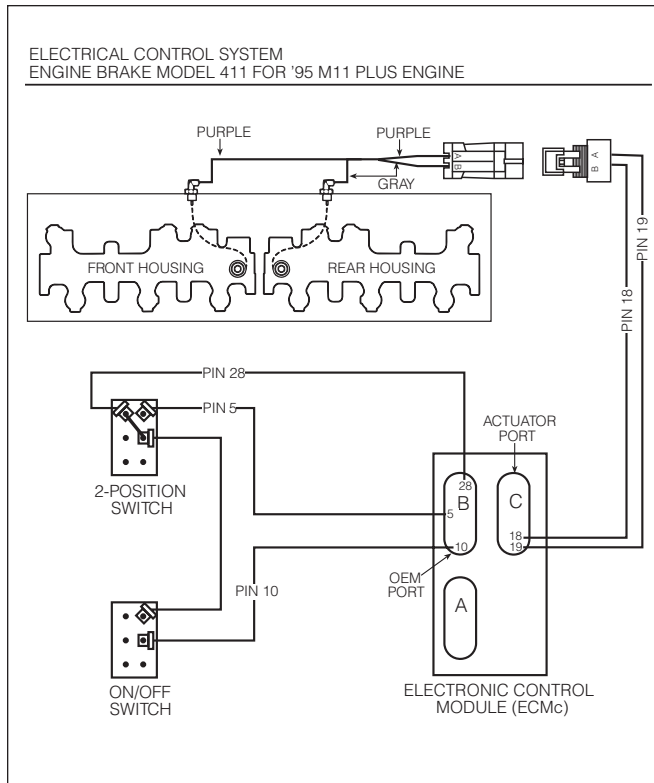


FIG. 20

M11 Plus CELECT™ Plus Wiring Installation (Model 411)

NOTE: ALL CUMMINS M11 PLUS ENGINES HAVE ELECTRONIC CONTROLS (CELECT plus).

1. For proper wiring installation, make all electrical connections as shown in Fig. 20.
2. Connect brake wiring harness to Cummins ECM Interface Connector. Connect PURPLE and GRAY leads to

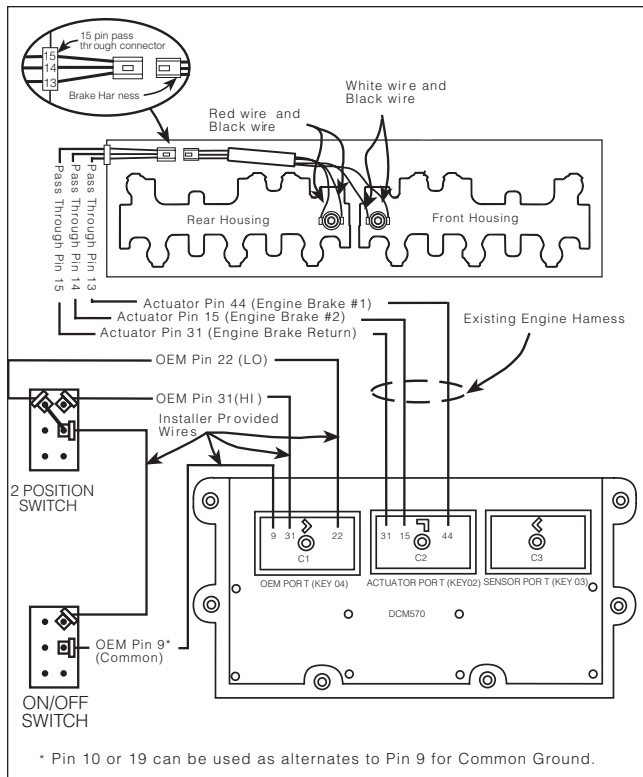


FIG. 21

ISM Wiring Installation (Models 411C)

For proper electrical wiring installation, make all electrical connections as shown in Figure 21, observing the following:

1. Connect the Solenoid Harness to the existing engine injector harness under the valve cover. Connect the RED lead on the Solenoid Harness to either terminal of the solenoid on the rear housing. Connect the WHITE lead to the solenoid on the front housing. Connect one BLACK lead to each remaining terminal of both solenoids.
2. All connections between the Cummins Electronic Control Module and the engine brake ON/OFF and HI/LOW switches are to be made with wiring provided by the installer.

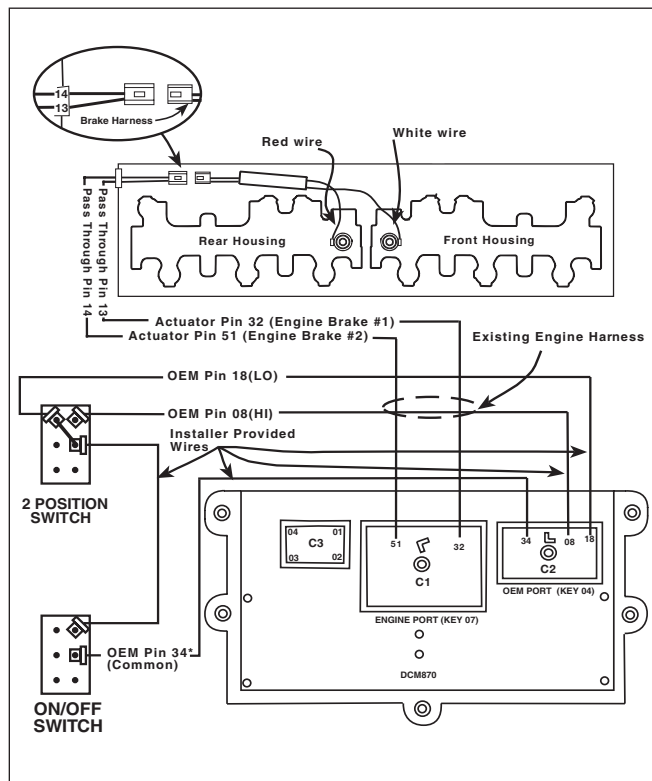


FIG. 22

ISM02 Wiring Installation (Models 411D)

For proper electrical wiring installation, make all electrical connections as shown in Figure 22, observing the following:

1. Connect the solenoid harness to the existing engine injector harness under the valve cover. Connect the RED lead on the solenoid on the rear housing. Connect the WHITE lead to the solenoid on the front housing.
2. All connections between the Cummins Electronic Control Module and the engine brake ON/OFF and HI/LOW switches are to be made with wiring provided by the installer.

NOTE:

JACOBS WIRING IS NOT REQUIRED ON ISM07 (MODEL 411E) - SEE VEHICLE OEM FOR WIRING DETAILS

Section 5: Brake Operation Check

The CBrake by Jacobs™ Model 411, 411C, 411D, & 411E installation is now complete. The following procedures and adjustments should be made.

Recheck the housing installation. Be certain no foreign objects have been left behind and all correct clearance requirements have been met.

Bleed and Operation Check



WEAR EYE PROTECTION AND DO NOT EXPOSE YOUR FACE OVER ENGINE AREA. TAKE PRECAUTIONS TO PREVENT OIL LEAKAGE DOWN ON THE ENGINE. WHEN ENGINE IS RUNNING AND VALVE COVERS ARE REMOVED, OIL SPLASHING IN THE ENGINE BRAKE AREA COULD CAUSE PERSONAL INJURY.

For Wastgate and Non- Wastgate Engines

1. Assure that the control wires are connected to the terminal assemblies in engine brake spacers (411 only).
2. Bleed brake housings and check their operation. Start engine and allow to run 5 to 10 minutes. Put dash switch in "LO". Accelerate engine to approximately 1800 RPM and release throttle. Only one solenoid valve should operate.
3. Repeating this procedure for position "HI", both solenoids should operate. Repeat this procedure several times to bleed brake housings for immediate operation.

For EGR/ VGT Engines

1. Bleed brake housings and check their operation. Start engine and allow to run 5 to 10 minutes. Put dash switch in "HI". Accelerate engine to approximately 1800 RPM and release throttle. Both solenoid valves should operate.
2. Repeat this procedure several times to bleed brake housings for immediate operation.

Replace Rocker Lever Cover

1. Remove the gasket and inspect for damage.
2. If the gasket is not damaged, it can be used again. If the gasket is damaged, it must be discarded and a new one used.
3. Set the new Cummins gasket on the cover.
4. Install flat washer, new sleeve and new noise isolator on the capscrew (see Fig. 23).
5. Install the capscrew assemblies in the cover (Fig. 24).
6. Install the cover on the spacer and tighten the cover capscrews to 130 lb.-in. (15 N•m) in the sequence shown in Fig. 25.

NOTE: ALSO REFERENCE CUMMINS TROUBLE SHOOTING & REPAIR MANUAL, SECTION 003-011 FOR ROCKER LEVER COVER INSTALLATION.

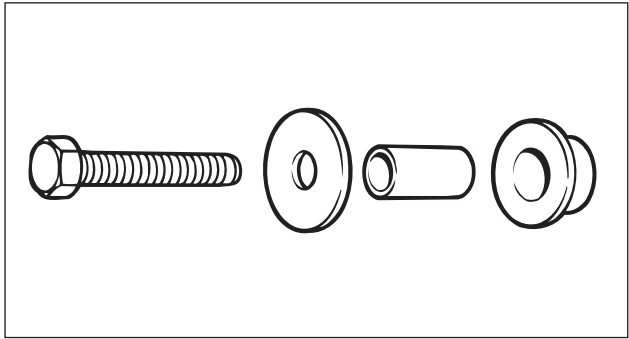


FIG. 23

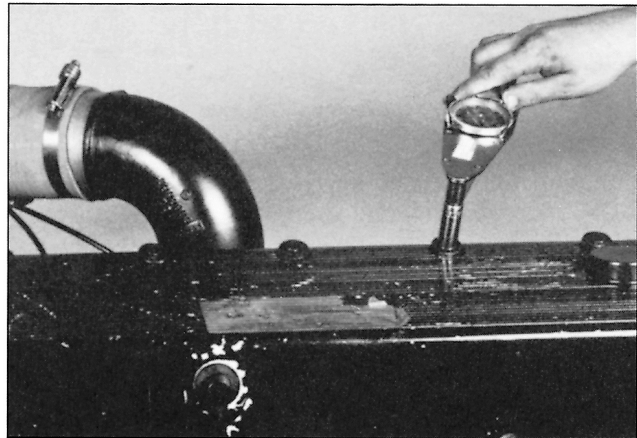


FIG. 24

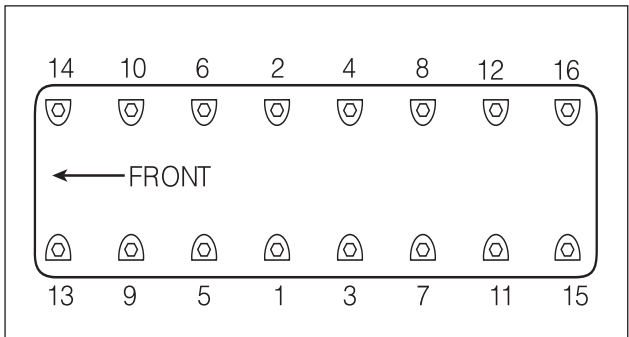


FIG. 25

Section 6: 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 through motion transfer using a master/slave piston arrangement which opens cylinder exhaust valves near the top of the normal compression stroke, releasing the compressed cylinder charge to exhaust.

The blowdown of compressed air to atmospheric pressure 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

Referring to Fig. 26, exhaust blowdown occurs as follows:

1. The energized solenoid valve permits engine lube oil to flow under pressure through the control valve to both the master piston and the slave piston.
2. Oil pressure causes the master piston to move down, coming to rest on the injector rocker arm adjusting screw.
3. The injector rocker arm adjusting screw begins upward travel (as in normal exhaust cycle), forcing the master piston upward and directing high pressure oil to the slave piston. The ball check valve in the control valve imprisons high-pressure oil in the master/slave piston system.
4. The slave piston, under the influence of the high-pressure oil moves down, momentarily opens the exhaust valve while the engine piston is near its top dead-center position, releasing compressed cylinder air to the exhaust manifold.
5. Compressed air escapes out to the atmosphere, completing a compression braking cycle.

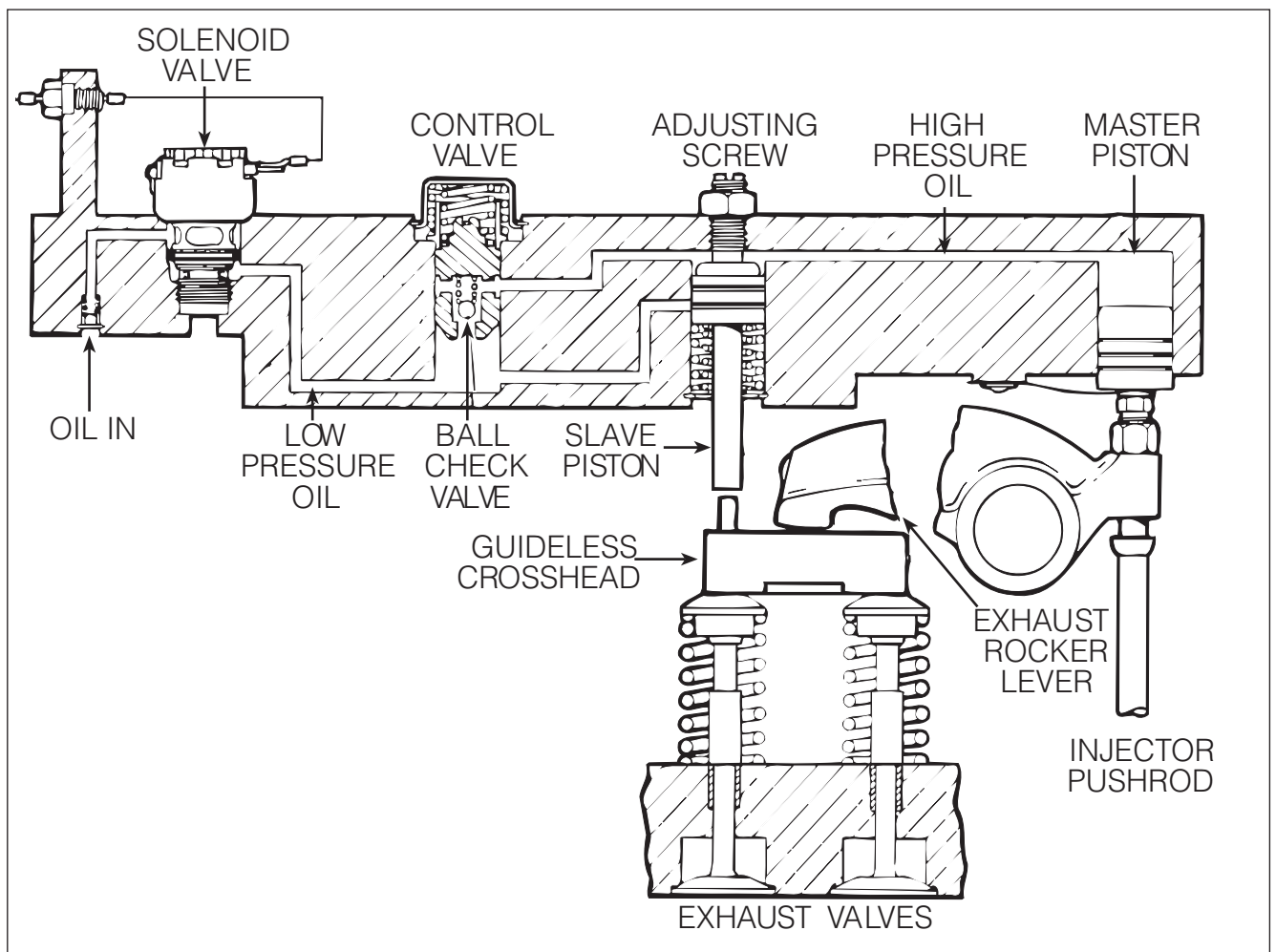


FIG. 26

The CBrake by Jacobs™ is a relatively trouble-free device. However, inspections and routine maintenance will need to be made from time to time. 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.



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

Control Valve



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

1. Apply pressure on the control valve cover and remove retaining ring using retaining ring pliers (see Fig. 28).

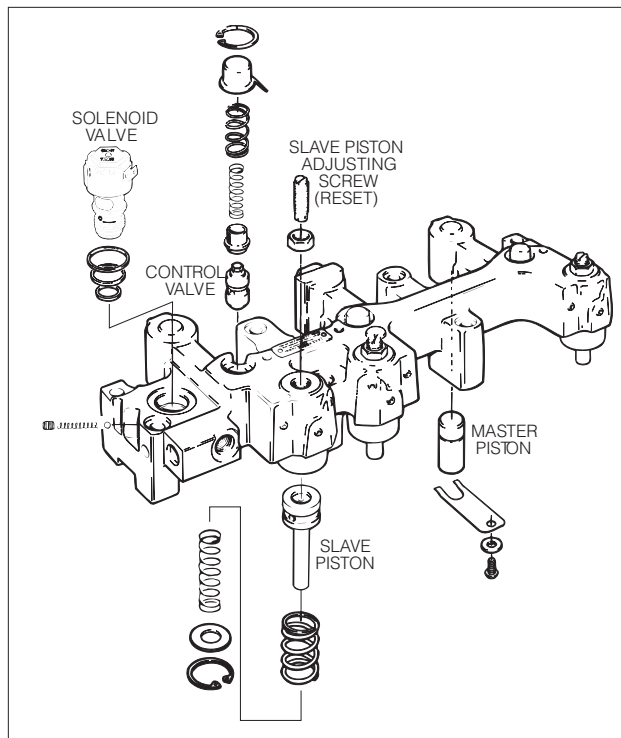


FIG. 27

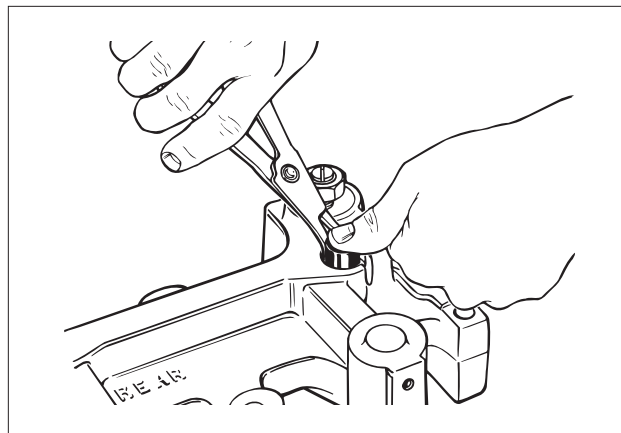


FIG. 28

2. Slowly remove cover until spring pressure ceases, then remove the control valve springs and collar (see Fig. 29).
3. Using needle-nose pliers, remove the control valve (see Fig. 30).
4. Wash the control valve with approved cleaning solvent. Push a wire through the hole in the base of the valve to ensure that the ball check is free. The ball should lift with light pressure on the wire. If the ball is stuck or there is no spring pressure, 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. Dip the control valve in clean lube oil. Drop the valve into its bore. If binding occurs, the control valve should be replaced.
7. Reassemble the parts, reversing the removal procedure. Be sure retaining ring ears are positioned opposite the oil drain slot in the housing (see Fig. 31).

NOTE:

BE SURE THE CONTROL VALVE COLLAR IS INSTALLED WITH THE LONGER SLEEVE AREA UP (SEE BELOW). IF THE COLLAR IS INSTALLED UPSIDE DOWN, THIS BRAKE CYLINDER WILL NOT OPERATE.

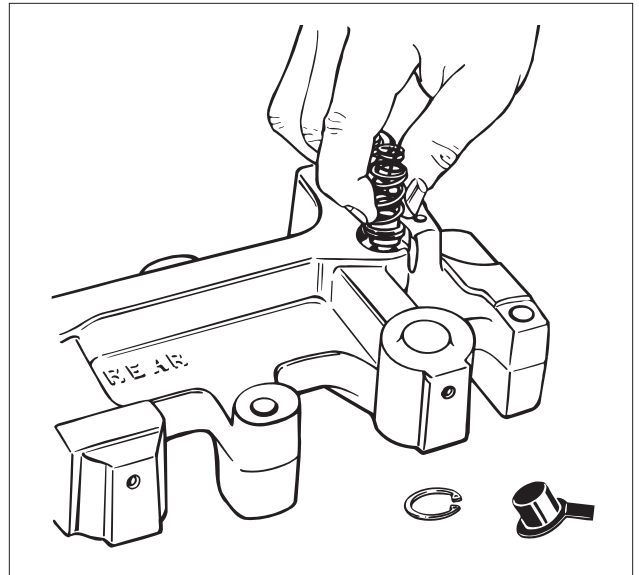
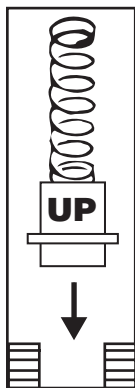


FIG. 29

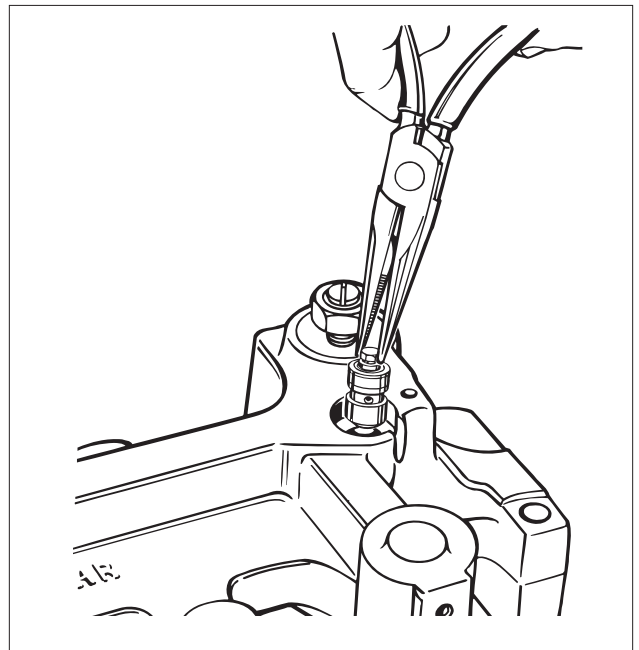


FIG. 30

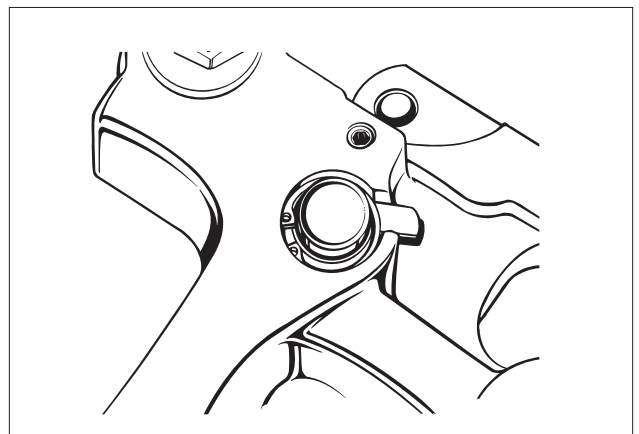


FIG. 31

Solenoid Valve

1. Disconnect the solenoid harness. Using a 3/4" socket and extension, unscrew the solenoid valve (see Fig. 32).



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

2. Remove and discard the three rubber seal rings (Fig. 33). If the lower ring stays in the bottom of the housing solenoid bore, remove with a seal pick.
3. Wash out the solenoid valve with approved cleaning solvent. Use a brush to clean the oil screen. Clean and dry the valve with compressed air. Replace oil screen, if necessary.
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. Reinstall the solenoid using new seal rings. Seat lower seal ring in the base of the solenoid valve bore. Wipe clean lube oil into and around the bore. Place upper and center seal rings on the solenoid valve body.
6. Be sure the seals are seated properly and carefully and screw the solenoid into the housing without unseating the seals. Torque the valve to 15 lb.-ft. (20 N•m) (see Fig. 34).

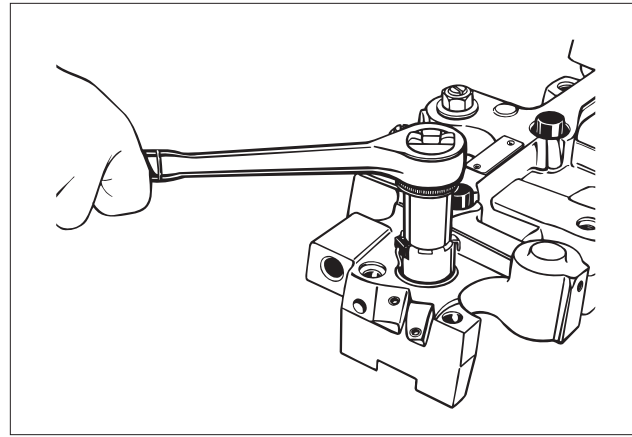


FIG. 32

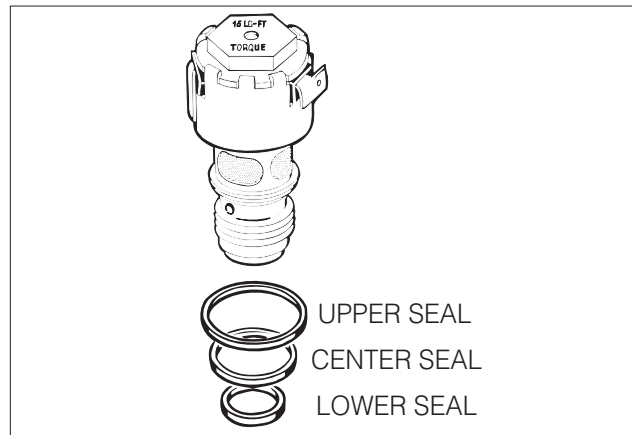


FIG. 33

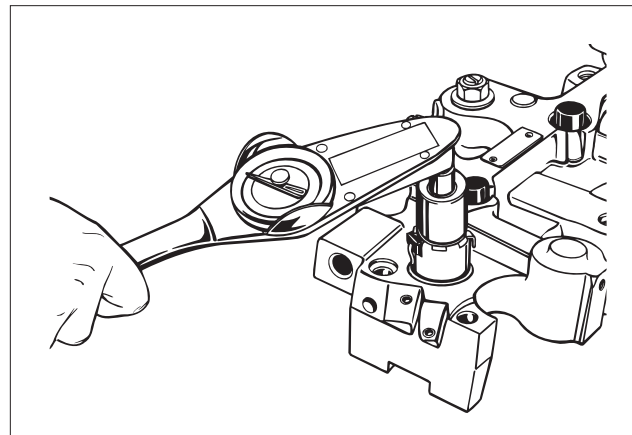


FIG. 34

Slave Piston Adjusting Screws (Reset)

1. Loosen slave piston adjusting screw locknut and remove adjusting screw from housing (Fig. 35).
2. Clean adjusting screw 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 (Fig. 36). Be sure the retaining ring is fully engaged in its groove. Replace the entire screw assembly if any defect is found.

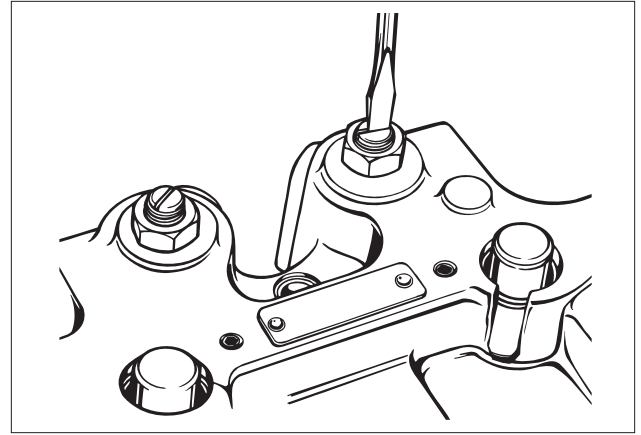


FIG. 35



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

Ball Check Valve

1. Remove hex socket pipe plug. Be careful during final turns to avoid losing the spring and ball. Remove spring and ball (Fig. 37).
2. Inspect, clean in an approved cleaning solvent and replace as required.
3. Reassemble, inserting first the ball, then the spring and plug. Torque the plug to 106 lb.-in. (12 N•m).

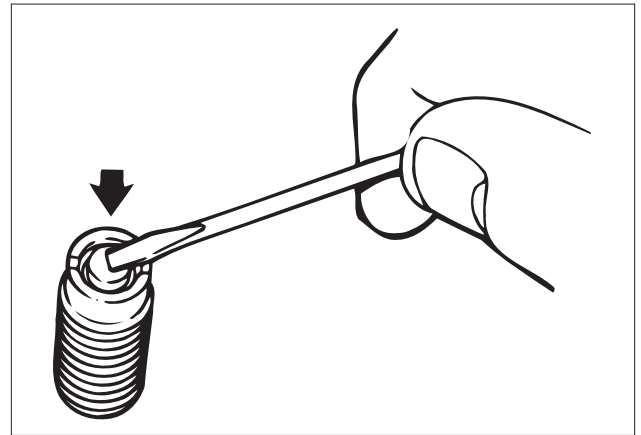


FIG. 36



INSTALL PARTS IN THE ORDER SHOWN. IMPROPER INSTALLATION MAY RESULT IN ENGINE DAMAGE.

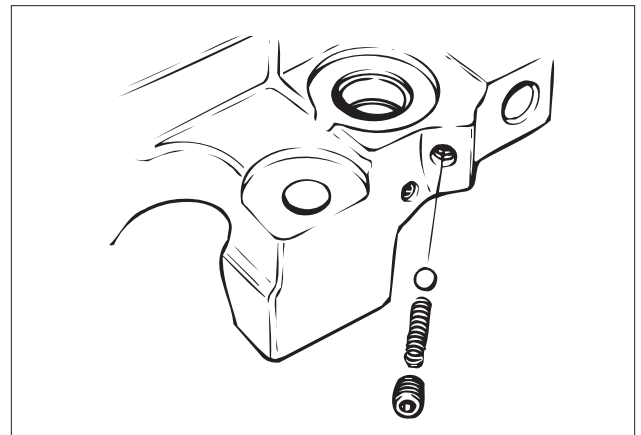


FIG. 37

Master Piston

1. Remove the button-head screw, washer and master piston spring from bottom of housing.
2. Remove the master piston from its bore using needle-nose pliers. If binding occurs, check for burrs or contaminants in the lube oil. Clean in an approved cleaning solvent (Fig. 38).

NOTE:

DO NOT ATTEMPT TO REMOVE THE MASTER PISTON WITHOUT FIRST REMOVING THE FLAT SPRING. BENDING THE SPRING BACK TOO FAR CAN DISTORT THE SPRING AND WOULD NEED TO BE REPLACED.

3. Inspect the hard face surface. A pitted, chipped, cracked or galled piston should be replaced. If the hard facing is damaged, inspect the corresponding rocker arm adjusting screws for excessive wear or pitting. Replace if damaged.
4. Reassemble in reverse order. When tightening the cap-screw, make certain the two spring tabs do not interfere with the sides of the master piston center raised portion (see Fig. 39). Torque the capscrew to 8 - 10 lb.-ft. (11 - 13 N•m).

NOTE:

THE TABS SHOULD BE EQUALLY SPACED FROM THE RAISED PISTON AREA.

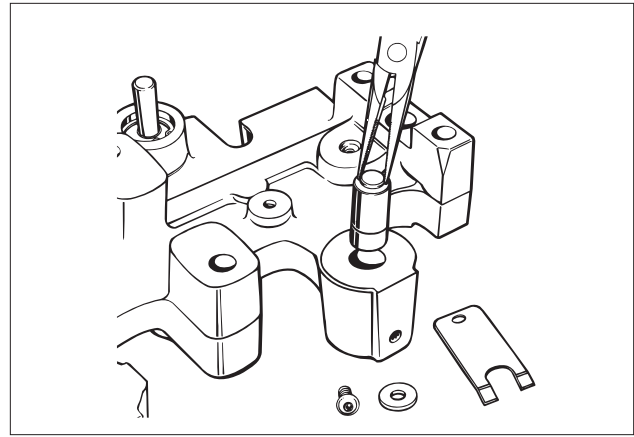


FIG. 38

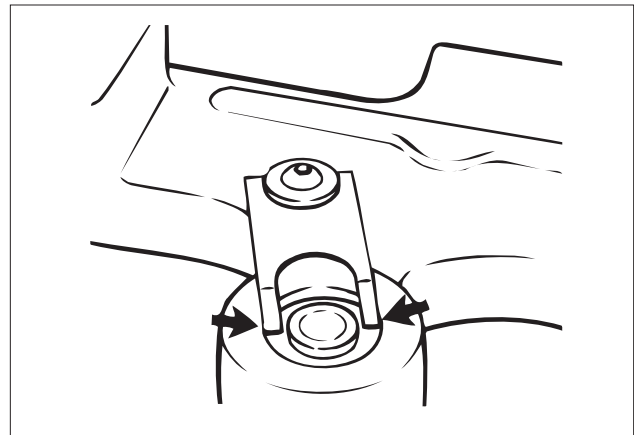


FIG. 39

Slave Piston



WEAR SAFETY GLASSES. REMOVE SLAVE PISTON CAREFULLY. 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 SPRING COULD BE DISCHARGED WITH ENOUGH FORCE TO CAUSE PERSONAL INJURY.

Remove the locknut on the slave piston adjusting screw. Back out the adjusting screw until the slave piston is fully retracted (screw is loose).

Use the slave piston removal tool and the following procedure to remove and replace the slave piston:

1. Place the hole in the clamp bracket over the slave piston adjusting screw (Fig. 40).

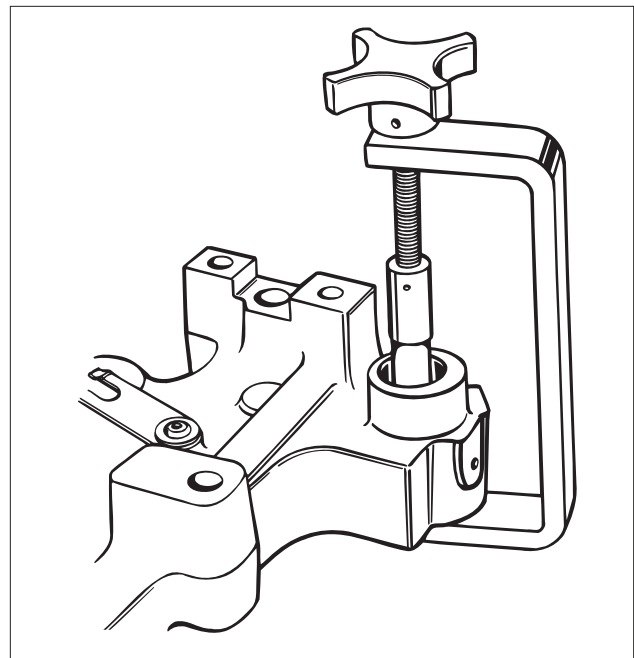


FIG. 40

2. While holding the tool in position, screw the holder down over the slave piston stem until the retainer is contacted.
3. Turn the handle slowly until the retainer is depressed, about 1/32" (1 mm), relieving pressure against the retaining ring.
4. Remove the retaining ring using retaining ring pliers. Back out the holder until the springs are loose. Remove the tool (see Fig. 41).
5. Remove the retainer, spring and slave piston. Check for nicks or burrs that could cause binding (see Fig. 42).
6. Clean the piston in an approved cleaning solvent. Run a small wire through any holes. Replace the piston if the ground surface on the outside diameter is scratched or scored.

NOTE:

BE SURE ALL COMPONENTS ARE REASSEMBLED IN CORRECT ORDER.

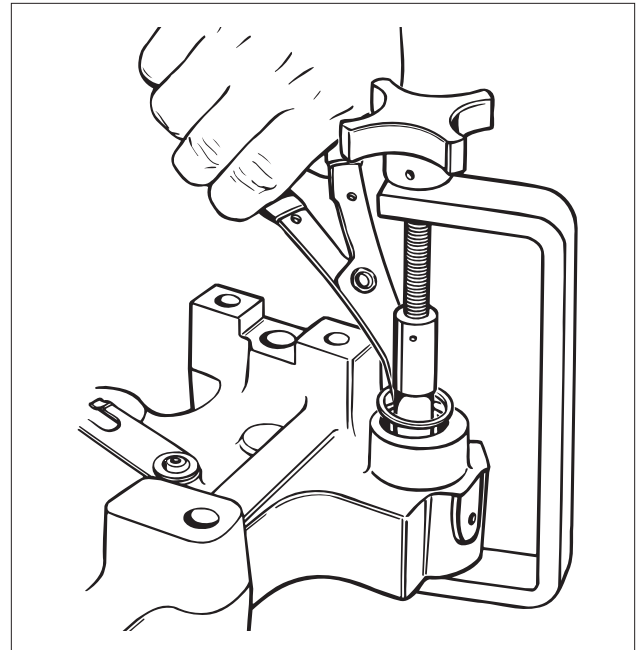


FIG. 41

7. Install the slave piston into the bore. Install the springs and retainer over the slave piston foot.
8. Use the removal tool to compress the slave piston and springs down until the retainer is about 1/32" (1 mm) below the retaining ring groove.
9. Slide the retaining ring over the threaded rod of the removal tool and reinstall the retaining ring in its groove. Be sure the retaining ring is fully engaged in the groove.
10. Remove the tool slowly to ensure proper seating of retaining ring.
11. Assemble the locknut; do not tighten.

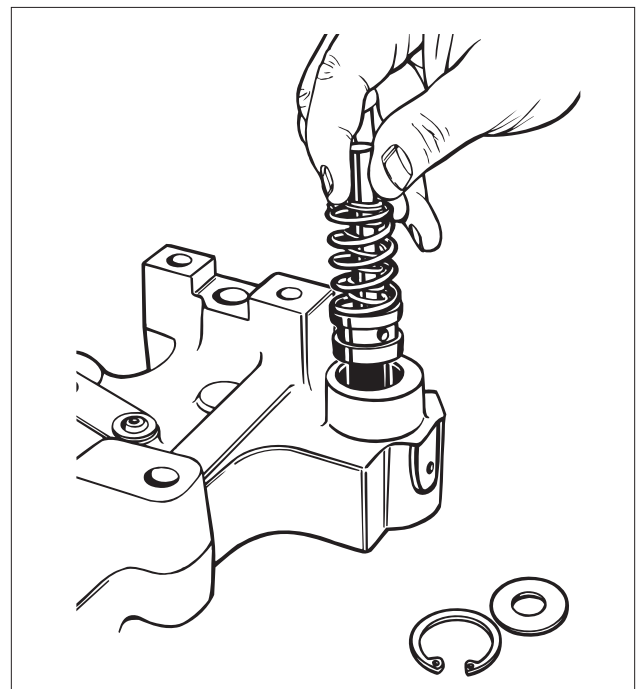


FIG. 42

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