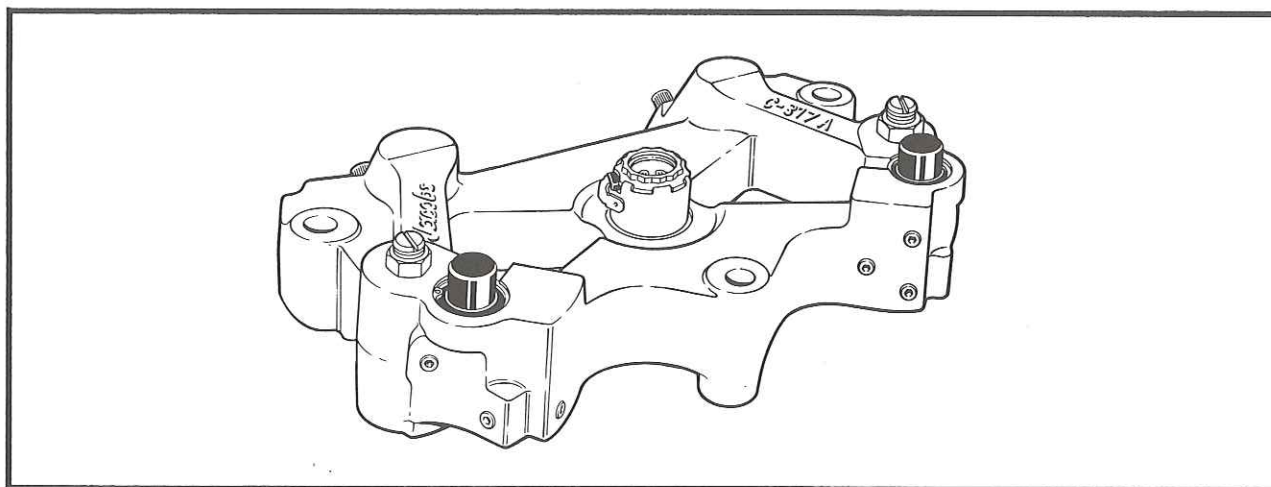




# Installation Manual for Models C317 and C317A Engine Brakes



The Model C317A Jacobs® Engine Brake is designed and approved for use on all Caterpillar Series 3176 engines.

The Model C317A replaces the former Model C317.

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## 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.



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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 wear eye protection. Always use correct tools and proper procedures as outlined in this manual.

## SECTION 1 INTRODUCTION

### Housing Identification

The model number for the Engine Brake is cast into the web on the top of the housing. See Fig. 1. The housing serial number is stamped on the flat surface of the housing near the control valve. The housing part number and slave lash is printed on a nameplate located on the top surface of the housing. Early production housings have the part number cast into the top surface of the housing.

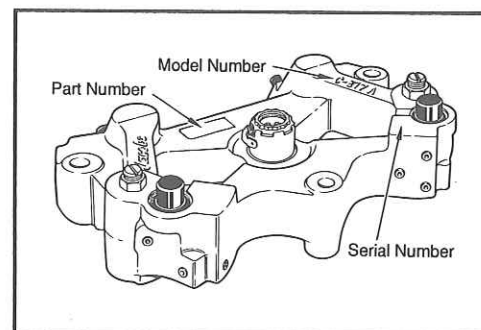


Fig. 1

### Engine Identification

Engine S/N prefix "7LG" indicates 91 model year engine. The 91 model year engines require a different slave piston adjustment than the pre-91 model year engines. See page 8 for slave piston adjustment procedures.

Electrical control systems also differ on 91 and pre-91 model year engines. Control system installation information begins on page 9.

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 C317A Jake Brake retarder. However, the Caterpillar Series 3176 Engine and the Model C317A 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)
Cylinder Head Bolt Spacers	65 lbft. (88 N·m)
Brake Mtg. Stud Assy. - <b>C317A</b>	70 lbft. (95 N·m)
Housing Hold-down Nuts - <b>C317A</b>	59 lbft. (80 N·m)
Housing Bolts -190 mm lg. - <b>C317</b>	70 lbft. (95 N·m)
Housing Bolts -70 mm lg.	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)

#### CAT Parts

Valve Bridge Adjusting Screw Locknut	18 lbft. (25 N·m)
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.

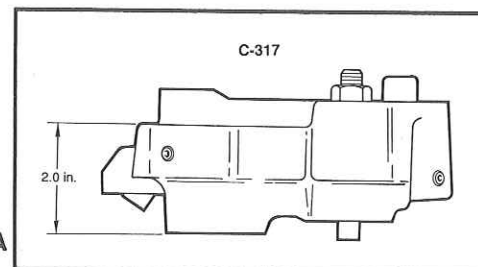


Fig. 2A

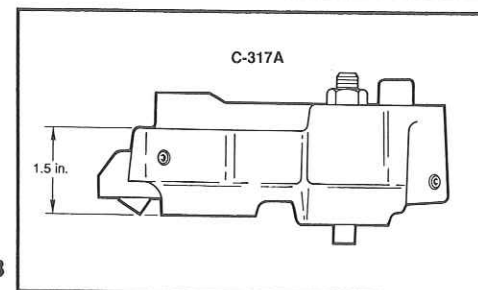


Fig. 2B

### Model Differences

Mounting methods for the C317A and C317 housings are different because of the height difference shown in Figs. 2A and 2B. See brake housing installation section for specific installation procedures.



## SECTION 2 ENGINE PREPARATION

### Valve Cover Base

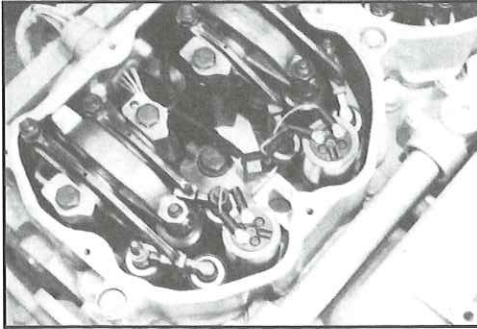


Fig. 3

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. 3.

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.**

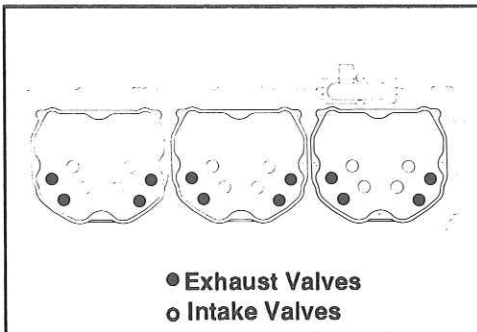


Fig. 4

### 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. 4.

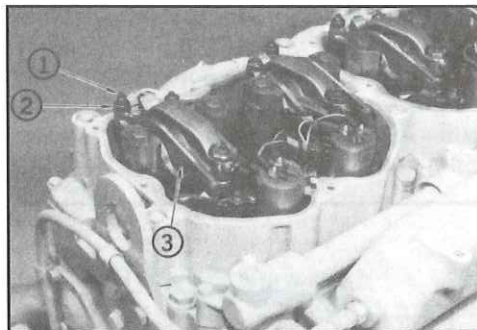


Fig. 5

Refer to Fig. 5. Loosen the locknut (2) and the adjusting screw (1) on the exhaust rocker arm (3).

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.

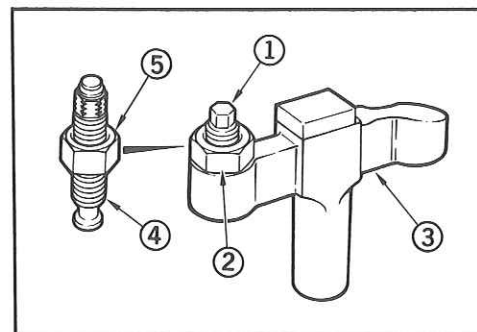


Fig. 6

Remove the exhaust valve bridge (3). See Fig. 6.

Remove the Caterpillar adjusting screw (1) and locknut (2) and install the Jacobs screw and pin assembly (4) and Jacobs locknut (5).

#### NOTE:

Install the screw and pin assembly so that the hexagon side of the screw is facing up when the bridge is installed in the engine.

## Valve Bridge Installation

Lubricate the bridge dowel, bridge bore, top pad and screw and pin assembly with clean lube oil.

Install bridge assembly (1) on bridge dowel with the adjusting screw toward the rocker shaft as shown in Fig. 7. This is *180 deg.* from the original position.

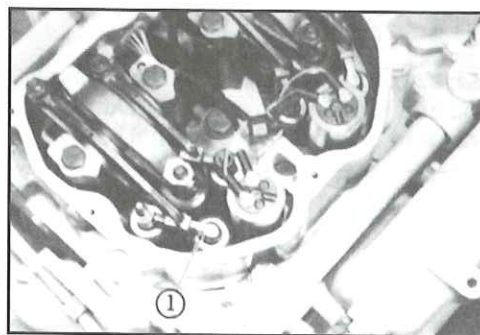


Fig. 7

## Valve Bridge Adjustment

While pressing straight down on the bridge pad (1), turn the adjusting screw (2) clockwise until contact is made with the valve stem. See Fig. 8.

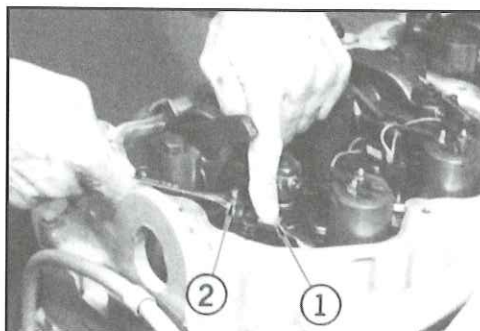


Fig. 8

Advance the screw an additional 1/8 turn (45 deg.) to straighten the bridge on the guide as shown in Fig. 9. Hold the adjusting screw in this position and tighten the locknut to 18 lbft. (25 N·m).

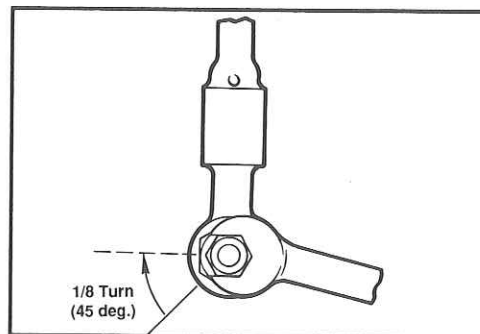


Fig. 9

### CAUTION

Be sure the exhaust valve bridge (1) is properly located on the exhaust valve stem (2). See Fig. 10. 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.

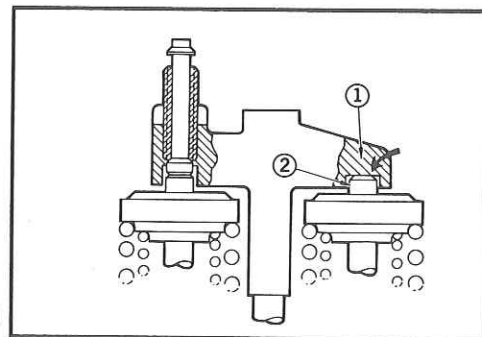


Fig. 10

Refer to Fig. 11 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.

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

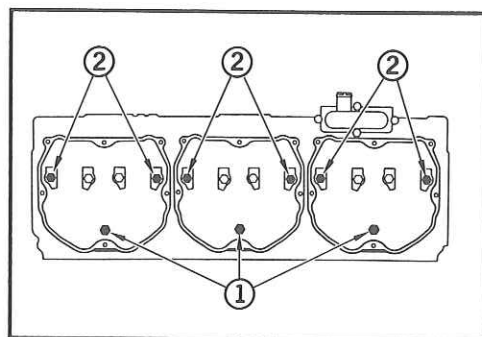


Fig. 11



# **⚠ WARNING**

Wear eye protection and cover the cylinder head bolt hole with towels to minimize oil spray and help prevent personal injury.

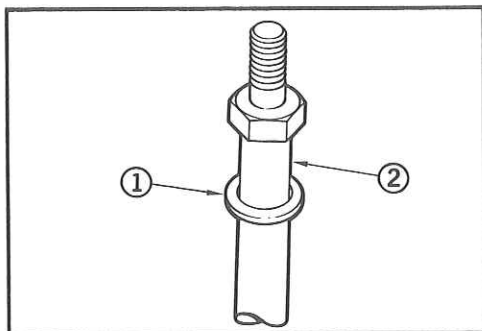


Fig. 12

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

Refer to Fig. 12 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).

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

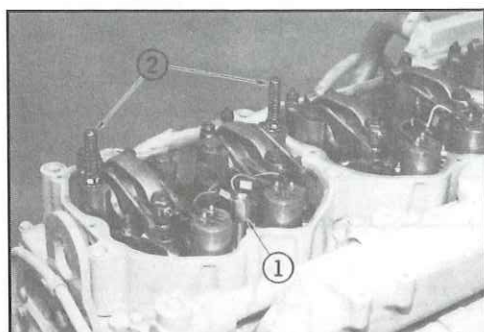


Fig. 13

Install the cylinder head bolt spacers (1) on the cylinder head bolts and torque to 65 lbft. (88 N·m). See Fig. 13.

**Model C317A Only**

## **NOTE:**

The following procedure applies to C317A housings only. For C317 applications see heading "Model C317 ONLY" on page 7.

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. 13.

## **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.

## **Valve And Injector Adjustments**

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

### **Valve And Injector Adjustment Sequence**

Set Engine	Set Intake Valve #	Set Exhaust Valve #	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 in. (0.38 mm)

Set Exhaust Valves to 0.025 in. (0.64 mm)

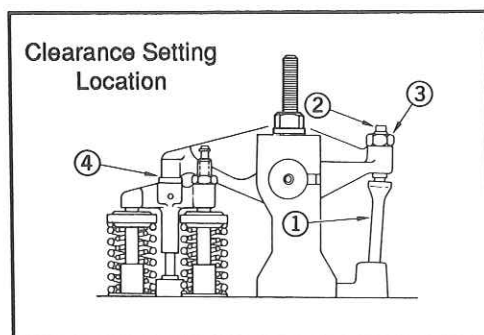
Set Unit Injectors to Zero Clearance plus 1/2 turn (180 deg.)

## **Valve Clearance Adjustment**

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

Fig. 14

Adjust the intake and exhaust valves using the same procedure. Set the intake valves to 0.015 in. (0.38 mm). Set the exhaust valves to 0.025 in. (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 deg.). Hold the adjusting screw in this position and tighten the locknut (2) to 41 lbft. (55 N·m).

### NOTE:

Rotate the engine 360 deg. In direction of rotation and adjust the remaining valves and injectors following the sequence in the above table.

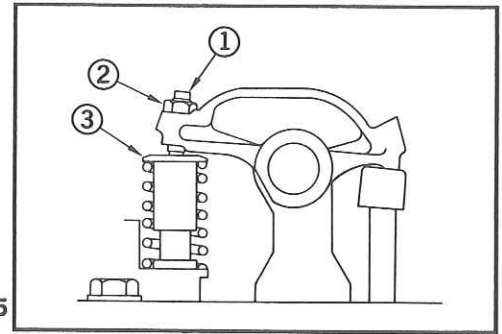


Fig. 15

## SECTION 3 ENGINE 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. *Do not tighten the nuts at this time.*

Install the 70 mm long bolts (2) through the housing into the spacers (one per housing). *Do not tighten bolts yet.*

Be sure 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.

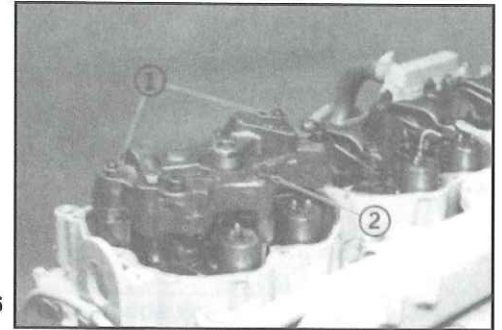


Fig. 16

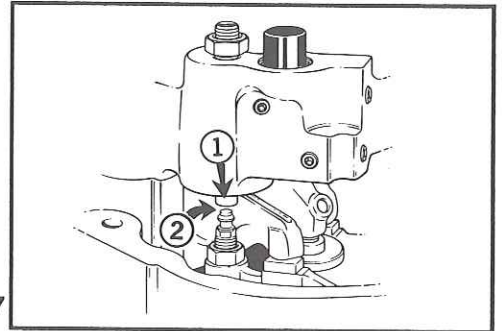


Fig. 17

First tighten hold-down nuts (1) to 59 lbft. (80 N·m).

Tighten bolts (2) to 41 lbft. (55 N·m).

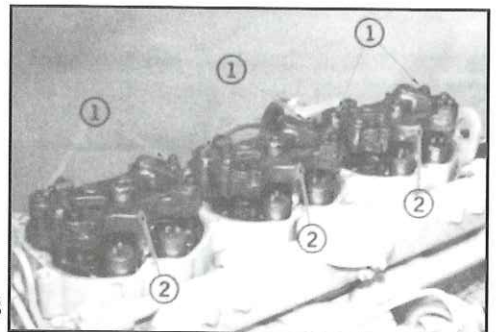


Fig. 18

### Model C317 Only

### NOTE:

The following 6 steps apply to Model C317 housings only and NOT to the C317A.

Extended stud, P/N 016088, has been replaced by bolt, P/N 014800. It is recommended when servicing or installing the C317 Engine Brake the extended stud, P/N 016088, be replaced by bolt, P/N 014800. Use the following procedure for C317 housing installation.

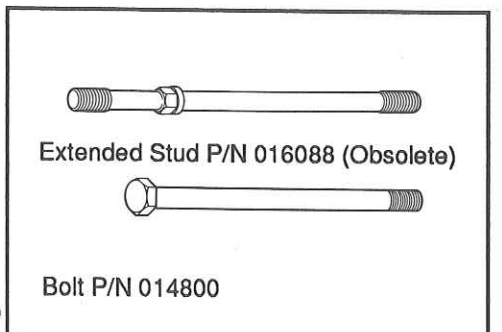


Fig. 19



**NOTE:**

To adjust the injectors and valves the engine brake housings must be removed and the rocker assembly secured with Caterpillar rocker pedestal capscrews or Jacobs P/N 014800 capscrew with 2 inch spacers, Jacobs PN 017535. Torque to 70 lbft. (95 N·m).



Fig. 20

**NOTE:**

Make the slave piston adjustments with the engine stopped and cold. The exhaust valves must be closed on the cylinder to be adjusted. Follow the sequence in the Slave Piston Adjustment table.

1. After injectors and valves have been adjusted remove the extended studs, or for new installations remove the Caterpillar rocker pedestal capscrews.
2. Install the engine brake housing on the rocker pedestals.
3. Install the Jacobs bolt P/N 014800 (2 per housing) into the housing and rocker pedestals.
4. Install the Jacobs bolt through the housing into the spacer on the cylinder head bolt.
5. Tighten bolt at the rocker pedestals to 70 lbft. (95 N·m).
6. Tighten the bolt at the head bolt spacer to 41 lbft. (55 N·m).

## 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	Mod. Yr.	Clearance	Gauge P/N
3176	Pre-91	.045 in. (1.14 mm)	16896
3176	91	.050 in. (1.27 mm)	17902

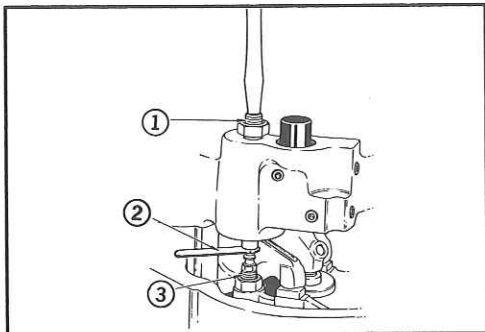


Fig. 21

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

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

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

Rotate the engine 360 deg. 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. 22.

**NOTE:**

A .375 in. (9.5 mm) gap should be left between each end of the gasket and the spacer.

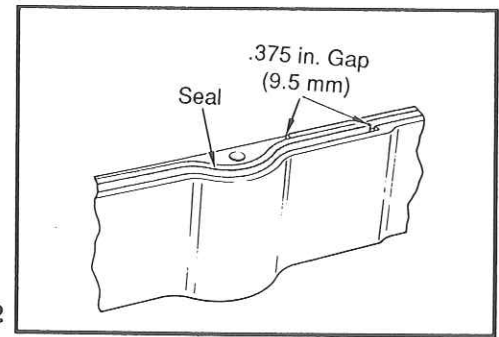


Fig. 22

Install the three Jacobs spacers on the valve cover base.

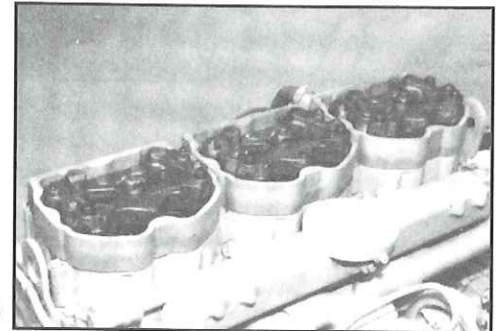


Fig. 23

Install the terminal leadout assemblies into the spacers and tighten with a six point box wrench until seated against spacer.

Connect the solenoid lead wires (1) to the terminal lead outs (2) in the three spacers. See Fig. 24.

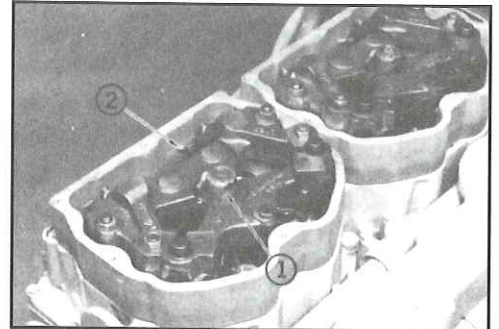


Fig. 24

## SECTION 4 CONTROL SYSTEM INSTALLATION

### Clutch Switch - All Engine Applications

A clutch switch is required for proper operation of the engine brake. Vehicles that have cruise control will include a clutch switch in the cruise control circuit for operation of the cruise control. Vehicles without the cruise control option do not include a clutch switch.

**For vehicles with cruise control (with clutch switch):**

These applications will not require installation of a Jacobs clutch switch. The clutch switch used for signaling the cruise control will provide a signal for proper engine brake operation with the wiring connected as shown in the pre-91 custom control wiring diagram. See Fig. 30.

**NOTE:**

Vehicle OEM installed control system components may differ from Jacobs supplied parts.

**WARNING**

Do not expose electrical components to RTV Sealants. Electrical spark can cause **FLAMMABLE** sealants to ignite, resulting in possible fire and personal injury.

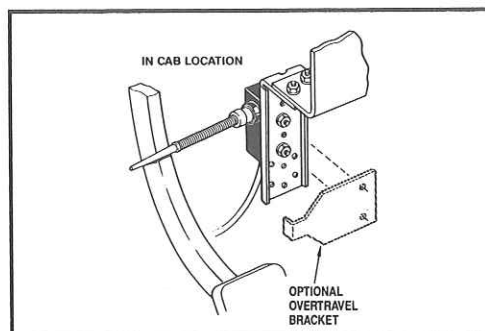


Fig. 25

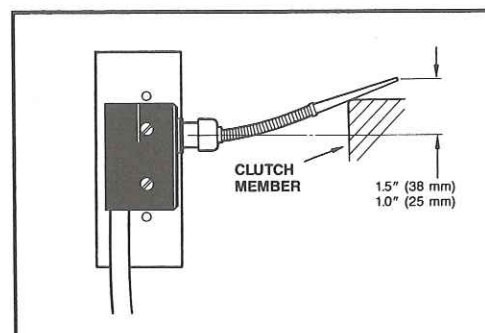


Fig. 26

Vehicles without cruise control (no existing clutch switch):

1. Mount the clutch switch in a convenient, accessible location. Locations may include in cab under dash, under floor wheel well location or in the area of the bell housing.
2. Install this switch with the switch actuator arm in contact with the clutch pedal arm or other clutch member.

**CAUTION**

Exceeding 1.5 in. deflection of the actuator arm may cause switch damage resulting in engine brake malfunction.

**NOTE:**

The optional overtravel bracket (Fig. 25) should be used when the clutch switch is installed in the wheel well location or a location where a build up of road contamination (ice, mud, etc.) can stick to the actuator arm.

3. Adjust the switch by moving the switch along the mounting bracket. The actuator arm should be deflected 1.0 - 1.5 in. (25 - 38 mm), measured at the top of the actuator, when the clutch pedal is in the up (clutch engaged) position. See Fig. 26.
4. Check installation by moving the clutch pedal. The switch should click in the freeplay motion of the clutch pedal before actual clutch disengagement takes place.

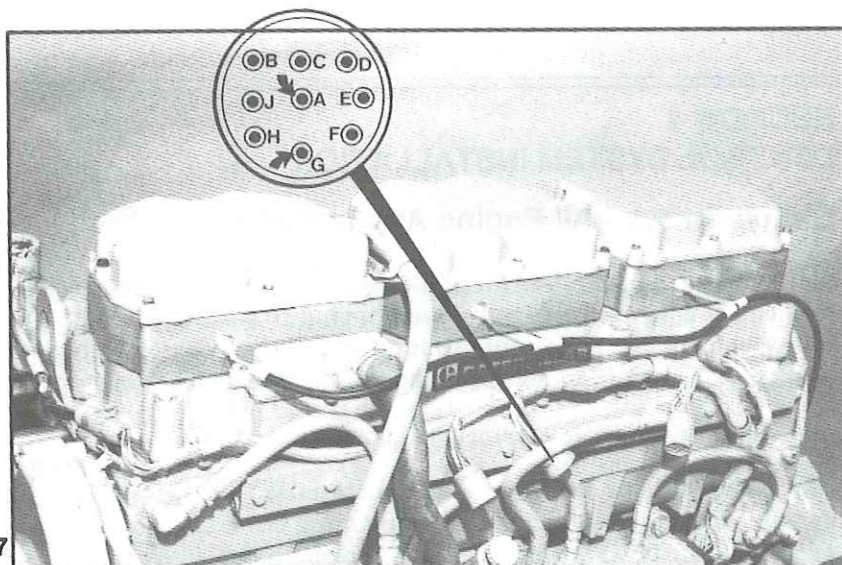


Fig. 27

5. Locate the J-7 electrical connector as shown in Fig. 27. Connect one wire from the clutch switch to a pin "A" in the J-7 electrical connector. The other clutch switch wire should be connected to pin "G" in the J-7 electrical connector. Pin "A" and "G" have "pigtail" wires coming from the connector. Butt splice the clutch switch wires to these "pigtails".



## Custom Control System - Pre-91 Model Year Engines

### Dash Module

1. Locate an area on the dash for the dash control module and drill a 2" hole.
2. Install the module and attach the bracket to the back of the module with the two nuts. See Fig. 28.
3. Attach the ribbon harness to the dash control module. See Page 14 for check out procedures.

### Control Module

Mount the control module (Fig. 29) inside the cab so that the harness will reach the dash module. Mount the module using two self-tapping screws.

Refer to the custom control schematic for the following electrical connections:

#### Harness, P/N 015683

Connect the wire harness, P/N 015683, to the control module.

#### Wire Harness, P/N 015684

1. Connect the wire harness, P/N 015684, to the Weatherpack® connector on the control module.
2. Connect the RED wire to a 10 amp circuit breaker that is controlled by the key switch.
3. The ORANGE wire is provided for use with an anti-skid system. If anti-skid is not used, insulate the end and store the wire.
4. The BROWN wire should be connected to the 3176 electronic control module, connection P-8 terminal C.

### MODEL C317 and C317A CUSTOM CONTROL SCHEMATIC FOR PRE-91 ENGINE APPLICATIONS

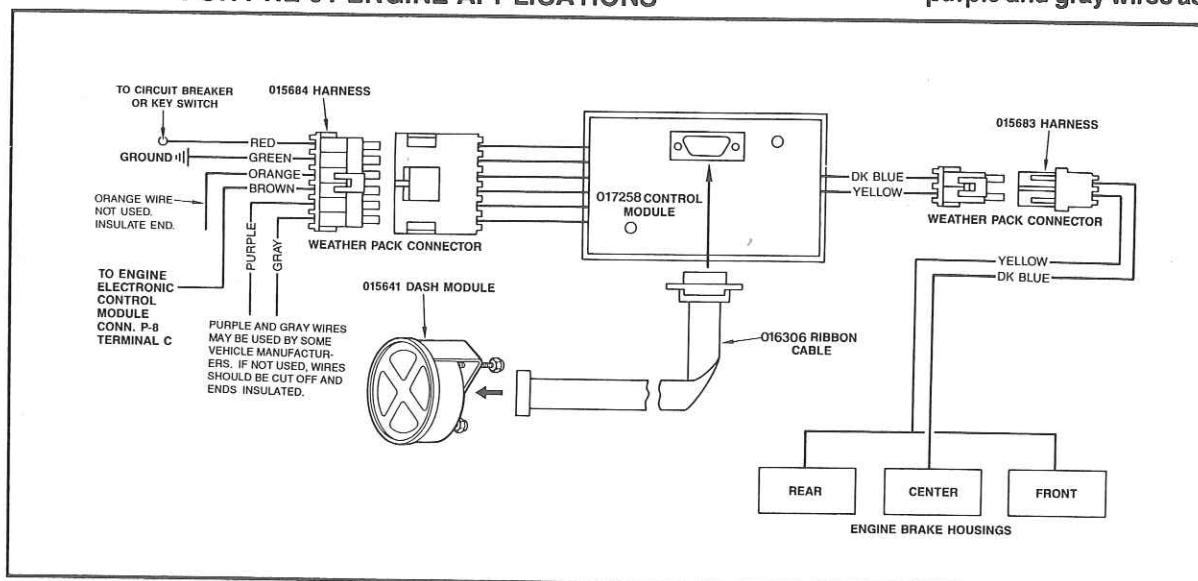


Fig. 30

### CAUTION

Do not overtighten nuts. Switch failure will result.

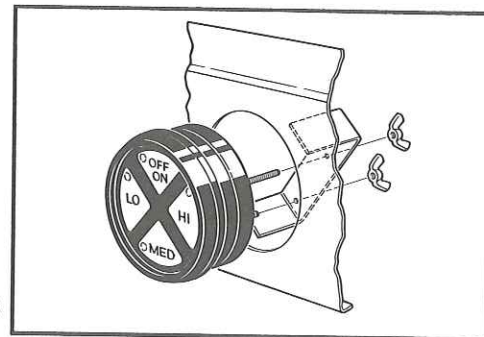
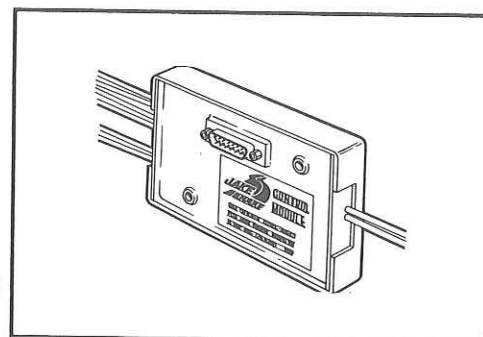


Fig. 28

### CAUTION

Do not allow control module to be unmounted or tie wrapped behind the dash. Control module will be stressed and failure will result.

Attach the ribbon cable from the dash module to the control module and tighten the two mounting screws. Mounting screws are not included in the kit.



### NOTE:

If the optional OEM dash switches are used in place of dash module, connect the purple and gray wires as shown in Fig. 33.

## WARNING

Proper operation of the Jake Brake engine retarder electrical control system is dependent on securing a good ground connection. The GREEN wire must be attached to the dedicated ground connection point located at the the cylinder head. See Fig. 31. Do not use body bolts or screws on the dash. A poor ground will cause intermittent engine brake operation and damage to the control module.

6. Connect the GREEN wire to a good ground. See Fig. 31.

## GROUND DIAGRAM - ALL APPLICATIONS

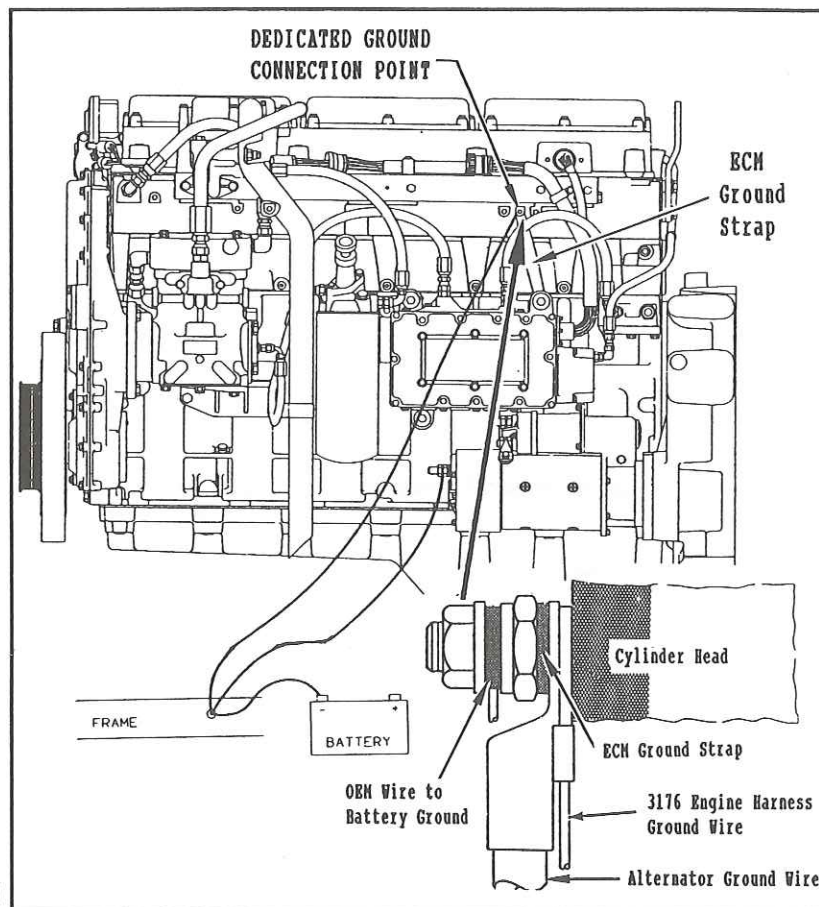


Fig. 31

Connect wires to the terminal leadouts in the spacers: YELLOW wires to the front and rear spacers; BLUE wire to the center location.

## Optional Jacobs Switch Group

### NOTE:

Use of the optional Jacobs switch group in place of the control module will eliminate the diagnostic trouble shooting feature of the standard electronic circuit.

Switch group, P/N 017328, and harness, P/N 017263, may be used instead of dash module, P/N 015641, and cable, P/N 016306. Connect harness, P/N 017263, between 017258 control module and 015684 harness.

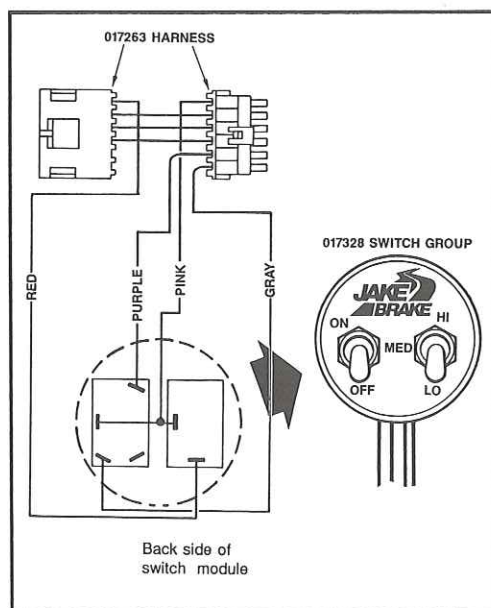


Fig. 32



## Optional OEM Dash Switches

Vehicle OEM dash switches may be substituted for the dash control module. The switches are connected as shown in Fig. 33.

### NOTE:

Use of the optional dash switches in place of the dash control module will eliminate the diagnostic trouble shooting feature of the standard electronic circuit.

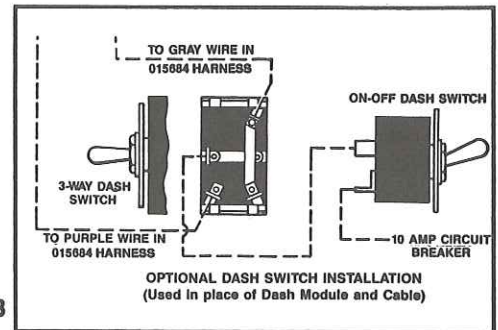


Fig. 33

## 91 Model Year

### Dash Switch Group

1. Locate an area on the dash for the dash switch group and drill a 2 in. hole.
2. Install the switch group and attach the bracket with the two nuts as shown in Fig. 34.
3. Attach the harness to the dash switches as shown in the appropriate wiring diagram. See Fig. 36 or 37 on next page.

### NOTE:

If desired, the two dash switches can be mounted directly on the dash with the faceplate. Drill two .625 in. holes 1 in. apart. Mount the faceplate and two switches with the two switch nuts. Install the on/off switch on the left and the hi/med/low switch on the right.



Do not overtighten nuts. Switch Failure will result.

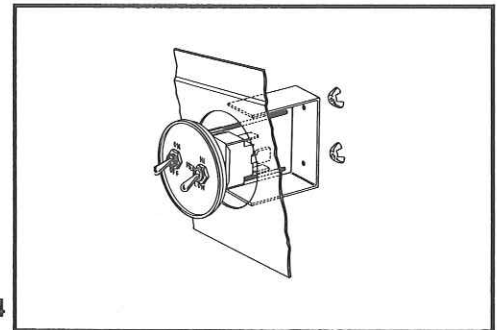


Fig. 34

### Relay Base

Mount the relay base (Fig. 35) inside the cab so that the harness will reach the dash switches.

### NOTE:

The relay base can be installed directly to the existing electrical panel in many cabs or attach the relay base to the firewall or suitable location inside the cab.

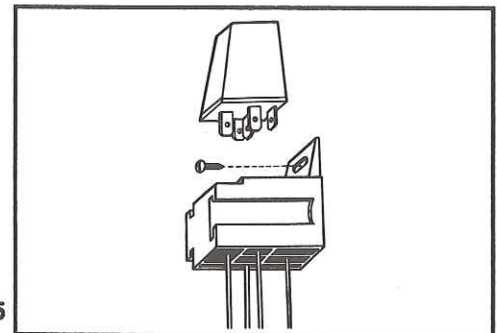


Fig. 35

### Solid State Relay

For specific connection information refer to the appropriate wiring diagram. See Fig. 36 or 37 on the following page.

For all applications:

Connect the GREEN wire to a good ground. See Fig. 31.

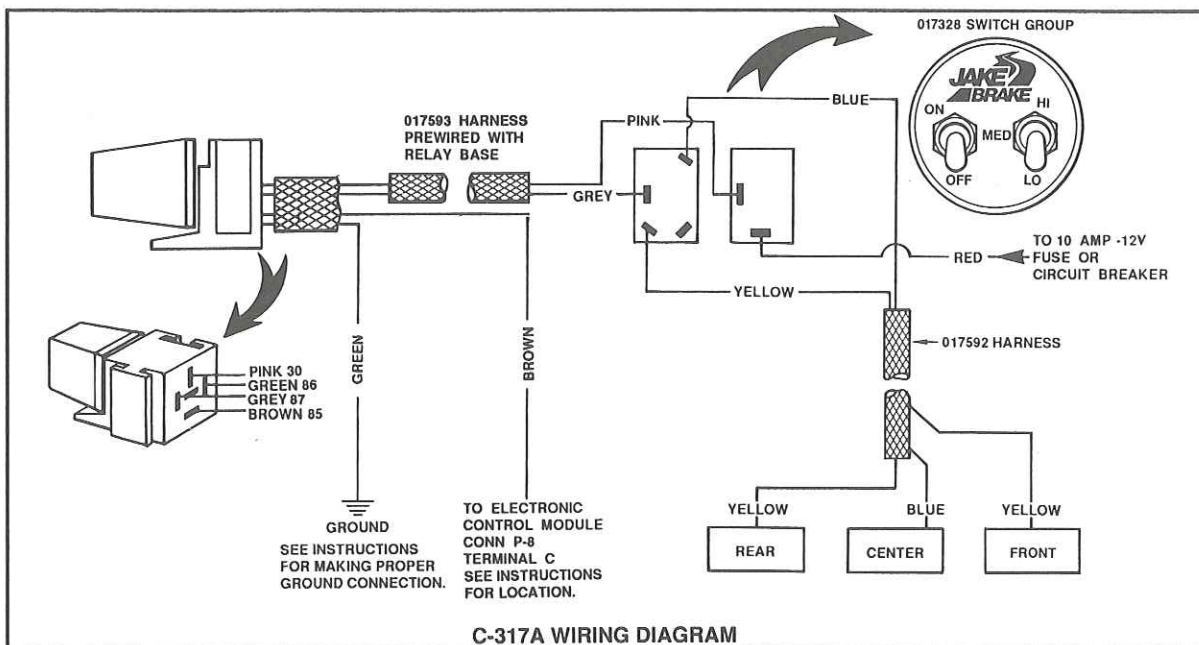
Connect wires to the terminal leadouts in the spacers: YELLOW wires to the front and rear spacers; BLUE wire to the center location.



Proper operation of the Jake Brake engine retarder electrical control system is dependent on securing a good ground connection. The GREEN wire must be attached to a grounding stud located at the the cylinder head. See Fig. 31. Do not use body bolts or screws on the dash. A poor ground will cause intermittent engine brake operation and damage to the control module.

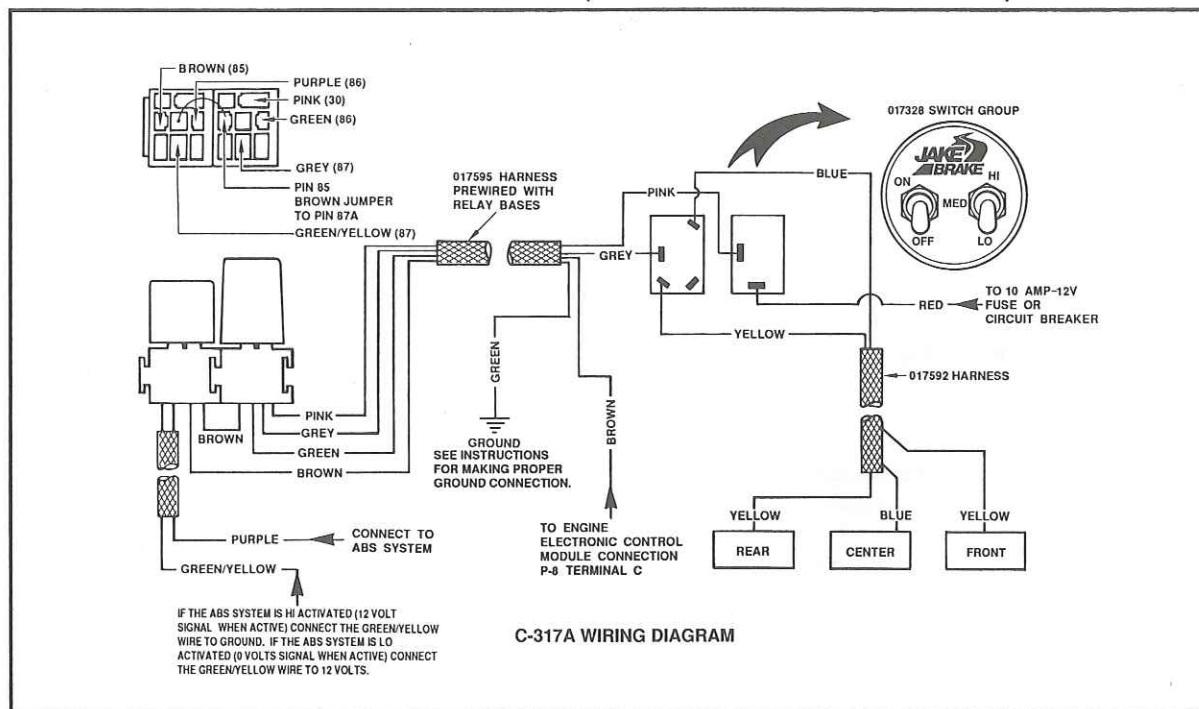
## FOR 91 ENGINE APPLICATIONS - W/O ABS (ANTI - LOCK BRAKING SYSTEM)

Fig. 36



## FOR 91 ENGINE APPLICATIONS - With ABS (ANTI - LOCK BRAKING SYSTEM)

Fig. 37



## SECTION 5 ENGINE BRAKE OPERATION CHECK

### Custom Control System - Models C317 and C317A on Pre-91 Engines

The electronic controls for these Engine Brakes include a dash module, control module and associated wire harnesses. See Section 4, pages 11 and 12 for installation instructions and use the following check out procedures.



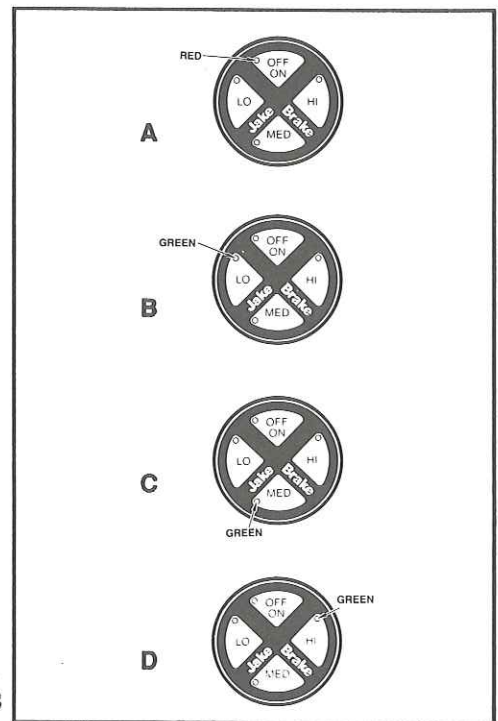
With the "ignition" switch turned on, the system is energized. The red light will be on indicating that the control module is "off". See Fig. 38A.

To turn the control module "on", press the on/off button. The red light in the **ON/OFF** quadrant will go off and the green light in the **LO** quadrant will come on indicating that the retarder is operational in the low mode, center housing only (2 cylinders). See Fig. 38B.

Pressing the **MED** button will turn off the light in the **LO** quadrant and turn on the light in the **MED** quadrant indicating that the retarder is operational in the **MED** mode, front and rear housings (4 cylinders). See Fig. 38C.

Pressing the **HI** button will cause the light in the **MED** quadrant to go out and the light in the **HI** quadrant to come on, indicating that the retarder is operational in the **HI** mode, all housings. (6 cylinders). See Fig. 38D.

Fig. 38



## Bleed Engine Brake Housings

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. 39.
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.



### 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.

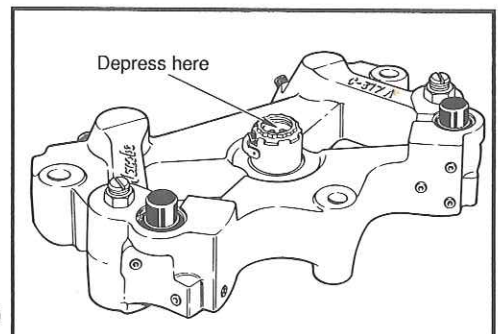


Fig. 39

## Rocker Cover Installation

Be sure the seal is located in the groove of the cover (Fig. 40) 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.

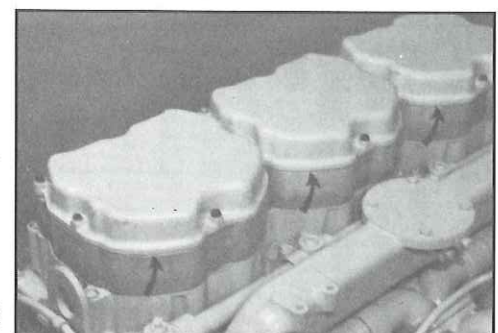


Fig. 40

## SECTION 6 ENGINE BRAKE MAINTENANCE

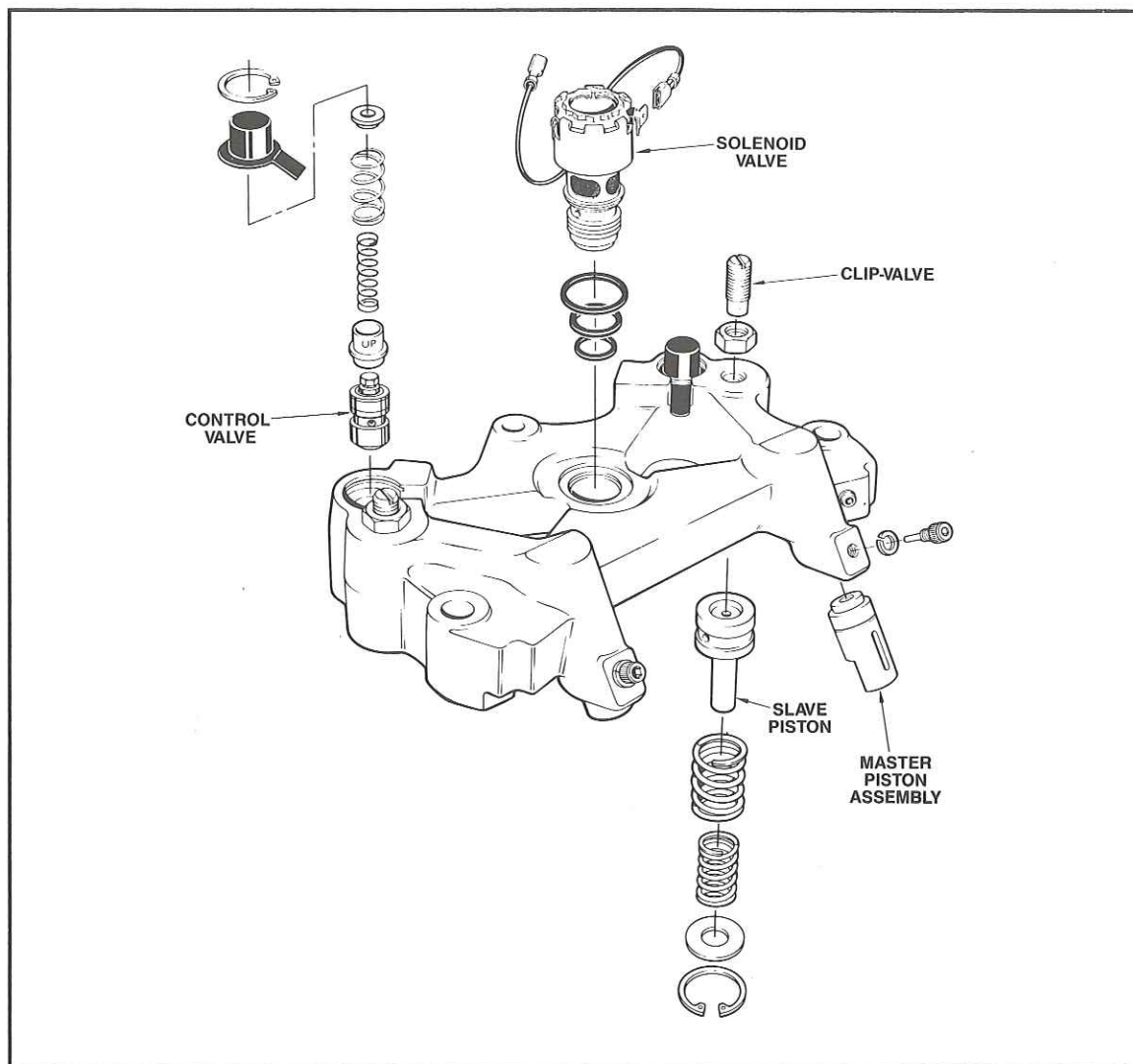


Fig. 41

### EXPLODED VIEW MODEL C317A HOUSING ASSEMBLY

**NOTE:**

All component parts in the C317 and C317A housing assemblies are the same.



Never remove any engine brake component with engine running. Personal injury may result.

The Jacobs Engine Brake is typically a trouble-free and maintenance-free device. However, periodic inspections are necessary and some maintenance is required. Use the following procedures to keep the engine brake in top condition.

This section covers 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



**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 in. socket and extension, unscrew solenoid valve.
2. Remove and discard the three rubber seal rings. If the lower ring stays in the bottom of 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. When clean, dry the valve with compressed air.

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.

4. Using new solenoid seal rings, coat them with clean lube oil. Install the upper and center seal ring on the solenoid body and the lower seal ring into the bottom of the solenoid bore in the housing. See Fig. 43.
5. Be sure the seals are seated properly. Carefully screw the solenoid into housing without unseating the seals. Torque the valve to 5 lbft. (7 N·m). Be careful not to twist the seals while installing.

Fig. 42

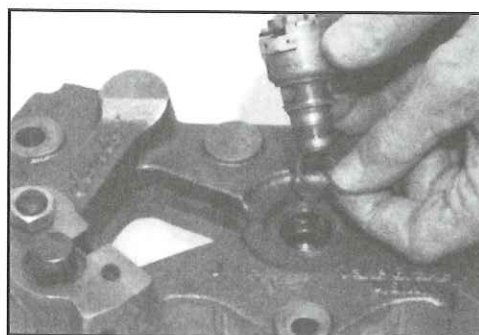
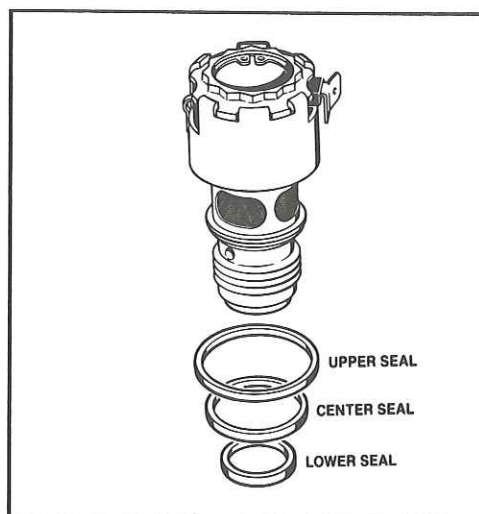


Fig. 43

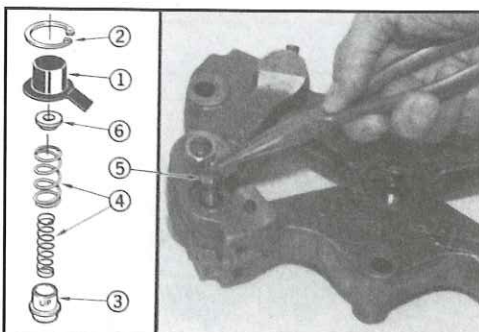
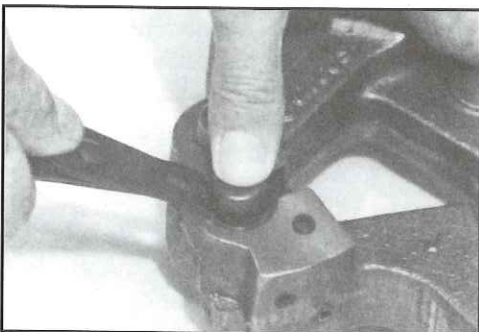
## Control Valve



**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) and rotate the retaining ring ears to the slot in the housing. Remove retaining ring (2) using retaining ring pliers. See Fig. 44 and 45.
2. Slowly remove cover until spring pressure ceases, then remove the two control valve springs (4), insert (6) and collar (3).
3. Using needle nose pliers, reach into the bore and grasp the stem of the control valve (5). See Fig. 45. Remove 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.

Fig. 45



Thoroughly clean the control valve bore in the housing, using clean paper towels.

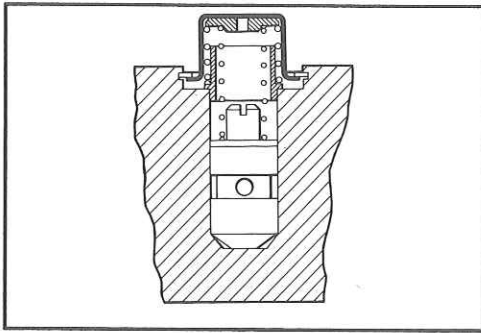


Fig. 46



Be sure the control valve collar is installed with the longer sleeve area up. See Fig. 46. If the collar is installed upside down, engine damage may result.

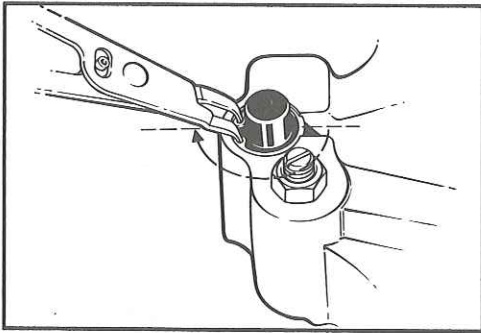


Fig. 47



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 springs will be discharged with enough force to cause personal injury.

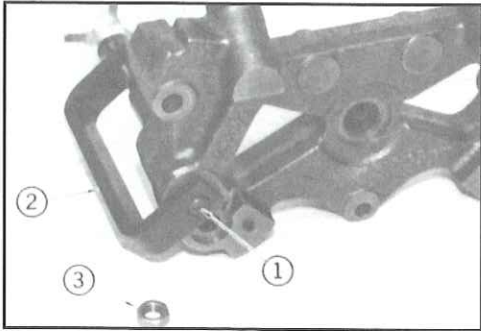


Fig. 48

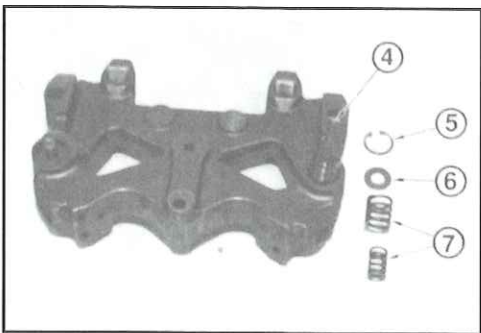


Fig. 49

5. Reassemble parts reversing the removal procedure.

6. Rotate the retaining ring so that the ears are located away from the slot in the housing as shown in Fig. 47.

## Slave Piston

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. 48.
3. While holding the fixture in position, screw holder down over the slave piston (4) until the spring retainer (6) is contacted.
4. Turn the handle slowly until the retainer is depressed to about 1/32 in. (1 mm), relieving pressure against the retaining ring (5).
5. Remove the retaining ring. Use retaining ring pliers. Back out the holder until the springs (7) 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 all components are reassembled in proper order. See Fig. 49.

7. Use 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 1/32 in. (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.



## Master Piston

Remove the anti-rotation pin assembly (3) and lock washer (2) from the housing.

Remove the master piston assembly (1). See Fig. 50.

### NOTE:

The master piston return spring is contained inside the master piston. Do not disassemble the master piston assembly in the field.

Inspect the master piston for damage. The piston surface must be free of score or wear marks, and must move freely in the housing bore. Visually inspect the spring to insure that it is not broken. See Fig. 51.

Refer to Fig. 52. Compress the return spring using a pick or probe (1). While holding the spring compressed, insert a small diameter pin (2) into the access hole and remove the probe.

Insert the master piston into the housing bore. Install the anti-rotation pin with the lockwasher into the housing and remove the pin so that the spring will be retained by the anti-rotation pin.

Tighten the anti-rotation pin with a 3/16 in. hex key wrench to 40 lbin. (4.5 N·m). See Fig. 53.

Move the piston in and out to be sure it moves freely and that the spring returns the piston to the bottom of the bore.

Fig. 50

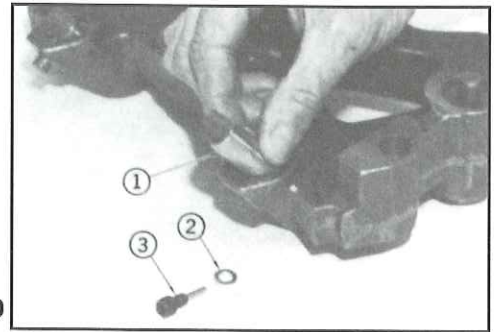


Fig. 51

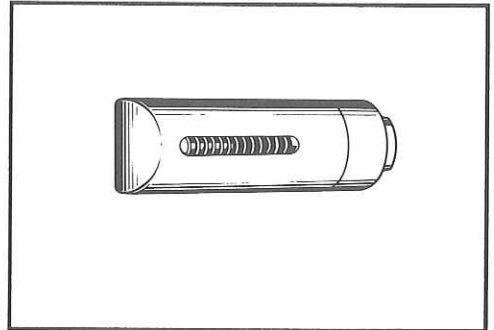


Fig. 52

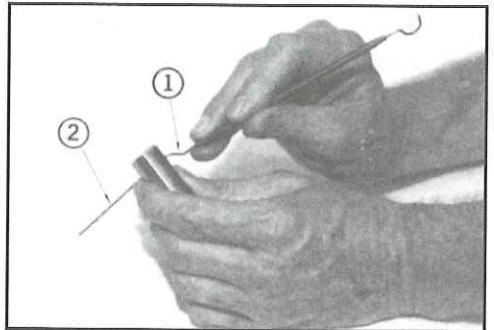
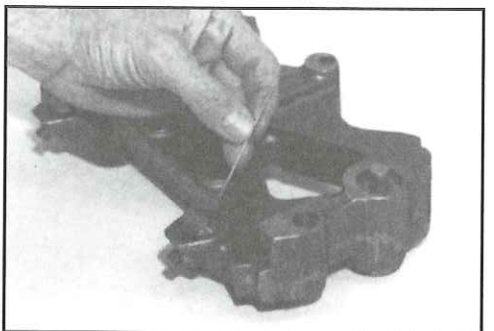


Fig. 53



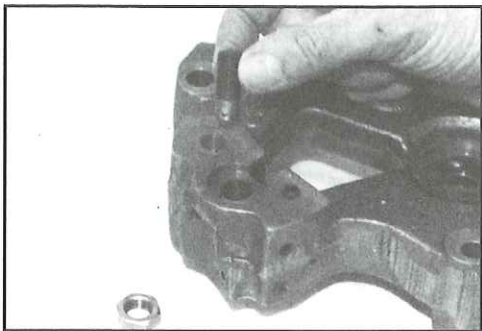


Fig. 54

## Slave Piston Adjusting Screw (Clip Valve)

Loosen slave piston adjusting screw locknut and remove adjusting screw from housing. See Fig. 54.

### NOTE:

The part number for the screw is located at the top of the screw next to the screw driver slot. Refer to the parts manual for part number identification.

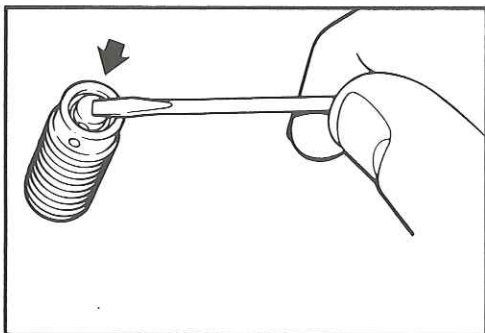


Fig. 55



Do not adjust or tamper with the adjusting screw assembly. Engine damage could result.

Clean in an approved cleaning solvent.

Inspect 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. 55. Replace the entire screw assembly, if any defect is found.