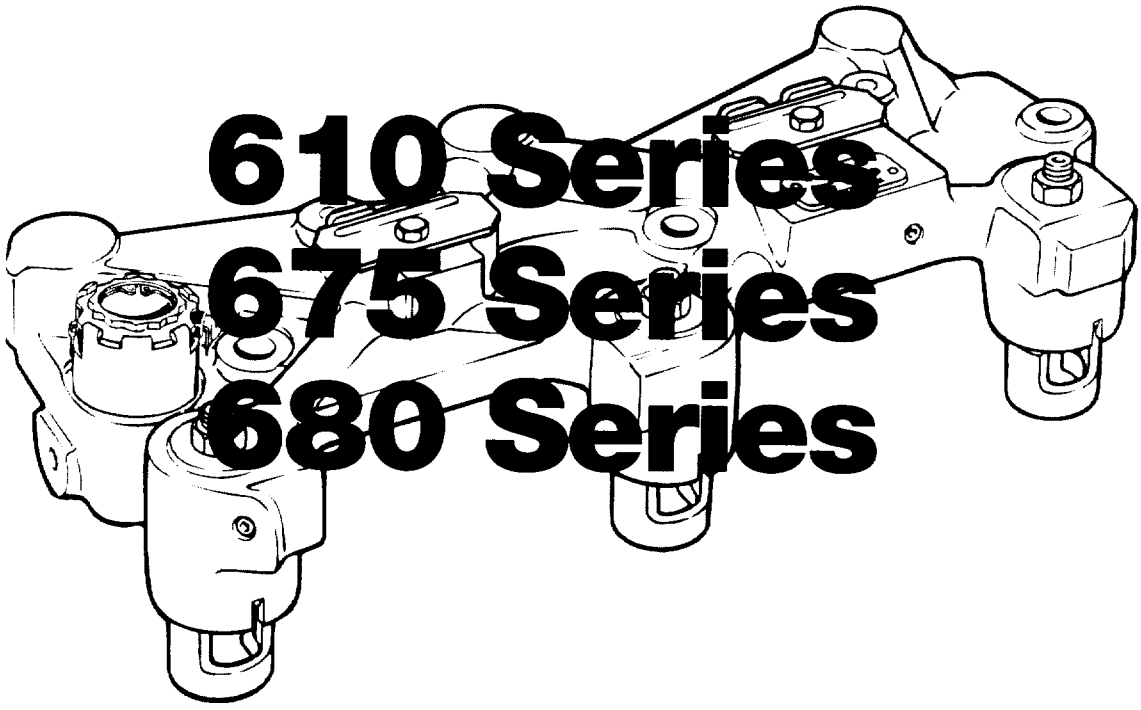
Jacobs Vehicle Systems™

# Jacobs Engine Brake™



# 610 Series
# 675 Series
# 680 Series

# TROUBLESHOOTING

# Table of Contents



# General Information

This manual covers Jacobs Engine Brake Models 675, 675A, 680A, 680B and 610.

Information in this manual was current at the time of printing and is subject to change without notice or liability.

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

The differences between the Models 680A and 680B are the attaching parts groups, exhaust valve yokes and control valve springs. The Model 680A fits Mack E6 engines with 4 valves per cylinder. The attaching parts have SAE threads. The Model 680B fits Mack E7 engines. Attaching parts have metric threads.

The Jacobs Engine Brake Model 675A is designed for the Mack 675 engine with a two-valve cylinder head configuration. The two-valve configuration requires a valve stem cap on each exhaust valve stem. The Jacobs Engine Brake Model 610 is designed for Mack E5 engines. The troubleshooting procedures are the same for all of these models.

# How to Use This Manual

*"Understand how the system is supposed to work before trying to figure out why it doesn't."*

To properly diagnose problems with the Jacobs Engine Brake, it is important to understand the operation of the product and its components.

This manual provides a systems overview of both the electrical and hydraulic/mechanical aspects of the brake, in addition to component descriptions. This is followed by some operational tests to help you isolate the problem, troubleshooting sequences and a Final Test to verify correct operation.

If you are unfamiliar with engine brakes, we recommend that you read this manual completely before attempting to troubleshoot. If you have some experience, we suggest that you review the figures and illustrations for any information that may be specific to the models covered here before proceeding to the Testing and Troubleshooting sections.

# Service Tools and Parts

| Item | Mack P/N | Jacobs P/N |
|---|---|---|
| Mack Tool Kit | 4559-22161 | 022161 |
| Oil Pressure Test Kit | 4559-18280 | 018280 |
| Slave Piston Removal Tool | 4559-18238 | 018238 |
| Distribution Kit | 4559-21322 | 021322 |
| Feeler Gage, 0.080" | 4559-18781 | 018781 |
| Feeler Gage, 0.080" | 4559-20521 | 020521 |
| Feeler Gage, 0.085" | 4559-14177 | 014177 |
| Feeler Gage, 0.100" | 4559-21327 | 021327 |
| Feeler Gage, 0.060" | 4559-22001 | 022001 |
| Feeler Gage, 0.095" | 4559-21172 | 021172 |
| Tune-up Kit, 675A | 4559-18676 | 018676 |
| Tune-up Kit, 680A | 4559-18677 | 018677 |
| Tune-up Kit, 680B | 4559-18678 | 018678 |
| Boost pressure gage/attachments | | |
| Mechanics hand tools | | |
| Volt/ohm meter | | |

# 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.

# Section 1: Electrical System

## Overview

The engine brake electrical control system is designed to permit engine brake operation under the following conditions:

1. No fuel to the engine;
2. Clutch engaged (manual transmission) or torque converter locked (automatic transmission).
3. ON/OFF switch must be on.
4. Engine speed must be above idle on engines equipped with a low speed cutoff, or engines with electronic fuel control.

When all of these conditions are met, there should be voltage to the wires leading to the solenoids.

The system is protected from short circuits by a fuse or circuit breaker.

## Components

**Electronic Fuel Control (V-MAC)**

The heart of the V-MAC system is a control module located under the dash on the passenger side. The module controls all engine system functions such as timing, idle, road speed and others.

The engine brake operation is controlled through the V-MAC module, and a system of dash switches and relays. Refer to Mack Trucks' troubleshooting documents for service.

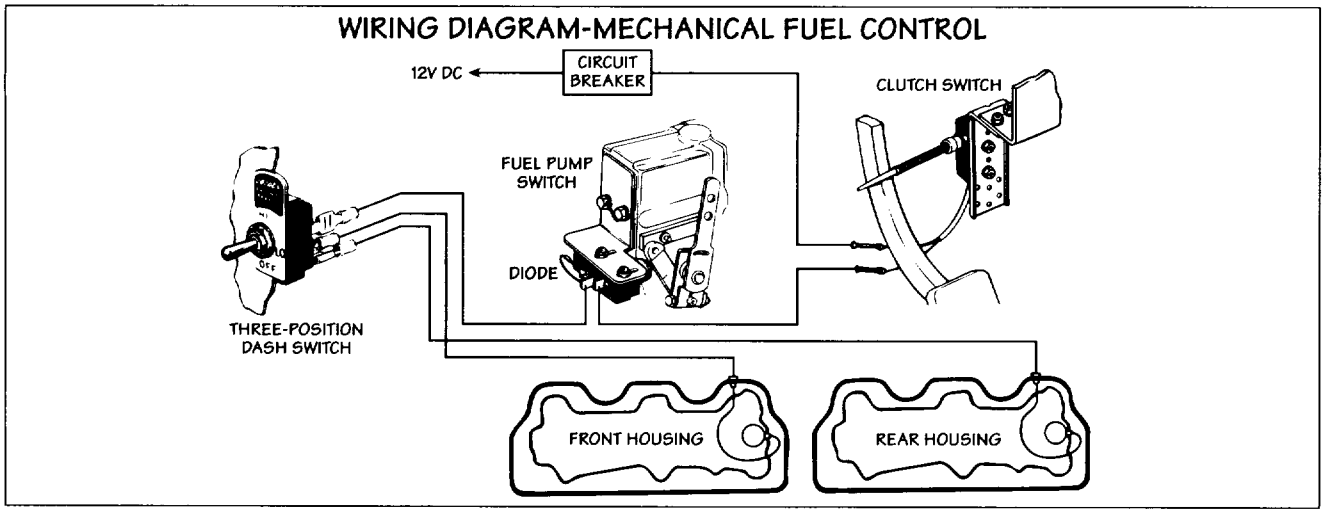



FIG. 1

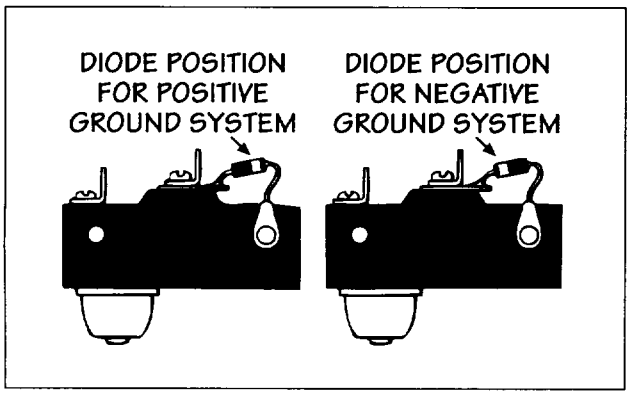



FIG. 2

**Mechanical Fuel Control**

The electrical control system for mechanical fuel control engines consists of the following:

1. A dash switch, consisting of three positions -- OFF, LO, HI. "LO" will activate one housing (3 cylinders) and "HI" will activate two housings (6 cylinders). This switch is used to control the amount of braking.

2. A switch and bracket assembly, mounted on the fuel pump. This switch permits engine brake operation only when the engine is in a "no fuel" condition. A diode installed at the fuel pump switch provides longer service life for all switches. The diode prevents high voltage surges when the system is shut off. Diodes are polarity sensitive and must be installed correctly (see Fig. 2).

3. A clutch switch, permitting engine brake operation only when the clutch is engaged. This prevents engine brake operation during gear shifting. In vehicles with automatic transmissions a torque converter pressure switch is substituted, and permits engine brake operation when the transmission is in lockup.

4. A circuit breaker or fuse (10 amp minimum) protecting the electrical circuit.

5. A solenoid valve (12- or 24-volt), located in the brake housing. The solenoid valve is a three-way, electrically activated valve. When activated, the solenoid valve permits engine lube oil to enter the brake housing and when deactivated, provides an oil exhaust feature for brake shut off. There are 12- and 24-volt solenoid valves available and the control system can be used with either 12- or 24-volt solenoids. Electrical specifications for solenoid valves are listed in Table 6 in Section 4 Electrical Troubleshooting.

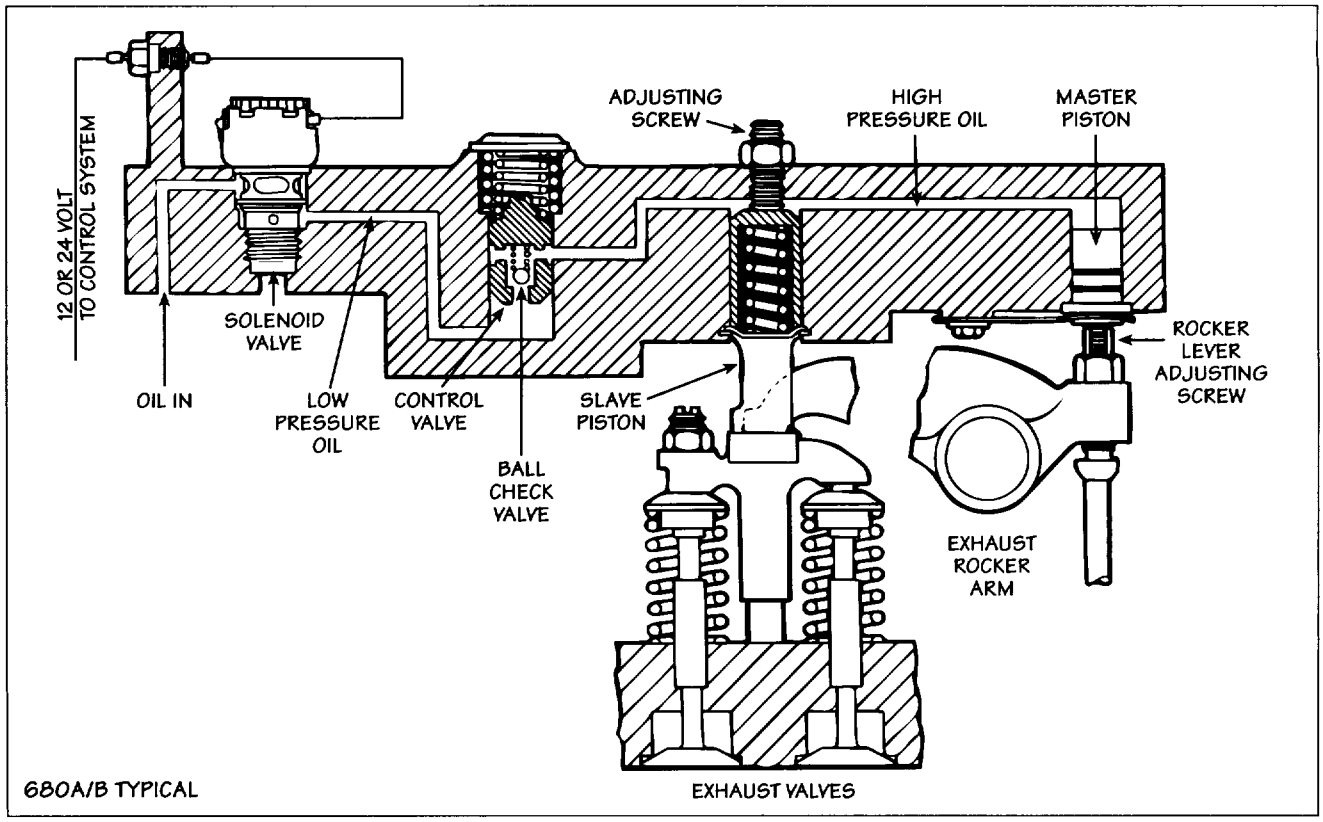



FIG. 3

# Overview

The blowdown of compressed air to atmospheric pressure prevents the return of energy to the engine piston on the expansion stroke, the effect being 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 pushrod motion of an exhaust valve of another cylinder during its normal exhaust cycle as follows:

1. Energizing the 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 corresponding exhaust rocker arm adjusting screw.

3. The exhaust rocker pushrod begins upward travel (as in normal exhaust cycle), forcing the master piston upward and directing high pressure oil to the slave piston of the braking cylinder. The ball check in the control valve traps high pressure oil in the master/slave piston circuit.

4. The slave piston (under the influence of the high pressure oil) moves down, momentarily opening the exhaust valves while the engine piston is near its top dead center position, releasing compressed cylinder air to the exhaust manifold.

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

The level of engine braking is controlled by using the solenoid to turn each housing ON or OFF. Figure 4 shows the relationships between master pistons, slave pistons and control valves within the housing.

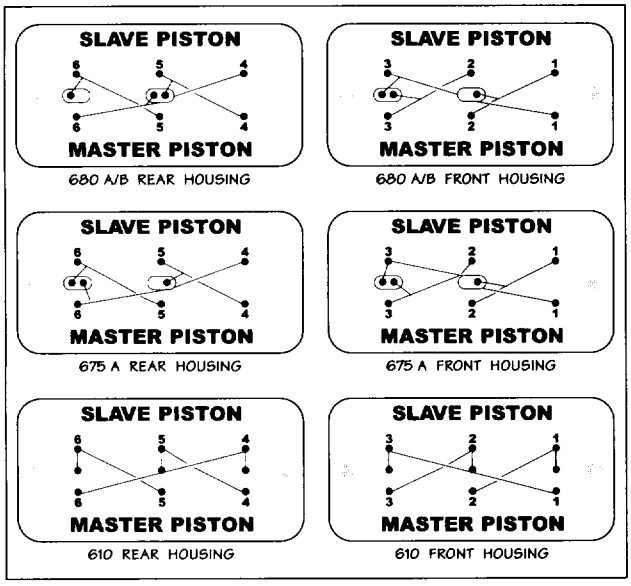



FIG. 4

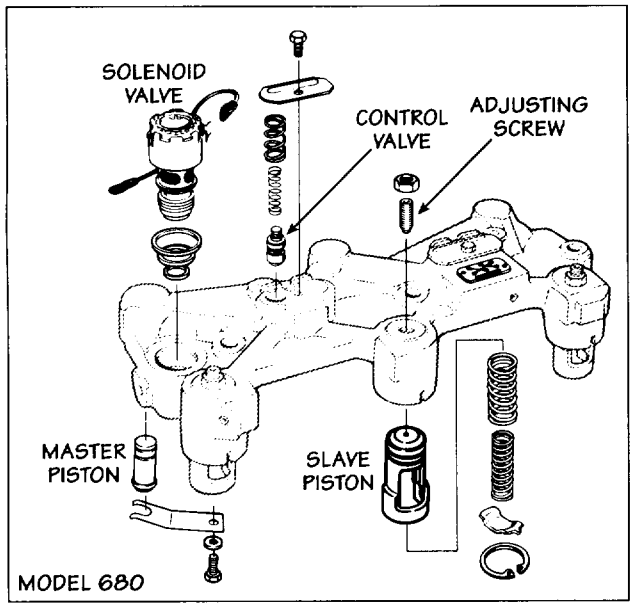



FIG. 5

# Components (Fig. 5)

### Solenoid Valve

An electrically operated valve that, when activated, permits engine oil to flow into the engine brake housing. When deactivated, shuts off supply of engine oil and provides a means for exhausting the pressure from the housing (see Table 6 for electrical specifications).

### Control Valve

Controls the flow of oil within the brake housing. Prevents the pressure that is developed in the master/slave piston circuit from feeding back into the engine oil supply.

### Master Piston

Follows motion of the exhaust camshaft pushrod, thereby forcing high pressure oil to the slave piston. A master piston spring returns the master piston to the housing when engine braking is terminated.

### Slave Piston

High pressure oil from the master piston moves the slave piston down, opening the exhaust valves near top dead center of the compression stroke. This allows the compressed air to escape to the atmosphere. A slave piston spring returns the slave piston to its starting position.

### Slave Piston Adjusting Screw

Provides a means for adjusting clearance between the slave piston and exhaust valve yoke. These screws incorporate a plunger that rides on top of the slave piston. The plunger uncovers a hole that bleeds off pressure, thereby limiting the total travel of the slave piston.

### Exhaust Rocker Lever Adjusting Screw

With brake on, makes contact with the master piston.

### Oil Supply Screw

Installed in the rocker brackets to supply engine oil to the engine brake solenoid (not illustrated).

# Section 3: Operational Tests

Before beginning the troubleshooting procedures, try to determine the exact nature of the problem. Talk to the driver, owner and/or mechanic to try and pinpoint the complaint or problem. The following list of checks may be helpful in trying to determine the nature of the problem.

## Before Starting the Engine

If there is a report of engine or engine brake noise, remove the engine covers to determine the cause.

1. Check for broken or loose parts.
2. Check valve and engine brake lash settings.
3. Check for possible bent valves or push tubes.

Possible causes of bent valves or push tubes could be:

- Engine overspeeding, usually several valves are affected
- One bent exhaust valve or push tube indicates a possible problem with a stuck slave piston, damaged slave piston adjusting screw (safety valve) or excessive oil pressure. See Table 8 for oil pressure requirements. A bent exhaust valve may be caused by the valve stem stuck in its guide, bad yoke adjustment, or broken or weak valve springs.

## Test Drive

1. Test drive the vehicle and measure intake manifold boost pressure with the engine brake operating.

   **NOTE:**
   IF THE VEHICLE DOES NOT HAVE A BOOST PRESSURE GAGE, ONE MUST BE INSTALLED. A PIPE FITTING IS LOCATED BETWEEN THE TURBO AND THE INTAKE MANIFOLD FOR THIS PURPOSE.

2. It is best to test with a loaded vehicle, engine at maximum rated RPM and the engine brake ON. Downhill operation is desirable to stabilize RPM.
3. Record the maximum boost pressure with both housings (HI position).
4. Record the boost pressure with the switch in the "LO" position.

**TABLE 1: RETARDING BOOST PRESSURE (PSI)**
**MACK E5 ENGINE**
**SCHWITZER S-300 TURBO**

| RPM | BOOST (PSI) |
|---|---|
| 2100 | 16 |
| 1900 | 14 |
| 1700 | 11 |
| 1500 | 9 |
| 1300 | 6 |
| 1100 | 4 |

**MODEL 610**

**TABLE 2: RETARDING BOOST PRESSURE (PSI)**
**MACK E6 ENGINE**
**2 VALVES PER CYLINDER**

| MAX BOOST (PSI) 2100 RPM | TURBO MODEL | ENGINE |
|---|---|---|
| 9 | HR0702 | ENDT 676 |
| 9 | B10406 | ENDT 675 |
| 8 | SCHWITZER 4LF | E6-350 |
| 11 | HR 0702 | EM6-285* |
| 10 | MACK 631G | EM6-237 |
| 11 | AIRESEARCH IK 761 | EM6-285* |
| 3 | AIRESEARCH TV 7701 | E6-350 |

*With tip turbine fan cut off

**MODEL 675 & 675A**

**TABLE 3: RETARDING BOOST PRESSURE (PSI)**
**MACK E6 ENGINE**
**4 VALVES PER CYLINDER**

| RPM | BOOST (PSI) |
|---|---|
| 2100 | 13 |
| 1900 | 12 |
| 1700 | 11 |
| 1500 | 9 |
| 1300 | 7 |
| 1100 | 5 |

**MODEL 680A**

**TABLE 4: RETARDING BOOST PRESSURE (PSI)**
**MACK E7 ENGINE**
**S-300 & S-400 TURBO CHARGER**

| RPM | EM7-250 275-300 | E7-300 325-350 | E7-375 400 |
|---|---|---|---|
| 2100 | 18 | 16 | 15 |
| 1900 | 17 | 15 | 14 |
| 1700 | 14 | 12 | 11 |
| 1500 | 10 | 9 | 8 |
| 1300 | 6 | 6 | 6 |
| 1100 | 4 | 4 | 3 |

**MODEL 680B**

**TABLE 5: RETARDING BOOST PRESSURE (PSI)**
**MACK E7 ENGINE**
**S3B & S4D TURBO CHARGER**

| RPM | EM7-250/275 300 HP | 300/325/350 375/400 HP | 427/454 HP |
|---|---|---|---|
| 2100 | 13 | 10 | 9 |
| 1900 | 12 | 9 | 8 |
| 1700 | 10 | 8 | 7 |
| 1500 | 8 | 6 | 5 |
| 1300 | 6 | 4 | 4 |
| 1100 | 4 | 3 | 3 |

**MODEL 680B**

**NOTE:**
LO POSITION MAY BE EITHER FRONT OR REAR HOUSING.

5. Disconnect the LO position harness to the solenoid and rerun the test with the switch in the "HI" position. Record the results.

**NOTE:**
THE INDIVIDUAL HOUSING READINGS WILL NOT BE 1/2 OF THE MAXIMUM BOOST PRESSURE READING DUE TO THE EFFECT OF THE TURBOCHARGER. THE INDIVIDUAL BOOST PRESSURE READINGS, HOWEVER, SHOULD BE APPROXIMATELY THE SAME.

6. A significantly lower reading in one housing indicates a possible problem with the housing. Compare the maximum boost pressure with the boost pressures in Tables 1-5. A low reading indicates a possible problem. Readings within 3 psi of the values shown indicate proper operation of the engine brake.

# Section 4: Electrical Troubleshooting

### No Engine Brake Operation

1. Check for blown fuse or circuit breaker.

2. With electrical power OFF, check the control system for a short to ground. Check systems separately to isolate the short. If the control system is OK up to the engine brake spacer connection, measure the resistance to the solenoid valve. High resistance means an open circuit in the solenoid or solenoid wire.

> **NOTE:**
> IF AN OPTIONAL LOW-SPEED SHUT-OFF DEVICE IS INCORPORATED, IT MUST BE BYPASSED FOR THESE CHECKS. REFER TO THE SPECIFIC LOW-SPEED INSTALLATION OR TROUBLESHOOTING DOCUMENTS FOR PROCEDURES.

If the report is no engine braking but some noise when the engine brake is ON, the brake housings may be reversed, front and rear. Nameplates on the housings identify front and rear.

> **NOTE:**
> NO DAMAGE WILL OCCUR IF THE HOUSINGS ARE REVERSED, BUT THERE WILL BE SOME NOISE AND NO ENGINE BRAKING.

### Only One Housing Operating

1. Determine which housing is not operating by closing all the switches and checking the power at the wires leading to the solenoid valves (front and rear).

2. Remove the wire to the solenoid valve at the spacer and check for resistance. Compare measured resistance to the values listed in Table 6. No reading indicates an open circuit in the wire or solenoid coil. A low resistance indicates a short to the ground either in the solenoid wire or solenoid coil.

### Intermittent Braking

1. Inspect all wiring for loose connections and all switches for proper adjustment.

### Poor Performance

Connect a trouble light to the electrical connector on the spacer. Verify that the light is on steady when the engine brake is active. If light does not come on or flickers during operation, check for loose connections or faulty switches. Repeat for all spacer terminals.

### TABLE 6: SOLENOID ELECTRICAL SPECIFICATIONS

| Solenoid Specifications | | | | | | |
|---|---|---|---|---|---|---|
| | | RESISTANCE (OHMS) | | CURRENT DRAW (AMPS) | | PULL IN (VOLTS) |
| P/N | VOLTAGE | COLD | HOT | COLD | HOT | MINIMUM |
| 16440 | 12 V S/L | 9.62 to 10.75 | 11.8 to 14.3 | 0.84 to 1.66 | 0.63 to 1.36 | 9 |
| 16442 | 24 V D/L | 31.5 to 38.5 | 38.2 to 50.0 | 0.47 to 0.89 | 0.36 to 0.73 | 21 |
| 20235 | 24 V D/L | 32.6 to 39.8 | 34.0 to 60.0 | 0.45 to 0.86 | 0.30 to 0.82 | 21 |
| 20239 | 12 V S/L | 8.7 to 10.0 | 9.0 to 14.0 | 0.9 to1.84 | 0.64 to 1.78 | 9 |
| 21252 | 12 V S/L | 8.7 to 10.0 | 9.0 to 14.0 | 0.90 to 1.84 | 0.64 to 1.78 | 9 |
| 21253 | 24 V D/L | 32.6 to 39.8 | 34.0 to 60.0 | 0.45 to 0.86 | 0.30 to 0.82 | 21 |

**D/L=DUAL LEAD**
**S/L=SINGLE LEAD**

# Section 5: Hydraulic/Mechanical Troubleshooting

Remove the covers to begin inspecting the brake housings and attendant hardware.

1. Visually inspect parts for obvious damage or missing parts. Replace as necessary.

   **NOTE:**
   IF THE COMPLAINT IS NO BRAKING, CHECK TO BE SURE THE HOUSINGS ARE INSTALLED CORRECTLY — FRONT ON CYLINDERS 1, 2 AND 3 AND REAR ON CYLINDERS 4, 5 AND 6. NAME TAGS ON THE HOUSINGS IDENTIFY FRONT AND REAR. BE SURE THE HOUSINGS ARE INSTALLED IN THE CORRECT POSITION.

2. Check the slave piston to exhaust valve yoke or valve cap for proper clearance. Correct clearance settings are given in Table 7. Also check the intake and exhaust valve clearance. Readjust if necessary.

   **NOTE:**
   EXCESSIVE EXHAUST VALVE CLEARANCE INDICATES POSSIBLE EXHAUST CAMSHAFT WEAR. CHECK AND REPAIR FOLLOWING MACK TRUCK MAINTENANCE INSTRUCTIONS.

   **⚠ WARNING**

   WEAR EYE PROTECTION AND DO NOT EXPOSE YOUR FACE OVER THE ENGINE AREA. KEEP HANDS AWAY FROM MOVING PARTS. TAKE PRECAUTIONS TO PREVENT OIL LEAKAGE DOWN ONTO THE ENGINE.

   WHENEVER ENGINE IS RUNNING AND THE CYLINDER HEAD COVERS ARE REMOVED, OIL SPLASHING IN THE ENGINE BRAKE AREA COULD CAUSE PERSONAL INJURY.

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

   **NOTE:**
   SLAVE PISTON CLEARANCE SETTINGS MUST BE MADE WITH THE ENGINE STOPPED AND COLD AND WITH THE EXHAUST VALVES CLOSED.

Adjust following the firing order: 1, 5, 3, 6, 2, 4.

**TABLE 7: Slave Piston Clearance Settings**

| Engine | Engine Brake Model | Adjustment | Slave Piston Adjusting Tool |
|---|---|---|---|
| '96 E7 with S300 or S400 Turbo | 680B | 0.060" (1.52 mm) | 022001 |
| '96 E7 with S3B or S4D Turbo | 680B | 0.080" (2.03 mm) | 018781 020521 |
| '91 - '95 E7 | 680B | 0.080" (2.03 mm) | 018781 020521 |
| Pre '91 E7 | 680B | 0.085" (2.16 mm) | 014177 |
| Pre 91-E6 4 Valve Head | 680A | 0.085" (2.16 mm) | 014177 |
| E6 2 Valve Head | 675 | 0.030" (0.760 mm) | 011355 |
| E6 2 Valve Head | 675A | 0.030" (0.760 mm) | 011355 |
| E5 | 610 | 0.080" (2.03 mm) | 020521 |

FIG. 12

3. Start engine and allow to idle for a few minutes. Check for oil leakage at the oil supply screw, solenoid valve and housing pipe plugs. Oil leakage can result in weak, intermittent or no braking. If leakage is found, replace seals or repair as needed with the engine shut down.

   Notice if oil is coming out at the bottom of the slave piston. If so, the plunger in the slave piston adjusting screws should be checked for wear or damage. If necessary, replace the screw assembly when the engine is shut down.

4. When the engine is shut down for several minutes, the oil in the brake housings will bleed down. To refill the brake housings for immediate operation, depress solenoid cap (pin) several times to fill the housing with engine oil.

   **NOTES:**
   THE ENGINE BRAKE REQUIRES A MINIMUM OIL PRESSURE TO OPERATE. TO DETERMINE THE OIL PRESSURE AT THE ENGINE BRAKE HOUSING SOLENOID VALVES, USE THE JACOBS OIL PRESSURE TEST KIT AND FOLLOW THE INSTRUCTIONS INCLUDED IN THE KIT. SEE TABLE 8 FOR OIL PRESSURE REQUIREMENTS

   IF THE OIL PRESSURE IS NOT AS SHOWN FOR THE SPECIFIC MODEL AT IDLE, RUN THE ENGINE AT HIGHER RPM (800-900) WHEN TROUBLE SHOOTING THE BRAKE.

   HIGHER PRESSURES THAN OVER-PRESSURE PSI RATING WILL CAUSE THE BRAKE TO SHUT OFF. REFER TO TABLE 8 FOR MAXIMUM ALLOWABLE OIL PRESSURE FOR SPECIFIC ENGINE BRAKE MODELS.

5. With the engine brake on, notice the master pistons moving out of the housing and making contact with the exhaust rocker adjusting screws. They should move in and out freely. If they do not, with the engine shut down, check the control valves and control valve springs for those cylinders.

**TABLE 8: OIL PRESSURE REQUIREMENTS**

| BRAKE MODEL | FULL FLOW PSI | BAR | OVER PRESSURE PSI | BAR |
|---|---|---|---|---|
| 680A | 35-90 | 2.4-6.1 | 110 | 6.9 |
| 680B | 25-85 | 1.8-5.8 | 90 | 6.2 |
| 675A | 16-78 | 1.1-5.3 | 100 | 6.9 |
| 610 | 25-65 | 1.7-4.4 | 116 | 8.0 |

Refer to Fig. 4 to identify the control valve, master piston and slave piston relationship.

**⚠ WARNING**

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

The control valve must move freely in the bore. If not, remove it and replace with a new control valve.

**NOTE:**
IF THE BORE IS DAMAGED (SCORED), USE A LIGHT CROCUS CLOTH TO SMOOTH THE BORE. CLEAN THE BORE AND INSTALL A NEW CONTROL VALVE. IF SEVERE DAMAGE TO THE BORE IS FOUND, REPLACE THE HOUSING.

Replace any broken springs.

6. If the control valves and springs are OK and the master and slave pistons did not operate, remove the housings for inspection.

   Visually inspect the following:

   Master piston springs — if broken or worn, replace.

   Master pistons — must move freely in the bore. Check the hard facing on the master piston for damage — this is the area that contacts the rocker adjusting screw.

   Adjusting screw — check the hex head for excessive wear. If a depression of 0.005" or deeper is found in the top of the hex head or if the pattern of "wipe" extends beyond the hex, replace the adjusting screw. Also replace the companion master piston. The spherical end should be checked for proper contour and smooth appearance. Replace if necessary.

   Oil supply screws — check for damage and replace if necessary. Install new seals.

7. Exhaust valve yokes (680A & B) caps (675A, 610) — inspect for wear. A shiny area will be seen on the top surface where the slave piston contacts the yoke/cap. This area should be less than 0.005" deep. Replace if necessary. Note that 680 slave piston contact is offset on yoke.

8. Slave piston adjusting screw — remove and inspect. A spring-loaded plunger located at the bottom of the screw seals the hole in the slave piston to provide proper master/slave operation. Over pressure or a stuck slave piston will cause the hole in the slave piston to be uncovered, dumping oil pressure and shutting down the circuit. See Table 8 for pressure requirements. This prevents overtravel of the slave piston and exhaust valve to engine piston contact.

**NOTES:**
SCREW ASSEMBLIES ARE NOT FIELD SERVICEABLE.

9. Remove the slave pistons using the following procedure.

**⚠ 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.

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

Place the hole in the slave piston clamp fixture over the slave piston adjusting screw. See Figure 6. Replace locknut. Finger tighten to hold fixture securely.

FIG. 6

While holding the fixture in position, screw the holder down over the slave piston until the spring retainer is contacted.

Turn the handle slowly until the retainer is depressed to about 1/32" (1 mm), relieving pressure against the retaining ring.

Remove the retaining ring using retaining ring pliers (see Fig. 7). Back out the holder until the springs are loose. Remove the fixture.

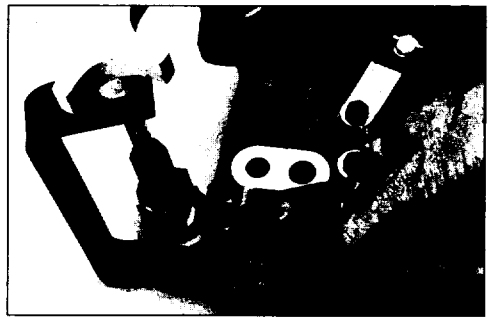


FIG. 7

Remove all components, ensuring there is no binding or burrs (see Fig. 8). Clean in an approved cleaning solvent. Inspect parts and replace as necessary.

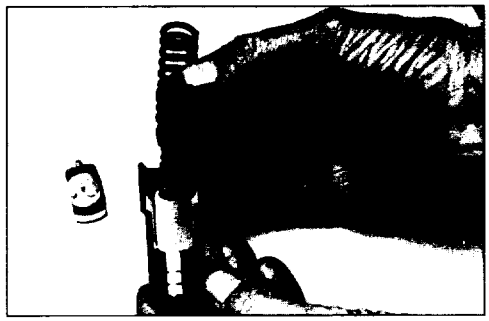


FIG. 8

**NOTES:**
BE SURE COMPONENTS ARE REASSEMBLED IN PROPER ORDER.

THE RETAINER MUST BE INSTALLED WITH THE KEY THROUGH THE SLOT IN THE SLAVE PISTON. INSTALL THE SLAVE PISTON WITH THE OPEN AREA TOWARD THE CENTER OF THE HOUSING. THE OPEN AREA OF THE SLAVE PISTON IS FOR ROCKER ARM CLEARANCE (SEE FIG. 9).

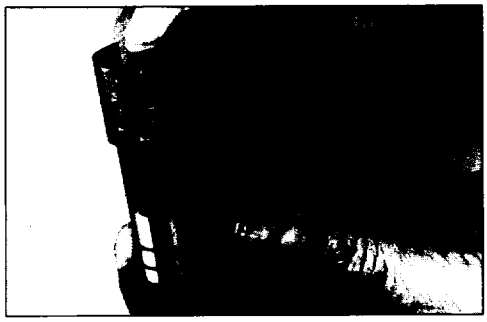


FIG. 9

A shiny, smooth contact surface on the plunger and slave piston is normal. If a rough surface exists on the plunger and/or slave piston, replace the parts. There should be a light spring force on the plunger. If not, replace the screw assembly.

Use the clamp fixture to reinstall the piston and springs. Be sure the retaining rings are placed on the retainer before screwing the clamp-holder down.

Compress the slave piston springs down until the retainer is about 1/32" (1 mm) below the retaining ring groove. Reinstall the retaining ring. Be sure the retaining ring is fully seated in the groove.

Rotate the retaining ring ears 90° counter-clockwise from the large rocker arm clearance gap (A) in the housing (see Fig. 10).

Remove the clamp fixture slowly to ensure proper seating of retaining ring.

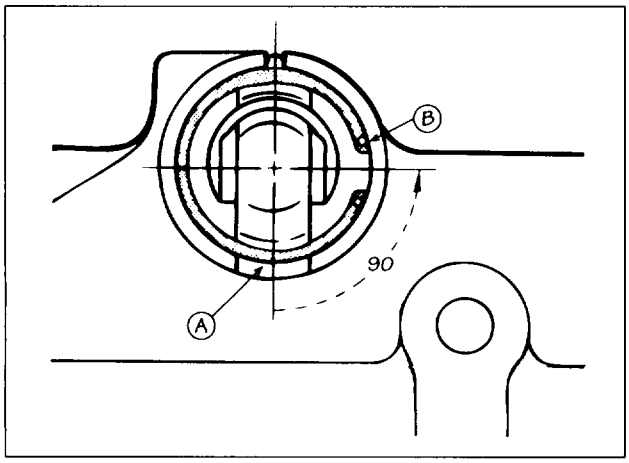



*FIG. 10*

**⚠ CAUTION**

MAKE SURE THE RETAINING RING IS POSITIONED AS SHOWN IN B, FIG. 10. FAILURE TO DO SO MAY RESULT IN ENGINE AND ENGINE BRAKE DAMAGE.

# Section 6: Final Test

Follow the instructions in the installation manual to reassemble the housings. Install a new oil supply seal ring.

Install the housings on the engine and adjust the slave piston clearance to proper settings shown in Table 7.

> **NOTE:**
> BE SURE TO INSTALL THE HOUSINGS CORRECTLY, FRONT ON CYLINDERS 1, 2 AND 3, AND REAR ON CYLINDERS 4, 5 AND 6.

Before installing the engine covers, start the engine and allow to warm up for a few minutes.

Depress the solenoid valve several times to fill the housing with engine oil.

> **NOTE:**
> ENGINE BRAKES REQUIRE A MINIMUM OIL PRESSURE FOR OPERATION. IF THERE IS LESS THAN MINIMUM. AT IDLE, RUN THE ENGINE AT HIGHER RPM (800-900) WHEN MAKING CHECKS. SEE TABLE 8 FOR OIL PRESSURE REQUIREMENTS.

Check for oil leaks at the oil supply screw, solenoid valve and housing pipe plugs. If leakage is noticed, shut down the engine and repair.

> **NOTE:**
> SOME LEAKAGE WILL BE SEEN AT THE MASTER PISTON, SLAVE PISTON AND CONTROL VALVES. THIS IS NORMAL. EXCESSIVE LEAKAGE MUST BE INVESTIGATED (SEE SECTION 5).

After final inspection and necessary repair, shut down the engine and replace the gaskets and covers.

Test drive the vehicle following the procedures in Section 3 to verify corrective action.

# Section 7: Cause and Effect Guide

## Problem: Engine fails to start

**Possible Cause: Solenoid valve stuck in "on" position.**

**Correction:** Ensure that electrical current is off to engine brakes. If solenoid valve remains "on" (cap down) with current off, replace solenoid valve.

## Problem: Engine Brake will not operate

**Possible Cause: Blown fuse, open electrical leads.**

**Correction:** Look for short circuit in wiring. Replace any broken, brittle or chafed wires. Check solenoid tab for signs of shorting; replace if necessary. Replace fuse (10 amp).

**Possible Cause: On/Off switch, clutch switch, throttle switch or multi-position switch out of adjustment or defective.**

**Correction:** Use a volt/ohm meter to make certain that there is electrical voltage available at both terminals of each switch. Readjust if needed or replace if voltage will not pass through switch.

⚠ WARNING

DO NOT TOUCH ELECTRICAL CONNECTION WHEN SYSTEM IS ENERGIZED.

**Possible Cause: Incorrect electrical power source.**

**Correction:** Check that the supply voltage is the appropriate voltage. Recommended power source is from the key switch "on" position. Ensure that power is not taken from a source with an additional on/off switch, i.e., light switch. See solenoid specifications Table 6. Make sure wiring is in accordance with Mack/Renault V.I. wiring instructions.

**Possible Cause: Low engine oil pressure.**

**Correction:** Determine oil pressure at engine brakes (Solenoid valve and Control Valve). See oil pressure requirements Table 8. If oil pressure is below specifications, engine should be repaired in accordance with manufacturers' procedures.

## Problem: Engine Brake activates with switches open (off)

**Possible Cause: Center solenoid valve seal ring damaged.**

**Correction:** Remove solenoid. Replace all seal rings.

**Possible Cause: Engine brake improperly wired.**

**Correction:** Check wiring in accordance with Mack/ Renault V.I. wiring diagrams.

## Problem: Engine Brake slow to operate or weak in effect

**Possible Cause: Lube oil cold and thick.**

**Correction:** Allow engine to warm before operating brakes.

**Possible Cause: Improper slave piston adjustment or slave piston binding in bore.**

**Correction:** Readjust in accordance with Jacobs procedures for model brake in question. Ensure that slave piston responds smoothly to the adjusting screw by loosening jam nut and screwing the screw through its full travel for full slave piston motion. Make sure piston travels full range without binding or sticking.

⚠ WARNING

REMOVE SLAVE PISTON CAREFULLY WHEN DISASSEMBLY IS NECESSARY. USE JACOBS SLAVE PISTON TOOL P/N 00-018238. SLAVE PISTON SPRINGS ARE UNDER HEAVY COMPRESSION.

**Possible Cause: Lower solenoid seal damaged, allowing oil to exit the housing.**

**Correction:** Remove solenoid valve and replace all seal rings.

**Possible Cause: Solenoid screen clogged stopping supply of oil to brake.**

**Correction:** Remove solenoid valve and clean or replace screen.

**Possible Cause: Master piston not moving in bore.**

**Correction:** Inspect master piston and bore for scoring or burrs. If any present, clean surface with crocus cloth. If unable to remove burrs, replace piston or housing. Inspect lube oil for signs of contaminants. If any are present, replace oil and filter and correct cause of contamination.

**Possible Cause: Control valves binding in housing bore.**

**Correction:** Remove control valve. If body is scored, replace control valve. Check for contaminants in lube oil. Clean housing and control valve. If binding continues, replace housing.

**Possible Cause: Control valve defective.**

**Correction:** Remove control valve. Make sure check ball is seated in bore and can be moved off seat. Make sure there is spring pressure against ball. Flush in cleaning solvent. Replace if necessary.

**Possible Cause: Switch operation sluggish. Check dash switches, clutch switch, throttle switch, or other control switches.**

**Correction:** Readjust or replace switch. Check throttle or clutch return springs for proper operation. Check all controls for correct operation, replace as required.

**Possible Cause: Solenoid Valve operation erratic.**

**Correction:** Check solenoid valve using electrical specifications explained in Table 6, with key on, brake switches on, and engine off, activate solenoid electrically. Ensure solenoid cap depresses.

⚠ WARNING

DO NOT TOUCH ELECTRICAL CONNECTION WHEN SYSTEM IS ENERGIZED.

**Possible Cause: Outer control valve spring broken, or engine oil pressure extremely high (see Section 1.2).**

**Correction:** Outer control valve spring broken allowing control valve to over-index. Problem is engine lube system. Consult appropriate engine repair manual for causes of high lube oil pressure.

## Problem: Oil pressure dropping below minimum required for engine brake operation.

**Possible Cause: Upper solenoid seal ring damaged.**

**Correction:** Remove solenoid. Inspect seal ring and replace all seal rings.

**Possible Cause: Damaged oil supply seals under housings.**

**Correction:** Remove housing and replace seals.

**Possible Cause: Aeration of lubricating oil.**

**Correction:** Check for aeration of the oil. Activate, then deactivate engine brake. Watch escape oil coming from control valve cover. If oil has bubbles or is foamy, air is present in system. Aeration can be caused by an overfilled or underfilled crankcase, crack in oil pickup tube or leaks in oil suction tube or hose. Correct in accordance with manufacturer's procedures.

**Possible Cause: Lubricating oil being diluted by fuel oil.**

**Correction:** Have an oil analysis of lube oil to determine if fuel is present. Correct per engine manufacturer's procedures.

**Possible Cause: Low engine oil level.**

**Correction:** Consult engine manual for specifications. Add oil or re-calibrate dipstick as required.

**Possible Cause: Worn engine rocker level bushings.**

**Correction:** Replace bushings in accordance with engine manufacturer's procedures.

**Possible Cause: Oil leaking from around cylinder head.**

**Correction:** Repair causes of leaks.

**Possible Cause: Restrictions in the oil passages leading to engine brake.**

**Correction:** Inspect all the passageways, remove any items restricting oil flow.

## Problem: One or more cylinders fail to stop braking or engine stalls.

**Probable Cause: Control valve inner spring broken.**

**Correction:** Replace inner spring.

**Probable Cause: One or more control valves stuck in "on" or up position.**

**Correction:** Check control valves for binding. Remove and clean or replace if necessary. Inspect lube oil for contaminates.

**Probable Causes: Solenoid valve sticking in "on" position.**

**Correction:** If solenoid valve cap remains down with no electric current being supplied, replace solenoid valve.

**Probable Cause: Center solenoid seal ring damaged. Allows oil to enter brake with solenoid valve closed.**

**Correction:** Remove solenoid and replace all seal rings.

**Probable Cause: Solenoid valve exhaust plugged.**

**Correction:** Remove any restrictions at exhaust (bottom) of solenoid valve.

**Probable Cause: Clutch switch or throttle switch stuck in "on" position or out of adjustment.**

**Correction:** Check for proper operation. Readjust or replace as needed.

## Problem: Engine misses or loses power.

**Probable Cause: Slave piston adjustment too tight.**

**Correction:** Readjust slave piston clearance in accordance with Table 7.

## Problem: Sudden drop in engine lube oil pressure.

**Probable Cause: Upper solenoid valve seal missing or damaged.**

**Correction:** Remove solenoid and replace upper seal ring.

# Notes

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