SECTION 01: ENGINE

CONTENTS

LIST OF ILLUSTRATIONS

1. ENGINE

1.1 Description

This vehicle is powered by a 6-cylinder, four-cycle, Detroit Diesel series 60 engine, equipped with an electronic control system (DDEC III). Two volumes of charge are used in the engine: 11 liters or 12.7 liters. Summary information on the Electronic Control System is given in this section. Complete maintenance and repair information on the engine will be found in the current DDEC III Service Manual #6SE483. Engine controls, accessories and related components are covered in the applicable sections of this maintenance manual. Engine removal and installation procedures are given at the end of this section. The DDEC system is self-diagnostic. It can identify faulty components and other engine-related problems by providing the technician with a diagnostic code. Refer to DDEC Troubleshooting Guide # 6SE492 for more complete information on diagnosis of components and system problems published by Detroit Diesel.

DDEC III (**D**etroit **D**iesel **E**lectronic **C**ontrol) controls the timing and amount of fuel injection by the electronic unit injectors (EUI). The system also monitors several engine functions using electrical sensors which send electrical signals to the Electronic Control Module (ECM). The ECM computes the electrical signals and determines the correct fuel output and timing for optimum power, fuel economy and emissions. The ECM also has the ability to display warnings or shut down the engine completely (depending on option selection) in the event of damaging engine conditions, such as low oil pressure, low coolant, or high oil temperature.

The system components are divided in two categories: engine-mounted components and engine-related components.

2. ENGINE-MOUNTED COMPONENTS

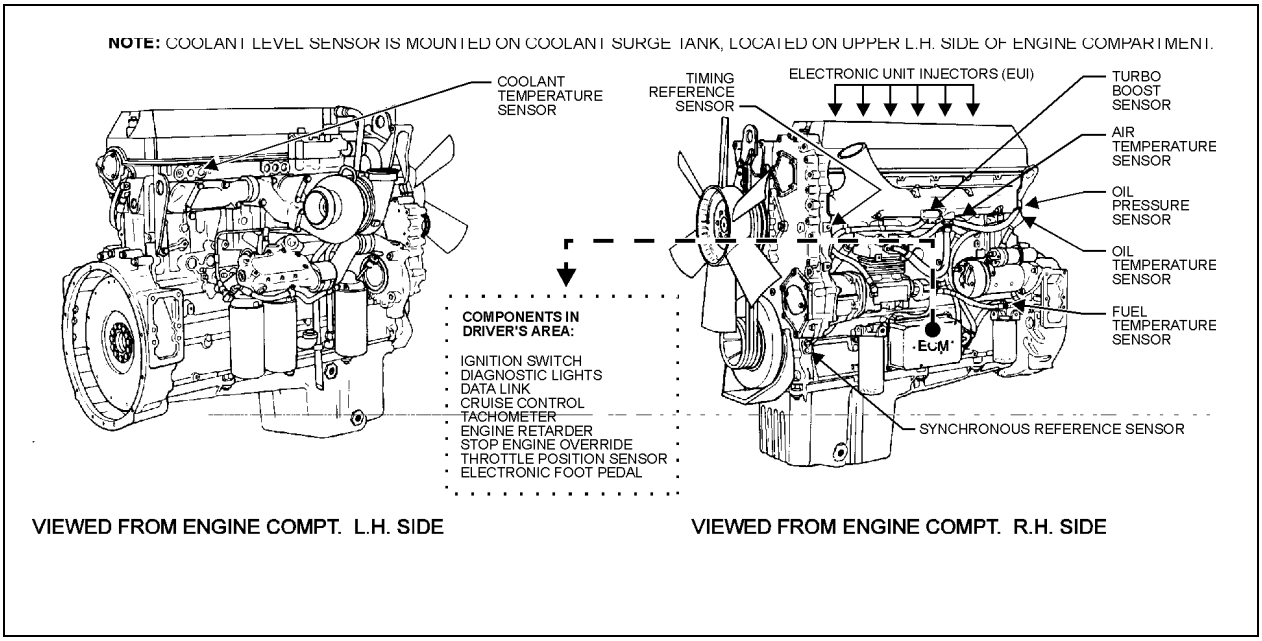

FIGURE 1: DETROIT DIESEL SERIES 60 ENGINE 01015

Engine-mounted components are as follows:

- Electronic Control Module
- Electronic Unit Injector
- Synchronous Reference Sensor
- Timing Reference Sensor
- Turbo Boost Pressure Sensor
- Coolant Temperature Sensor
- Fuel Temperature Sensor
- Air Temperature Sensor
- Oil Pressure Sensor
- Oil Temperature Sensor

2.1 Electronic Control Module

The Electronic Control Module is mounted, on the starter side of the engine (Fig. 2). It is considered the *"Brain"* of the DDEC III system because it provides overall monitoring and control of the engine by comparing input data from the various sensors to a set of calibration data stored in the EEPROM (**E**lectrically **E**rasable, **P**rogrammable, **R**ead-**O**nly **M**emory) within the Electronic Control Module. After comparing the input data with the calibrations data, the ECM sends high current command pulses to the Electronic Unit Injectors (EUI) to initiate fuel injection. The ECM also receives feedback regarding the start and end of injection for a given cylinder.

The EEPROM within the Electronic Control Module is factory programmed by Detroit Diesel. Reprogramming must be done at a Detroit Diesel authorized service center. However, some changes may be performed to the cruise control and road speed limit using a diagnostic data reader (see paragraph "4. DDEC III Diagnostic Codes" in this section).

01018

FIGURE 2: ELECTRONIC CONTROL MODULE (ECM)

2.2 Electronic Unit Injector

The Electronic Unit Injector is a compact unit that injects diesel fuel directly into the combustion chamber (Fig. 3). The amount of fuel injected and beginning of injection timing is determined by the Electronic Control Module (ECM). The ECM sends a command pulse which activates the injector solenoid. The EUI performs four functions:

- Creates the high-fuel pressure required for efficient injection
- Meters and injects the exact amount of fuel required to handle the load
- Atomizes the fuel for mixing with the air in the combustion chamber
- Permits continuous fuel flow for component cooling

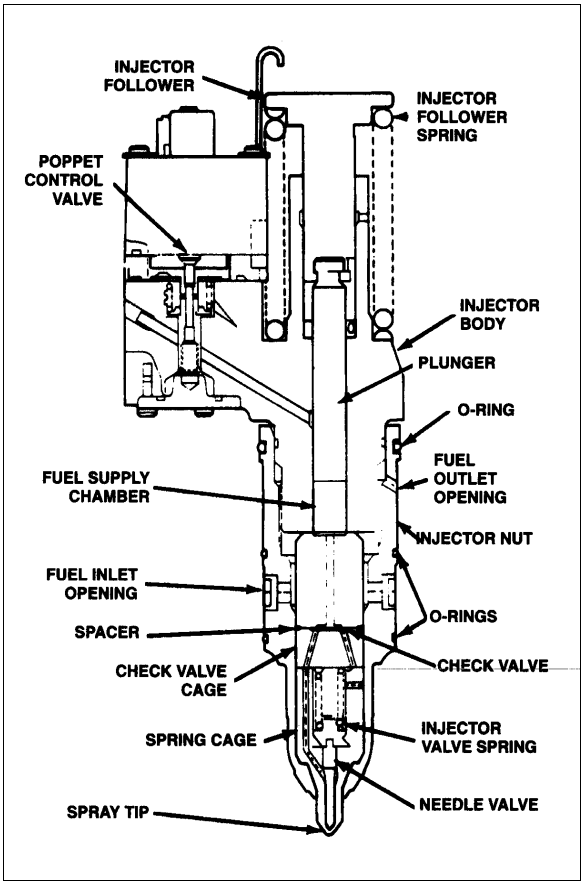

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FIGURE 3: ELECTRONIC UNIT INJECTOR CROSS-SECTION

2.3 Synchronous Reference Sensor

The Synchronous Reference Sensor (SRS) is an electronic component that is mounted to the rear of the gear case (Fig. 4). The SRS sensor extends through a hole in the gear case and is positioned near the rear of the bull gear. A bolt, inserted through a hole in the SRS bracket, secures the SRS assembly to the gear case. The SRS connector is black. The SRS sends a signal to the ECM. This signal is generated by a raised metal pin on the rear of the bull gear (Fig. 5).

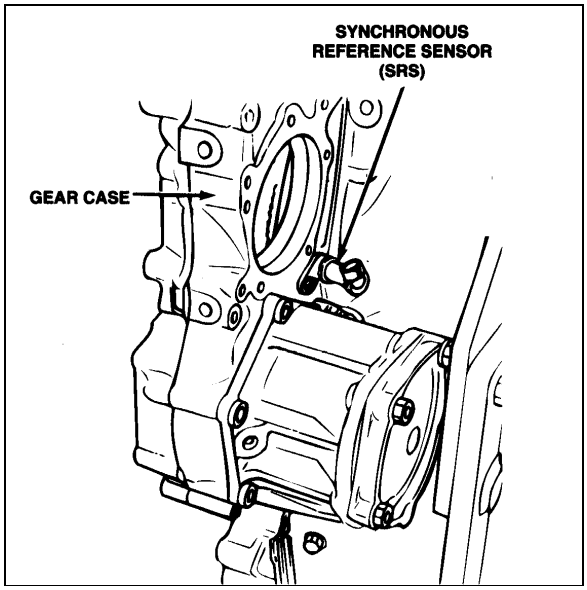

FIGURE 4: SRS LOCATION 01020

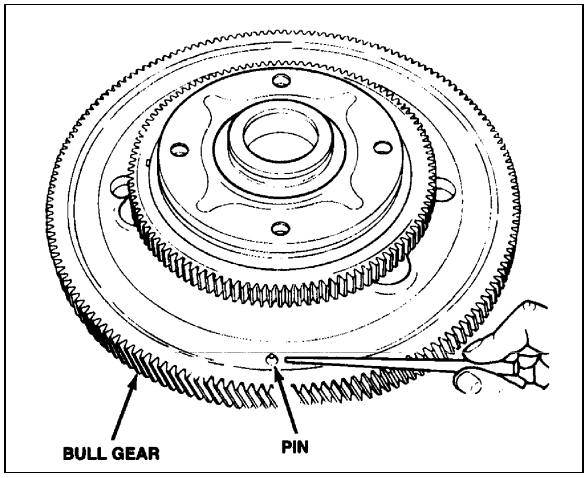

FIGURE 5: BULL GEAR 01021

The bull gear pin passes by the SRS as the number one piston reaches 45° before Top-Dead-Center. This information is used by the ECM to determine engine speed.

The SRS is non-serviceable and must be replaced as a unit. No adjustment is required.

2.4 Timing Reference Sensor

The Timing Reference Sensor (TRS) is an electronic component that is mounted on the left side of the gear case, near the crankshaft center line (Fig. 6).

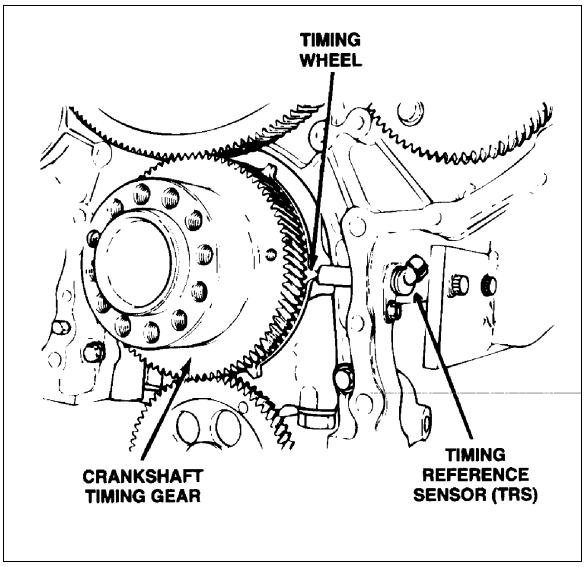

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FIGURE 6: TIMING REFERENCE SENSOR AND RELATED PARTS

The TRS sensor extends through an opening in the gear case and is positioned near the timing wheel gear teeth. A bolt, inserted through a hole in the TRS bracket, secures the TRS assembly to the gear case. The TRS connector is gray.

The TRS sensor sends a signal to the ECM. This is generated by a series of evenly spaced teeth on the timing wheel, rotating by the crankshaft. A tooth passes by the TRS as each cylinder reaches 10° before Top-Dead-Center. These signals are used by the ECM to determine injector solenoid operation time. The TRS is non-serviceable and must be replaced as a unit. No adjustment is required.

2.5 Turbo Boost Pressure Sensor

The Turbo Boost Pressure Sensor is mounted to the intake manifold with two bolts. A rubber O-ring is used to seal the sensor to the manifold (Fig. 7). This device is a pressure sensor that sends an electrical signal to the ECM. The ECM uses this information to compute the amount of air entering the engine. Fuel supply is regulated by the turbo boost sensor information to control engine exhaust. The turbo boost sensor is non-serviceable and must be replaced as an assembly. No adjustment is required.

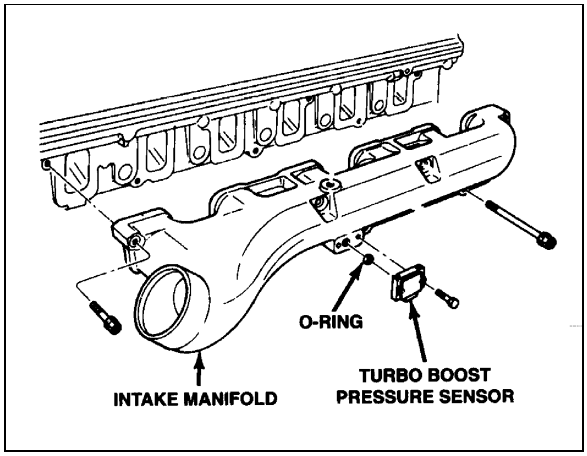

FIGURE 7: TURBO BOOST PRESSURE SENSOR 01023

2.6 Coolant Temperature Sensor

The coolant temperature sensor is mounted on the engine, on the radiator side of the engine (Fig. 1). The sensor protects the engine in case of overheating by sensing coolant temperature.

2.7 Fuel Temperature Sensor

The Fuel Temperature Sensor (FTS) is installed on the secondary fuel filter (Fig. 8). The FTS sends an electrical signal to the ECM indicating fuel inlet temperature. The ECM uses this information to calculate fuel consumption.

The FTS is non-serviceable and must be replaced as a unit. No adjustment is required.

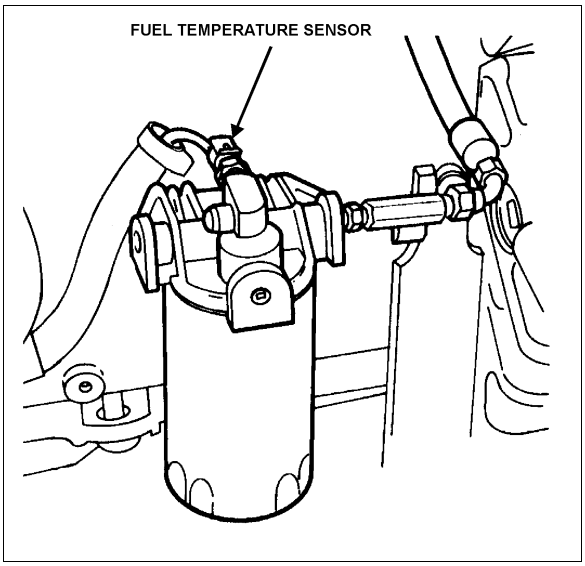

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FIGURE 8: ENGINE FUEL TEMPERATURE SENSOR

2.8 Air Temperature Sensor

The Air Temperature Sensor (Fig. 1) located on the engine (starter side) near the intake manifold provides input data to vary hot idle speed and injection timing. This helps to improve cold starts and reduces white exhaust.

2.9 Oil Pressure Sensor

The Oil Pressure Sensor (OPS) is installed in the main engine oil gallery. A typical location is the left rear corner of the cylinder block (Fig. 9).

The OPS sends an electrical signal to the ECM indicating the engine oil pressure at any given speed. A low oil pressure signal exceeding seven seconds is used by the ECM to begin the stop engine or warning function. The OPS is non-serviceable and must be replaced as a unit. No adjustment is required.

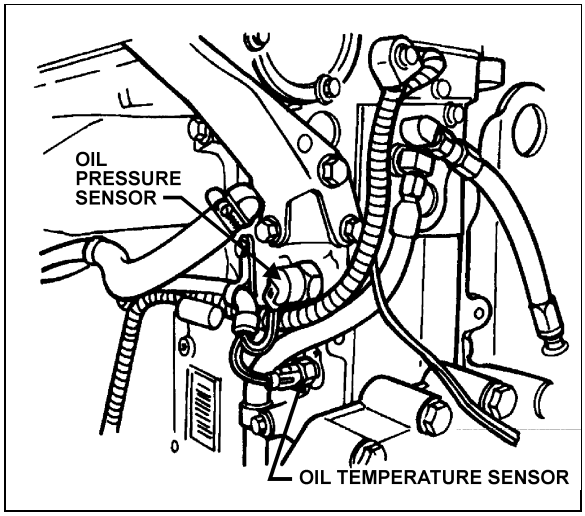

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FIGURE 9: ENGINE OIL PRESSURE AND OIL TEMPERATURE SENSOR

2.10 Oil Temperature Sensor

The Oil Temperature Sensor (OTS) is installed on the main engine oil gallery. A typical location is the left rear corner of the cylinder block as shown in Figure 9. The OTS sends an electrical signal to the ECM indicating engine oil temperature. The ECM uses this information to modify engine speed for better cold weather starts and faster warm-ups. Oil temperatures exceeding engine specifications for two seconds or more will illuminate the Check Engine Light. The OTS is non-serviceable and must be replaced as a unit. No adjustment is required.

3. ENGINE-RELATED COMPONENTS

Engine-related components:

- Coolant Level System (CLS)
- Electronic Foot Pedal Assembly (EFPA) and Throttle Position Sensor
- Cruise Control Switch (CCS)
- Diagnostic System Accessories (DSA)

3.1 Coolant Level System (CLS)

The coolant level system consists of a conductivity probe mounted in the surge tank and an electronic interface module located, inside the rear junction box. Coolant level is determined by the change in impedance of the probe and its brass mount when it is immersed in coolant. The electronic device in the module conditions the signal to levels compatible with DDEC. Low coolant level will trigger the warning engine functions. The probe and the electronic interface module are non-serviceable items and if found defective, they should be replaced as units. No adjustment is required.

3.2 Electronic Foot Pedal Assembly (EFPA) & Throttle Position Sensor

The Electronic Foot Pedal Assembly (EFPA) connects the accelerator pedal to a Throttle Position Sensor (TPS). The (TPS) is a device that sends an electrical signal to the Electronic Control Module (ECM) that varies in voltage, depending on how low the pedal is depressed. The system is installed in the space normally occupied by the mechanical foot pedal. The (EFPA) has maximum and minimum stops that are built into the unit during manufacturing (Fig. 10).

The (TPS) converts the operator's foot pedal input into a signal for the ECM. The (EFPA) is shown in Figure 10.

When installed by the equipment manufacturer, the TPS should not require adjustment. If the TPS is suspected of being misadjusted, confirm that the sensor is installed in accordance with the manufacturer's specifications. It is recommended that the idle count be at 50 or higher with a full throttle count of up to 200.

The TPS is self-calibrating and therefore has no optimum closed throttle or wide open throttle count value. If the counts are within the 50 to 200 range, the sensor is properly set.

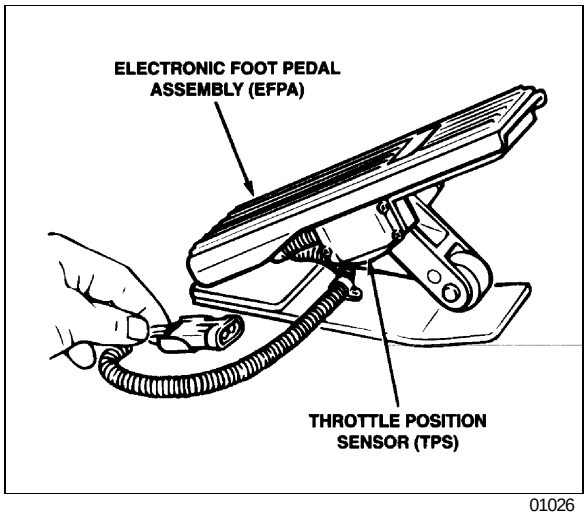

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FIGURE 10: ELECTRONIC FOOT PEDAL ASSEMBLY

Monitor the (TPS) as the controls move it through its full stroke. Be sure there is no misalignment or obstruction preventing the smooth movement of the TPS through the full stroke. Using a diagnostic data reader, check that the idle and full throttle position counts do not fall within the error zones. The error zones occur when the idle position is less than 14 counts, or when the full throttle position is more than 233 counts. Should these conditions occur, the ECU will signal diagnostic codes of 21-12 for idle error and 21-23 for wide open throttle error.

3.3 Cruise Control Switches (CCS)

The four cruise control switches are located in the driver's area on the L.H. side control panel.

1. **Cruise On/Off:** This is the main switch that actuates the ECM memory in order to use the speed regulating mode.

2. **Cruise Set:** This switch is used to set the cruise control speed or to decrease the set speed by 2 MPH at each application.

Note: *Cruise control system will not accept speed settings, nor will the "Resume" switch operate below 20 mph (32 km/h) and the engine speed must be above 1100 RPM.*

3. **Cruise Resume:** Each time this switch is actuated, the speed will be increased by 2 mph (3,5 km/h). This switch allows the driver return to the last regulated speed following a brake or *"DECEL"* switch application.

Note: *On-off switch must be in the "ON" position in order to return to the last regulated speed.*

4. **Cruise Decel:** Will cancel the cruise temporarily like a brake application but without actuating brake light. Set speed is still in memory for resume.

For additional information, see your "Operator's Manual"

3.4 Diagnostic System Accessories (DSA)

The DDEC III engine Diagnostic System Accessories include the following:

- Check Engine warning light;
- Stop Engine warning light;
- Stop Engine Override switch; and
- Diagnostic Data Link (DDL) connectors.

1. **Check Engine Warning Light:** This light, mounted on the central dashboard panel, illuminates to indicate that a problem is currently being detected and that a code has been stored in the ECM memory. This light also has a 5-second bulb check when the ignition is first turned on. The Check Engine Light illuminates when the temperature at coolant sensors exceeds 217°F (103°C) and the temperature at oil sensors exceeds 260°F (127°C). When sensors reach those temperatures, engine power starts to decrease linearly.

2. **Stop Engine Warning Light**: This light, also mounted on the central dashboard panel, illuminates to indicate that a major engine problem is occurring (with the exception of a 5-second bulb check when the ignition is first turned on). The Stop Engine Light illuminates when temperature at coolant sensors exceeds 222°F (106°C) and the temperature at oil sensors exceeds 239°F (115°C). When sensors reach those temperatures, the engine will shut down after 30 seconds. This 30-second delay period may be repeated using the OVERRIDE switch.

Note: *Once engine is stopped, it can not be restarted until the malfunction is corrected.*

3. **Stop Engine OVERRIDE Switch:** This switch, mounted on the L.H. lower control panel, is used when the Stop engine warning light is illuminated. Push down the switch to allow a 30-second delay period (non cumulative) in the shutdown procedure. This swicth can be repeatedly depressed, i.e. one (1) pulse is sufficient for each 30 second period, in order to move the vehicle out of traffic.

Note: *The stop engine override switch will be operative only if it has been depressed before the end of the 30 second delay period.*

Caution*: The OVERRIDE switch must be used only in emergency cases, such as to move the vehicle out of traffic. Excessive use of this switch could cause serious damage to the engine.*

4. **Diagnostic Data Link (DDL) Connectors:** A connector is mounted on the L.H. Lower Control Panel. Another connector is located in the rear electric compartment. They allow to connect the Diagnostic Data Reader (DDR) and to read the codes or to access pertinent data on the engine condition. This enables a more complete analysis of any defect found in the DDEC system operation. For more information, see Detroit Diesel Troubleshooting Guide #6SE492.

4. DDEC III DIAGNOSTIC CODES

4.1 Reading Diagnostic Codes - Flash Method:

DDEC III makes use of two types of codes: Active and inactive. The difference between the two types of codes are as follows:

1. **Active Codes:** These are the codes which are currently keeping the Check Engine or Stop Engine light illuminated. Active codes are flashed via the Stop Engine Light when check with override switch.

2. **Inactive Codes:** These are all the codes logged in the ECM (whether or not they are currently turning on the Stop or Check Engine Light). Inactive codes are flashed via the Check Engine light when checked with override switch.

In most instances, only the DDR can provide the information necessary for a quick diagnosis of the problem. If you just need to read out codes, however, and do not have a DDR available, the following procedure will let you read out codes. Make sure the rear starting switch (located in the engine compartment) is in the normal position. Momentarily depress the Stop Engine Override switch (located on the L.H. lower control panel) with the ignition ON, the engine idling or engine shut-off. Active codes will be flashed on the stop engine telltale (located on the central dashboard), followed by the inactive codes being flashed on the check engine telltale (located on the central dashboard). The cycle repeats itself until the operator depresses the Stop Engine Override Switch. A code "43" consists of four flashes, followed by a short pause, then three flashes in quick succession.

4.2 DDEC III Diagnostic Codes List

DDC Code Number (Flashed)	Description	DDC Code Number (Flashed)	Description
11	Variable speed governor sensor voltage low	12	Variable speed governor sensor voltage high
13	Coolant level circuit failed low	14	Intercooler temperature circuit failed high
14	Coolant temperature circuit failed high	14	Oil temperature circuit failed high
15	Intercooler temperature failed low	15	Coolant temperature circuit failed low
15	Oil temperature circuit failed low	16	Coolant level circuit failed high
17	Bypass position circuit failed high	18	Bypass position circuit failed low
21	EFPA circuit failed low	22	EFPA circuit failed low
23	Fuel temperature circuit failed high	24	Fuel temperature circuit failed low
25	Reserved for "no codes"	26	Aux. shutdown #1 active
26	Aux. shutdown #2 active	27	Air temperature circuit failed high
28	Air temperature circuit failed low	31	Aux. output #3 open circuit (high side)
31	Aux. output #3 short to ground (high side)	31	Aux. output #4 open circuit (high side)
31	Aux. output #4 short to ground (high side)	32	SEL open circuit
32	SEL short to battery	33	Turbo boost pressure circuit failed high
34	Turbo boost pressure circuit failed low	35	Oil pressure circuit failed high
36	Oil pressure circuit failed high	37	Fuel pressure circuit failed high
38	Fuel pressure circuit failed low	41	Too many SRS (missing TRS)
42	Too few SRS (missing SRS)	43	Coolant level low
44	Intercooler temperature high	44	Coolant temperature high
44	Oil temperature high	45	Oil pressure low

DDC Code Number (Flashed)	Description	DDC Code Number (Flashed)	Description
46	Battery voltage low	47	Fuel pressure high
48	Fuel pressure low	52	A/D conversion fail
53	Nonvolatile checksum incorrect	53	EEPROM write error
54	Vehicle speed sensor fault	55	J1939 data link fault
55	Proprietary link fault (master)	55	Proprietary link fault (receiver)
56	J1587 data link fault	57	J1922 data link fault
58	Torque overload	61	Response time long
62	Aux. output #1 short to battery	62	Aux. output #1 open circuit
62	Aux. output #2 short to battery	62	Aux. output #2 open circuit
62	Aux. output #5 short to battery	62	Aux. output #5 open circuit
62	Aux. output #6 short to battery	62	Aux. output #6 open circuit
62	Aux. output #7 short to battery	62	Aux. output #7 open circuit
62	Aux. output #8 short to battery	62	Aux. output #8 open circuit
63	PWM #1 short to battery	63	PWM #1 open circuit
63	PWM #2 short to battery	63	PWM #2 open circuit
63	PWM #3 short to battery	63	PWM #3 open circuit
63	PWM #4 short to battery	63	PWM #4 open circuit
64	Turbo speed circuit failed	65	Reserved for air filter differential pressure circuit failed high
65	Reserved for air filter differential pressure circuit failed low	66	Reserved for oil filter differential pressure circuit failed high
66	Reserved for oil filter differential pressure circuit failed low	67	Coolant pressure circuit failed high
67	Coolant pressure circuit failed low	68	Idle validation circuit fault (grounded circuit)
68	Idle validation circuit fault (open circuit)	71	Injector response time short
72	Vehicle overspeed	72	Reserved for vehicle overspeed (absolute)
73	Reserved for air differential pressure high	74	Oil differential pressure high

DDC Code Number (Flashed)	Description	DDC Code Number (Flashed)	Description
75	Battery voltage high	76	Engine overspeed with engine brake
77	All other faults not listed	81	Timing actuator (dual fuel) failed high
81	Oil level circuit failed high	81	Crankcase pressure circuit failed high
82	Timing actuator (dual fuel) failed low	82	Oil level circuit failed low
82	Crankcase pressure circuit failed low	83	Oil level high
83	Crankcase pressure high	84	Oil level low
84	Crankcase pressure low	85	Engine overspeed
86	Pump pressure circuit failed high	86	Barometric pressure circuit failed high
87	Pump pressure circuit failed low	87	Barometric pressure circuit failed high
88	Coolant pressure low	--	CEL short to battery
--	CEL open circuit	--	Clock Module failure
--	Clock module abnormal rate		

5. ENGINE OIL LEVEL

Check the oil level daily with the engine stopped. If the engine has just been stopped and is warm, wait at least 10 minutes to allow the oil to drain back to the oil pan before checking. Wipe the dipstick clean, then check oil level. The level should always be within the safe range on the dipstick (Fig. 11) . Add the proper grade of oil to maintain the correct level on the dipstick. All diesel engines are designed to consume some oil, so a periodic addition of oil is normal.

Warning: *Touching a hot engine can cause serious burns.*

Caution: *Do not overfill. Oil may be blown out through the crankcase breather if the crankcase is overfilled.*

Caution: *Clean end of tube before removing the dipstick to prevent oil contamination.*

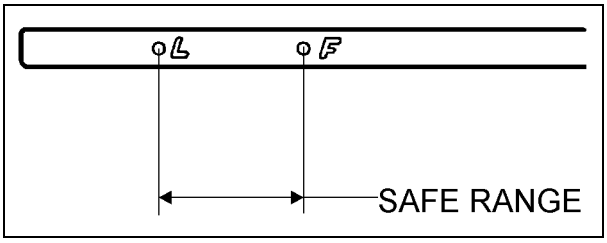


FIGURE 11: ENGINE OIL LEVEL DIPSTICK 01027

Caution: *If the oil level is constantly above normal and excess lube oil has not been added to the crankcase, consult with an authorized Detroit Diesel service outlet for the cause. Fuel or coolant dilution of lube oil can result in serious engine damage.*

The vehicle is provided with an oil reserve tank in the engine compartment which is used for the engine. To adjust oil level, open the oil reserve tank valve and allow oil to discharge into the engine until reaching the "Full" mark on the dipstick, then close the valve. Check oil reserve tank level through the level sight tube on the side of the tank and pour oil in the reserve tank if necessary (Fig. 12).

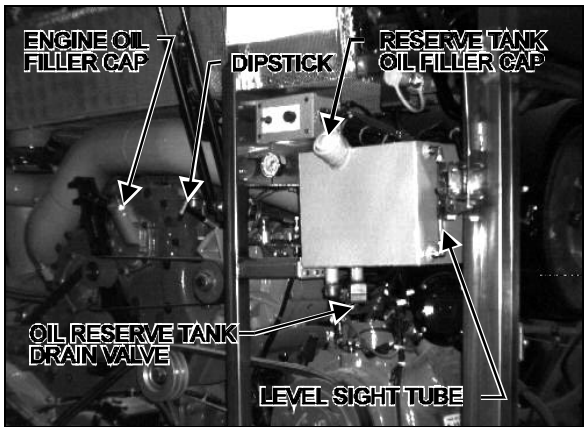


FIGURE 12: ENGINE COMPARTMENT 01028

6. ENGINE OIL AND FILTER CHANGE

Both the oil and filter should be changed every 12,500 miles (20 000 km) or once a year, whichever comes first. However, more frequent changes may be required when the engine is subject to high level of contamination and/or overheating. Change intervals may be decreased or gradually increased with experience on specific lubricants until the most practical service condition has been established. Always refer to the lubricant manufacturer's recommendations (analysis of drained oil can be helpful).

Caution: *Do not use solvent to dilute the engine oil when draining oil. Dilution of the fresh oil can occur which may be detrimental to the engine.*

Change engine oil with the vehicle on a flat and level surface and with the parking brake applied. It is best to drain the oil when the engine is still warm.

1. From under the vehicle, remove the engine drain plug on the oil pan. Allow oil to drain (Fig. 13).

Warning: *Hot engine oil can cause serious burns. Wear coveralls with sleeves pulled down and gloves to protect hands.*

2. Reinstall the drain plug.

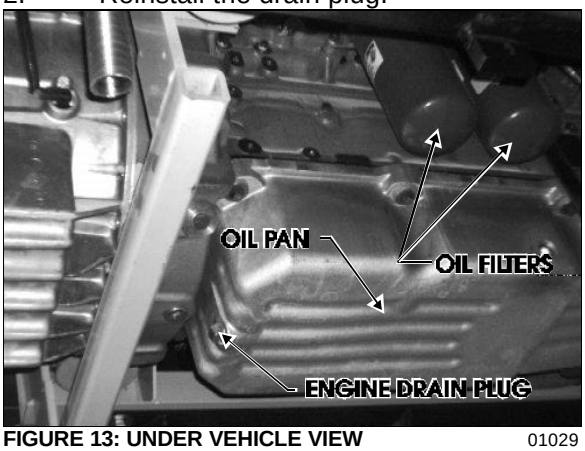


FIGURE 13: UNDER VEHICLE VIEW 01029

3. Remove the spin-on filter cartridge using a 1/2" drive socket wrench and extension.

4. Dispose of the used oil and filter in an environmentally responsible manner in accordance with state and/or federal (EPA) recommendations.

5. Clean the filter adaptor with a clean rag.

6. Lightly coat the filter gasket (seal) with clean engine oil.

7. Install the new filter on the adaptor and tighten manually until the gasket touches the mounting adaptor head. Tighten fullflow filters an additional two-thirds of a turn manually. Then, tighten bypass filter one full turn manually.

Caution: *Overtightening may distort or crack the filter adaptor.*

8. Remove the engine oil filler cap and pour oil in the engine until it reaches the "FULL" mark on the dipstick (Fig.11).

9. Start and run the engine for a short period and check for leaks. After any leaks have been corrected, stop the engine long enough for oil from various parts of the engine to drain back to the crankcase (approximately 20 minutes).

Add oil as required to bring the level within the safe range on the dipstick (Fig. 11).

7. RECOMMENDED ENGINE OIL TYPE

To provide maximum engine life, lubricants shall meet the following specifications:

SAE Viscosity Grade: 15W-40
API Classification: CG-4

Note: *Monograde oils should not be used in these engines regardless of API Service Classification.*

Note: *The use of supplemental oil additives are discouraged from use in Detroit Diesel Engines.*

Synthetic oils

Synthetic oils may be used in Detroit Diesel engines provided they are API licensed and meet the performance and chemical requirements of non-synthetic oils outlined previously. Synthetic oils does not permit extension of recommended oil drain intervals.

Lubricant Selection World Wide

Oils meeting API CD or CC specifications may be used if they also meet military specification MIL-L-2104 D or E. Oil which meet European CCMC D4 specifications may also be used. Modification of drain interval may be necessary, depending on fuel quality. Contact Detroit Diesel Corporation for further guidance.

8. WELDING PRECAUTION

1. Cut off battery power (battery master switch) from battery compartment.

2. Disconnect wiring harness connectors from ECM (Electronic Control Module). The ECM is mounted on the starter side of the engine.

3. For vehicles equipped with an automatic transmission, disconnect wiring harness connectors from ECU (Electronic Control Unit). The ECU is located in rear electrical compartment.

4. For vehicles equipped with ABS (Anti-Brake System), disconnect wiring harness connectors from ABS Electronic Control Unit. The ABS Electronic Control Unit is located in the front service compartment.

5. Cover electronic control components and wiring to protect from hot sparks, etc.

6. Do not connect welding cables to electronic control components.

7. Do the appropriate welding on vehicle.

8. Connect ECM, ECU and ABS electronic control unit.

9. POWER PLANT ASSEMBLY REMOVAL (AUTOMATIC AND MANUAL)

To access the engine or engine-related components, the vehicle power plant assembly must be removed as a whole unit by means of a slide-out cradle. The power plant assembly includes the engine, transmission (including retarder if so equipped), air compressor, alternator and transmission oil cooler.

Remove the power plant assembly as follows:

Caution: *Tag hoses and cables before disconnecting in order to facilitate reinstallation. Plug all openings to prevent dirt from entering the system.*

Note: *No parts within the ECM are serviceable. If found defective, replace the complete ECM unit.*

1. Disconnect the battery or batteries from the starting system by removing one or both of the battery cables from each battery system. With the electrical circuit disrupted, accidental contact with the starter button will not produce an engine start. In addition, the Electronic Unit Injectors (EUI) will be disabled, preventing any fuel delivery to the injector tips.

Warning: *Due to the heavy load of the rear bumper assembly, it must be adequately supported before attempting to remove it.*

2. Remove the rear bumper assembly from the vehicle. Refer to Section 18, BODY, under paragraph "6.5 REAR BUMPER REMOVAL AND INSTALLATION".

3. Drain the engine cooling system. Refer to Section 05, COOLING under paragraph "4.7 DRAINING COOLING SYSTEM".

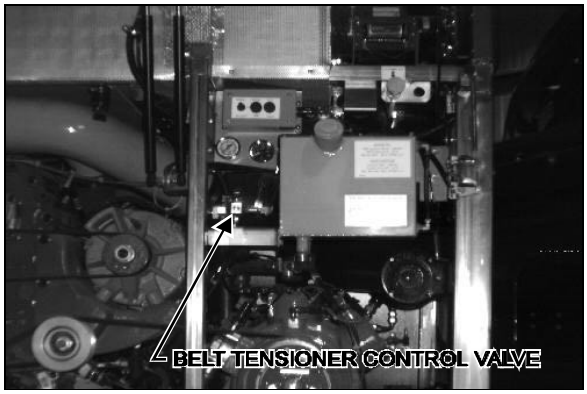


FIGURE 14: ENGINE COMPARTMENT 05035

4. Locate the belt tensioner control valve (Fig. 14). Turn handle counterclockwise in order to reverse pressure in belt tensioner air bellows and release tension on belts. Remove belts.

5. Exhaust all air from the air system. If necessary, refer to Section 12, BRAKES & AIR SYSTEM.

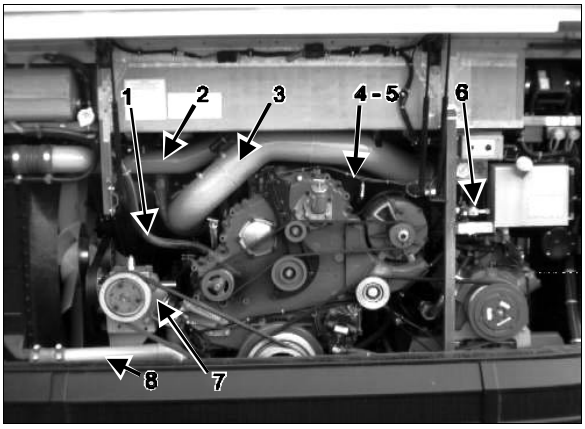


FIGURE 15: ENGINE COMPARTMENT 01030

6. Disconnect and remove the engine air intake duct mounted between air cleaner housing and turbocharger inlet (3, Fig 15).

Caution: *To avoid damage to turbocharger, cover the turbocharger inlet opening to prevent foreign material from entering.*

7. Disconnect and remove the air intake duct mounted between the air cooler outlet and the intake engine (2, Fig. 15).

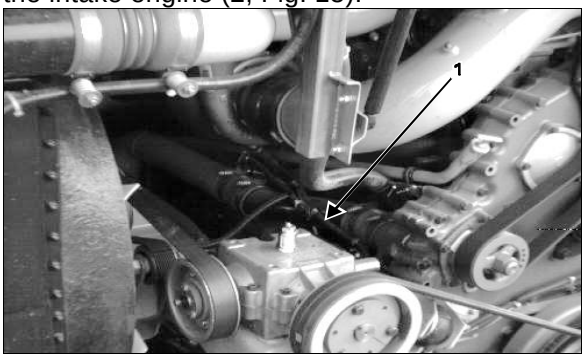


FIGURE 16: ENGINE COMPARTMENT 01031

8. Disconnect and remove section of coolant pipe assembly mounted between the radiator outlet and the water pump inlet (8, Fig. 15).

9. Disconnect the coolant delivery hose located inside of engine close to the water pump.

10. Disconnect the connector for electric fan clutch close to the water pump (1, Fig. 16).

11. Dismantle the air bellow of the upper bracket tensioner for the fan drive assembly. Remove the upper bracket (7, Fig. 15).

12. If necessary, remove the fan drive of the motor compartment by removing the four retaining bolts, washers and nuts securing the fan drive to the radiator floor.

13. Disconnect and remove the air intake duct mounted between the turbocharger outlet and the air cooler inlet.

14. Disconnect two vent hoses from the thermostat housing and from the coolant pipe assembly.

15. Disconnect and remove section of coolant pipe assembly mounted between the thermostat housings and the radia-tor inlet.

16. Disconnect and remove the small hose connected to the heater line valve and to the water pump.

17. Disconnect the small heater hose located on the cylinder head at the back of the engine.

18. Disconnect temperature sensor for the pyrometer located above the exhaust pipe, close to the turbocharger (optional).

19. Disconnect and remove the exhaust pipe mounted between the turboharger outlet and the exhaust bellows. If necessary, refer to Section 4, EXHAUST SYSTEM under paragraph "2. MUFFLER REMOVAL AND INSTALLATION"

Caution: *To avoid damage to turbocharger, cover the turbocharger outlet opening to prevent foreign material from entering.*

20. Disconnect the block heater connector above the power steering pump (on the right side).

21. Disconnect the steel-braided air line from the A/C compressor air bellows.

22. Disconnect the engine oil pressure steelbraided hose from the mechanical oil pressure gauge and the cable of the gauge water temperature (4 and 5, Fig. 15).

23. Disconnect the oil delivery hose from the valve located at the reserve tank exit.

24. Disconnect the power steering pump supply and discharge hoses. Cap hose openings immediately to limit fluid loss. Remove retaining clips from cradle.

25. Close engine fuel supply shutoff valve on primary fuel filter. Disconnect the fuel line connected to inlet port. On vehicles equipped with the optional water separator fuel filter, disconnect the connector and remove cable ties from cradle.

26. Disconnect the air compressor discharge, governor steel-braided air lines and the manual filling air lines from compressor. Remove retaining clips.

27. Disconnect the hose connecting the compressor head to the septic reservoir.

28. Disconnect ground cables from rear subframe ground stud, located close to the starting motor.

29. Disconnect positive cable (red termi-nal) from starting motor solenoid.

30. Disconnect the power plant wiring harness main connectors from EMC and remove retaining clips from engine compartment back wall.

31. On vehicles equipped with an automatic transmission provided with a hydraulic output retarder, disconnect steel-braided air line from pressure regulator output. The pressure regulator is mounted in the upper section of engine compartment back wall.

32. Disconnect fuel return line from bulk head fixed on engine cylinder head end.

33. On vehicles equipped with an electrically operated cold starting aid, disconnect the delivery hose from the starting aid cylinder solenoid valve. Remove cable ties securing hoses.

34. Disconnect turbo boost pressure gauge air line (if vehicle is so equipped) from engine air intake.

35. (Only if the vehicle is equipped with a retarder). Remove the transmission rubber damper assembly above transmission by removing: nut, bushing, rubber damper, rubber damper guide, bolt and washer. Remove the rubber damper bracket from transmission

36. Disconnect connectors from transmission. On the left side, four on rear side with one close to yoke. On right side, look close to the solenoid valve of the output retarder.

37. From under the vehicle, disconnect the propeller shaft as detailed in Section 09, under heading "Propeller Shaft".

Manual Transmission:

- **Disconnect gear shift linkage.**

- **Remove clutch slave cylinder from transmission without disconnecting the hydraulic hose.**

38. Inspect the power plant assembly to ensure that nothing will interfere when sliding out the cradle.

39. Remove the six retaining bolts, washers and nuts securing the power plant cradle to the vehicle rear subframe (Fig. 18).

Note: *Check if any spacer(s) have been installed between power plant cradle and vehicle rear subframe, and if so, note position of each washer for reinstallation purposes.*

40. Using a forklift, with a minimum capacity of 4,000 lbs (1 800 kg), slightly raise the power plant cradle. Pull engine out slowly from the engine compartment. Make sure all lines, wiring and controls are disconnected and are not tangled.

Caution*: Due to the minimum clearance between the power plant equipment and the top of the engine compartment, extreme care should be used to raise the power plant cradle, just enough to free the cradle. Clearance between power plant cradle and mounting rail should range between 1/4" and 1/2" (6-12 mm).*

10. POWER PLANT ASSEMBLY INSTALLATION (Automatic and Manual)

To install a power plant assembly, follow the same procedure as in "9. Power Plant Assembly Removal" except in a reverse order. Then proceed with the following:

1. Torque the power plant cradle mounting bolts to 113-144 lbf•ft (153-195 N•m).

2. (only if the vehicle is equipped with an automatic transmission and a retarder).

- Install the bracket from transmission (Fig. 17) (torque screw to 71-81 lbf•ft [96-110 N•m]).

- Install the transmission rubber damper assembly above transmission by assembling: bolt, washer, rubber damper guide, rubber damper, bushing nut. Respect rubber damper tolerance (58 mm) (Fig. 17).

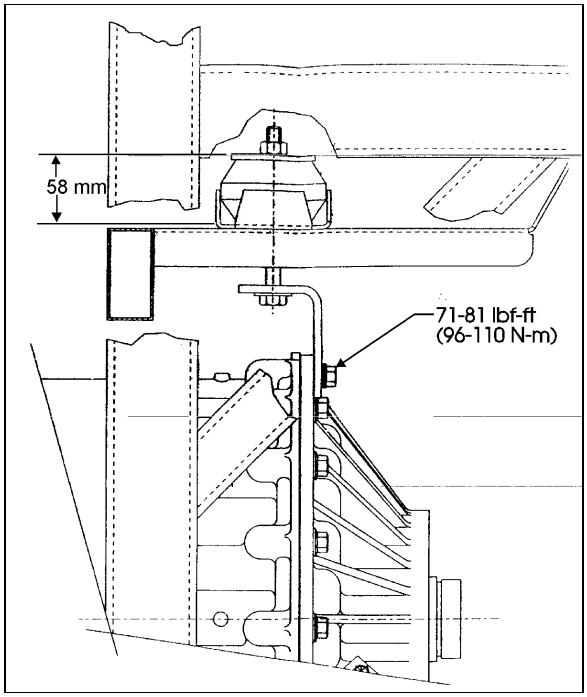


FIGURE 17: RUBBER DAMPER TOLERANCE 07014

3. If fan drive has been removed, reinstall and align as per Section 05, COOLING SYSTEM, under paragraph "10. FAN DRIVE ALIGNMENT".

4. Refill cooling system with saved fluid (refer to Section 05, COOLANT SYSTEM).

5. After engine fuel system has been drained, it will aid restarting if fuel filters are filled with fuel oil (refer to Section 03, FUEL SYSTEM).

6. After work has been completed start engine for a visual check. Check fuel, oil, cooling, pneumatic and hydraulic system connections for leakage. Test operation of engine controls and accessories.

11. ENGINE MOUNTS

The power plant assembly is mounted to the cradle by means of four rubber mounts on a vehicle powered with a series 60 engine.

Two rubber mounts are used at the front of the engine while other two are mounted on each side of the flywheel housing, on vehicles equipped with automatic and manual transmissions (Fig.18).

It is recommended that new rubber mounts be installed at each major overhaul.

12. JAKE BRAKE

Refer to both "The Jake Brake Troubleshooting and Maintenance Manual" and "Installation Manual for Models 760/760A/765 Engine Brakes" for troubleshooting and installation procedures. They are annexed to the end of this section.

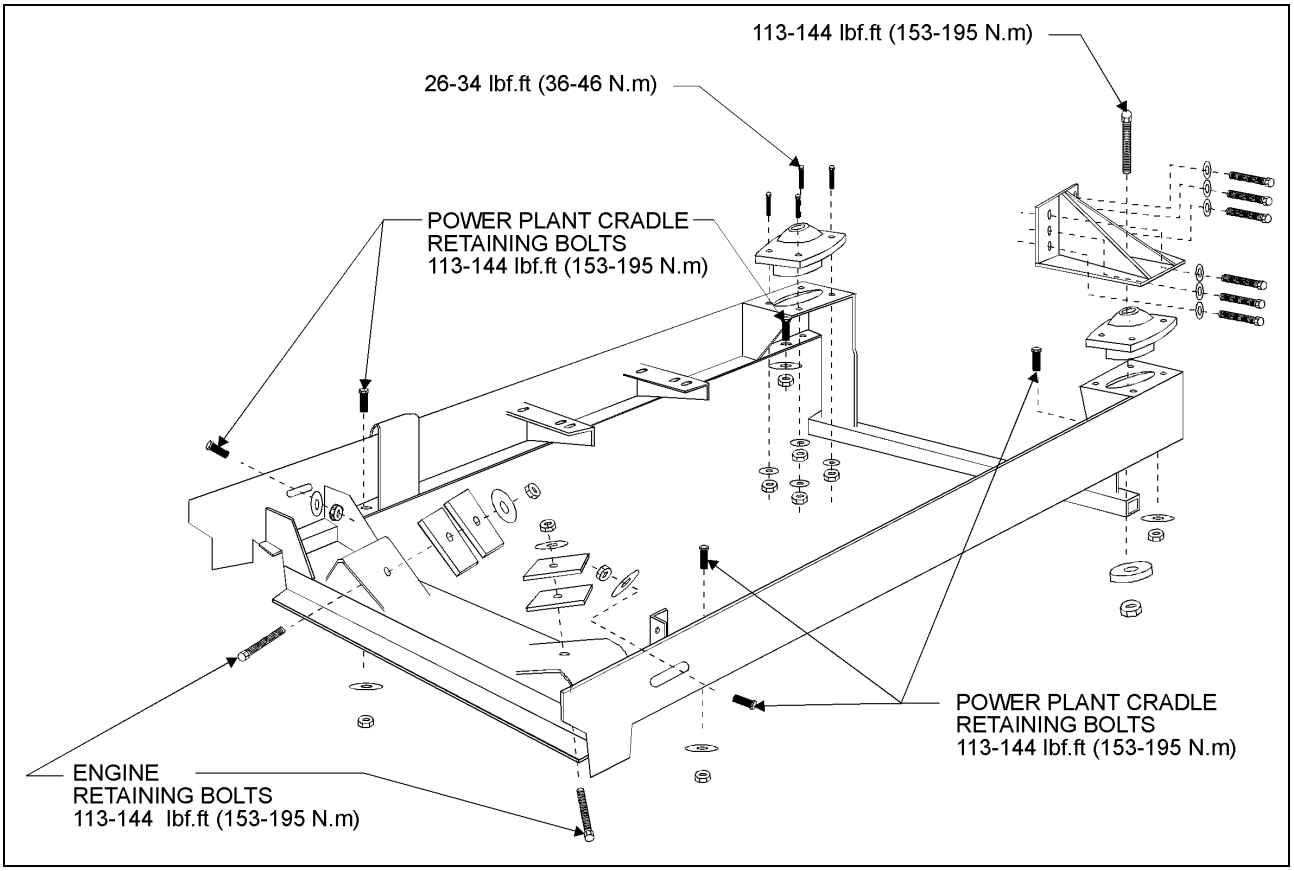


FIGURE 18: POWER PLANT CRADLE INSTALLATION 01032

13. SPECIFICATIONS

Series 60 Engines

Make ..... Detroit Diesel
Type ..... Diesel four cycle/in-line engine
Description ..... Turbo/Air to air charge cooled
No. of cylinders 6
Operating range ..... 1200-2100 RPM
Maximum RPM 2100

Model 11.1 Liter
Bore & Stroke ..... 5.12 X 5.47 in (130 X 139 mm)
Horsepower Range ..... 325 BHP

Model 12.7 Liter
Bore & Stroke ..... 5.12 X 6.30 in (130 X 160 mm)
Horsepower Range ..... 400 BHP, 470 BHP

Lubricant

Heavy-duty engine oil SAE Viscosity Grade 15W-40, API Classification CG-4 and meeting MIL-L-2104 D or E specifications. Synthetic oil may be used if it meets the performance and chemical requirements of non-synthetic oils outlined previously. Some engine operating conditions may require exceptions to this recommendation.

Caution: *To avoid possible engine damage, do not use single grade (Monograde) lubricants in Detroit Diesel four-cycle Series 60 engines, regardless of API classification.*

Capacity

Oil reserve tank.....10 US qts (9.5 L)

Engine oil level quantity

Oil Pan Capacity, Low Limit ..... 26 quarts/25 liters
Oil Pan Capacity, High Limit ..... 32 quarts/30 liters
Total Engine Oil Capacity With Filters ..... 41 quarts/39 liters

Lubricating oil filter elements

Make .....AC Rochester Div. GMC # 25014505
Make ..... A/C Filter # PF-2100
Type.....Full Flow
Prevost number.....510458

Torque specification

Engine oil filter ..... Tighten 2/3 of a turn after gasket contact

Filters

Engine Air Cleaner Filter

Make .....Nelson # 70337-N
Prévost P/N.....530197

Engine Coolant Filter/Conditioner

Make .....Nalco Chemical Company # DDF3000
Make ..... Detroit Diesel # 23507545
Prévost P/N.....550630

Note: *For primary and secondary fuel filter, refer to paragraph "12 specifications", Section 03.*

DETROIT DIESEL

SERIES 60 Service Information

NUMBER: 11–60–95 **S.M. REF.:** 13.9.1 **ENGINE:** 60 **DATE:** March 1995

SUBJECT CG–4 LUBRICATING OILS RECOMMENDED

INTRODUCTION

In January of 1995, the API (American Petroleum Institute) began voluntary licensing of API Service CG–4 lubricating oils for use in on–highway truck engines. To conform with this change, Detroit Diesel now recommends the use of CG–4 oils in Series 60 engines.

DETAILS AND REASON

Oils meeting the new CG-4 classification were developed for on-highway, emission-controlled engines operating on low sulfur fuel in applications where API CF–4 lubricants were formerly used. To conform with this API licensing change, Detroit Diesel now recommends the use of CG–4 oils in Series 60 engines and in all other DDC four–cycle products.

NOTICE:
To avoid possible engine damage, do not use single grade (monograde) lubricants in Detroit Diesel four–cycle Series 50 and 60 engines, regardless of API classification.

The recommended viscosity grade continues to be 15W-40. See Figure 1 for the API symbol required on CG–4 lubricants.

SERVICE

The phase-in of API CG-4 oils will not be immediate. Therefore, API CF–4 lubricants may continue to be used until CG–4 products become available. The use of CG-4 oils does not permit extension of oil drain intervals. Required oil drain and filter change intervals must be strictly observed when using either CG–4 or CF-4 lubricants.

For oil drain intervals and additional information on lubricating oils, refer to publication 7SE270, *Engine Requirements: Lubricating Oil, Fuel, and Fifters*, available from authorized Detroit Diesel Distributors.

ADDITIONAL SERVICE INFORMATION

Additional service information is available in the Detroit Diesel *Series* 60 *Engine Seruice Manual, 6SE483*. The next revision to the *Series* 60 *Engine Service Manual* will include this information.

-Over-

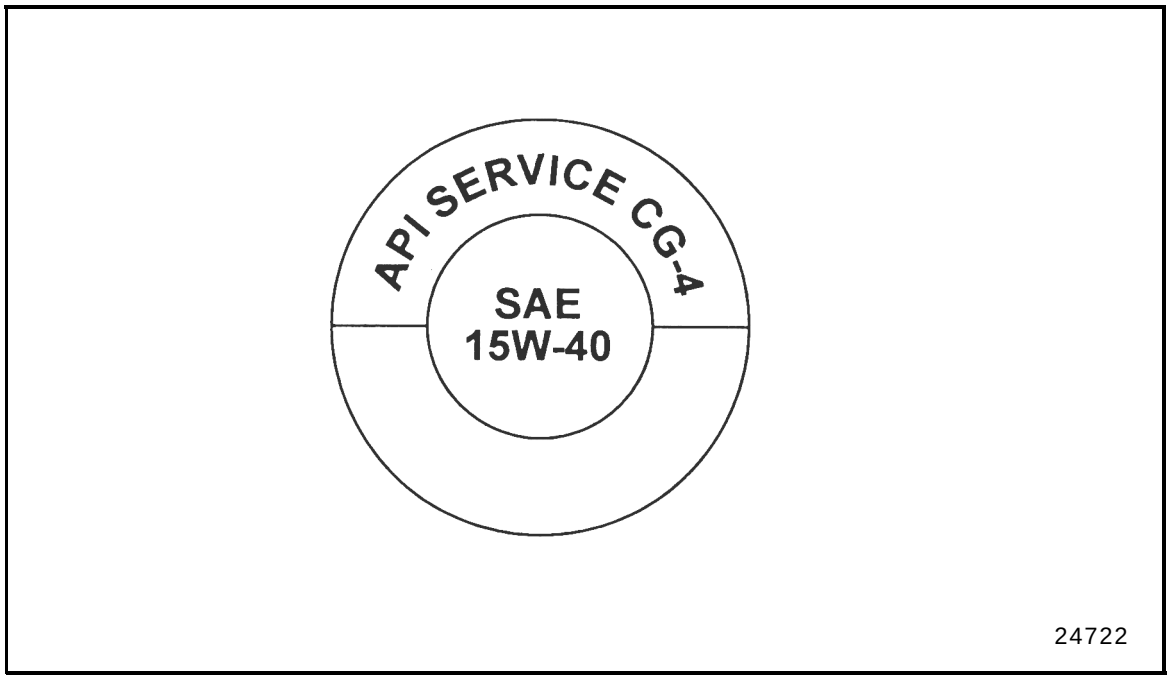


FIGURE 1 API Symbol

DETROIT DIESEL CORPORATION

13400 Outer Drive, West / Detroit, Michigan 482394001
Telephone: 313-592-5000
FAX: 313-592-7288

SERIES 60 FEATURES AND BENEFITS

The Series 60 Engine. Designed and manufactured by Detroit Diesel Corporation for the North American Heavy Duty truck market. Let's look at the Features and Benefits the Series 60 engine makes available to you as a customer in today's demanding trucking Industry,

The Series 60 engine IS a 4 cycle in-line 6 cylinder diesel engine with Integral electronic controls. It is the most advanced on-highway heavy duty diesel engine in the market today, The design started in 1980 with a desire to develop a fully electronic controlled diesel engine that would take the trucking industry through the 90's and beyond.

That IS why the Series 60 engine is a completely new design and not an attempt to rework an existing product.

Detroit Diesel listened to the customers needs, looked at the future stringent emission standards, and added their own objectives during the development stages of the Series 60 engine. They quickly realized that improvements on existing technology and the development of new technology was necessary to meet their objectives.

The end result is an Electronically controlled governing system that helps the Series 60 engine meet the stringent emission regulations of the 1990's and beyond. The simplistic design and dependable electronic controls improve reliability, durability, and offer reduced engine maintenance.

Detroit Diesel offers the Series 60 with two (2) engine displacements. The 11.1 liter and 12.7 liter versions. Both displacements have the same cylinder diameter with **a** longer piston stroke for the 12.7 liter engine. The horsepower range of the Series 60 is from the 11.1 liter at 285 hp to the 12.7 liter at 450 hp.

Both the 11.1 liter and the 12.7 liter look physically the same because they both use the same external parts like the cylinder block, the cylinder head, the rocker cover and oil pan. In fact there are only eight parts that are different between the 285 hp 11.1 L and the 450 hp 12.7L engine.

Those parts include the crankshaft, connecting rod, oil cooler, vibration damper, and crankshaft gear to build the larger bore engine, with different camshaft, injectors, and turbocharger for engine performance.

Each engine displacement has two (2) families of engine power ratings. The 11.1 liter ratings are from 285 to 350 hp, while the 12.7 liter ratings are from 365 to 450 hp.

With in an engine family the horsepower can be changed by reprogramming the ECM. The cost for this programming change is minimal and can increase the residual value of the vehicle, Just contact your local Detroit Diesel Distributor for the simple re-programming of the electronic control module. Make sure the engine support systems such as the radiator and drive train components have sufficient capacity to handle any increased horse power and peak torque changes.

Now lets look at a performance curve of the Series 60 engine. Here IS an 11,1 liter, 320 hp. 1800 RPM engine. Notice the engine peak torque IS at 1200 RPM's, Also notice that the fuel curve stays almost flat throughout the operating range of the engine. This feature offers more consistent fuel economy throughout the engine performance range, a wider operating range for the truck, and less shifting for the driver.

The electronic engine control offers cruise control similar to a passenger car. Detroit Diesel expanded this feature to offer Cruise Power This feature offers engine horse power chosen for normal truck operation and a higher horsepower during the cruise control operation.

For example, the 11.1 liter offers a 320/350 hp cruise power option. This means that 320 hp IS available during normal engine operations and 350 hp IS available while operating in cruise control. This option gives the driver more power for climbing hills, more power for fighting head winds, and more power means less shifting Feed back from the drivers indicate they really Iike this feature and operating the vehicle in cruise control promotes better fuel economy.

As you know the Series 60 has a reputation for being an efficient and reliable engine. Some physical features which contribute to this success include:

Air to air charge cooling. Cooler, denser intake air helps engine efficiency.

The **cylinder block** has a simple, clean design.This design includes serpentine external walls for noise reduction. The absence of push rod cavities in the block allows for a more evenly spaced bolt hole pattern around each cylinder bore This gives the engine a more uniform cylinder head bolt clamp load.

The **cylinder head** is a one piece casting it holds the overhead camshaft, the thermostats, and provides more rigidity to the cylinder block. The 38 cylinder head bolts create 1,000,000 Ibs clamp load to the cylinder head gasket. The fire deck of the cylinder head has machined slots between the cylinders to provide thermal stress relief.

The **overhead camshaft** eliminates the need for push rods and related hardware. The sturdy rocker arm assembles operate directly off the camshaft making it possible to have very high fuel injection pressures. These high injection pressures are necessary for maximum fuel economy and reducing engine exhaust emissions. However, engines with push rods also require higher injection pressures to meet todays stringent emission standards,

The **crankshaft** is very strong, is very durable, and has the largest main and rod bearing journal diameters of any diesel engine manufactured in the United States, For this reason, the rod bearings and main bearings do not have a recommended change Interval, Under normal operating conditions the bearings will last until engine overhaul,

The **piston assembly** is a Detroit Diesel cast iron cross-head, two piece design. The fire ring groove is near the top of the piston to minimize dead space during combustion. The piston assembly has a dome, a skirt, a piston pin and piston pin bearing. The top two rings are keystone design to prevent sticking. The skirt has tin plating to assist break-in and eliminate scuffing during test. The piston pin holds the entire assembly together with the connecting rod bolted directly to the pin.

Jacobs Manufacturing designed an engine brake specifically for the Series 60 engine, The braking system is electrically linked to the electronic control Module, and offers responsive and excellent braking performance to the driver.

A very Important component in the Series 60 engine is the **electronic unit injector.** Detroit Diesel used a mechanical unit injector since they started building enginesim 1938. It was redesigned to include a solenoid which operates a valve inside the injector. The valve wiII regulate fuel injection duration and injection timing with electrical commands from the Electronic Control Module or ECM.

Diagnosing the injector is simple with the ECM and a hand held Diagnostic Data Reader or a DDR. Using this equipment will eliminate any guess work as to the performance of any injector in the engine.

Some additional premium features of the Series 60 engine include the use of **grade eight** (8) cylinder head bolts, durable **roller bearings** for the accessory drives, **silicone hoses** for the cooling system, and **viton o-rings** to seal between the liner and block and the injector tube areas of the engine. The block and head casting are also **pre-painted** to maintain a clean and rust free engine appearance.

As you can see the Series 60 is truly a world class diesel engine that incorporates state of the art technology and assembly procedures. Now lets look at the other major contributing factor that makes the Series 60 engine so successful. The Detroit Diesel Electronic Control system.

The DDEC system consists of the ECM, the Electronic unit Injectors, various engine mounted sensors, a coolant level sensor in the radiator, and an electronic foot pedal assembly located in the Vehicle The ECM micro processor wiII compile data from the sensors and control engine operation as conditions change for maximum engine performance.

These are the engine sensors that the ECM uses to maintain engine performance Notice that DDEC monitors fuel temperature, 011 temperature, and the engine coolant level . The Turbo boost sensor monitors boost to control engine acceleration smoke,

Another feature of the DDEC system IS the programmable options available to the customer These options include:

★ **Engine protection** shutdown features,

★ **Programmable governor RPM droop** which makes the engine more driver friendly,

★ **Engine idle time from 1 to 100 minutes.** When activated this option can help reduce fuel costs and engine wear from excessive idling.

★ **High engine idle** is available with a PTO switch or with the cruise control switch system. In this mode DDEC is a variable speed governor throughout the engine operating range.

★ **Road speed governing** and **Cruise control** tailor the vehicle road speed to the customers needs. DDEC will calculate vehicle speed from the axle ratio, transmission top gear ratio, tire revolutions per mile, and vehicle speed sensor. From these calculations DDEC can now control the vehicle road speed while operating in high gear. Cruise Control is available in all gears above 1200 engine RPM.

The DDEC system offers many benefits to you as a customer. These benefits include:

An Engine protection feature that stops a running engine when sensors detect a condition that could cause engine damage. A red stop engine light and a yellow check engine light on the vehicle instrument panel will appear while DDEC will identify the problem with a code logged in its non-volatile memory. An audible warning system may be available from your OEM.

The **ECM diagnostics** offer: an active code display from the DDR with a check engine warning light on the vehicle dash board, Historical diagnostic codes stored in von-volatile memory for future retrieval, Engine performance checks, injector cylinder cutout, and an active engine sensor data display from the DDR. DDEC Reduces Maintenance by eliminating the high and low idle spring adjustments of a mechanical governor, the adjustments of smoke control devices like throttle delay or fuel modulator, the injector rack adjustment, the governor gap settings, compensations for mechanical governor wear, and adjustments with mechanical throttle linkage connections.

The **DDR** will also display the basic engine data such as engine serial number or the programmable option features of the engine. (26) The DDR hardware includes a housing with a liquid crystal display and a removable cartridge for any custom EPROM upgrades to the DDEC software system.

The **engine protection** feature of the DDEC system will shut the engine down in 30 seconds if the radiator coolant level is too low, if the oil pressure is too low for the engine speed or, if the oil temperature is too high. Should one of these conditions occur, the historical data will record the engine hours of the first occurrence, the number of occurrences, and the total time the engine ran in this condition.

During the engine shutdown sequence the driver can use an engine shutdown override switch. This switch gives the driver a repeatable thirty seconds to move the vehicle into a safe location. However, the historical data will reveal how many times the driver used the override switch.

Reprogramming, upgrading or changing engine performance is a very simple procedure with the DDEC system. Just contact your local Detroit Diesel Distributor. From their location they can access the main frame computer whitch stores the DDEC engine calibrations of every Detroit Diesel engine. The Distributor uses a P. C., a modem, and ECM plug-in hardware to reprogram the DDEC system, The fee for these changes is minimal and can help increase residual value at time of trade-in.

This presentation is a brief overview of the Series 60 features and benefits. Detroit Diesel is proud of the Series 60 engine product line and Its acceptance in the marketplace, The Series 60 engine is our commitment to your future, by providing the trucking industry with a durable and reliable engine with excellent fuel economy.

We are confident that once you try the Series 60 you will realize the importance of selecting the right product for your business future. The Series 60 engine is the product that will take you through the 90's and beyond. The Series 60, a commitment to the future,

$20.00

Troubleshooting and Maintenance Manual

Jacobs®

P/N 013680B

PRINTED IN USA 7/95

Table of Contents

Section 1: Troubleshooting

Section 2: Preventive Maintenance

Section 1: Troubleshooting

Introduction

Jacobs Engine Brakes are manufactured to the highest standards of quality. Care has been taken in every step of manufacture to produce a product capable of functioning reliably at normal and peak performance. This manual has been prepared to assist the operator and mechanic in correct maintenance and troubleshooting procedures that ensure satisfactory engine brake operation.

Troubleshooting, as discussed in Section 1, is a step-by-step procedure to determine the cause of malfunctions and problems interfering with satisfactory engine brake operation. Malfunctions and/or problems occurring in the Jake Brake can be classified as Electrical or Hydraulic/ Mechanical in nature. To effectively troubleshoot the engine brake system, the mechanic must have a working knowledge of these two systems.

Section 1 also describes the basic operation of engine brakes and components, and recommends procedures to follow when troubleshooting.

Proper maintenance, as discussed in Section 2, will assure maximum engine brake performance and a reliable service life.

Safety Precautions

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

THIS SYMBOL WARNS OF POSSIBLE PERSONAL INJURY.

THIS SYMBOL REFERS TO POSSIBLE EQUIPMENT DAMAGE.

Do not work on this equipment when mentally or physically fatigued. Always wear eye protection.

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

The Jake 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.

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

Engine Brake Part Replacement

Each engine brake housing assembly has an identification tag showing model number and part number. A packaged housing assembly has a different part number than the housing assembly inside the package. When ordering a replacement housing assembly, the packaged housing assembly part number must be used.

The Installation Manual should be used in conjunction with the Jacobs Parts Manual when additional replacement part information is required. The Parts Manual can be obtained from your Jacobs distributor.

For more information on driving with the Jake Brake, read your Jacobs Driver Manual.

Automatic Transmissions

For vehicles with automatic transmission, refer to Jacobs Service Publications or contact your nearest distributor.

1.1 Electrical System

Electric and Electronic Controls

Advancements in vehicle and engine controls have demanded changes to Jacobs Engine Brake control systems. New engine control systems include the following:

Caterpillar:PEEC	Cummins: CELECT
Detroit Diesel: DDEC	Mack: V-MAC

Section 1.1 Electrical System covers basic information and troubleshooting of electric and electronic control systems.

Electrical power to energize the Jake Brake should always come from a terminal on the vehicle ignition switch that is energized when the switch is turned “on”. This circuit must be protected by a 10-amp fuse or circuit breaker. The circuit is then connected to the ON/OFF switch, clutch switch, fuel pump (buffer) switch, and then to the solenoid valves.

Refer to the wiring diagram for specific engine brake models being worked on.

NOTE:

A DIODE IS INCORPORATED IN THE SYSTEM AT THE FUEL PUMP (BUFFER) SWITCH. THE DIODE PREVENTS HIGH VOLTAGE SPIKES THAT OCCUR EACH TIME THE SOLENOIDS ARE DE-ENERGIZED. THIS PREVENTS INTERNAL DAMAGE TO THE SWITCHES.

Required Tools

The following tools should be available to troubleshoot electrical problems:

1. Volt/OHM/AMP meter (digital readout)
2. Continuity tester
3. Test light

Preliminary Electrical Checks

1. **Vehicle Electrical Power.** Using a voltmeter, check to see that the supply voltage is at least 12 - 14 VDC or 24 - 28 VDC. Verify that wiring follows the correct Jacobs Engine Brake wiring schematic.

   If the truck is factory pre-wired and the power source is from a breaker panel, make sure the circuit breaker is correctly reset. Make certain power is not drawn from a source with an additional ON/OFF switch or power draw for other components.

2. **Jacobs’ Switches.** Using a voltmeter, check the dash switch, clutch switch and throttle switch for a voltage drop across each switch with the switch closed. Replace the switch if a voltage drop is 0.4 VDC or greater.

   Inspect switches for correct adjustment. Check the throttle and clutch return springs for correct adjustment and operation.

3. **Wiring.** Check for short circuit in the wiring. Replace any broken, brittle, chafed, scorched or melted wires. it is recommended that all under-hood or under-doghouse wiring be covered by Jacobs’ Auto-Loom or similar good quality loom. Replace Jacobs in-line fuse (10 amps) if blown or reset circuit breaker if necessary..

The following procedures are recommended:

Wire-end terminals should be securely attached to wires. If not, replace terminal. Wire size should be no smaller than 16 gage.

Wire-end terminals should be attached tightly to space connectors. If not, remove and replace, or if necessary, re-crimp and reattach.

Harness wire or loom should be carefully routed and should not contact moving equipment such as throttle, clutch or transmission linkage.

Harness wire or loom should not contact high temperature engine components such as exhaust manifold or turbo housings.

Harness should be secured in place with tie-wraps at regular intervals.

Clutch Switch

Adjust the switch by moving the switch along the mounting bracket. The actuator arm should be deflected 1.0-1.5" (25 - 38 mm), measured at the tip of the actuator, when the clutch pedal is in the up (clutch engaged) position.

Check installation by moving the clutch pedal. The switch should click from the open to closed position of the switch contacts in the free-play motion of the clutch pedal before actual clutch disengagement takes place.

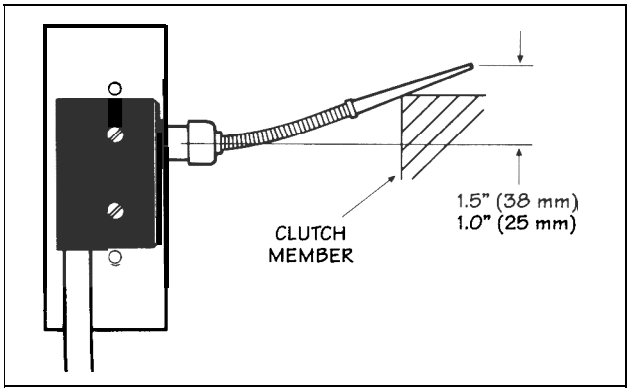


FIG. 1.1.1

CAUTION

EXCEEDING 1.5" DEFLECTION OF THE ACTUATOR ARM MAY CAUSE SWITCH DAMAGE, RESULTING IN ENGINE BRAKE MALFUCTION.

Fuel Pump Switch (Cummins PT Fuel Pump)

Move the throttle to the low idle position and insert a 0.05" (1.27 mm) feeler gage between the switch plunger and actuating lever (A, Fig. 1.1.2). Push the switch lever against the switch plunger until the plunger bottoms. Tighten the cap screw to 7 lb.-ft. (1 0 NŽm).

WARNING

AFTER INSTALLING THE ACTUATING ARM, CHECK THE FUEL PUMP THROTTLE SHAFT TO BE SURE THE THROTTLE PEDAL WILL MOVE THE SHAFT TO THE FULL FUEL POSITION. FAILURE TO DO SO MAY RESULT IN RESTRICTED ENGINE CONTROL. IF THE RESTRICTED MOVEMENT IS FOUND, CORRECT THE PROBLEM AND READJUST THE ACTUATING LEVER.

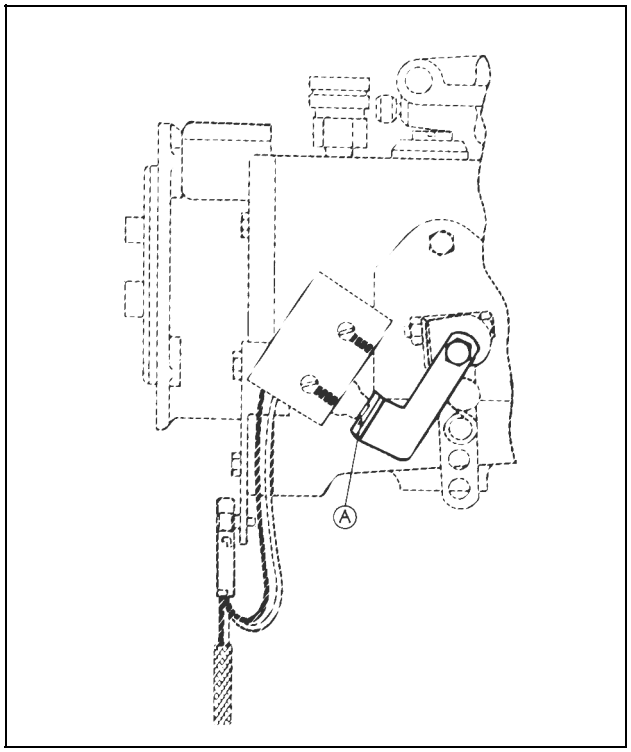


FIG. 1.1.2

Diode Protection

NOTE:

SWITCH CONTACTS ARE PROTECTED AGAINST ARCING BY A SMALL DIODE CONNECTED BETWEEN THE LOAD SIDE SWITCH TERMINAL AND GROUND. THE ENGINE BRAKE MUST BE CONNECTED TO THE LOAD SIDE TERMINAL. IF THE VEHICLE HAS A POSITIVE GROUND ELECTRICAL SYSTEM, REVERSE THE DIRECTION OF THE DIODE (FIG. 1.1.3).

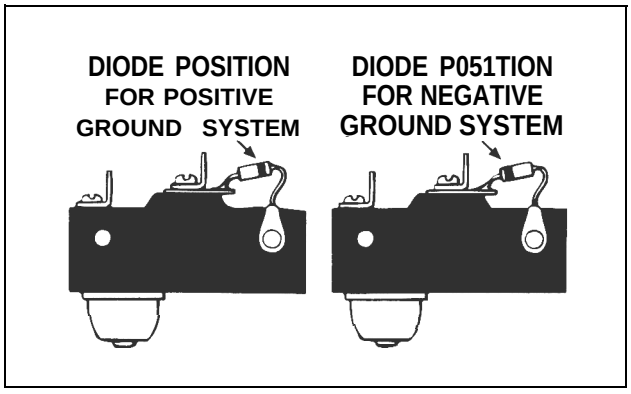


FIG. 1.1.3

Buffer Switch Adjustment

Buffer Switch - Detroit Diesel

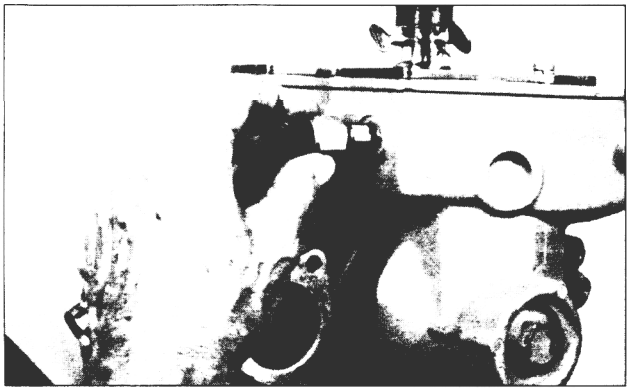


FIG. 1.1.4

1. Start the engine and allow to warm up. Record the idle RPM and maximum no load RPM.
2. With the idle speed set, adjust the buffer switch as follows:
   a. Turn the buffer switch in until it contacts the connecting link as lightly as possible and eliminates engine roll (Fig.1.1.4).

   NOTE:

   ENGINE IDLE SPEED WITH THE BUFFER SWITCH MUST NOT INCREASE MORE THAN 15 RPM FROM THE READING RECORDED IN STEP 1.

   b. Hold switch in this position and tighten locknut.

   ⚠ CAUTION

   DO NOT TIGHTEN LOCKNUT MORE THAN 60 LB.-IN. (7 NŽM). SWITCH FAILURE WILL RESULT FROM OVER-TORQUING.

   c. Check maximum no-load speed. If the increase is more than 25 RPM from the reading recorded in Step 1, back off buffer switch until increase is less than 25 RPM.
3. Shut down engine.
4. Early style buffer switches are polarity sensitive. Attach **NEGATIVE** lead (load side) to tin-plated terminal and the **POSITIVE** lead (power side) to the brass-colored terminal of the switch.
5. Current style buffer switches include a two-diode system for switch protection. The two-diode type switch is not polarity sensitive and electrical connections can be made to either terminal (see Fig. 1.1.5). This switch must only be used with negative ground systems.

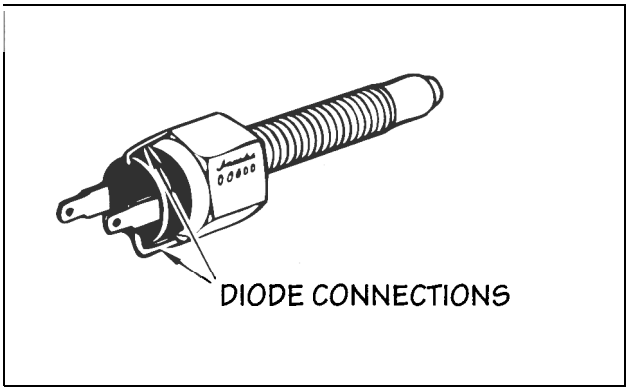


FIG. 1.1.5

Fuel Pump Switch Adjustment - CAT

1. Start engine and check low idle RPM. Disconnect the throttle linkage and adjust the idle per Caterpillar specification by turning the switch clockwise to increase and counterclockwise to decrease engine RPM (Fig. 1.1.6).

Fuel Pump Switch - Caterpillar 3406

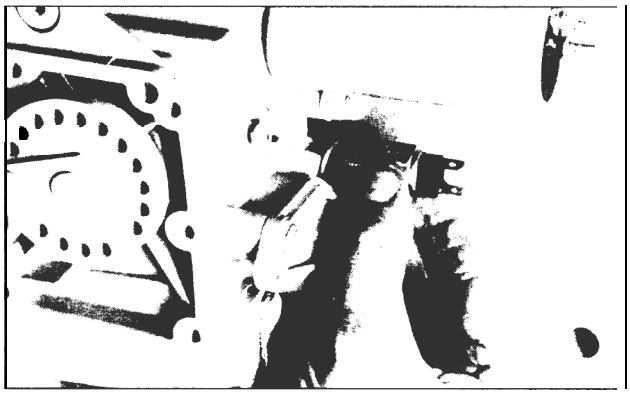


FIG. 1.1.6

2. When proper RPM is set, advance the throttle lever to increase engine speed and then return to idle. Check to be sure the idle RPM setting did not change. Readjust if necessary.

3. Hold the Jacobs switch and tighten locknut to 5 lb.-ft. (7 N*m). Reconnect throttle linkage.

If the fuel pump switch has a letter “D” or lower suffix after the part number, this switch is polarity sensitive. Connect the white wire from the engine harness to the silver terminal. Connect the orange wire from the engine harness to the brass (load side) contact. This ensures diode protection of the switches.

If the fuel pump switch has a letter “E” or greater suffix after the part number, harness wires can be connected to either switch terminal. These switches have two diodes for protection and are not polarity sensitive. This switch can only be used with negative ground systems.

⚠ CAUTION

CHECK TO BE SURE THAT THE GOVERNOR OPERATING LEVER MOVES FREELY FROM LOW IDLE TO HIGH IDLE POSITION AND RELEASES WITHOUT BINDING.

Foot Switch

Optional Jacobs Foot Switch provides added driver convenience and control. Jacobs offers three different systems for engine brake control. Besides the standard semi-automatic system used with Caterpillar, Cummins and Mack engines, the customer now has the choice of two added options: fully automatic control with a “low speed” shut-off or fully manual control with a “foot switch”.

The foot switch is installed on the cab floor within easy reach of the operator’s left foot. After installation, light foot pressure on the top plate is all that is needed to operate the Jake Brake. The throttle switch, or buffer switch, remains in the system to ensure that fueling and engine braking do not occur at the same time.

NOTE:

ENGINES WITH ELECTRONIC CONTROLS (NO FUEL PUMP SWITCH): CONNECT THE WIRES FROM THE FOOT SWITCH TO THE WIRE CONNECTING THE 12-VOLT (OR 24-VOLT) POWER TO THE DASHBOARD ON/OFF SWITCH.

Foot Switch Diagram

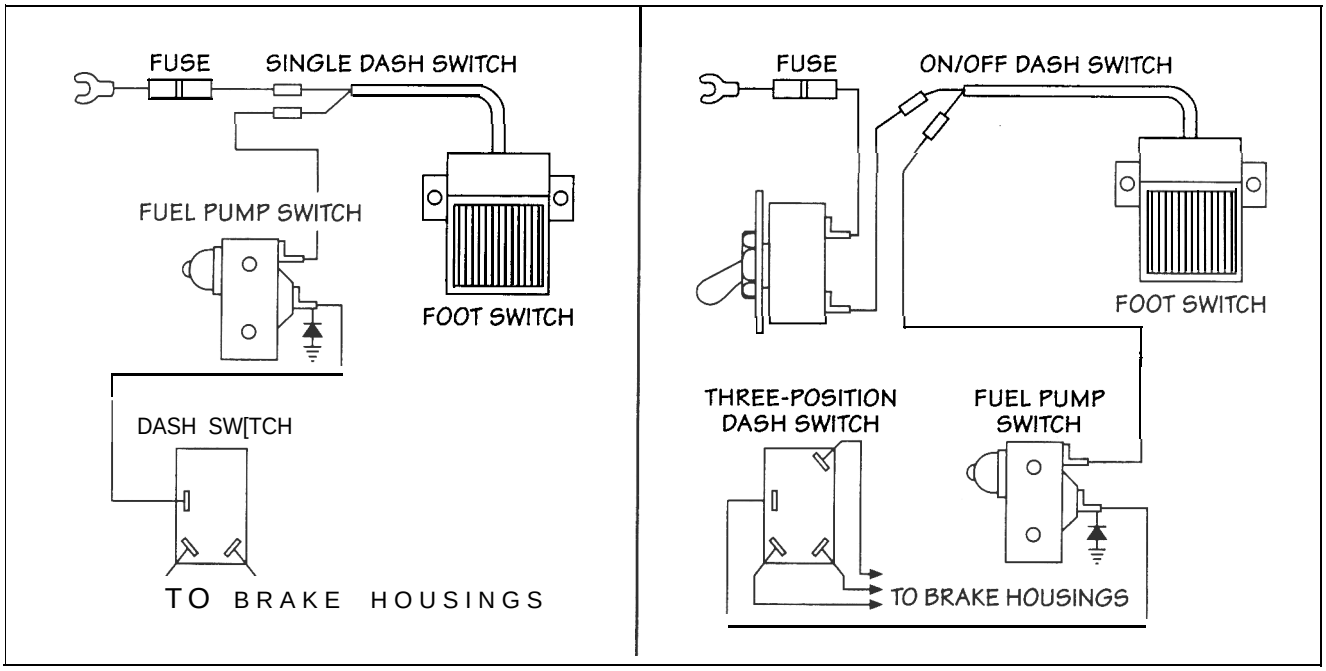


FIG. 1.1.7

Solenoid Valve

The Solenoid Valve cannot be overhauled or repaired in the field. if any problem other than seal ring-related exists, the Solenoid Valve must be replaced.

Operation Check

The best way to examine a solenoid valve coil for correct operation is with a volt/amp/ohm meter and then compare the readings for each solenoid with the proper specifications. If the proper meters are not available, a secondary check of proper solenoid valve operation can be made as follows:

⚠ WARNING

DO NOT TOUCH THE ELECTRICAL CONNECTION WHEN A SOLENOID IS ENERGIZED. ELECTRICAL SHOCK COULD RESULT.

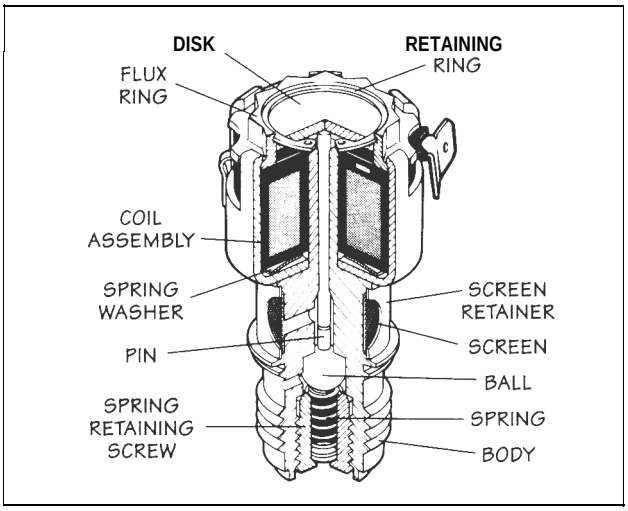


FIG. 1.1.8

1. Apply a 12-volt (or 24-volt) source to the solenoid electrical terminal.
2. When electrical power is supplied, make sure each solenoid valve cap depresses. If the cap does not depress, replace the solenoid.

		RESISTANCE (OHMS)		CURRENT DRAW (AMPS)		PULL IN VOLTAGE (MINIMUM)	
P/N	VOLTAGE	COLD	HOT	COLD	HOT	COLD	HOT
016440*	12 VDC	9.62 to 10.75	11.8 to 14.3	1.12 to 1.23	0.84 to 1.02	8.0	8.5
016441*	24 VDC	31.5 to 38.5	38.2 to 50.0	0.62 to 0.69	0.47 to 0.55	17.0	21
019650*	12 VDC D/L	9.75 to 10.75	11.8 to 14.3	1.12 to 1..23	0.84 to 1.02	8.0	8.5
016442*	24 VDC D/L	31.5 to 38.5	38.2 to 50.0	0.69 to 0.62	0.47 to 0.55	17.0	21
020239*	12 VDC	9.0 to 10.0	11.5 to 14.0	1.0 to 1.2	0.8 to 1.0	8.0 to 9.0	10.0 to 11.0
018674	12 VDC	9.5 to 10.5	11.5 to 14.0	1.15 to 1.25	0.86 to 1.04	9.5	11.9 to 12.7
013472*	24 VDC SCREW	34.9 to 38.7	43.3 to 51.3	0.62 to 0.69	0.47 to 0.55	18.0	22 to 24
003784, 004205, 003433, 002689	12 VDC	19.8 to 22.0	24.0 to 29.5	0.54 to 0.61	0.4 to 0.5	9.0	9.8 to 12.1
003784, 004205, 003433, 002689	24 VDC	19.8 to 22.0	24.0 to 29.5	1.08 to 1.22	0.8 to 1.0	9.0	9.8 to 12.1

* Current Production Solenoid Valves
D/L Dual Lead

FIG. 1.1.9

Jacobs Models 346 B/C/D) with Caterpillar PEEC* Controls

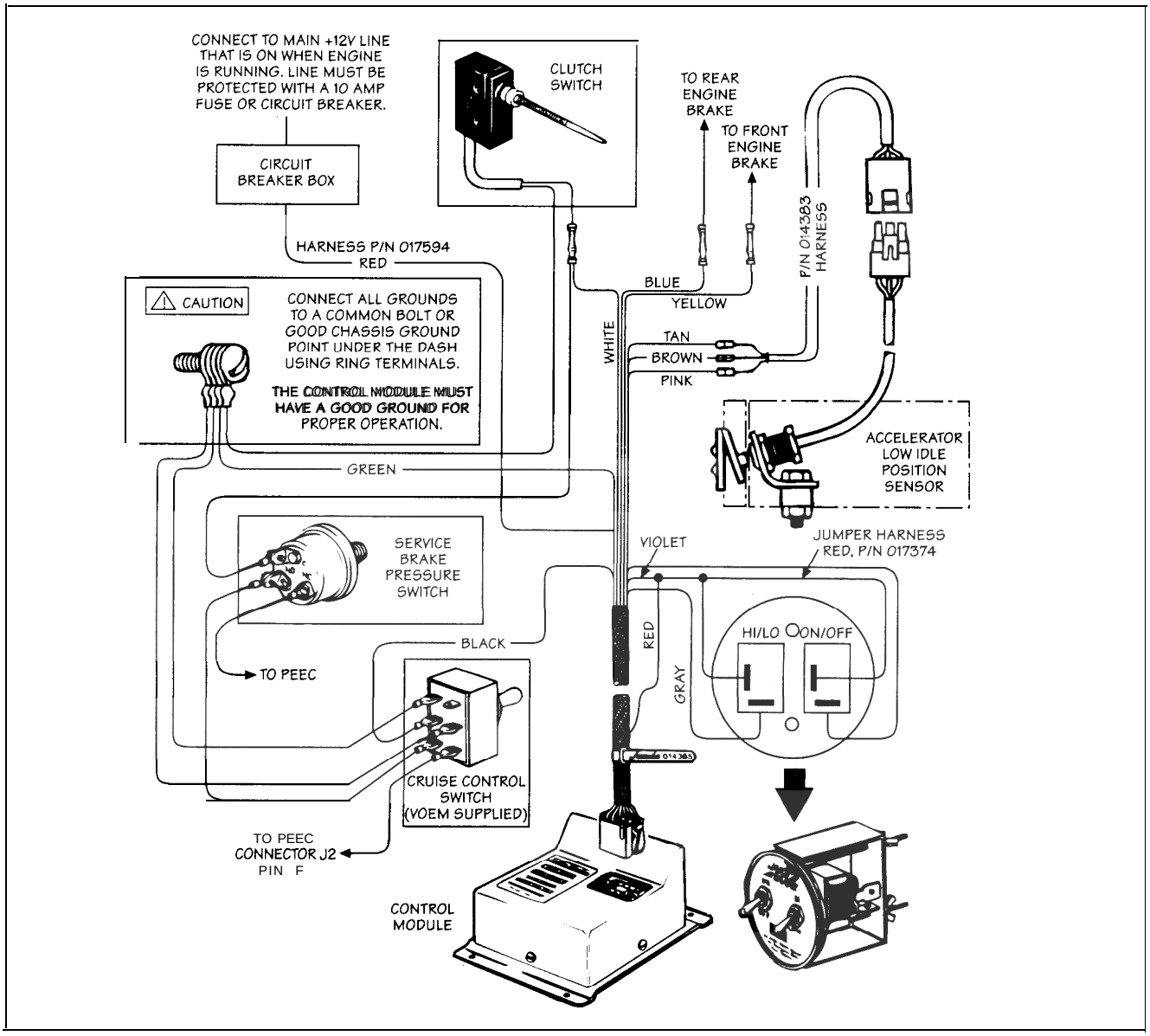


FIG. 1.1.10

* Information on Caterpillar electronics (PEEC III) applications is not covered here and will be covered in separate documents.

Troubleshooting: CAT PEEC Controls

Problem: Engine Brake is Inoperable

Probable Cause: No electrical power.

Correction: Connect VOM positive (+) probe to common (lower) terminal of ON/OFF switch and negative (-) probe to ground (Fig. 1.1.11). With ignition switch on, VOM should read +12 volts. If not, check circuit breaker or fuse and wiring to switch and repair/replace as needed.

Probable Cause: Dash switch(es) inoperative.

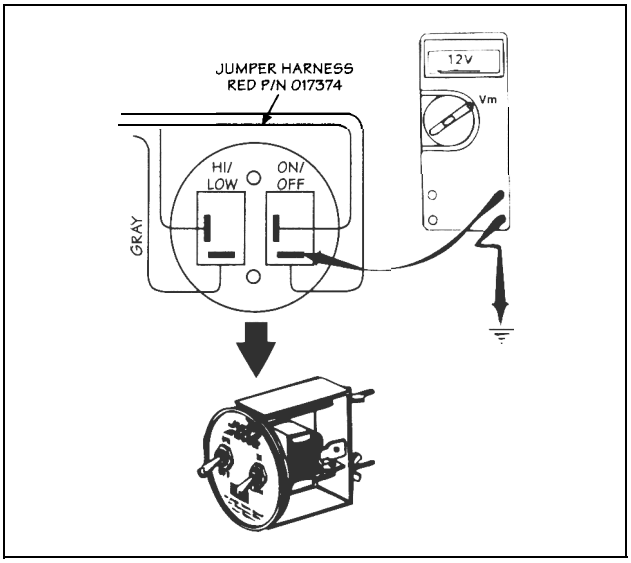


FIG. 1.1.11

Correction:

A. Connect positive (+) probe of VOM to center terminal of ON/OFF switch and negative (-) probe to ground. With system energized and switch off, reading should be 0 volts. With switch on, reading should be 12 volts. If these readings are not obtained, replace ON/OFF switch.

B. Connect positive (+) probe to center terminal of Hi/LO switch and negative (-) probe to ground. With ON/OFF switch on and HI/LO switch in lo position, reading should be 12 volts. If not, check switch jumper wire and connections and repair/replace as needed.

C. Connect positive (+) probe to lower terminal of Hi/LO switch and negative (-) probe to ground. With Hi/LO switch in lo position and ON/OFF switch on, reading should be 9 volts. With Hi/LO switch in HI position, reading should be 12 volts. If these readings are not obtained, replace Hi/LO switch.

Probable Cause: Control module defective.

Correction: De-energize the system and disconnect the harness, P/N 014383, from the ALIPS harness. Using the three clip leads, reconnect the brown, tan and pink wires. Connect the positive (+) probe to the tan wire and the negative (-) probe to the brown wire (Fig. 1.1.12). With the system energized and clutch engaged (pedal up), reading should be 5 volts. if not, replace the control module.

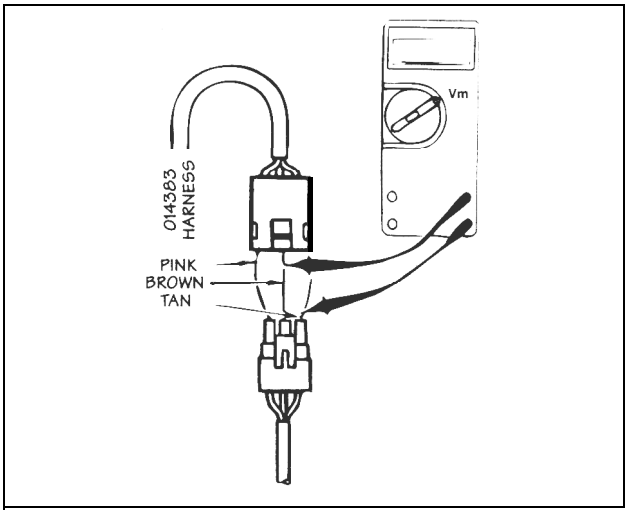


FIG. 1.1.12

Probable Cause: ALIPS sensor inoperative.

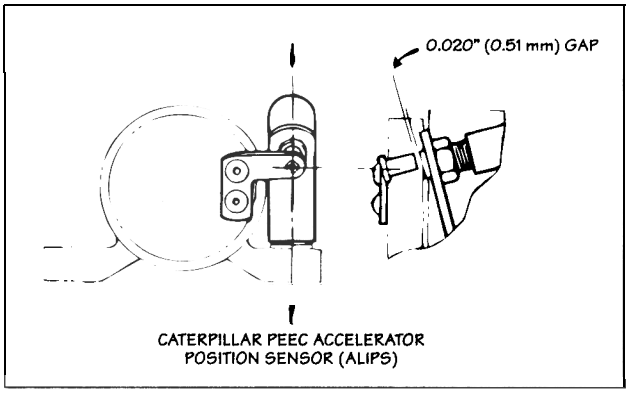


FIG. 1.1.13

Correction: If the previous reading was 5 volts, connect the positive (+) probe to the pink wire and the negative (-) probe to the brown wire. With the accelerator in the low idle position, the VOM should read O volts. If the reading is not O volts, the clearance between the magnet and sensor may be too large or the magnet may not be in line with the sensor. If necessary, realign the magnet and sensor and readjust the clearance to 0.02" (0.51 mm) (Fig. 1.1.13). If the volt meter still does not read O volts, replace the sensor assembly.

With the accelerator depressed, the reading should be 5 volts. If not, replace the ALIPS sensor assembly.

If the ALIPS sensor assembly functions properly, remove the clip leads and reconnect the harness.

Probable Cause: Clutch switch inoperative.

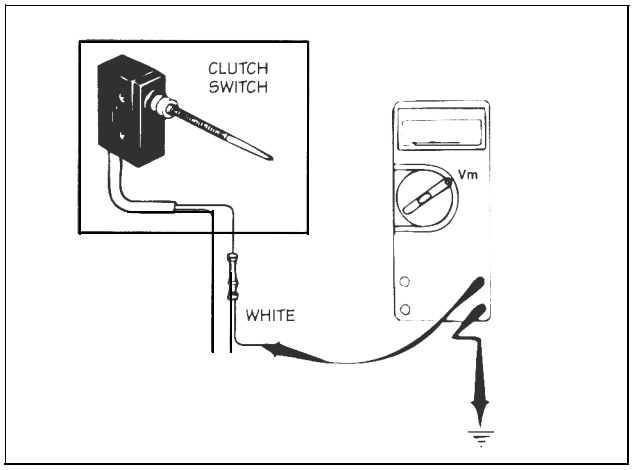


FIG. 1.1.14

Correction: Connect the negative (-) probe to the common ground point and the positive (+) probe to the white lead in the main harness (Fig. 1.1.14). Energize the system. With the clutch engaged (pedal up), VOM should cause a reading of 5 volts. if these readings are not obtained, check adjustment of clutch switch. Switch should actuate in the top travel portion of the pedal. Readjust if necessary.

If these checks are not OK, disconnect the wires at the clutch switch. Check continuity between the switch terminals. There should be O ohms resistance with the switch activated (contacts closed) and infinite resistance with the switch relaxed (contacts open). if these conditions do not exist, replace switch.

Probable Cause: Service brake pressure switch inoperative.

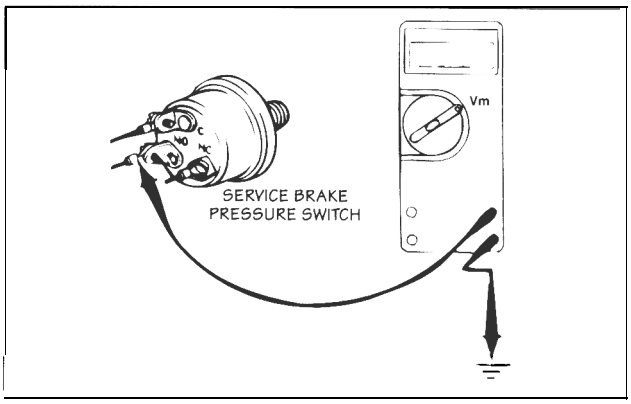


FIG. 1.1.15

Correction: Connect the positive (+) probe of the VOM to the normally open (NO) contact of the brake pressure switch and the negative (-) probe to ground. With the system activated, sufficient air pressure to activate the brake pressure switch, cruise control switch on, and clutch pedal up, the volt meter should read 5 volts (Fig. 1.1.15). with the service brake pedal depressed, the volt meter should read 0 volts. If these readings are not obtained, replace the service brake pressure switch.

Probable Cause: Control module inoperative.

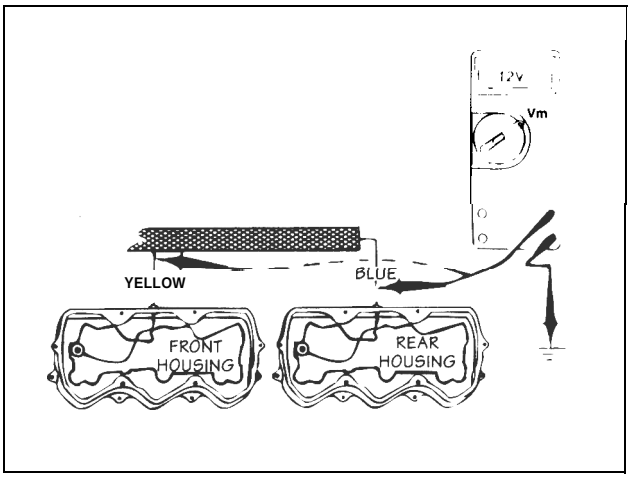


FIG. 1.1.16

Correction: If of the above procedures do not locate the problem, disconnect the wire harness at the engine brake spacers. Set the selector switch in HI, accelerator in low idle, cruise control switch off and clutch switch activated, both blue and yellow wires should read 12 volts (Fig. 1.1.16). Depressing the clutch should cause the voltage at each wire to drop to 0 volts. if these readings do not occur, replace the control module.

Probable Cause: Solenoid Valve

Correction: With the blue and yellow wires disconnected at the engine brake spacers, connect one probe of the VOM to the solenoid terminal and the other probe to ground at the solenoid body (Fig. 1.1.17).

Reading should be 9.75 to 10.75 Ohms for current solenoid valves, P/N 016640. For early style solenoid valves, P/N 004205, the resistance should be 19.8 to 22 Ohms. If not, replace the solenoid valve (see Fig. 1.1.9 on page 1.1.5).

If solenoid resistance is OK, check continuity of solenoid lead wires. No reading from solenoid to connection at spacer indicates an open circuit and wire must be replaced.

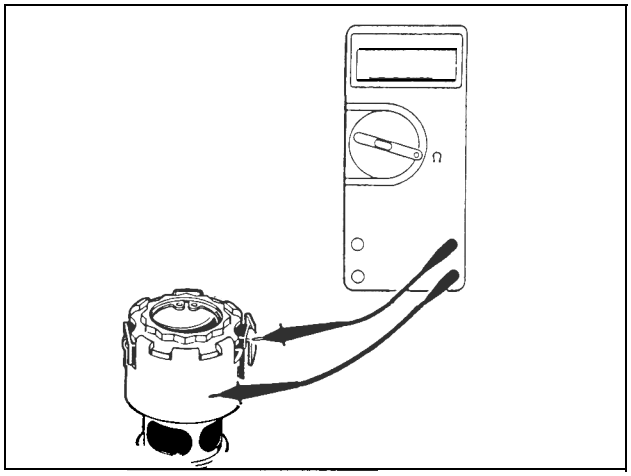


FIG. 1.1.17

Wiring Diagram for DDC Engines

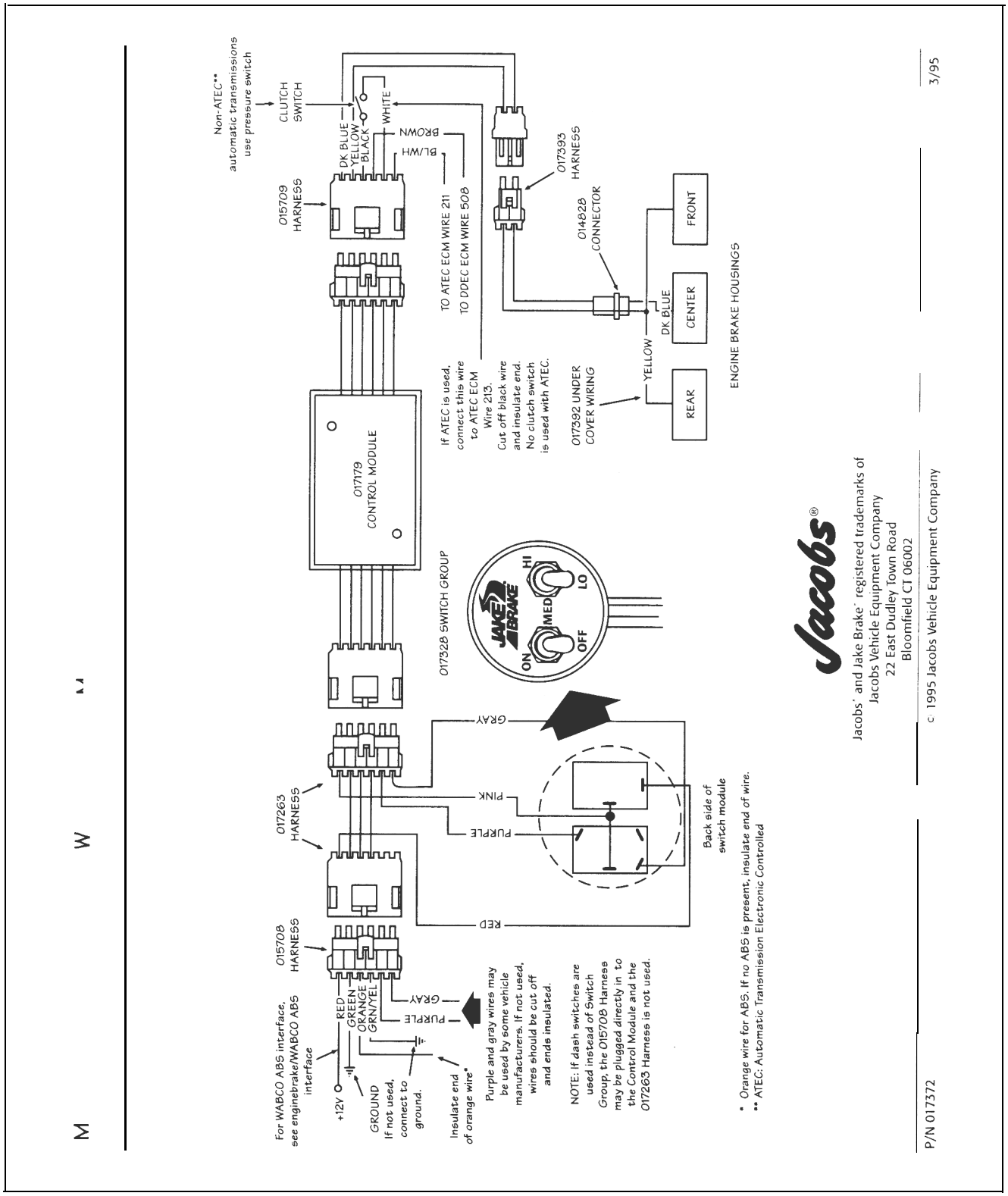


FIG. 1.1.18

Troubleshooting: DDEC II Controls

Models 760/760A/765 and 7l/92A Engine Brakes

The Jacobs Electronic Control Module, P/N 017179, is a sealed electronic device and is not field serviceable. The Control Module can be operated using the standard dash toggle switches or the Jacobs Dash Switch Module, P/N 017328 or 017346. To test if this device requires replacement, follow the step-by-step procedures within the troubleshooting guide.

Equipment Required for Testing:

Voltmeter with 20,000 Ohm/volt input impedance, minimum. Keep the voltmeter on the 20 VDC/div scale for the 12-volt control and 200 VDC/div scale for the 24-volt control for all test measurements.

NOTE:

THIS CONTROL CAN BE USED FOR 12-OR 24-VOLT OPERATIONS. USE + 12/24 VOLTS WHEN REFERRING TO THE (+) BATTERY VOLTAGE. THIS GUIDE WILL MAKE REFERENCE TO A 12-VOLT OPERATION. ACTUAL BATTERY VOLTAGE MAY VARY UP TO 2 VOLTS.

If measuring the voltage at the solenoid valves, make sure that all wiring harnesses are connected. if the voltage at the output of the control is measured without the solenoid valves connected, both the BLUE and YELLOW wires will measure approximately +1 volt. These are internal voltages established by the control module when the output wires are disconnected.

Operation Function

- The in-line switch module (if used) is connected to the power input side of the control. This is the harness with the RED and GREEN wires, P/N 015708.
- The ON/OFF power switch connects the RED wire to the +12 volt vehicle electrical system providing power to the control module.
- The PURPLE and GRAY inputs select which one of the DK BLUE or YELLOW outputs will be active. The (AUX LO) GRN/YEL, (AUX HI) ORANGE, (#508) BROWN, and (CLUTCH SWITCH) BLACK and WHITE inputs control when the DK BLUE and YELLOW will be active. To allow the outputs to be active, the following must be true:

  1. The clutch switch closed connecting the BLACK and WHITE wires together.
  2. The (AUX LO) GRN/YEL wire connected to ground (0 VDC).
  3. The (#508) BROWN wire switches to ground (0 VDC).
  4. The (AUX HI) ORANGE wire connected to ABS. If no ABS, end of wire should be insulated.

Before active troubleshooting is begun, check the integrity of all wiring and harness connections to verify that connections are tight and that wires are not pinched or have scraped insulation.

Wiring Diagram for DDC Engines

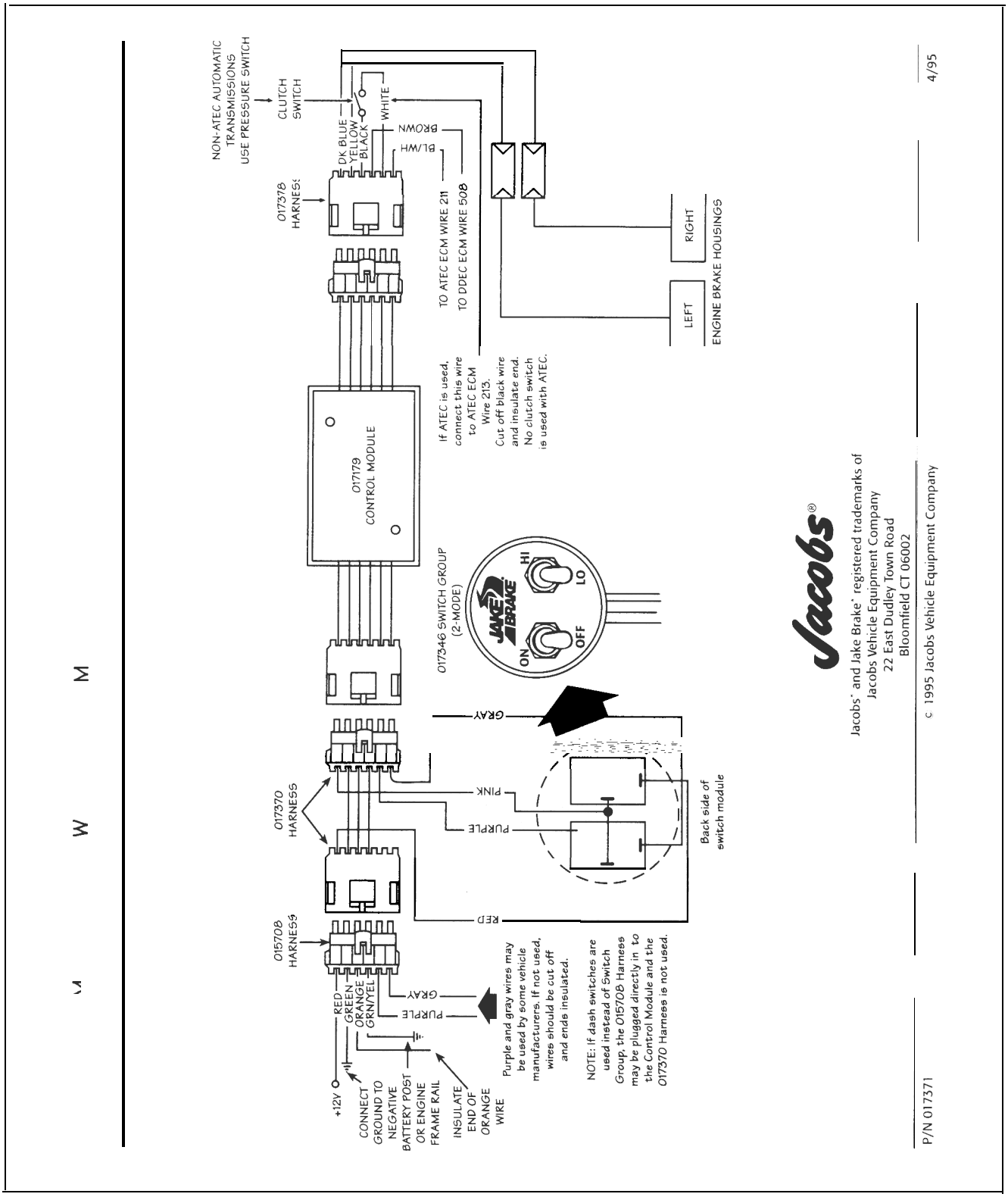


FIG. 1.1.19

Problem: Engine Brake will not activate

Probable Cause: Check supply voltage

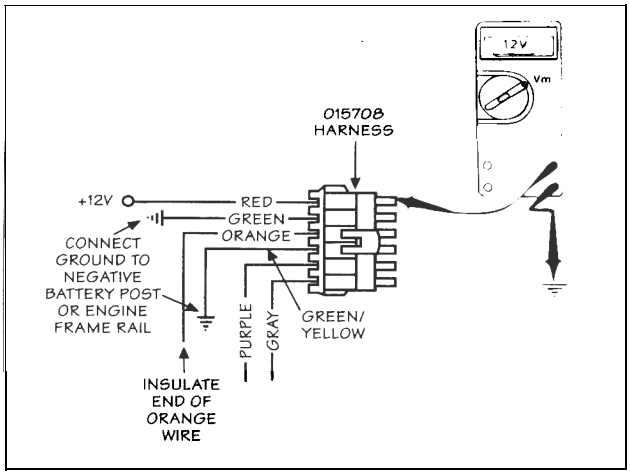


FIG. 1.1.20

Correction: With the ignition switch on, disconnect the P/N 015708 harness from the control module connector. Measure the voltage at the RED wire. Place the positive probe (+) of the voltmeter on the terminal of the RED wire and the negative probe (-) to ground. The voltmeter should read +12 VDC (Fig. 1.1.20). If this condition is not present, check that system is energized and check power supply.

Probable Cause: Check switches and connections

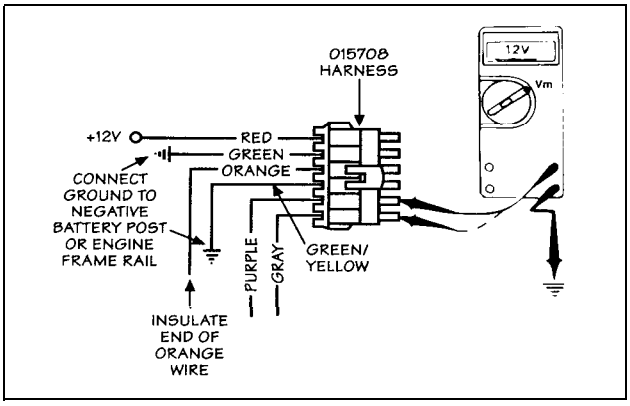


FIG. 1.1.21

Correction:

Optional Selector Switch: Disconnect P/N 015708 harness from control module. Measure voltage at both PURPLE and GRAY wires. With selector switch in HI position, both wires should read +12 VDC (Fig. 1.1.21). If this condition is not present, check power supply, connections and switches. Repair or replace as required.

Jacobs Switch Group: Disconnect P/N 017263 (017370) harness from Jacobs control module. Measure the voltage at the RED wire. The voltmeter should read +12 VDC when the main power supply is ON and O VDC with main power supply OFF (Fig. 1.1.22). If these conditions are not present, check power supply and connections.

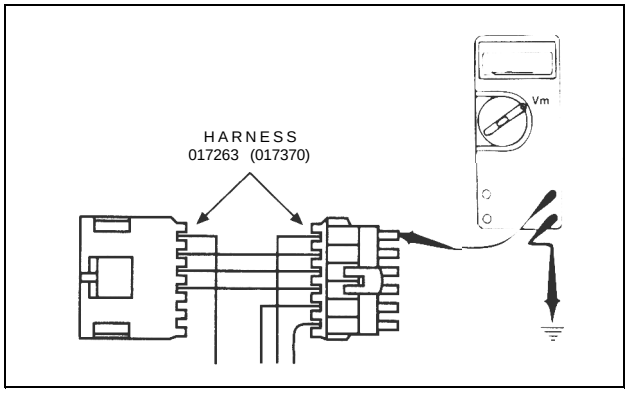


FIG. 1.1.22

(Fig. 1.1.23) With main power supply ON and selector switch in LO, the PURPLE wire should read +12 VDC and GRAY wire O VDC. With selector switch in MED position, GRAY wire should measure+12 VDC; PURPLE wire O VDC. With selector in HI position, both PURPLE and GRAY wires should measure +12 VDC. If these conditions are not present, check connections, check wiring schematic for proper position of wires to switch and/or replace switch.

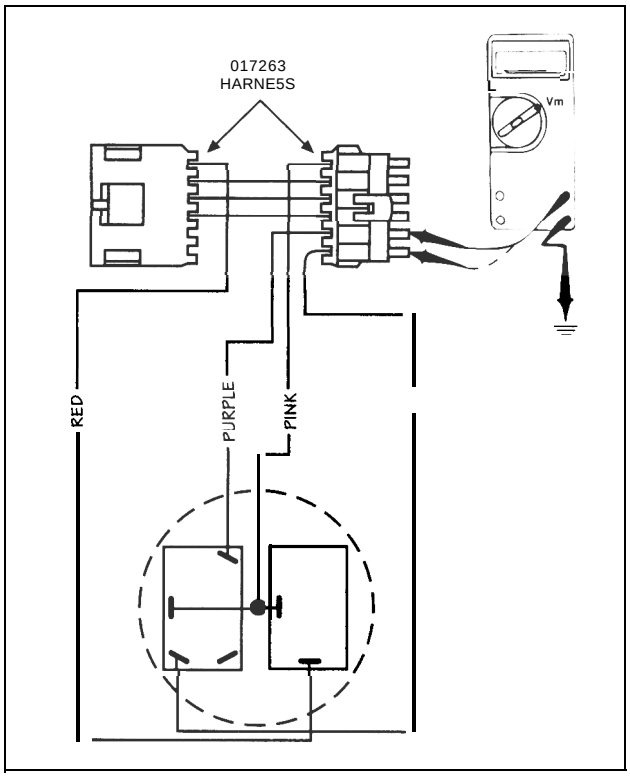


FIG. 1.1.23

Probable Cause: Check clutch switch.

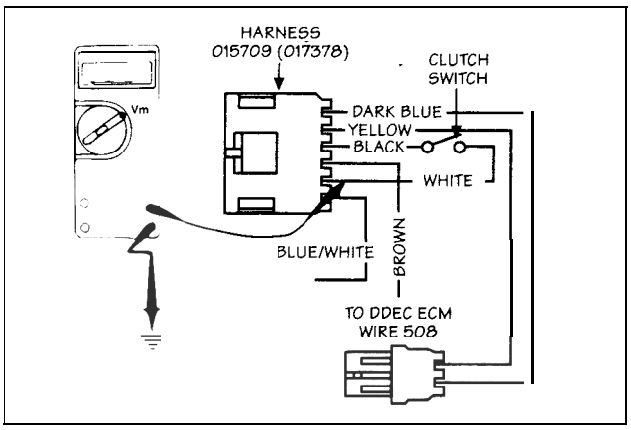


FIG. 1.1.24

Correction: With the P/N 015709 (017378) harness connected to the control module, measure the voltage at the terminal of the WHITE wire. With the clutch engaged (pedal not depressed), a reading of O VDC should be measured. With the clutch disengaged (pedal depressed) a reading of +5 VDC +/- 0.5 VDC should be measured (Fig. 1.1.24). If this condition does not exist, check continuity of clutch switch and BLACK and WHITE wires.

Probable Cause: Check engine brake enable signal.

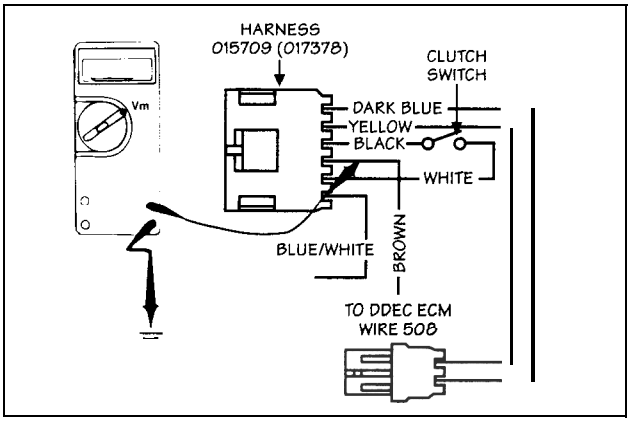


FIG. 1.1.25

Correction: Disconnect 015709 (017378) harness from 017179 module. Start the engine. Turn the engine brake switch OFF. Place the positive probe of the voltmeter at the terminal of the BROWN wire and the negative probe on ground (Fig. 1.1.25). Increase engine RPM to rated engine speed. The voltmeter should measure +12 VDC. Release throttle; voltage should drop to O VDC. When the engine reaches idle, the voltage should again read +12 VDC. If the voltage does not change, check connections and wiring. if problem continues, have the engine ECM checked.

Probable Cause: Check output.

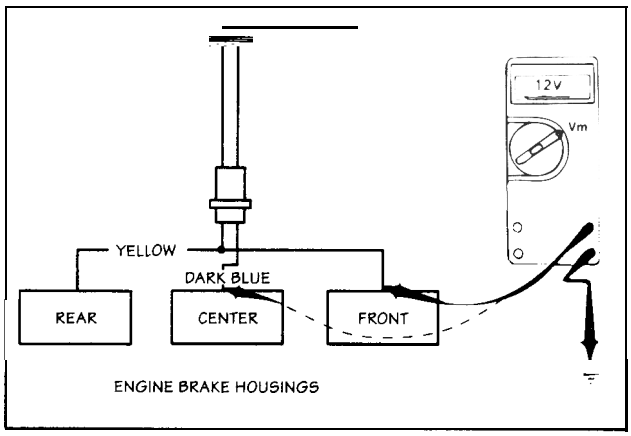


FIG. 1.1.26

Correction: Inspect DK BLUE and YELLOW wires leading to solenoid valve connectors. Check for loose contacts, pinched wires or scraped insulation. Start the engine, turn the engine brake switch ON and select HI. Advance the throttle to rated speed and then release the throttle. Voltage at both YELLOW and DK BLUE wires should measure +12 VDC (Fig. 1.1.26).

NOTE:

WHEN MEASURING VOLTAGE, CHECK THAT ALL HARNESS CONNECTIONS ARE TIGHT. IF THE VOLTAGE IS MEASURED WITH THE HARNESS FROM THE SOLENOID LOOSE OR DISCONNECTED, BOTH THE DK BLUE AND YELLOW WIRES WILL MEASURE APPROXIMATELY +1 VDC. THIS IS AN INTERNAL VOLTAGE ESTABLISHED BY THE CONTROL MODULE FOR REFERENCE.

Probable Cause: Check Jacobs control module.

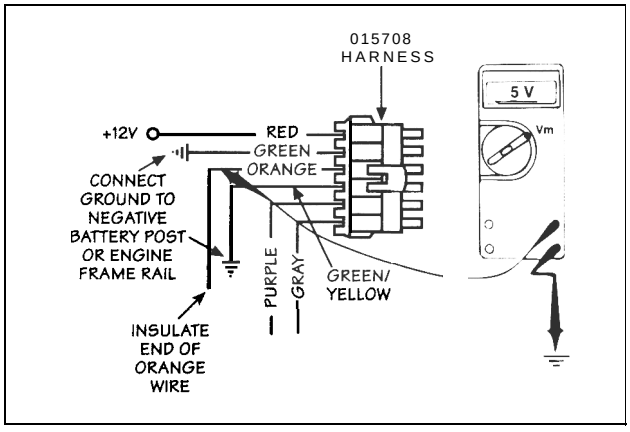


FIG. 1.1.27

Correction: Measure the voltage at the ORANGE wire of the control module. With system power ON, the voltage should measure +5 VDC +/- 0.5 VDC (Fig. 1.1.27). If this condition is not present, replace module.

Problem: Engine Brake performance erratic/intermittent

Probable Cause: Check ground connection.

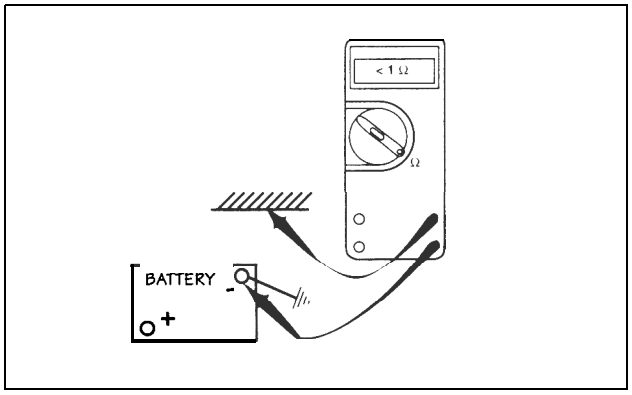


FIG. 1.1.28

Correction: The resistance between the engine block and the negative terminal of the battery must be less than 1 ohm (Fig. 1.1.28). The resistance between the GREEN wire of the engine brake control module and the negative terminal of the battery must be less than 5 ohms for-proper module operation (Fig. 1.1.29).

If vehicle is NOT equipped with ABS system:

The GREEN/YELLOW wire must be grounded, preferably to the same point as the GREEN wire. These wires should be isolated from other system ground wires. The ORANGE wire must not be grounded and must be insulated when not in use (no ABS).

Vehicles equipped with ABS system:

Refer to specific ABS or vehicle manufacturer's electrical wiring diagrams or consult a Jacobs distributor for more information

Probable Cause: Check undercover wiring.

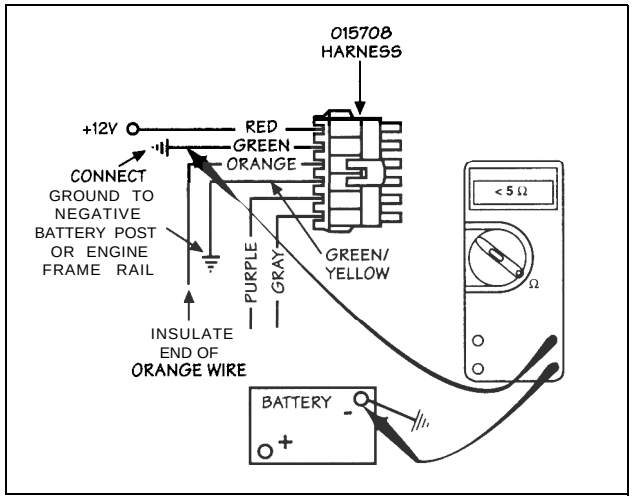


FIG. 1.1.29

Correction: Make sure solenoid wires are securely attached to the solenoid valves.

Probable Cause: Check for solenoid failure.

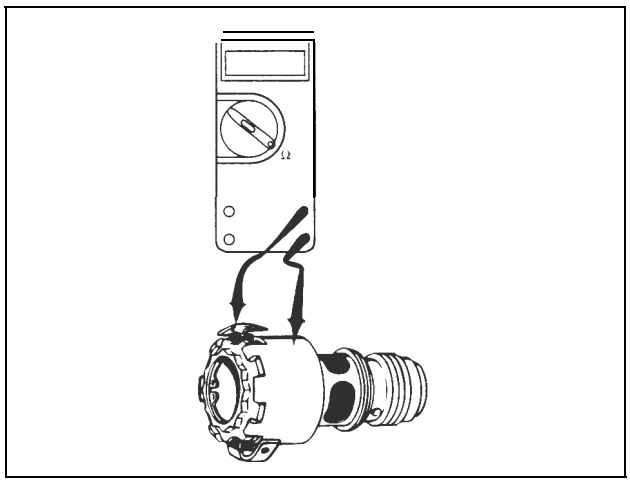


FIG. 1.1.30

Correction: Measure resistance of each solenoid valve (Fig. 1.1.30). Solenoid valves not within correct values must be replaced.

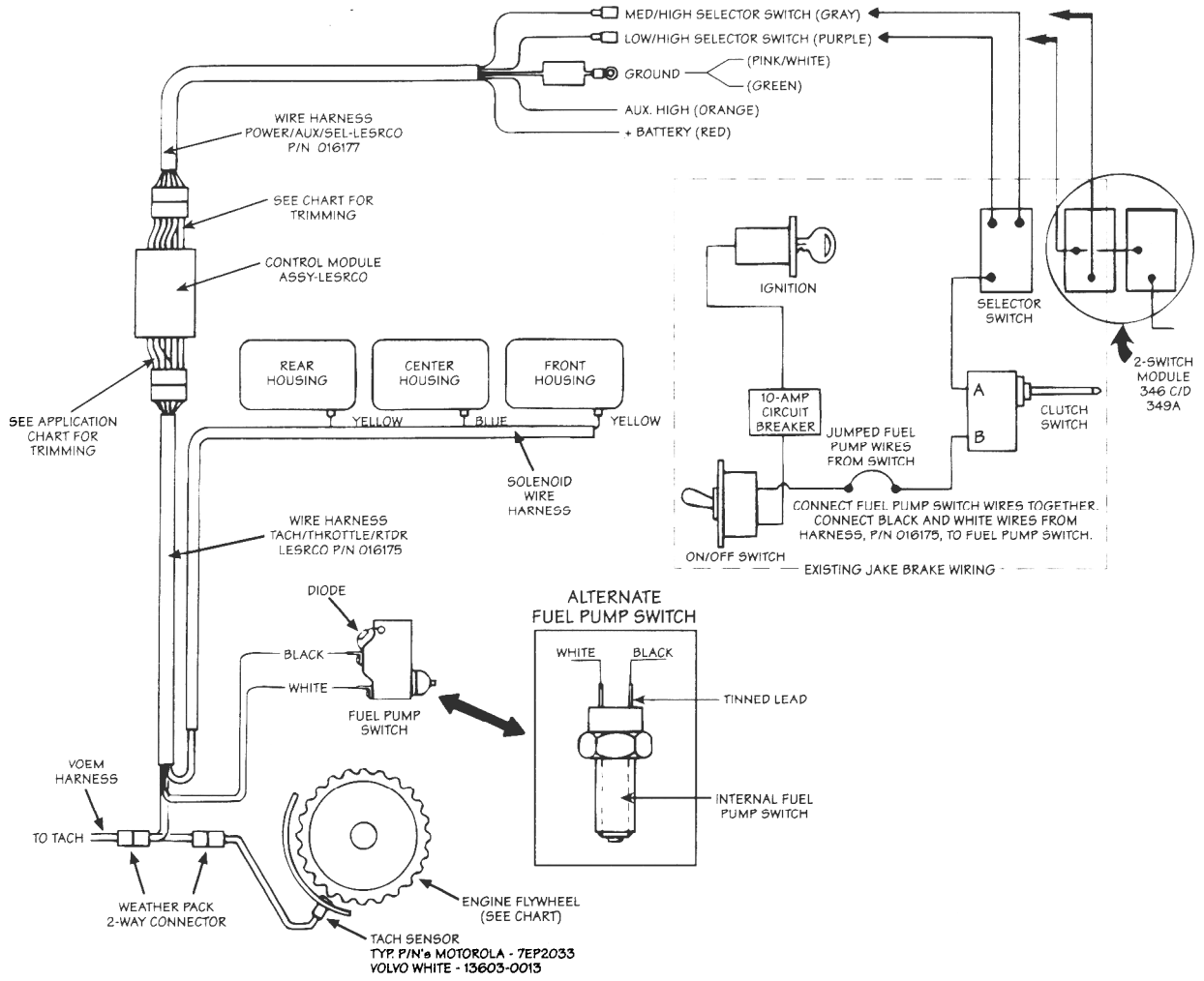
NOTE:

RESISTANCE MAY INCREASE SIGNIFICANTLY WHEN SOLENOID VALVES ARE AB0VE 100° F. SEE FIG. 1.1.9, PAGE 1.1.5, FOR ELECTRICAL REQUIREMENTS.

Probable Cause: Check Allison ATEC automatic transmissions.

Correction: Check that the BLUE/WHITE wire from the control module is connected to the ATEC ECM wire #211. The WHITE wire from the control module is connected to ATEC ECM wire #213. The BLACK wire from the control module must be insulated.

Low Engine Speed Retarder Cutoff



Application Chart

Engine Make and Model	Flywheel Teeth	Cut-off Speed (RPM)	Trim Required
Mack, Cummins NT	118	850	Cut both green/yellow and blue/white
Cummins 10 Liter	105	950	Cut both green/yellow and blue/white
CAT 3406	113	880	Cut both green/yellow and blue/white
CAT 3406	113	1060	Cut green/yellow only
CAT 3306	132	910	Cut green/yellow only
CAT 3306	156	960	Cut blue/white only

Refering to the chart above, select the engine make and model and the desired cut-off speed (RPM) and cut the Control Module wires accordingly. Install caps on the ends of wires for insulation.

FIG. 1.1.31

Troubleshooting: Low Engine Speed Retarder Cut-off

Problem: Engine Brake will not operate.

Probable Cause: Power supply wire (red) disconnected, not energized.

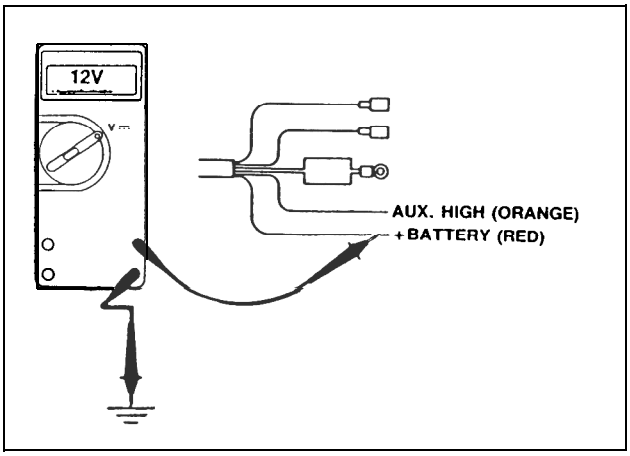


FIG. 1.1.32

Correction: Check that the connector between the vehicle power supply and the red line to the Jacobs control module is tight and free of any corrosion or oil. With the vehicle ignition turned on, +12 VDC must be measured at the red fire (Fig. 1.1.32). if not, continue with checks.

Probable Cause: Blown fuse or circuit breaker.

Correction: Replace fuse (10 amp) or reset circuit breaker. Search for cause of blown condition.

Probable Cause: Disconnected or bad fuel pump switch.

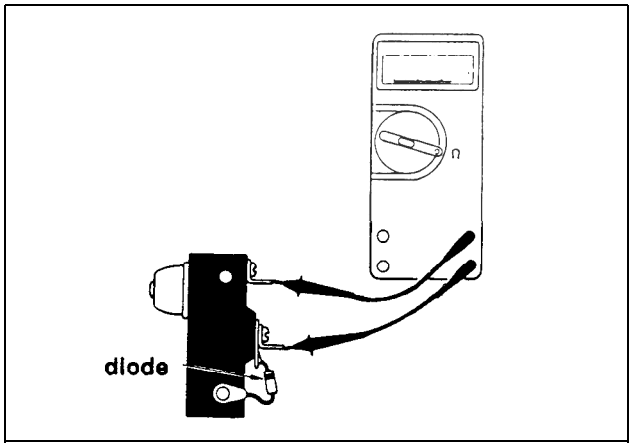


FIG. 1.1.33

Correction: Check that connections are made and are tight. Check for corrosion on terminals and clean as required. Check function of fuel pump switch. With the switch open, the VOM should register an “0. L.” condition (Fig. 1.1.33). With the switch closed (plunger released), the VOM should register continuity. Replace or adjust as needed.

Probable Cause: Disconnected or failed clutch switch.

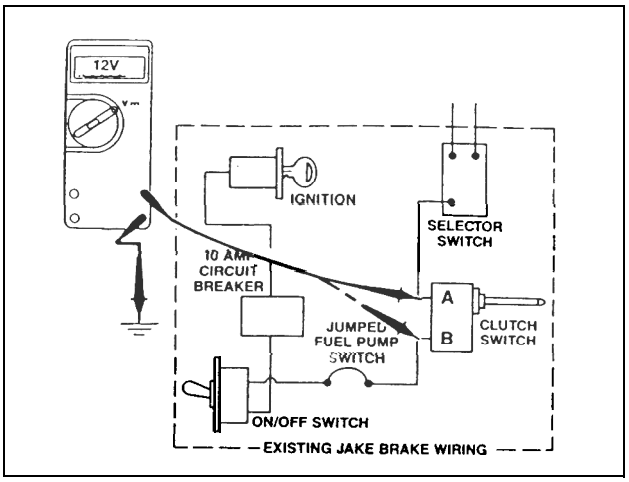


FIG. 1.1.34

Correction: Check that connections are tight on the clutch switch terminals. Check that there is no corrosion on connectors. Clean or replace as required. Check the clutch switch. With ignition ON and the Jacobs ON/OFF switch ON, measure the voltage at “A” (Fig. 1.1.34). VOM should read +12.5 VDC. At position “B” with switch closed, VOM should measure +12.5 VDC; with switch open, O VDC at position “B”.

Probable Cause: Disconnected or failed selector switch.

Correction: Selector switch LO: 12.5 +/- 1 VDC must be applied to the purple wire to activate the blue solenoid output wire.

Selector switch MED/HI: 12.5 +/- 1 VDC must be applied to the gray wire to activate the yellow solenoid output wire.

Probable Cause: Orange wire grounded.

Correction: ABS (Aux) connection High: Orange wire for normal operation is not used. If connected to VOM, reading should be +5 VDC. If connected to ground, engine brake will not operate.

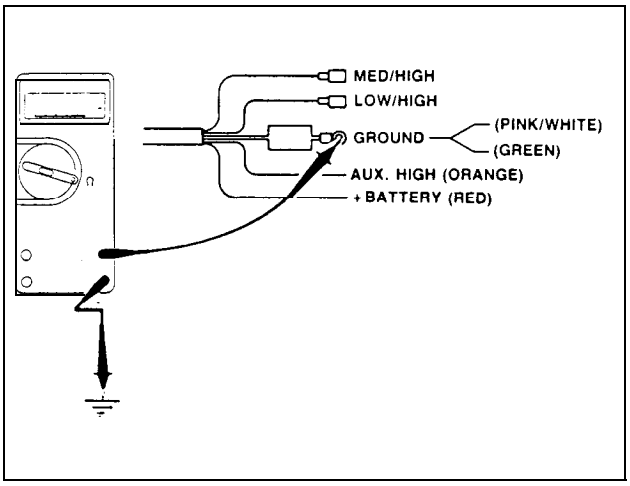


FIG. 1.1.35

Probable Cause: Pink/white wire not grounded.

Correction: ABS connection LOW: pink/white wire is, for most applications, connected to ground with the green wire. If not connected to ground, brakes will not operate. VOM reading when not connected should be +5 VDC (Fig. 1.1.35).

Probable Cause: Green wire not grounded or inadequately grounded.

Correction: Ground reference must be 1 ohm or less measure with VOM.

Probable Cause: Trim wires not properly cut

Correction: Check application chart (Fig. 1.1.31) for proper wires to be cut.

Probable Cause: Failed or disconnected tach sender.

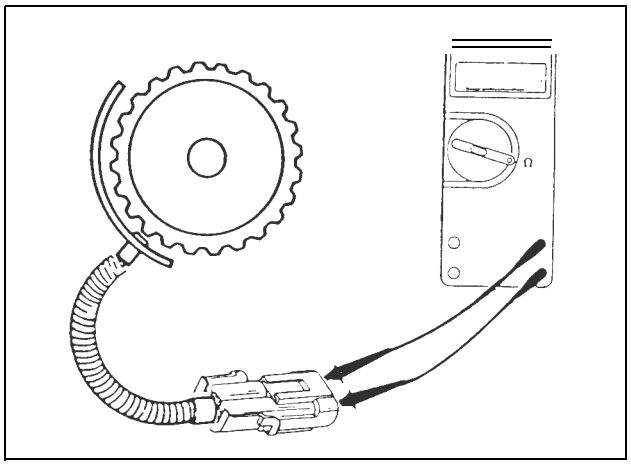


FIG. 1.1.36

Correction: Check that connections are tight with no evidence of corrosion. Disconnect harness at the control module. Measure resistance between tach sender wires; 50-300 ohms is a good reading (Fig. 1.1.36). The Motorola 7EP2033 or Volvo/white 13603-0013 will read 245-255 ohms.

Readings outside the accepted range indicate a short circuit or broken wire.

The sensor must be properly adjusted to manufacturers' specifications to generate the proper signal.

Probable Cause: Bad control module.

Correction: If all the above steps check OK, replace control module.

Problem: Brake modulation does not work properly.

Probable Cause: Gray and purple input wires not connected or improperly connected to switch.

Correction: Check for tight connections and no corrosion.

- Gray wire to MED/HIGH selector position.
- Purple to LO selector position.

Probable Cause: Selector switch failure.

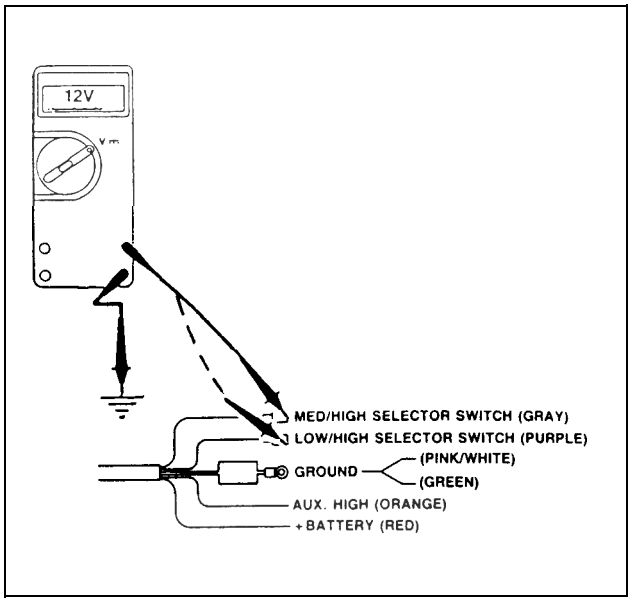


FIG. 1.1.37

Correction: With the selector switch in LO position, ignition ON and ON/OFF switch ON, measure voltage output at purple wire (Fig. 1.1.37). Proper reading should be 12.5 +/- 1 VDC. Measure output at gray wire. Output should be 0 VDC. Select HI position on selector. VOM should read 12.5 +/- 1 VDC at each output terminal.

Probable Cause: Blue and yellow output wires disconnected or reversed.

Correction: Check to be sure connectors are tight and there are no signs of corrosion. Check that the blue wire is attached to the center housing (3-housing installation) or the rear housing (2-housing installation). Insure the yellow harness is attached to the front or first and third housings.

With the engine operating, transmission in neutral, dash switch on, selector switch on HI, accelerate engine to high idle and then release throttle. The VOM readings at the blue and yellow wires should be 12 VDC (Fig. 1.1.38).

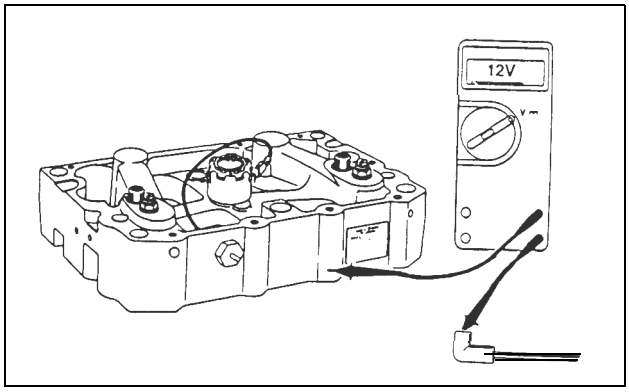


FIG. 1.1.38

Check that 12 VDC is present at housing connector(s). If engine brake does not operate, remove valve cover(s).

Probable Cause: Solenoid valve does not function.

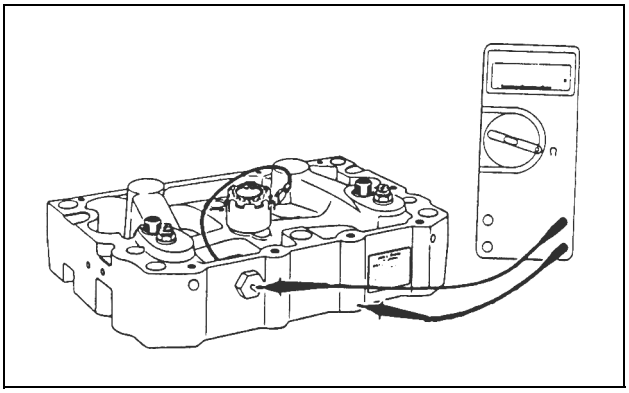


FIG. 1.1.39

Correction: Check to be sure solenoid harness is properly connected.

With electrical power OFF, check resistance of solenoid coil. VOM should read 9.75-10.75 ohms (Fig. 1.1.39). If it does not, replace solenoid valve.

Problem: Engine Brake operation erratic.

Probable Cause: improper ground.

Correction: Using the VOM, measure the resistance from the point the green wire if grounded to the engine block. Resistance must be no greater than 1 ohm. If resistance is greater than 1 ohm, the ground wire must be repositioned to the engine block.

The green ground and the pink/white wire must be grounded alone. Grounding with other components at a common point may lead to “phantom” signals causing erratic operation.

Probable Cause: Improper or insufficient tach signaL

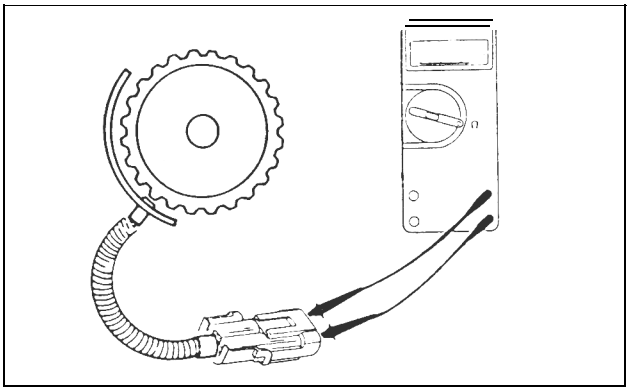


FIG. 1.1.40

Correction: Disconnect Weather pack connector from Jacobs control module. Measure the resistance between the two wires from the tach sender (FiG. 1.1.41). An acceptable reading will be from 50 to 300 ohms. The Motorola 7EP2033 or Volvo/White 13603-0013 will read between 245-255 ohms. Readings outside this range indicate a short circuit or broken wires.

Probable Cause: Check that the tach sender is properly adjusted.

Correction: With engine running, measure AC voltage signal between 500-800 RPM and record reading (Fig. 1.1.41). Above 1000 RPM, the VAC should be greater. If it is not, replace the sending unit.

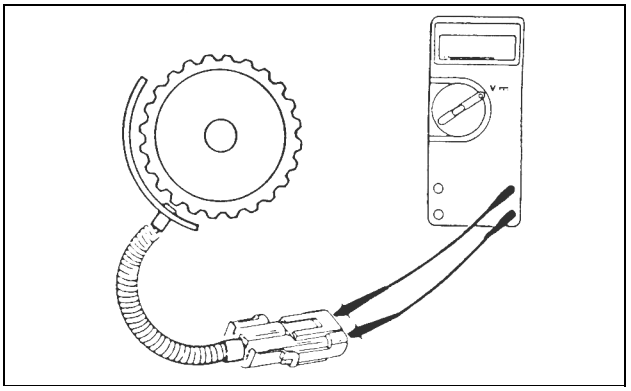


FIG. 1.1.41

Probable Cause: Insufficient tach ground

Correction: Measure the resistance of each tach sender wire to ground (Fig. 1.1.42). The one wire with a reading of O ohms is at ground potential. This wire should be cut and the two ends insulated. If the problem continues, add a separate sending unit for the low speed signal.

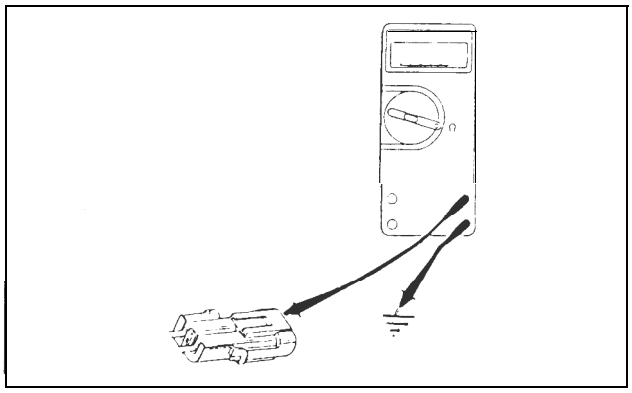


FIG. 1.1.42

Basic Wiring Diagrams

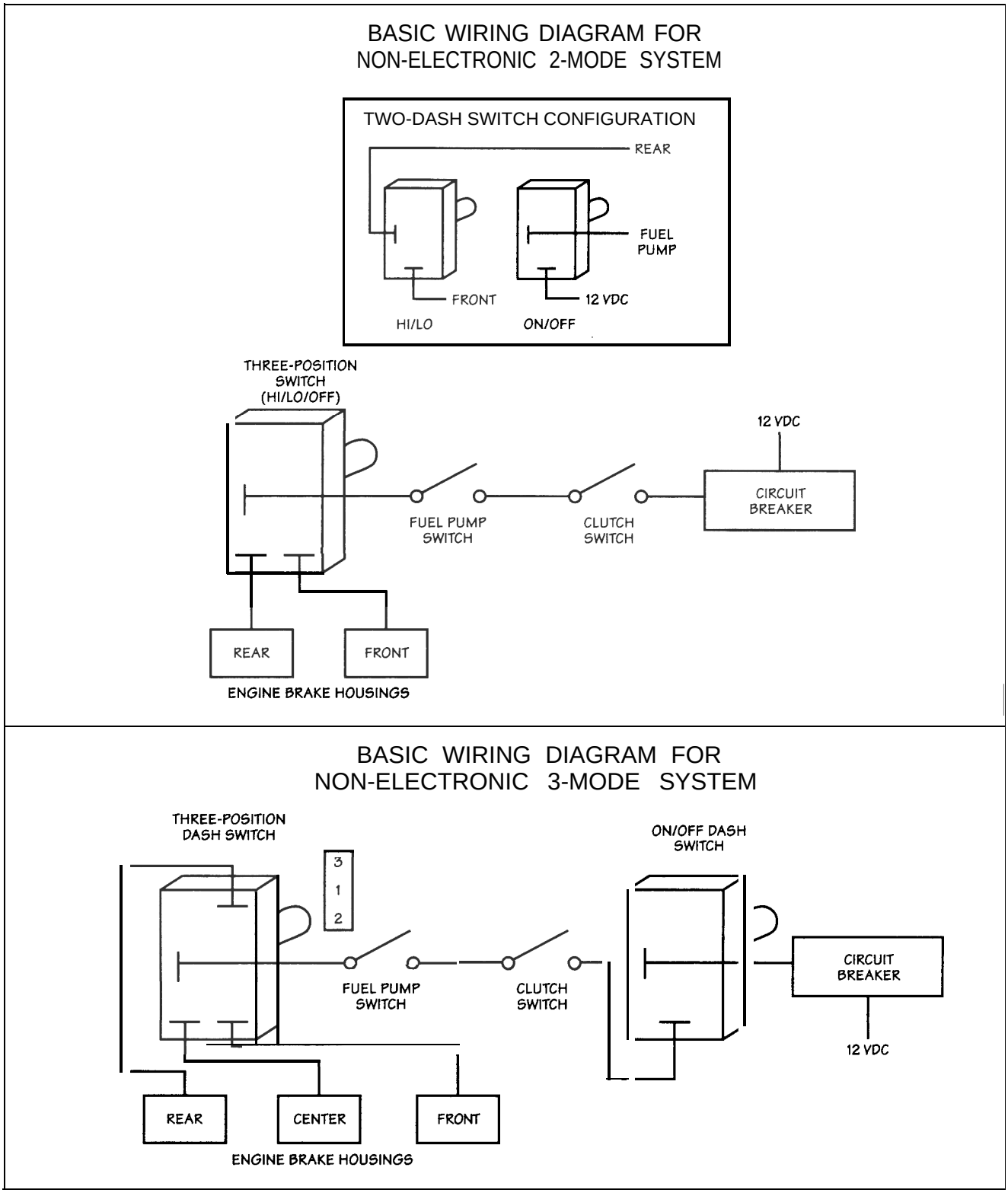


FIG. 1.1.43

Caterpillar Cab Controls

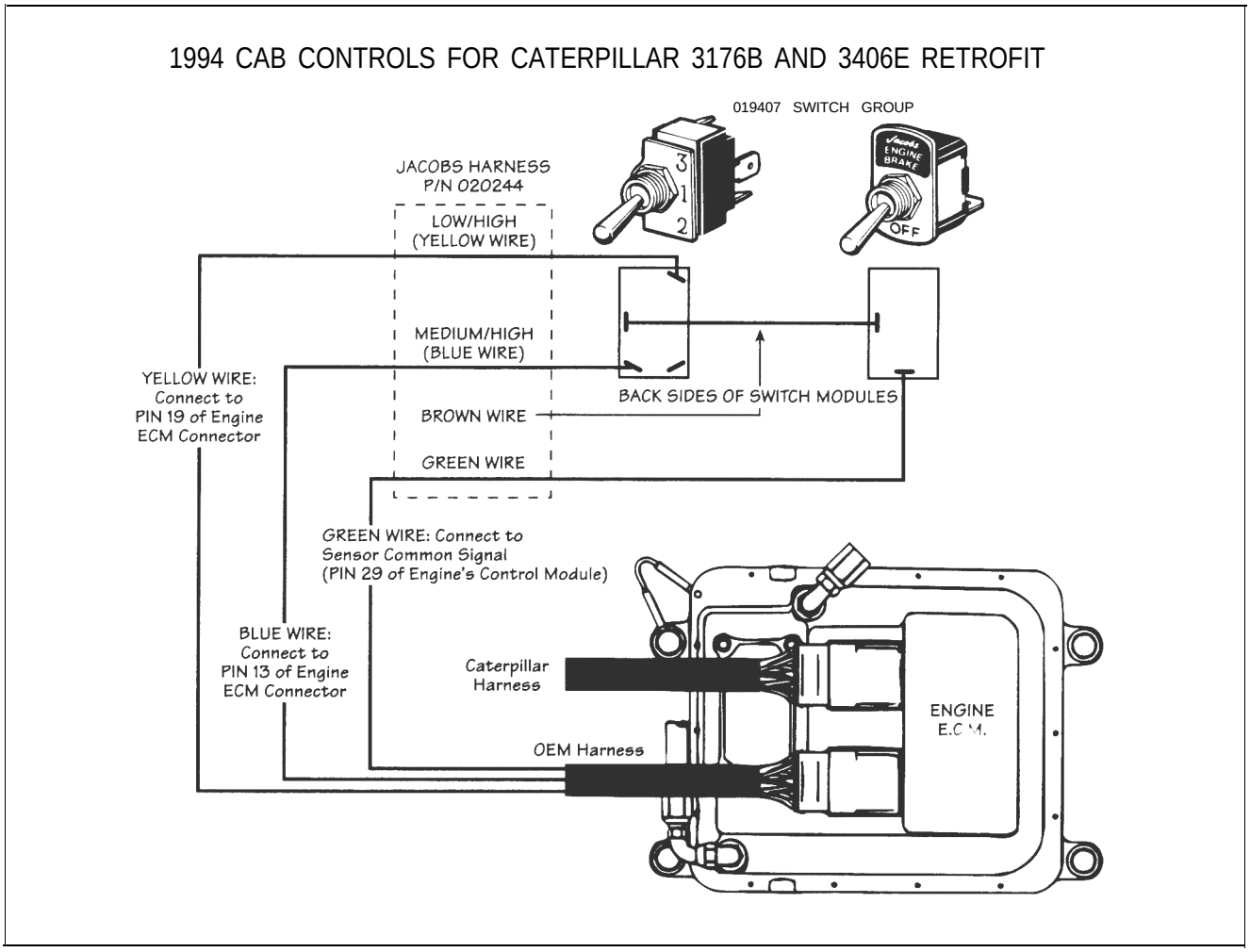


FIG. 1.1.44

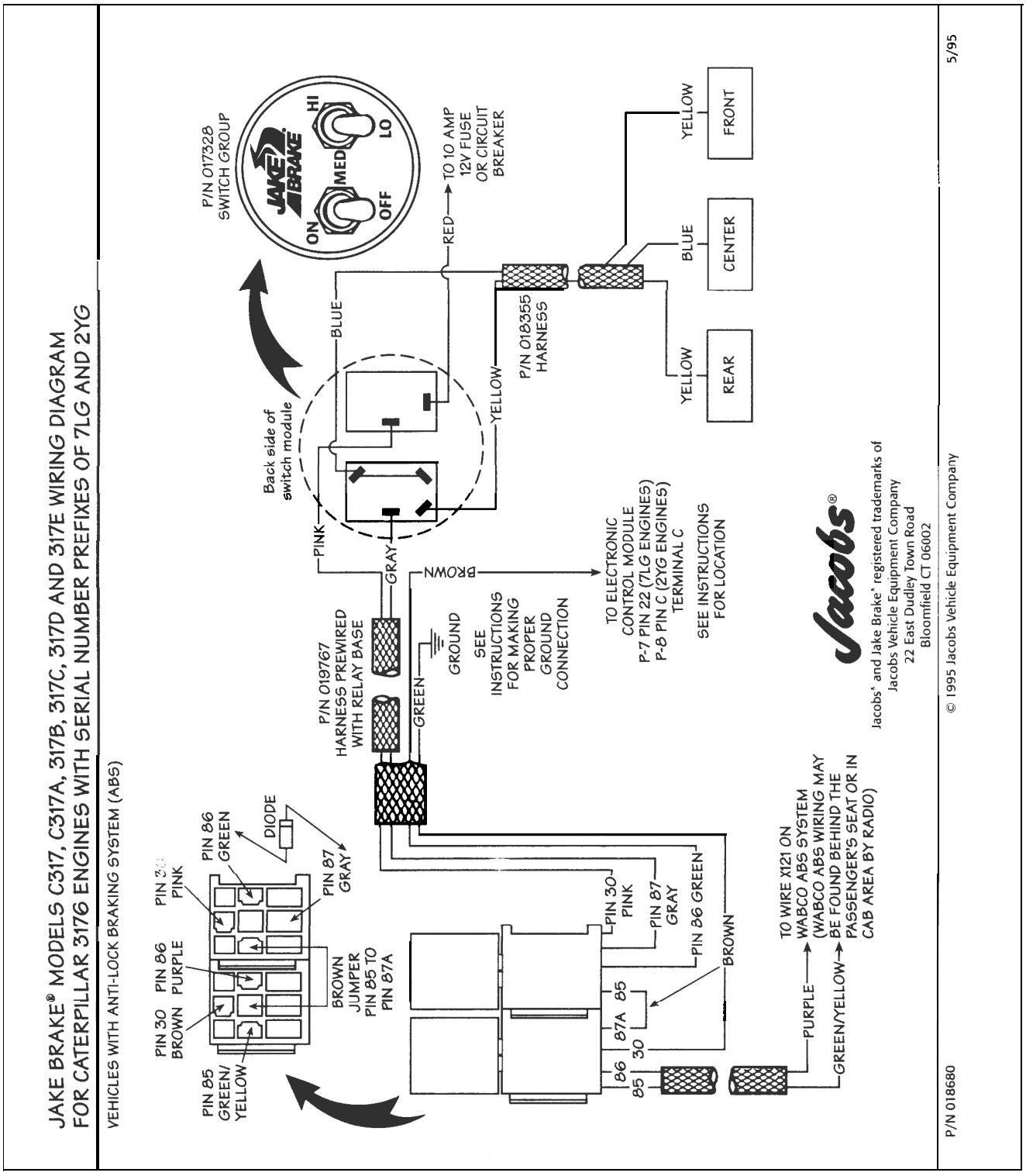
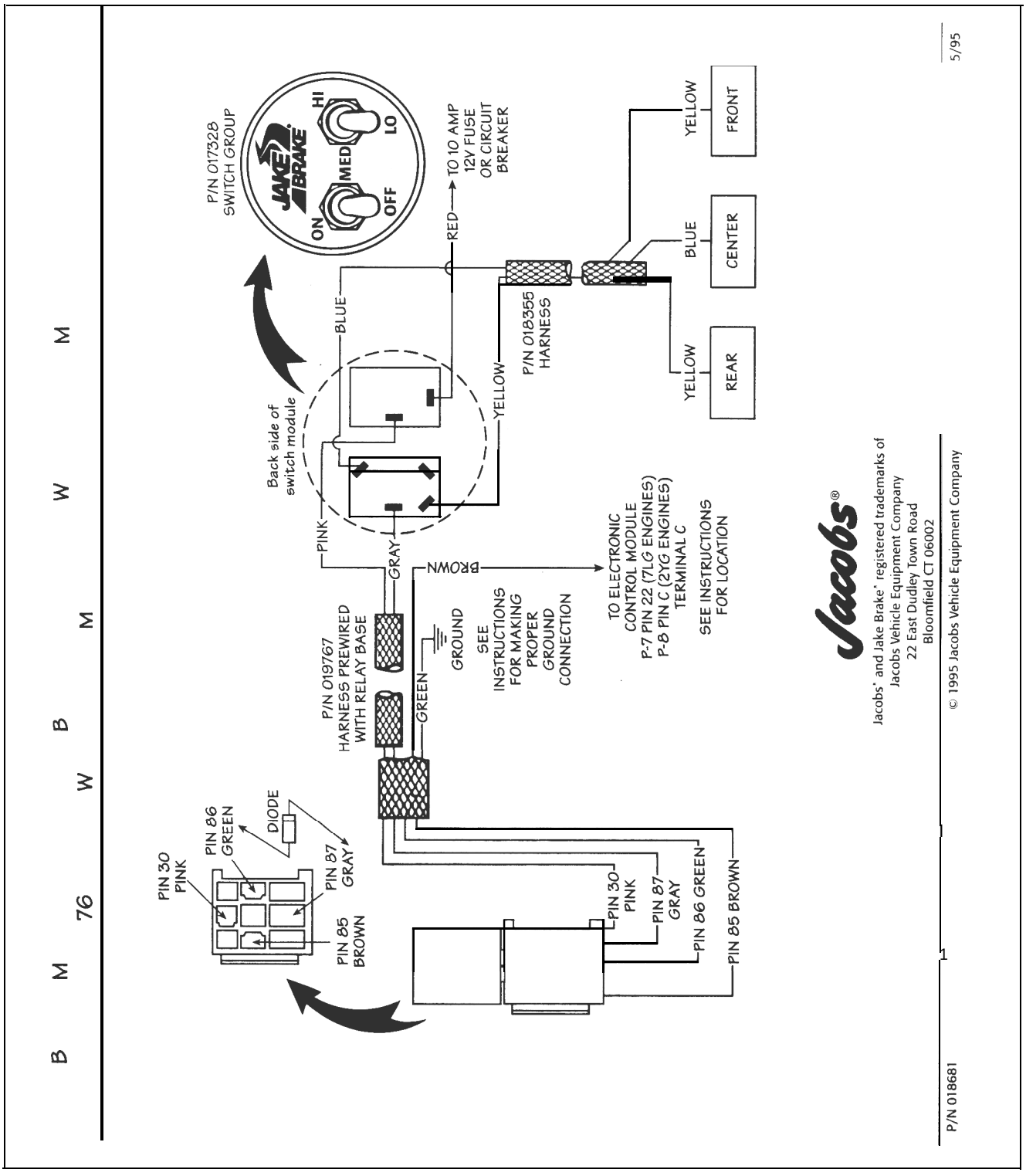

JAKE BRAKE® MODELS C317, C317A, 317B, 317C, 317D AND 317E WIRING DIAGRAM
FOR CATERPILLAR 3176 ENGINES WITH SERIAL NUMBER PREFIXES OF 7LG AND 2YG
VEHICLES WITH ANTI-LOCK BRAKING SYSTEM (ABS)
P/N 017328 SWITCH GROUP
HI
LO
MED
OFF
ON
JAKE BRAKE
TO 10 AMP 12V FUSE OR CIRCUIT BREAKER
RED
BLUE
YELLOW
P/N 018355 HARNESS
FRONT
CENTER
REAR
Back side of switch module
PINK
GRAY
BROWN
GREEN
P/N 019767 HARNESS PREWIRED WITH RELAY BASE
GROUND
SEE INSTRUCTIONS FOR MAKING PROPER GROUND CONNECTION
TO ELECTRONIC CONTROL MODULE P-7 PIN 22 (7LG ENGINES) P-8 PIN C (2YG ENGINES) TERMINAL C
SEE INSTRUCTIONS FOR LOCATION
DIODE
PIN 86 GREEN
PIN 87 GRAY
PIN 30 PINK
PIN 86 PURPLE
PIN 30 BROWN
PIN 85 GREEN/ YELLOW
BROWN JUMPER PIN 85 TO PIN 87A
PIN 30 PINK
PIN 87 GRAY
PIN 86 GREEN
BROWN
86 87A 85
85 30
TO WIRE X121 ON WABCO ABS SYSTEM (WABCO ABS WIRING MAY BE FOUND BEHIND THE PASSENGER'S SEAT OR IN CAB AREA BY RADIO)
PURPLE
GREEN/YELLOW
Jacobs®
Jacobs' and Jake Brake® registered trademarks of Jacobs Vehicle Equipment Company
22 East Dudley Town Road
Bloomfield CT 06002
© 1995 Jacobs Vehicle Equipment Company
P/N 018680
5/95

FIG. 1.1.45


B M 76 W B M W M
P/N 017328
SWITCH GROUP
JAKE BRAKE
ON
OFF
MED
HI
LO
TO 10 AMP
12V FUSE
OR CIRCUIT
BREAKER
RED
BLUE
YELLOW
P/N 018355
HARNESS
FRONT
CENTER
REAR
Back side of
switch module
PINK
GRAY
BROWN
GREEN
P/N 019767
HARNESS PREWIRED
WITH RELAY BASE
GROUND
SEE
INSTRUCTIONS
FOR MAKING
PROPER
GROUND
CONNECTION
TO ELECTRONIC
CONTROL MODULE
P-7 PIN 22 (7LG ENGINES)
P-8 PIN C (2YG ENGINES)
TERMINAL C
SEE INSTRUCTIONS
FOR LOCATION
DIODE
PIN 30
PINK
PIN 86
GREEN
PIN 87
GRAY
PIN 85
BROWN
PIN 86 GREEN
PIN 85 BROWN
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P/N 018681
1

FIG. 1.1.46

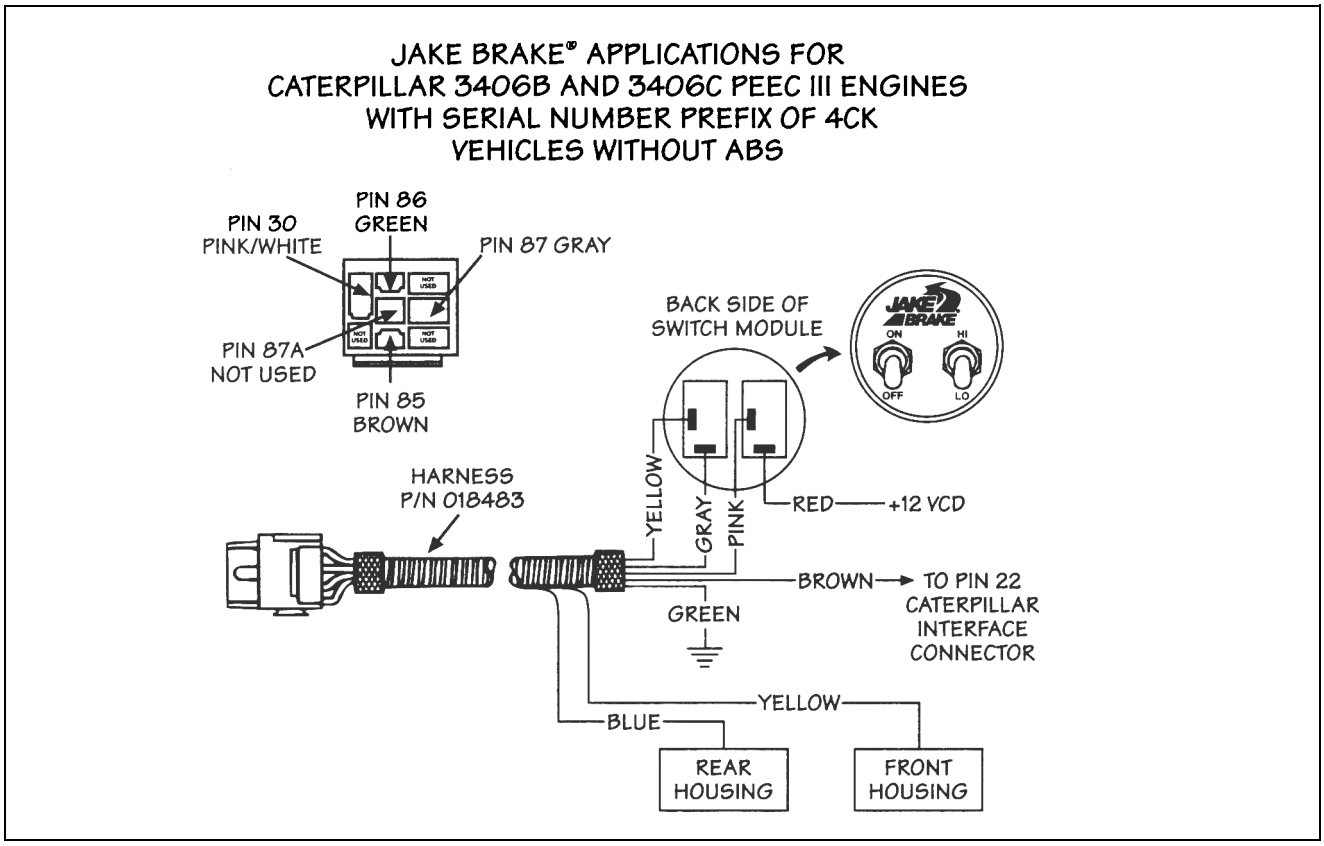

JAKE BRAKE® APPLICATIONS FOR
CATERPILLAR 3406B AND 3406C PEEC III ENGINES
WITH SERIAL NUMBER PREFIX OF 4CK
VEHICLES WITHOUT ABS
PIN 30
PINK/WHITE
PIN 86
GREEN
PIN 87 GRAY
PIN 87A
NOT USED
PIN 85
BROWN
BACK SIDE OF
SWITCH MODULE
JAKE BRAKE
ON
HI
OFF
LO
HARNESS
P/N 018483
YELLOW
GRAY
PINK
RED
+12 VCD
BROWN
TO PIN 22
CATERPILLAR
INTERFACE
CONNECTOR
GREEN
YELLOW
BLUE
REAR
HOUSING
FRONT
HOUSING

FIG. 1.1.47

Wiring Diagrams for Cummins CELECT

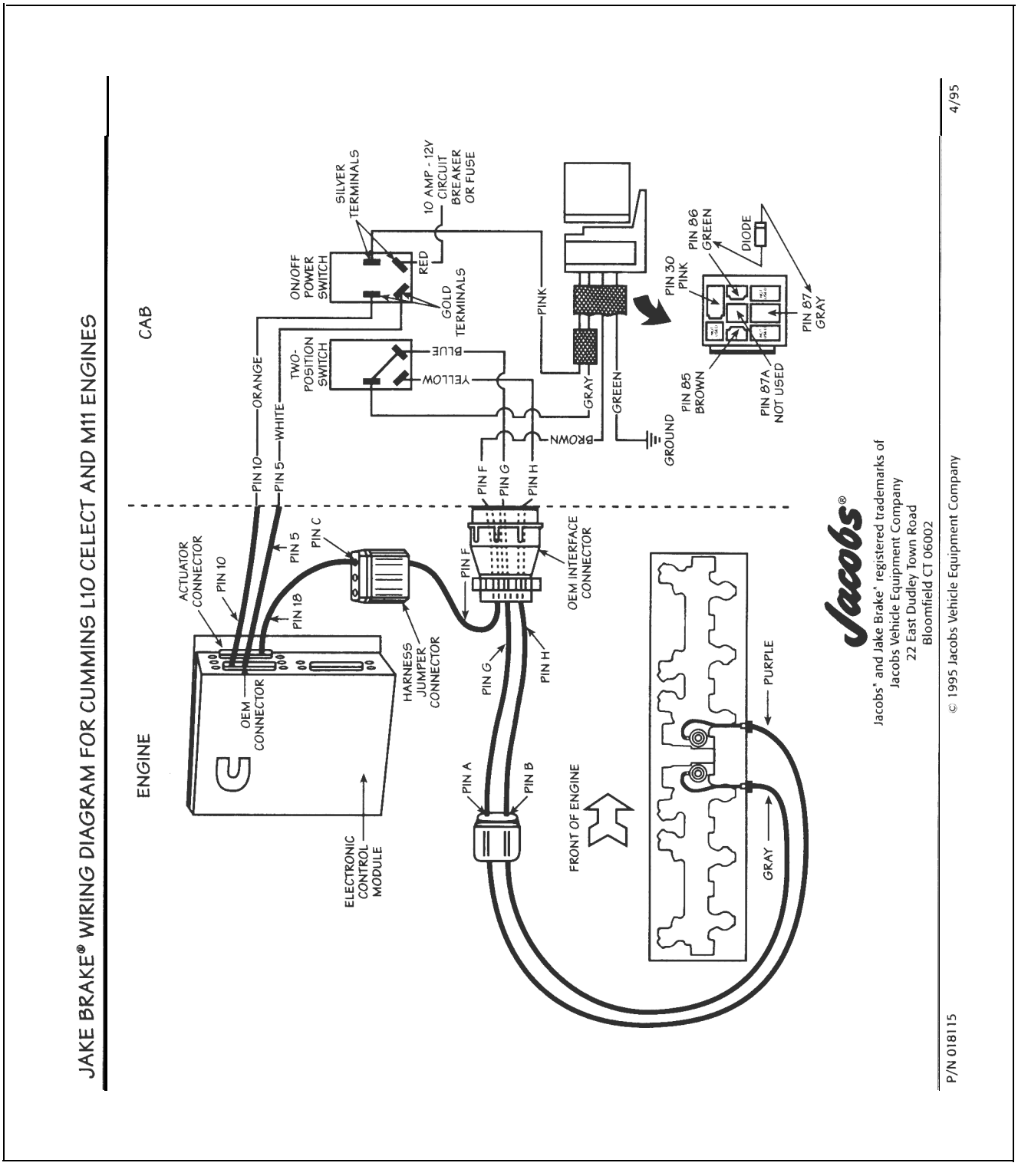


FIG. 1.1.48

Wiring Diagrams for Cummins CELECT

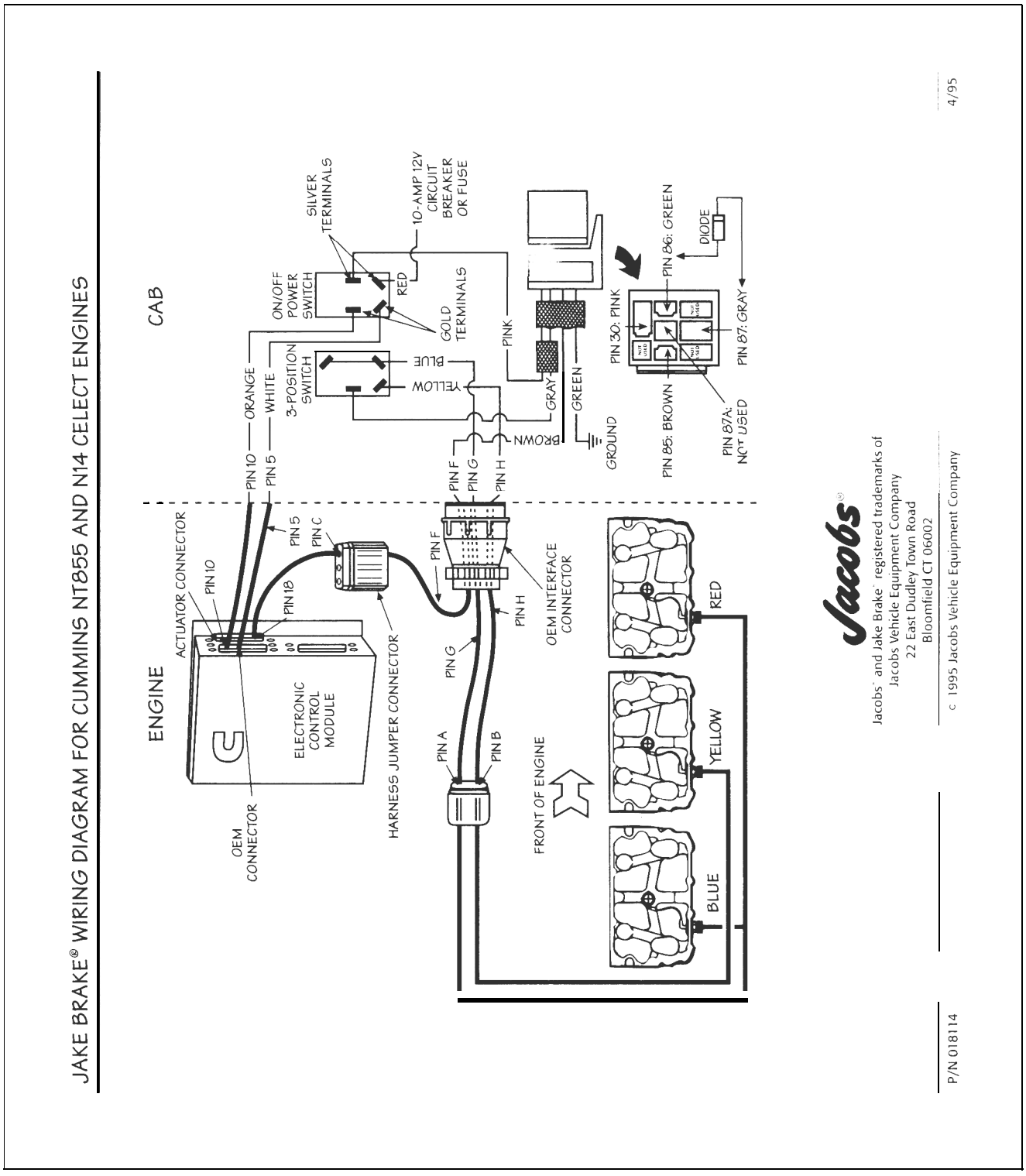


FIG. 1.1.49

Wiring Diagrams for DDC Engines

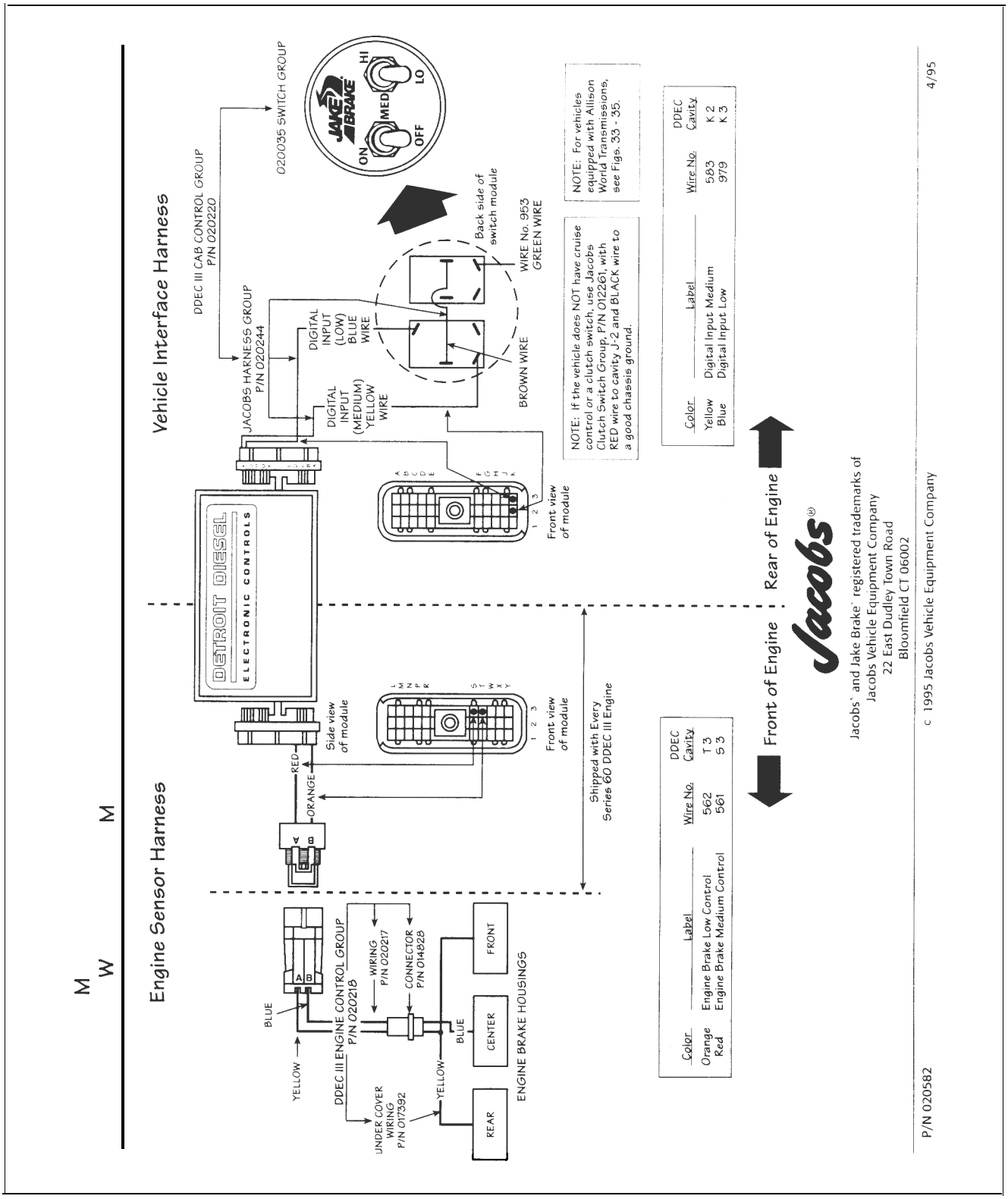


FIG. 1.1.50

Wiring Diagrams for DDC Engines

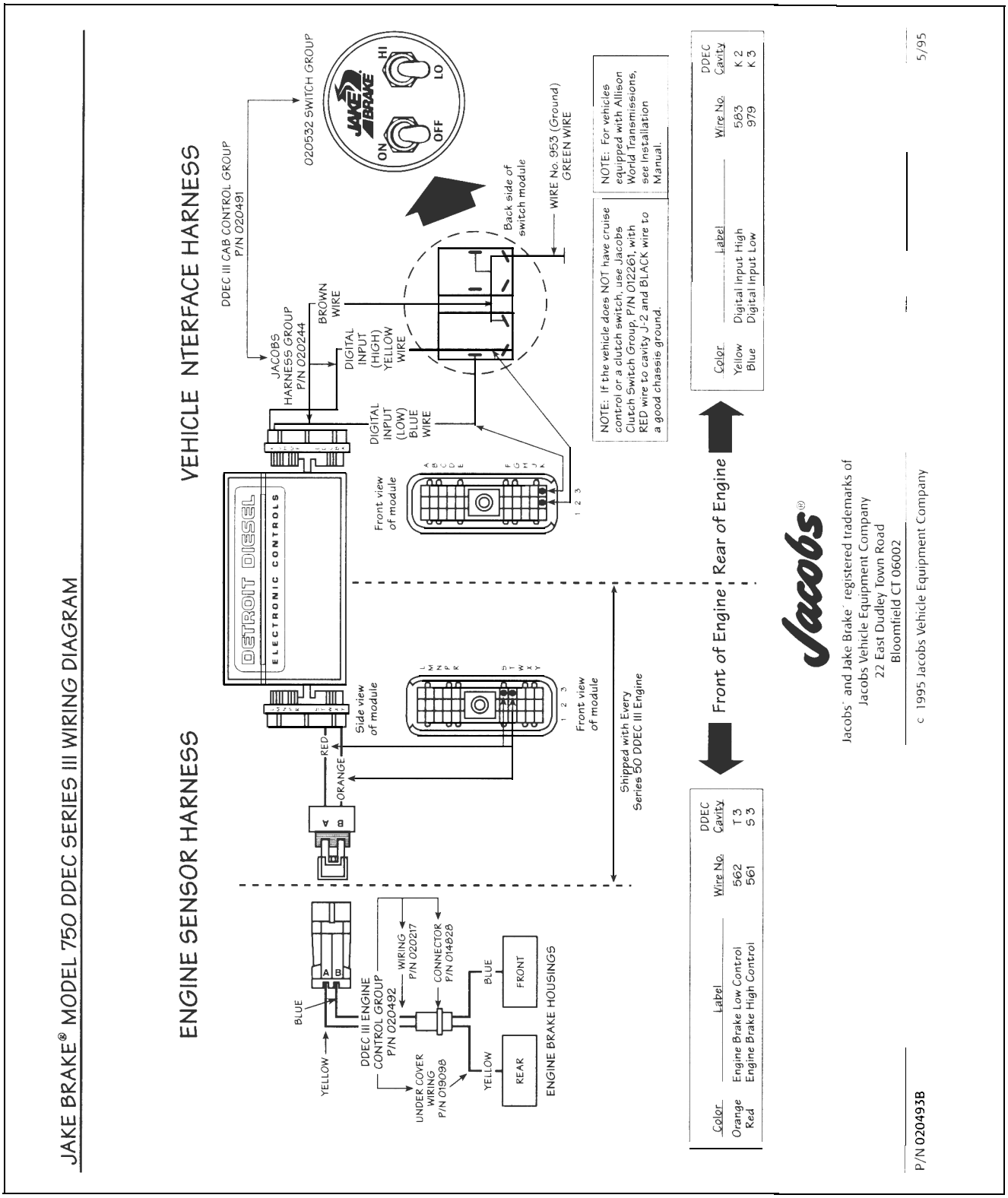


FIG. 1.1.51

Wiring Diagrams for DDC Engines

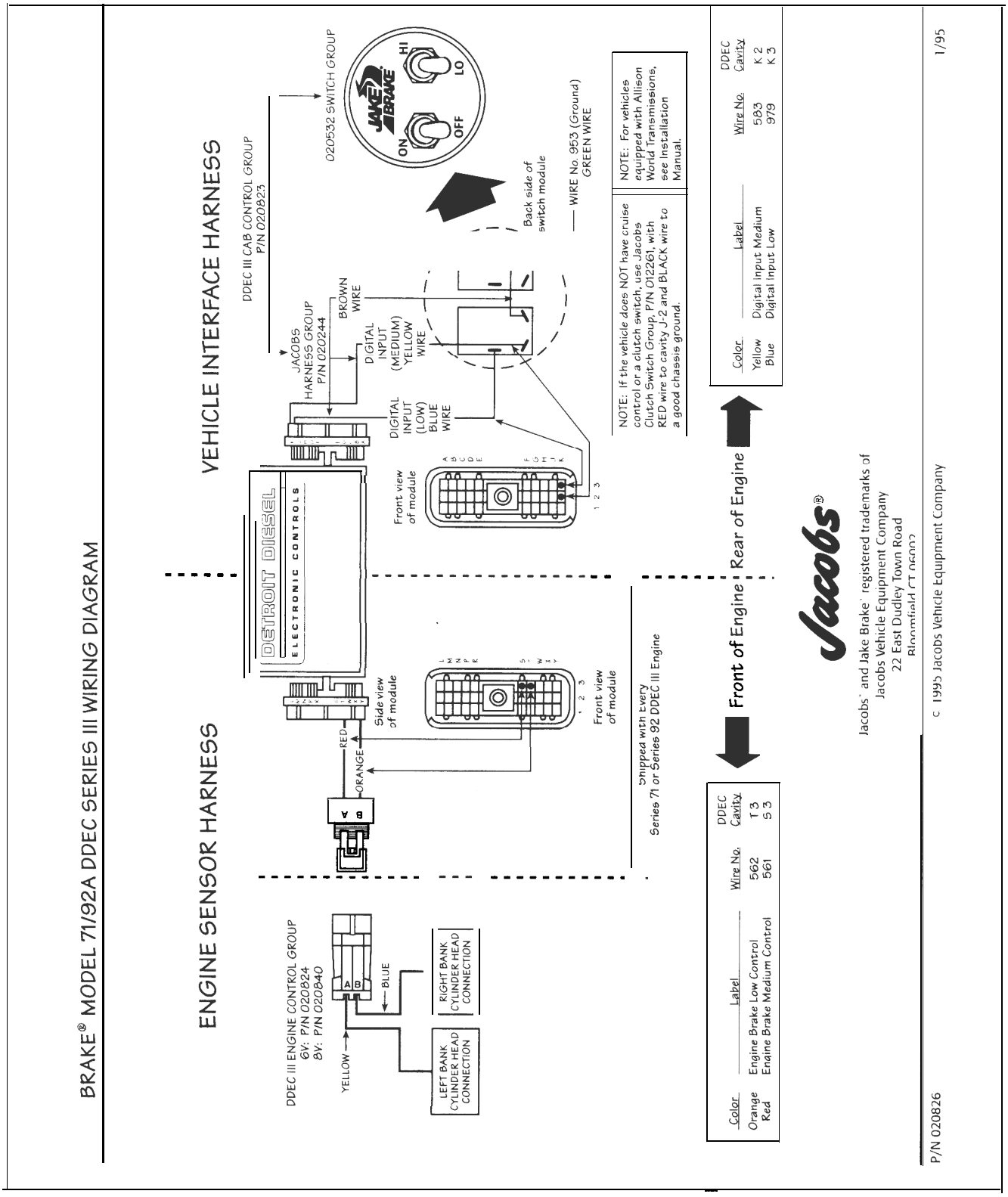


FIG. 1.1.52

1.2 Hydraulic/Mechanical

Theory of Operation

When an engine brake is energized, a power- producing diesel engine is converted into a power-absorbing air compressor. As shown in the schematic diagrams below, this is accomplished by the motion of a master-slave piston arrangement. Near the top of the normal compression stroke, the cylinder exhaust valves open releasing a compressed, cylinder charge to the exhaust system, preventing the engine from producing positive power.

Operational Sequence

Step 1 (Fig. 1.2.1)

The main components of the hydraulic system are the solenoid valve, the control valve, the master piston and the slave piston. The control valve and the solenoid valve regulate the flow of the engine oil, which acts as Jake Brake hydraulic fluid. As shown in this figure, when the Jake Brake is not in operation, the solenoid valve is closed, preventing engine oil from entering the system and allowing oil to drain to the sump from the previous operation.

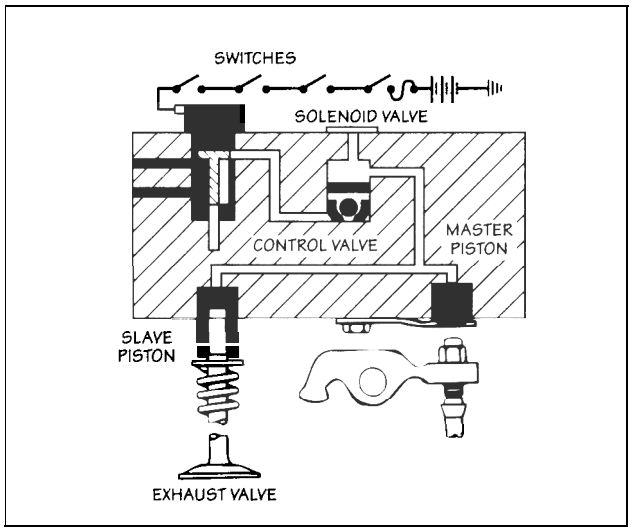


FIG. 1.2.1

Step 2 (Fig. 1.2.2)

When the solenoid valve is actuated, oil fills the passageway to the control valve. This exerts enough force to raise the control valve inside its bore and unseat the check ball inside the control valve. Engine oil then flows out through the control valve cross-port, fills the passageway between the slave and master pistons, and forces the master piston down against the injector rocker lever adjusting screw, or in some engines, the exhaust rocker lever adjusting screw of an alternate cylinder. This sequence connects engine camshaft motion to engine brake timing.

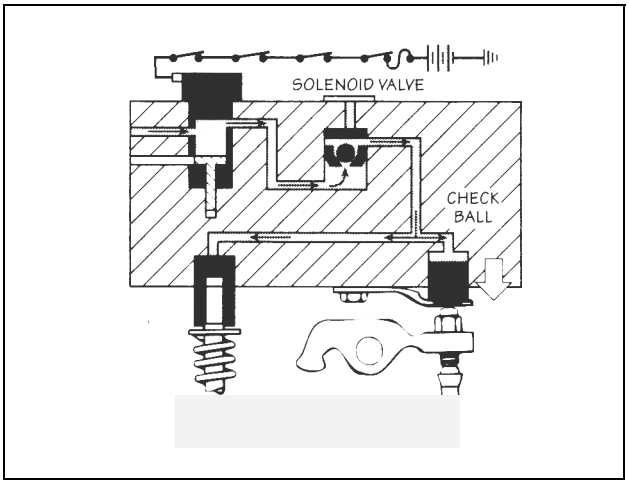


FIG. 1.2.2

Step 3 (Fig. 1.2.3)

When the rocker lever adjusting screw contacts the master piston, oil pressure increases and seats the check ball in the control valve. This creates a closed hydraulic system between the slave and master pistons. The oil pressure in the closed system increases and forces the slave piston down against the exhaust valve crosshead (bridge). The exhaust valves then open just before the engine piston reaches top dead center, releasing compressed air from the cylinder.

When electrical power is discontinued to the solenoid valve, engine lube oil is blocked from entering the brake housing. The inner control valve spring forces the control valve to the bottom of the control valve bore. The entrapped oil from the master piston/slave piston circuit can now escape from under the control valve cover, ending the engine brake cycle.

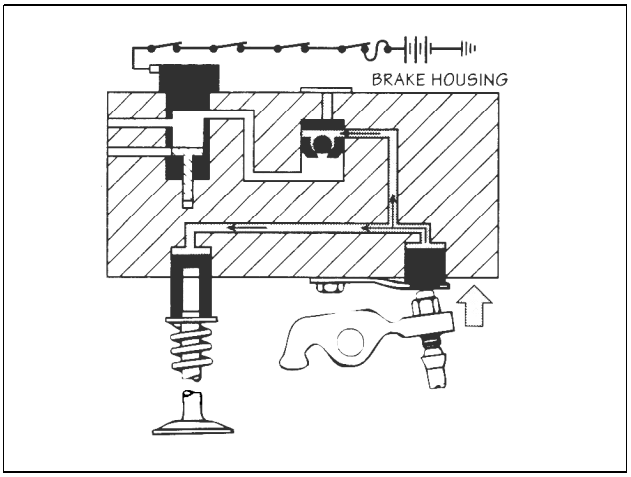


FIG. 1.2.3

Brake Housings and Rocker Groups Inspection

1. Before inspecting the brake housings and rocker groups, remove over-engine equipment such as air intake and turbocharger crossover pipes, plus the valve mechanism upper covers. With the valve covers removed, start the engine and let the engine warm up to operating temperature. Manually depress the solenoid cap and make the following checks

⚠ WARNING

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

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

a. In Models 53/71/92 series, Models 59/903, 336 and Model 404, check all oil connector screws and seals to ensure that oil is being transferred to the adjacent housings and screws are not loose or broken.

b. Inspect the nylock plugs on housing ends where applicable to make sure none are leaking.

c. As solenoid cap is depressed, check master piston assemblies to ensure that no binding occurs and all drop from their respective bores evenly and immediately.

NOTE:

IN SOME CASES, IDLE OIL PRESSURE IS NOT ADEQUATE TO OPERATE THE ENGINE BRAKE (SEE FIG 1.2.5 FOR OIL PRESSURE REQUIREMENTS),

IF THIS CONDITION EXISTS, RAISE THE RPMS BY USING THE THROTTLE, RELEASE THE THROTTLE AND THEN MANUALLY DEPRESS THE SOLENOID.

d. Look for any cracks in the engine brake housings.

e. Look for leaks from the solenoid upper seal area.

2. Release solenoid cap and check for:

a. Immediate shut off. Check the condition of oil exhausted from the control valve cover. If exhausted oil has bubbles or is foamy in appearance, air is present in the system. Repeat this procedure several times. If aeration continues, the source of aeration must be determined before continuing with diagnostic procedures. Aeration causes a spongy brake because of reduced piston travel.

b. Quick and complete master piston retraction.

Engine Brake Housing Oil Pressure Check

To properly troubleshoot the engine brake, the mechanic **must** know the supply oil pressure reading to the engine brake housing. The mechanic must understand that the oil pressure reading on the instrument panel gage is **not** the same as at the engine brake housings.

Insufficient oil pressure to compress the control valve return spring or to cause deflection of the master piston return spring will prevent the brake from working. Partial or incomplete compression and deflection of these springs from marginal oil pressure supply will produce marginal, if any, brake performance.

NOTE:

WHEN MAKING OIL PRESSURE CHECKS ON JACOBS MODELS 401,404 AND 760 (NOT 760A OR 765), IT IS NECESSARY TO START AT IDLE SPEED AND THEN GRADUALLY INCREASE RPMS. THE ONE WAY CHECK VALVE IN THE HOUSING ENTRANCE PREVENTS THE TOTAL ESCAPE OF ENGINE OIL. IF FULL RPM OIL PRESSURE IS TAKEN FIRST, THAT PRESSURE IS ACCURATE. HOWEVER, WHEN THE RPMS ARE LOWERED, THERE IS ENOUGH ENTRAPPED OIL TO GIVE AN ARTIFICIALLY HIGHER READING. TO CORRECT THIS CONDITION, LOOSEN THE SOLENOID ADAPTERS AND ALLOW THE PRESSURE TO BLEED DOWN, THEN RETIGHTEN THE ADAPTER AND RECORD THE PRESSURE. SHUT DOWN THE ENGINE BEFORE LOOSENING THE SOLENOID.

If oil pressure is insufficient for engine brake operation, the engine should be examined by an authorized facility. Oil may be leaking past cam bearings, rocker bushings, or other oil-pressure-fed engine bearings, if worn. This can produce insufficient oil supply to operate engine brakes. Brakes could operate an higher RPM levels, but fade out at lower RPM levels.

On some of today's new diesel engines which operate at lower average regulated oil pressures, oil pressure values below 1000 RPM are not of great concern. Below this engine speed, the engine brake is least efficient. The old standard that the engine brake should stall the engine at idle as a troubleshooting technique is now outdated.

High oil pressure or "over pressur" can also cause poor braking by forcing the control valves to shut off the engine brake units. This can occur on models that have the control valve double spring over-pressure system. The double spring system allows the control valve to shut off the engine brake before oil pressure reaches a level which can cause the slave piston to jack.

See Fig. 1.2.5 for specific oil pressure requirements for the control valve springs used in the brake model you are working on.

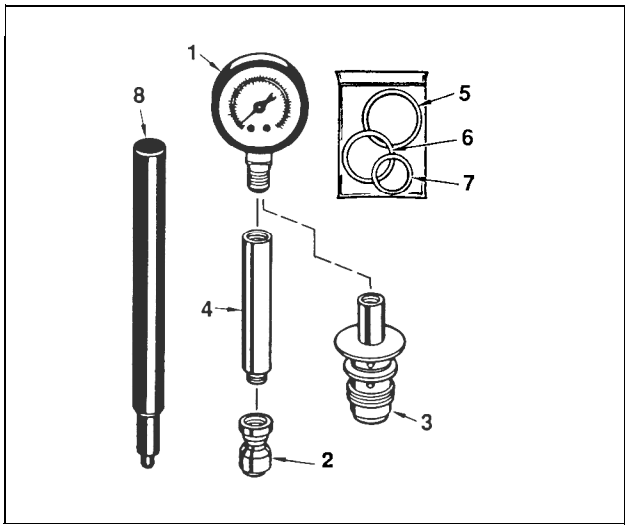


FIG. 1.2.4

Oil Pressure Test Kit, P/N 018280

Ill. No.	Part Name
1	Pressure Gauge
2	Body, Control Valve - Pressure Test
3	Solenoid Valve - Pressure Test
4	Adaptor - Pressure Test
5	Solenoid Seal Ring
6	Solenoid Seal Ring
7	Solenoid Seal Ring
8	Control Valve Cover Removal Tool
Nl	Tool Box
Nl	Instructions - Pressure Test
Nl	Chart, Oil Pressure

The tools in this kit can be used to determine ergine oil pressure available for operation of any model Jacobs engine brake. Complete instructions are contained in the kit.

WARNING

TO PREVENT PERSONAL INJURY, WEAR SAFETY GILASSES AND USE CAUTION WHEN WORKING ON AN ENGINE. WHEN ENGINE IS RUNNING, COVER OPEN AREAS WITH TOWELS TO REDUCE OIL SPRAY.

preliminary Checks

1. Before starting engine, check the following:

   a. Oil level on dipstick. Overfull or underfull condition in crankcase will cause aeration in the engine brake hydraulic system.

      If oil level is questionable, refer to manufacturer's charts for correct dipstick calibration. Re-calibrate if necessary.

   b. Condition of engine lubricating oil for presence of fuel or water or both. This indicates engine problems and must be corrected.

2. Check engine brake slave piston setting and engine valve injector settings. See applicable installation and service literature.

3. Weak, intermittent or no engine braking may be due to electrical, hydraulic or mechanical problems. Prior to using the test kit, check all electrical components, switches, wiring and slave piston adjustments.

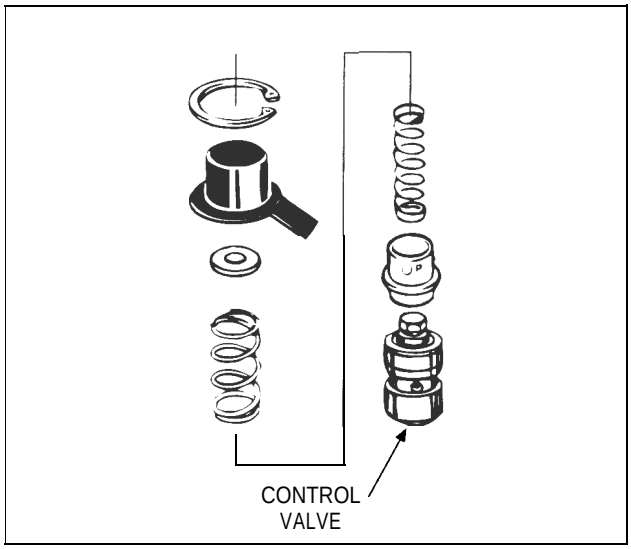


FIG. 1.2.5

NOTE:

COMPONENTS USED WITH THE CONTROL VALVES IN VARIOUS ENGINE BRAKE MODELS MAY DIFFER (SEE FIG. 1.2.5), BE SURE ALL PARTS ARE REINSTALLED IN THE SAME ORDER AS REMOVED. REFER TO INSTALLATION MANUALS FOR SPECIFIC MODELS IN QUESTION.

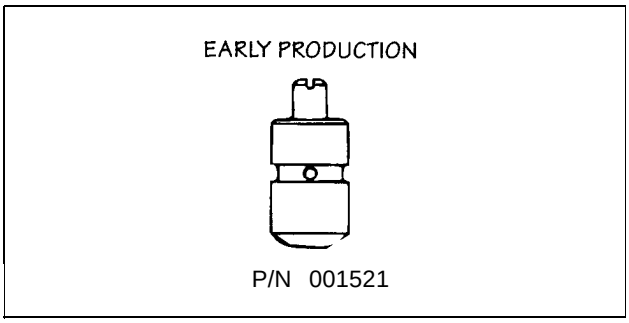


FIG. 1.2.6

Control Valve Component Inspection

WARNING

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

1. If any of the above problems are found, inspect the control valve components of the questionable cylinder for the following:

   a. Broken control valve springs.

   b. Smooth movement of the control valve in its bore.

   c. Spring tension and check ball seating in the base of the control valve body.

2. Apply pressure to the control valve cover and slowly remove the hex head capscrew or snap ring. Slowly raise the cover until all spring pressure is relieved.

3. Remove the control valve springs and other components, if applicable.

4. Using needle-nose pliers or fingertips, reach into the bore and grasp the stem of the control valve. Pull the valve straight up and out of its bore. If binding occurs, clean or replace if necessary.

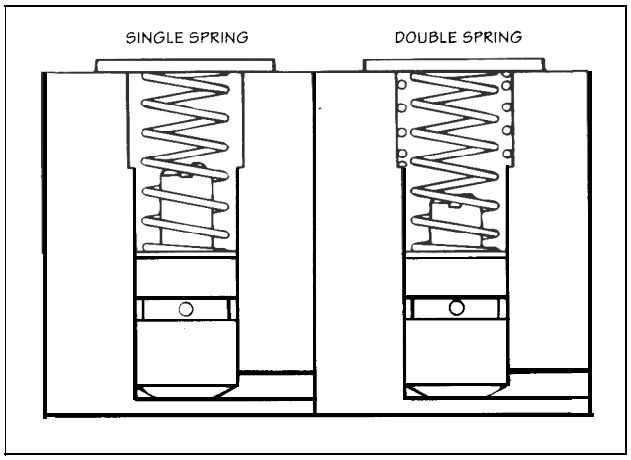


FIG. 1.2.7

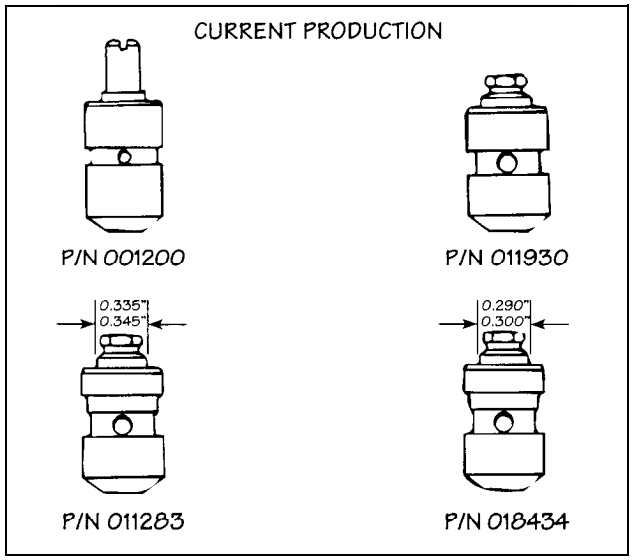


FIG. 1.2.8

Engine Brake Oil Pressure Requirements

Current Production Engine Brake Models

Model	Control Valve	Control Valve Springs	Fill Flow PSI	Over Press. PSI
317 B/C	018434	010504/19190	18-50	75
C336/A	011930	007500/010843	16-80	95
346D	011930	011435/011434	16-78	100
349/A	011930	011823/011434	20-87	95
404BG	011283	011823/011253	20-53	75
404D	011283	007500/011253	25-56	78
425A	011930	007500/001519	22-53	65
430	011930	007500/010843	16-80	95
440/A	011930	007500/011253	25-65	70
680A	011930	003109/010843	35-90	110
680B	011930	011823/010843	25-85	90
71/92A	011930	007500/011434	15-77	85
760A/765	011930	018179/001519	25-56	78

Past Product Engine Brake Models

C317A	018434	001518/011253	25-56	78
C346	001200	001518	25+	N/A
C346B/C	011930	011435/011434	16-78	100
20	001200	001012	20 - 58	N/A
30/25B	001521*	001518/001519	25-56	78
30E	011283	007500/001519	15-54	66
59/59A	001521	003109/003110	35-78	92
59B	001521	003109/010843	35-104	110
903	011930	001518/010843	25-80	90
K200	001200	003410	6+	N/A
K1150	001200	006536	16+	N/A
K1200	001521	007500/001519	15-54	66
400, 400H	011283	007500/001519	15-54	66
401A/B/C	007505*	007500/011253	15-46	65
404/404B	011283	011823/011253	20-53	75
404C	011283	007500/011253	25-56	78
425/420	011930	007500/001519	22-53	65
445	011930	007500/011253	25-65	70
675	001200	001518	25+	N/A
675A	011930	011435/011434	16-78	100
53A	011930	001012/001519	22-53	65
760	011930	001518/001519	25-56	78

* The Jacobs control valve, P/N 007505, has been superseded by P/N 011283. The Jacobs control valve, P/N 001521, has been superseded by P/N 011930.

CAUTION

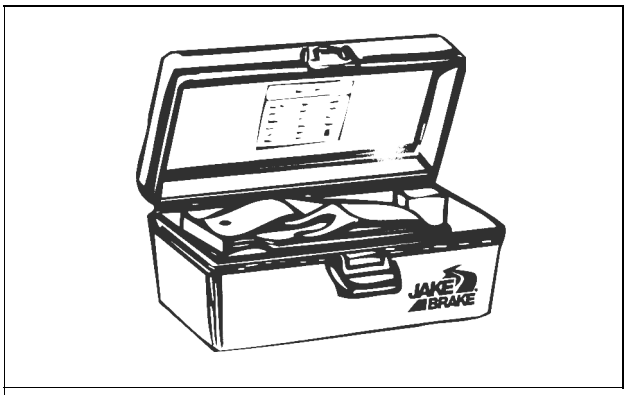
DO NOT INTERMIX SPRING COMBINATIONS.

NOTES

1.3 General Problem Analysis

Tools and Parts Available for Servicing and Maintaining Jacobs Engine Brakes

Tool Box



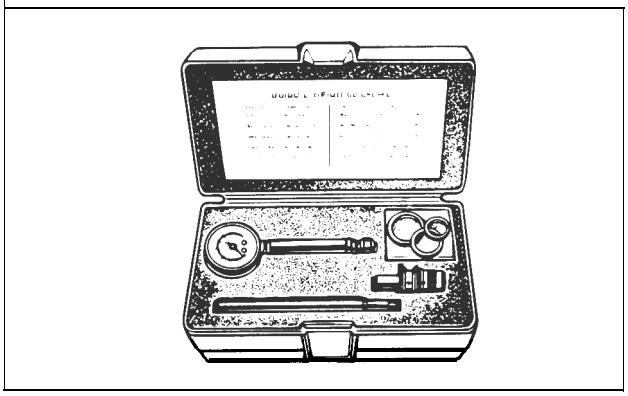
Tool Box for All Models: P/N 017469

Tool Boxes for Engine Families:

- Caterpillar: P/N 017465
- Cummins: P/N 017468
- Detroit Diesel: P/N 017466
- Mack: P/N 017467

Tool Box only: P/N 017471

Oil Pressure Test Kit



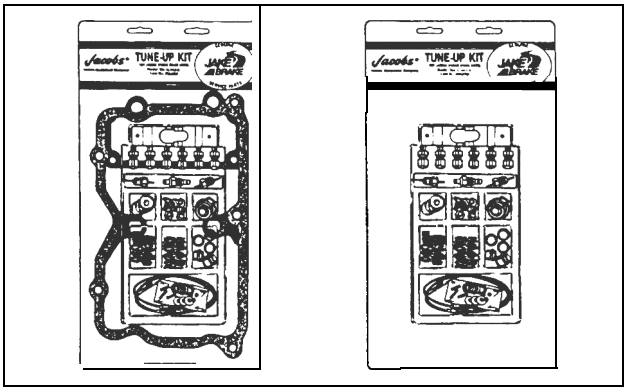
Use for all Jake Brake models to troubleshoot weak and/or no engine brake conditions.

Check engine oil supply pressure at the engine brake solenoid valve and the control valve.

Pressure gage, three adaptors, seals and control valve cover release tool packaged in a sturdy case.

Includes laminated chart with specifications for all past and current models.

Tune-up Kits



Genuine Jacobs replacement parts.

Everything needed for a complete tune-up in one convenient package.

Complete step-by-step instructions.

All parts include the latest Jacobs design improvements.

All parts backed by full Jacobs replacement parts warranty.

Problem: Engine fails to start

Probable 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

Probable Cause: Blown fuse, open electrical leads.

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

Probable 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 current available at both terminals of each switch. Readjust if needed or replace if voltage will not pass through switch.

DO NOT TOUCH ELECTRICAL CONNECTION WHEN SYSTEM IS ENERGIZED.

Probable Cause: Incorrect electrical power source.

Correction: Power supply must be a minimum of 12 VDC. Recommended power source if 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. Make sure wiring is in accordance with Jacobs installation manual for brake model.

Probable Cause: Low engine oil pressure.

Correction: Determine oil pressure at engine brakes using procedures given in this manual (see Section 1.2 for oil pressure requirements). If oil pressure is below specifications, engine should be repaired in accordance with manufacturers’ procedures.

Problem: Engine brake activates with switches open (off)

Probable Cause: Center solenoid valve seal ring damaged.

Correction: Remove solenoid. Replace all seal rings.

Probable Cause: Engine brake improperly wired.

Correction: Check wiring in accordance with Jacobs wiring diagrams.

Problem: Engine brake slow to operate or weak in effect

Probable Cause: Lube oil cold and thick.

Correction: Allow engine to warm before operating brakes.

Probable 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.

REMOVE SLAVE PISTON CAREFULLY WHEN DISASSEMBLY IS NECESSARY. USE EITHER THE JACOBS SLAVE PISTON REMOVAL TOOL OR AN ARBOR PRESS. SLAVE PISTON SPRINGS ARE UNDER HEAVY COMPRESSION.

Probable Cause: Lower solenoid seal damaged, allowing oil to exit housing.

Correction: Remove solenoid valve and replace all seal rings.

Probable Cause: Solenoid screen clogged, stopping supply of oil to brake.

Correction: Remove solenoid valve and clean or replace screen.

Problem: Engine brake slow to operate or weak in effect (cont.)

Probable 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 filters and correct cause of contamination.

Probable 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.

Probable 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.

Probable Cause: Switch operation sluggish. Check dash switches, clutch switch, throttle switch.

Correction: Readjust or replace switch. Check throttle or clutch return springs for proper operation. On 71/92A, ensure engine is going to "no fuel" position and governor riser bearing is allowing free governor operation.

Probable Cause: Solenoid valve operation erratic

Correction: Check solenoid valve using electrical specifications explained in this manual or, 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.

Probable Cause: Engine brake housing plugs leaking.

Correction: Check plugs for signs of leaks. If leaks are present, remove plug, clean threads and install at 100 lb.-in. (11 N•m) torque. Use Jacobs plugs.

Probable 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

Probable Cause: Upper solenoid seal ring damaged.

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

Probable Cause: Damaged oil supply seals under or between housings.

Correction: Remove housing and replace seals. Inspect for cracked or broken oil connectors, replace seals.

Probable 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 if foamy, air is present in system. Aeration can be caused by the crankcase being too full of oil or not enough oil being present in the crankcase, a crack in the oil pickup tube or leaks in the oil suction tube or hose. Correct in accordance with manufacturer's procedures.

Probable 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.

Probable Cause: Low engine oil level.

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

Probable Cause: Worn engine rocker lever bushings.

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

Probable Cause: Oil leaking from around cylinder head.

Correction: Repair causes of leaks.

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

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

Probable Cause: Models 401,404 and 760 only (not 760A or 765). Check ball valve assembled inversely or more than one spring is used.

Correction: Remove check ball valve. Check number of springs used. Reassemble, using one spring, in the following order:

Model 401: First insert the spring, then the ball, washer and retaining ring.

Models 404 and 760: First insert the ball, then the spring and plug.

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 contaminants.

Probable Cause: 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 appropriate Jacobs installation manual.

Probable Cause: Insufficient clearance between exhaust crosshead and underside of exhaust rocker lever (Cummins engine applications only).

Correction: Pass a 0.020" wire gage between back section of crosshead and underside of rocker lever. If 0.020" clearance cannot be obtained, change crosshead with another cylinder and re-measure. If clearance still cannot be obtained, check for bent crosshead guide pin or enlarged rocker lever. Replace as required.

Probable Cause: Auto-Lash® plunger in full extended position (Cummins engine applications only).

Correction: Check for over-torque of locknut. Re-torque to 25 lb.-f-t. maximum. If condition continues, replace Auto-Lash.

Problem: Sudden drop in engine lube oil pressure.

Probable Cause: Oil inlet supply seal missing or damaged.

Correction: Replace seal.

Probable Cause: Upper solenoid valve seal missing or damaged.

Correction: Remove solenoid and replace upper seal ring.

Probable Cause: Models 71/92 and 53A rapid dilution of lube oil caused by loose or cracked fuel pipes.

Correction: Inspect fuel pipes for proper torque (10 lb.-ft.) or cracks at flare ends. Start engine. Pressure check heads for signs of more pipe leakage. Replace any showing signs of leakage.

Probable Cause: External oil supply hoses or fittings cracked and leaking.

Correction: Inspect all hoses and fittings for tightness, chafes or cuts. Replace or repair as necessary.

Probable Cause: Oil connectors between housings (where applicable) broken or leaking.

Correction: Inspect all oil connectors for cracks and broken or loose screws. Look for missing seals and seals that are brittle split or damaged. Replace as required.

1.4 Engine Brakes for Cummins Engines

Two-valve Design

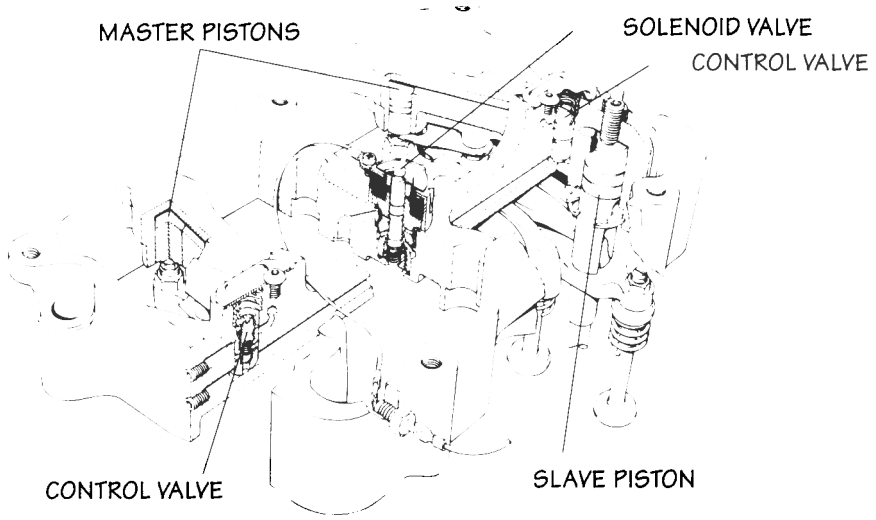
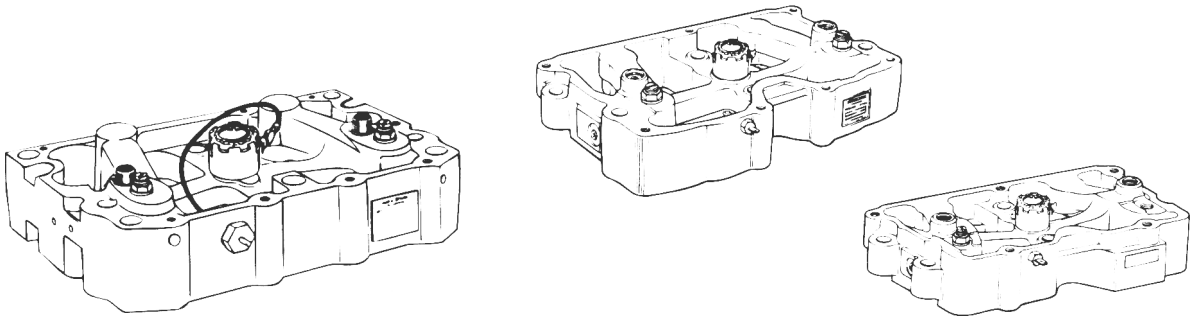


FIG. 1.4.1

Current Production Models



Model 450A/450B	**Model 440/440A**	**Model 430**	**Model 425A**
'94 N14 CELECT	Pre '94 N14 STC and N14 CELECT	88/89 NT	All NT 855 cu. in. except 88/89 NT

Fig. 1.4.2

Former engine brake models for Cummins NT-855 cu. in. engine applications:

25	25B	30	30E
30 SN (Spray Nozzle)	400	400H	

The former Models 401A/B/C single-valve design were also used for Cummins 855 CID engines (see Page 1.4.3).

For proper application information, refer to your nearest Jacobs Warehouse Distributor or your Jacobs Field Representative.

Special Features

Auto-Lash': Used in Jacobs Engine Brakes for Cummins Engines with two-valve operation only.

The Auto-Lash adjusting screws are designed to provide optimum exhaust valve opening during engine brake operation. Each engine brake model uses a different Auto-Lash; the distinguishing feature is the amount of plunger protrusion. The plunger protrusion amount is directly related to engine brake timing advancement.

⚠ CAUTION

AUTO-LASHES CANNOT BE INTERMIXED

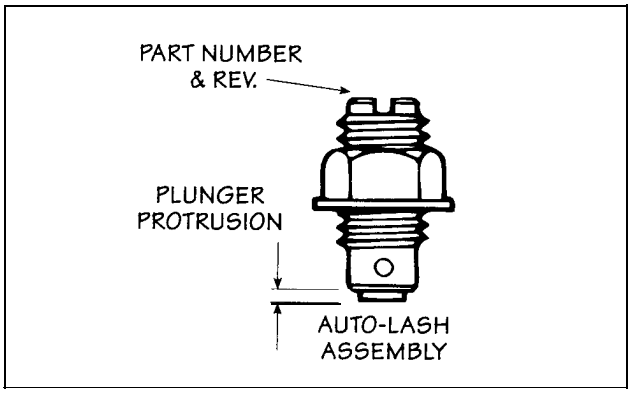


FIG. 1.4.3

Part Number Identification & Matrix

Refer to specific engine brake model parts manual for proper Auto-Lash.

Operation (example only)

Engine brake in "OFF" mode. Static setting of 0.018" clearance for normal engine operation (see Fig. 1.4.4).

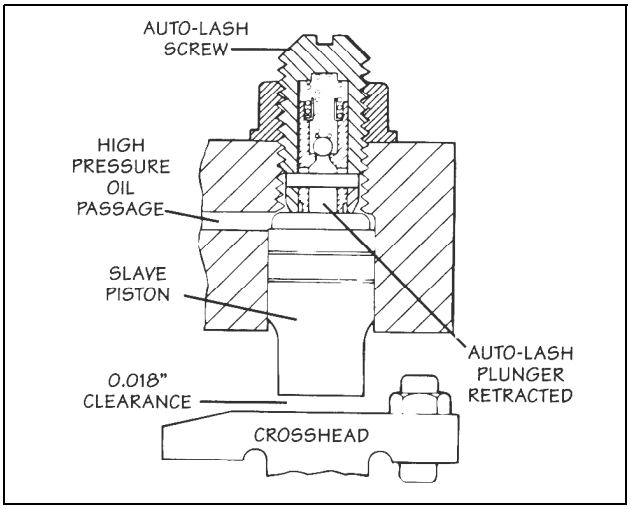


FIG. 1.4.4

Engine brake in "OPERATING" mode. Clearance of 0.009" for more valve opening.

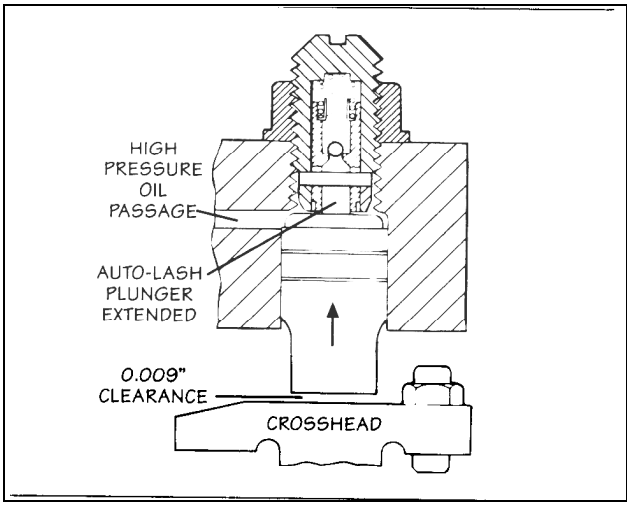


FIG. 1.4.5

During engine brake operation, the spring inside the Auto-Lash assembly moves the plunger out to its fullest extension (see Fig. 1.4.5). Oil under pressure enters the Auto-Lash body through the hole in the plunger and "locks" the plunger in its extended position. This reduces the slave piston clearance from 0.018" to 0.009" (Model 400 Auto-Lash example).

Slave piston travel provides optimum exhaust valve opening for most effective engine brake operation for this engine/ engine brake combination (see Fig. 1.4.6).

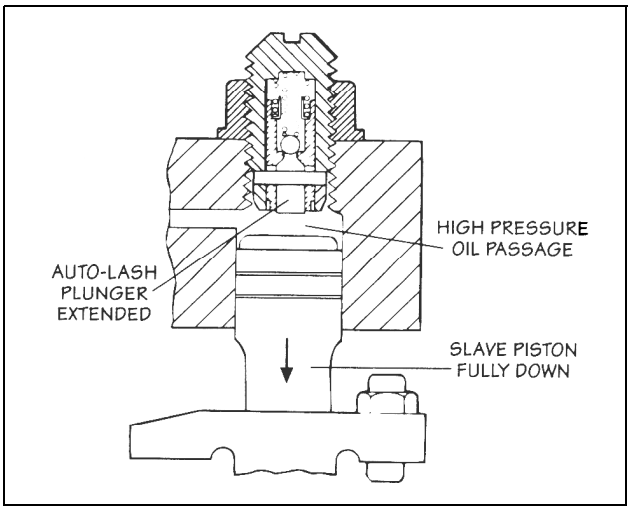


FIG. 1.4.6

When the engine brake is shut off, the oil bleeds off and the plunger retracts from the force of the slave piston spring. The slave piston clearance returns to 0.018" for normal engine operation (see Fig. 1.4.4).

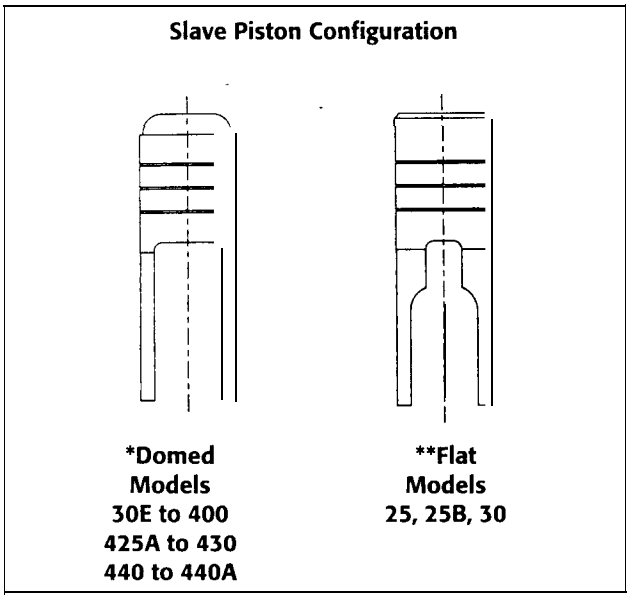


FIG. 1.4.7

Short Slave Piston Part Numbers for Reworked Cylinder Heads and Exhaust Valves

	Domed*	Flat**	425A	430	440/ 440A
Stand	007623	001484	017409	014864	017409
Short	007696	001486	017728	017078	017728

Short slave pistons may be required where cylinder heads and exhaust valves have been reworked. Valve stems may protrude too high above cylinder head to allow for sufficient slave piston-to-crosshead clearance

Single-valve Design

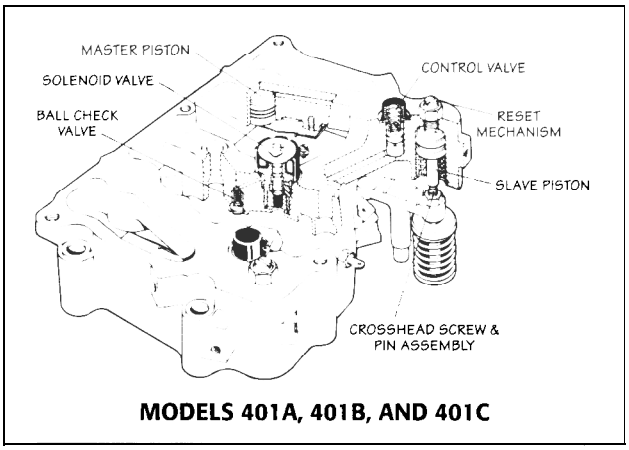
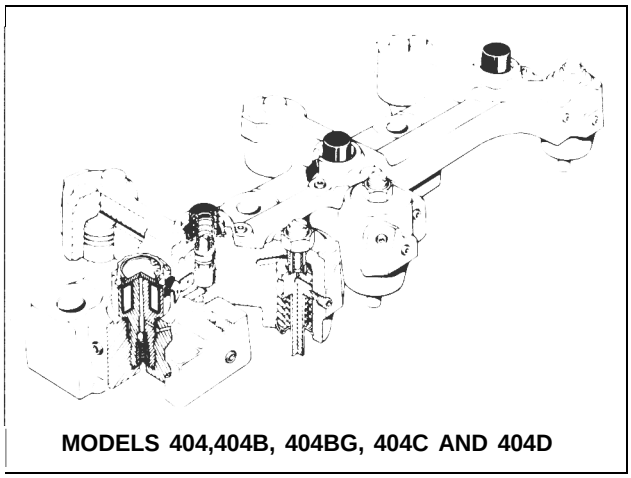


FIG. 1.4.8

Some early model engine brakes for 855 CID engines used a single-valve operating system. Only one exhaust valve per cylinder is opened during engine braking. The two-valve operation opens two exhaust valves.



FIG, 1.4,9

The major difference between the brake models is the diameter of the master piston. Neither the master pistons nor the housings are interchangeable.

Model	Master Piston Diameter
401A	0.938”
401B	0.875”
401C	1.000”
404	0.875”
404B	0.875”
404BG	0.875”
404C	0.6875”
404D	0.6875”

Special Features

Guideless Crossheads

All 91L1O and later engines use guideless crossheads (Fig. 1.4.10).

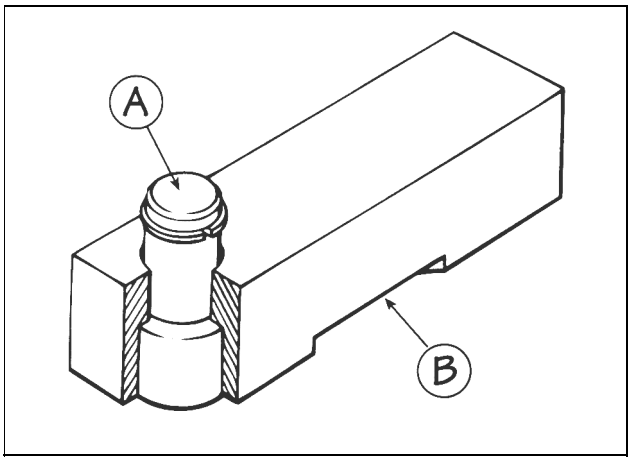


FIG. 1.4.10

A. Jacobs retained actuator pin

B. Jacobs guideless crosshead assembly

CAUTION

DO NOT DISASSEMBLE THE ACTUATOR PIN FROM THE JACOBS CROSSHEAD. THE ASSEMBLY IS MADE UP OF MATCHED PARTS AND MUST NOT BE FIELD SERVICED.

Lubricate the actuator pins and valve stems with engine oil and install the Jacobs crossheads over the exhaust valves. Locate the actuator pins on the exhaust valves closest to the rocker shaft.

The crosshead should move freely from side to side, pivoting on the side without the actuator pin. No adjustment is required with guideless crossheads.

Crosshead Screw and Pin Assembly

The crosshead pin assembly is a key component in the single-valve system. The pin assembly allows for only one valve to be opened by the engine brake slave piston. It allows for the re-use of the Cummins exhaust crosshead, simplifying installation. The pin assembly replaces the Cummins crosshead adjusting screw and nut and can be adjusted using Cummins procedures. The pin assembly requires no specific maintenance.

FIG. 1.4.11

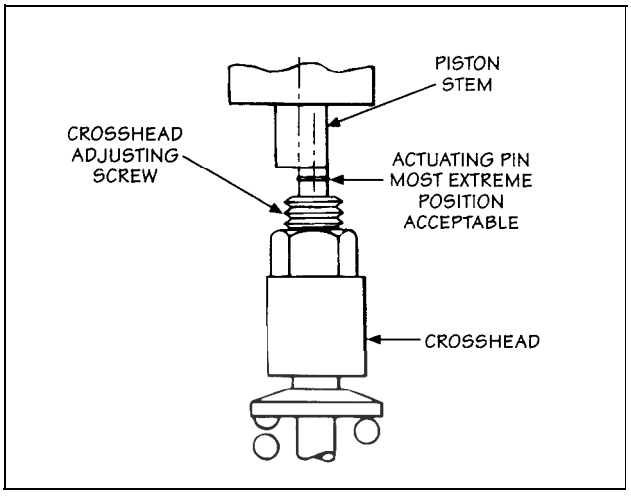


FIG. 1.4.12

Check Ball Valve: Used in Models 401 and 404

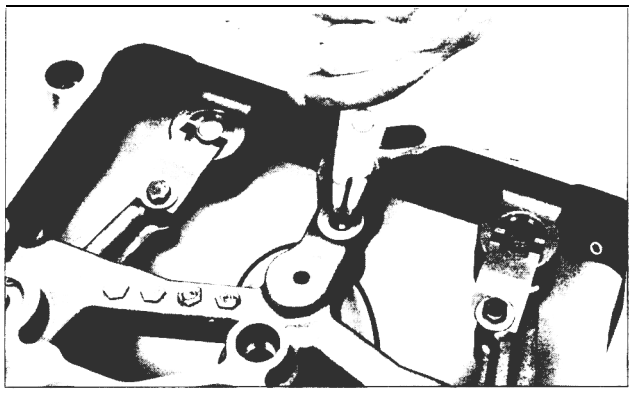


FIG. 1.4.13

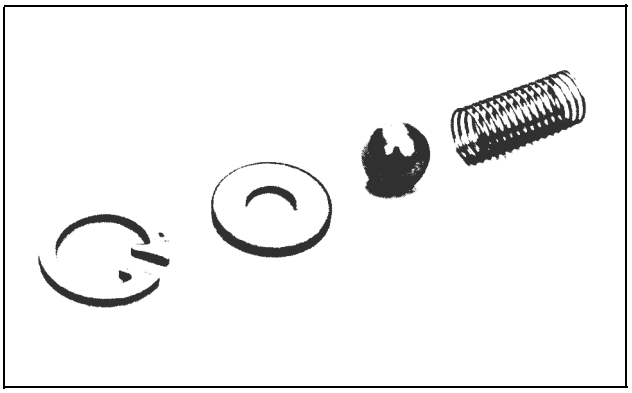


FIG. 1.4.14

The check ball mechanism in the single-valve engine brake is used to prevent the high-pressure oil that is passing through the slave piston drillings from leaving the engine brake housing. If the oil did escape from the housing, the normal engine oil supply would be insufficient to make up the loss of oil and the engine brake performance would be greatly reduced.

During reassembly, pay special attention to the proper sequence of reinstalled parts and make sure that the proper parts are used.

Reset Mechanism: Used in Models 401 and 404

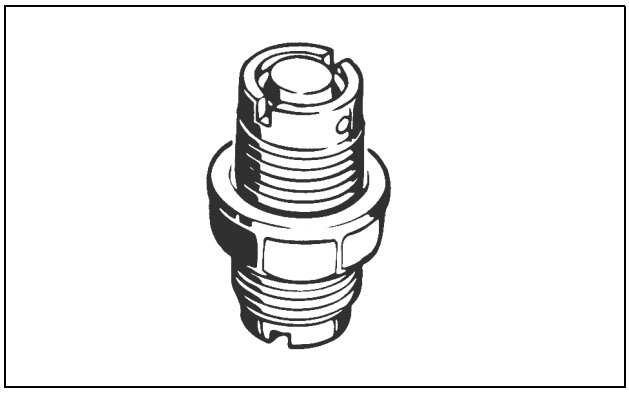


FIG. 1.4.15

The purpose of the reset mechanism is (1) to allow the opening of a single exhaust valve during engine brake operation: and (2) after the energy is released from the cylinder, to close the exhaust valve that was open before the normal exhaust rocker motion begins. This prevent excessive side loading on the engine's crosshead guide pin.

Reset Design

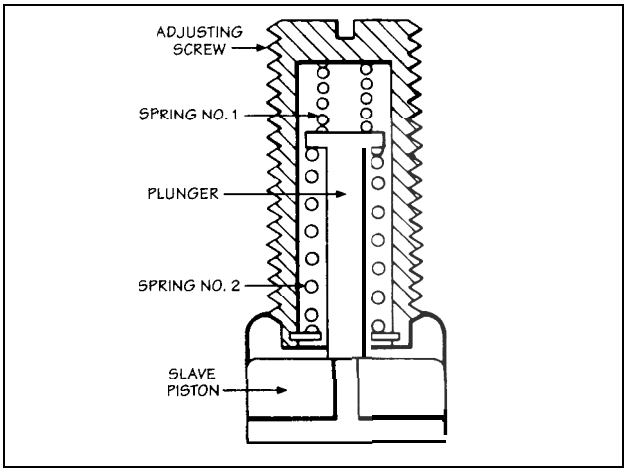


FIG. 1.4.16

The main components are the screw body, the plunger and two springs. Spring #1, on top of the plunger, holds the plunger lightly against the slave piston upper hold, preventing the oil from flowing out too early in the engine brake cycle. Spring #2 pops the plunger off the slave piston when the reset mechanism activates. This uncovers the upper slave piston hole and allows the oil to flow to the bottom of the control valve bore.

Initially, the top spring holds the reset plunger against the slave piston and covers a hole in the top of the slave piston. When the engine brake is activated and engine oil pressure moves the master piston down against the injector adjusting screw, the rocker upward motion starts building high hydraulic pressure in the engine brake high-pressure circuit. The slave piston moves down against the Jacobs crosshead pin assembly and the engine exhaust valve stem. The oil in the housing high-pressure circuit build pressure rapidly, producing the force required to open the exhaust valve.

Since the area above the reset plunger is greater than the area under it, the plunger is forced down with the slave piston, keeping the top hole sealed.

As the slave piston moves down on the exhaust valve stem, the reset plunger follows the slave piston and compresses Spring #2. At this time, the high oil pressure above the reset plunger is greater than pressure from Spring #2, and the plunger continues following the slave piston.

When the exhaust valve is opened and the compressed air leaves the cylinder, the high pressure in the housing drops rapidly. When the oil pressure drops below the force of Spring #2, the spring forces the plunger back into the screw body and the hole in the top of the slave piston is uncovered. The oil passes through the hole in the top of the slave piston, out through the crosshole and into the passage to the bottom of the control valve bore. Since this oil is still at a relatively high pressure, it moves the control valve upward. This reduces the pressure to nearly that of how-pressure supply oil.

With oil pressure reduced, the slave piston springs return the slave piston to the start position and the engine exhaust valve closes. The engine valve is closed before normal engine exhaust motion begins. The engine exhaust rocker pushes against the crosshead with both exhaust valves opening together.

The engine brake is now ready for another cycle.

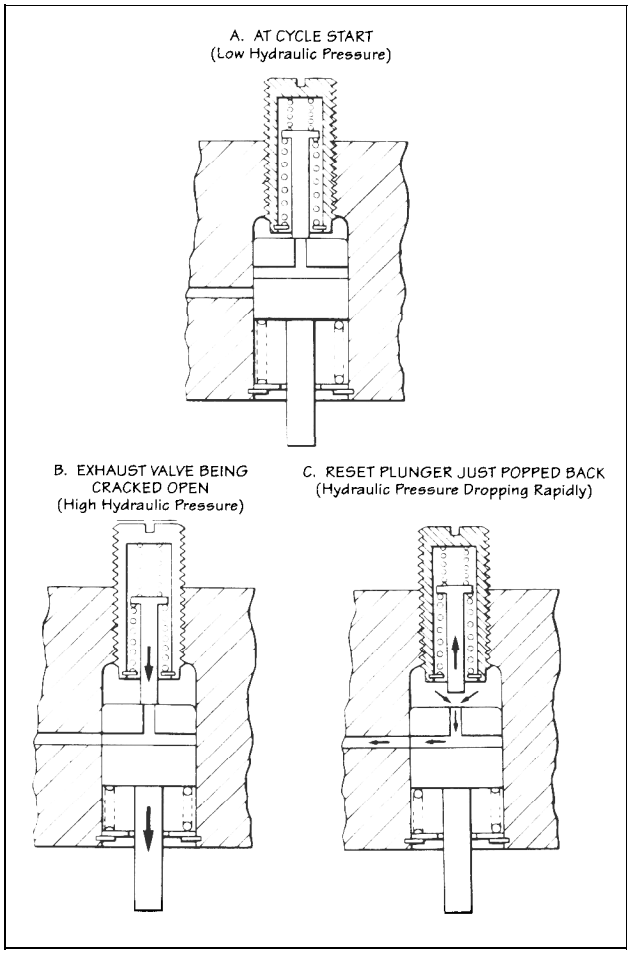


FIG. 1.4.17

Short Slave Piston Part Numbers for Reworked Cylinder Heads and Exhaust Valves

	401	404/BG/C/D	404-404BG
Standard	009439	016774	011377
Short	012397	017260	012419

Short slave pistons may be required where cylinder heads and exhaust valves have been reworked. Valve stems may protrude too high above cylinder head to allow for sufficient clearance between slave piston and crosshead screw and pin assembly.

1.5 Engine Brakes for Caterpillar Engines

Model 346D

The Model 346D Jake Brake Engine Retarder is designed and approved for use on all Caterpillar engines: 3406, 3406B and 3406C (with an serial number of 5KJ07800 and above or with an engine serial number of 3Z116182 and above). The Model 346D replaces the former Models C346, C346A, C346B and C346C.

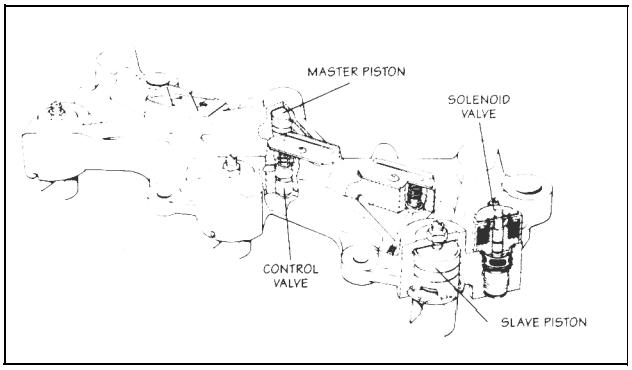


FIG. 1,5,1

Master-Slave Circuit Relationship Listed in Engine Firing order

Location of Master Piston	Location of Slave Piston
Actuates	
No. 1 Pushrod	No. 3 Exhaust Valve
No. 5 Pushrod	No. 6 Exhaust Valve
No. 3 Pushrod	No. 2 Exhaust Valve
No. 6 Pushrod	No. 4 Exhaust Valve
No. 2 Pushrod	No. 1 Exhaust Valve
No. 4 Pushrod	No. 5 Exhaust Valve

CHART 1

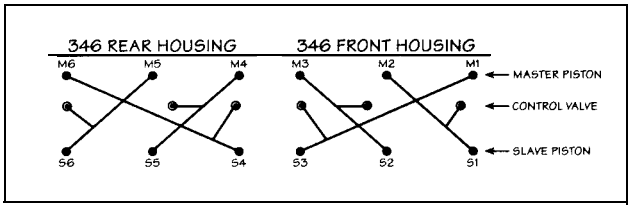
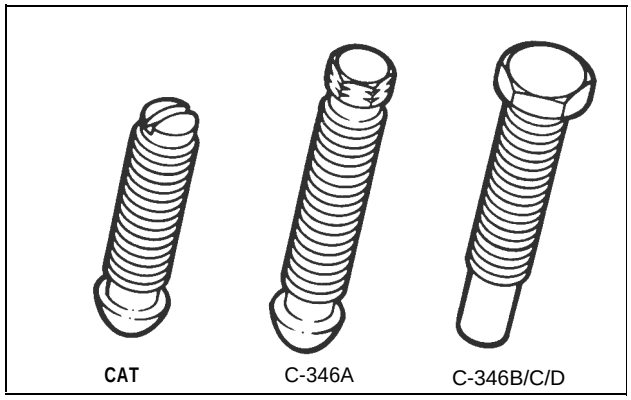


CHART 2

Special Features

Exhaust Rocker Adjusting Screw



FIG, 1.5.2

The large headed screws can be used with C346A and C346 housings. If large-headed screws are used on C346A and C346 housings, Model C346B/C/D master piston return springs must also be used. See parts manual for part numbers.

Slave Piston Adjusting Screw

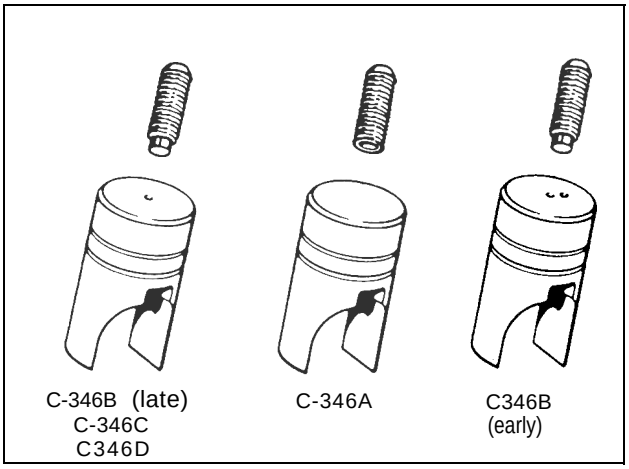


FIG. 1.5.3

The Models C346 and C346B use an adjusting screw with a spring loaded valve at the slave piston end. Note that the adjusting screws are different and have different part numbers and are not interchangeable..The adjusting screw valve seals the center hole in the slave piston during engine brake operation. The piston used in the early production C346B also has a 0.025" (0.64 mm) diameter bleed hole located to the side of the center hole.

The Model C346A uses a solid adjusting screw and a solid slave piston **(no hole through the top).**

NOTE:

IT IS RECOMMENDED THAT C346A HOUSING BE CONVERTED TO INCLUDE NEW ADJUSTING SCREWS AND SLAVE PISTONS. THESE PARTS ARE ONES CURRENTLY USED IN C346D HOUSINGS.

⚠ CAUTION

SOLID ADJUSTING SCREWS MUST NOT BE USED IN MODEL C346, C346B, 346C AND 346D HOUSINGS BECAUSE THE HOLE IN THE TOP OF THE SLAVE PISTON WILL NOT BE SEALED AND ENGINE BRAKING WILL BE LOST. EXCESS OIL WILL BE SPILLED IN THE OVERHEAD.

⚠ CAUTION

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

NOTE:

FOR C346B APPLICATIONS, A "B+ UPGRADE KIT" CAN BE INSTALLED TO IMPROVE RETARDING PERFORMANCE. SEE A JACOBS DISTRIBUTOR OR DEALER FOR DETAILS.

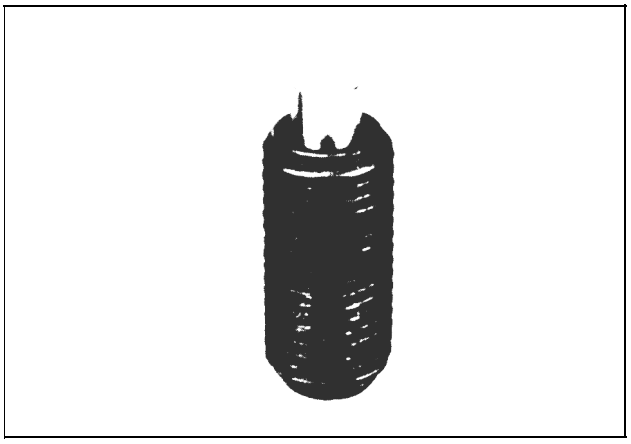


FIG. 1.5.4

Model 349A

The Model 349A Jake Brake Engine Retarder is designed and approved for use on Caterpillar 3406B ATAAC (Air-to-Air After-cooled) engines with PEEC or mechanical fuel controls. The Model 349A replaces the former Model 349.

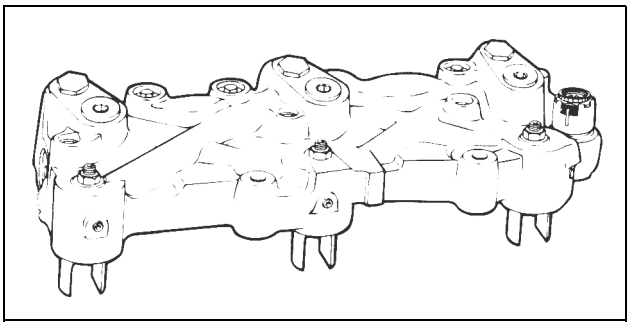


FIG. 1.5.5

⚠ CAUTION

THE MODEL 349A IS NOT TO BE INSTALLED ON 3406B ENGINES WITH SERIAL NUMBERS LOWER THAN 7FB39279 OR ANY 3406 ENGINES WITH THE 92U SERIAL NUMBER PREFIX.

Master-Slave Circuit Relationship Listed in Engine Firing Order

Location of Master Piston	Location of Slave Piston
Actuates	
No. 1 Pushrod	No. 3 Exhaust Valve
No. 5 Pushrod	No. 6 Exhaust Valve
No. 3 Pushrod	No. 2 Exhaust Valve
No. 6 Pushrod	No. 4 Exhaust Valve
No. 2 Pushrod	No. 1 Exhaust Valve
No. 4 Pushrod	No. 5 Exhaust Valve

CHART 3

Model 349A Operating Schematic

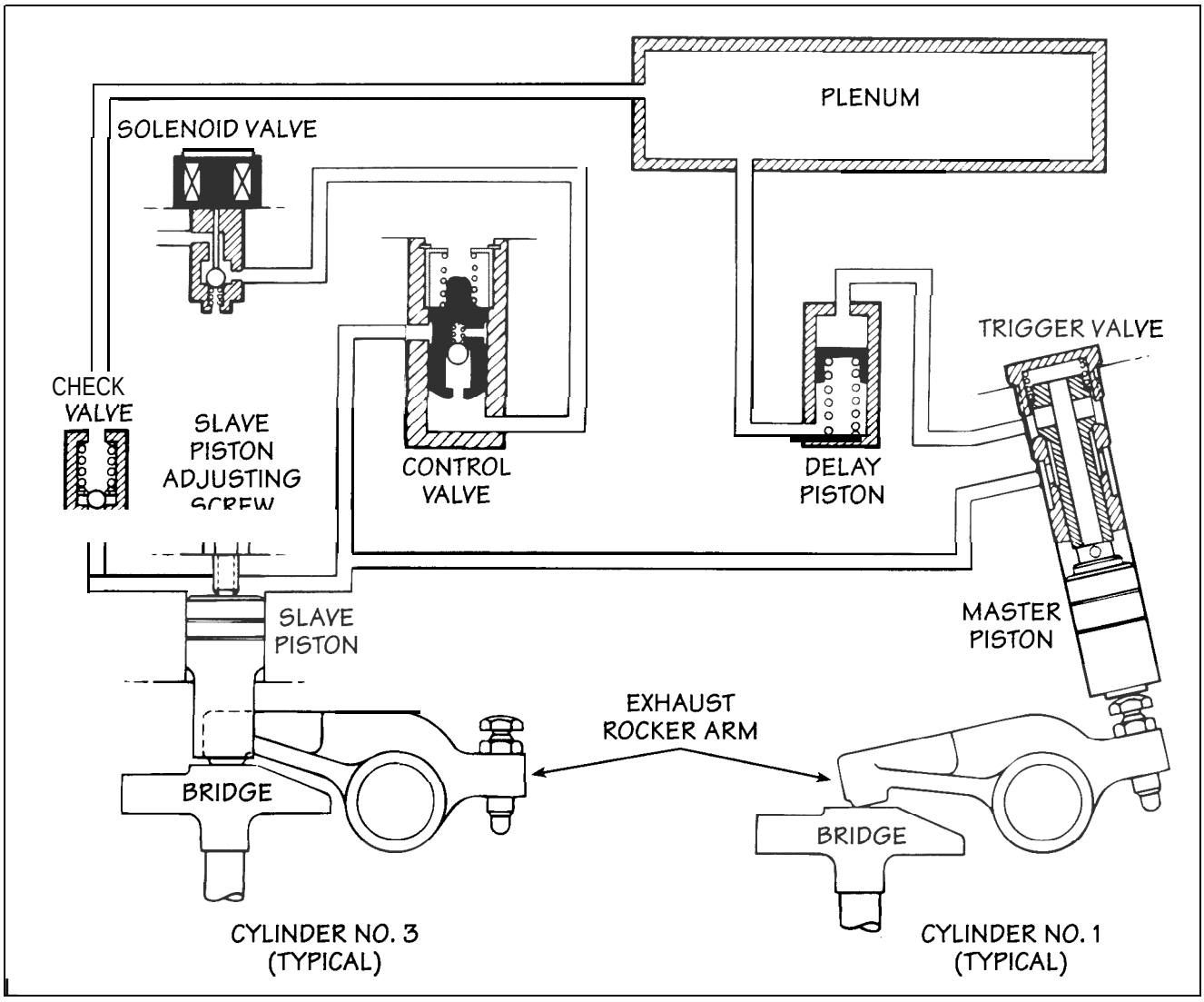


FIG. 1.5.6

Exhaust Blowdown

The braking cycle is accomplished by utilizing the pushrod motion of an exhaust valve of another cylinder during its normal exhaust cycle. Referring to the chart above, Cylinder No. 1 exhaust pushrod opens the exhaust valves of Cylinder No. 3 in this sequence:

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 corresponding exhaust rocker arm adjusting screw. See the accompanying chart for master/slave operation relationship.
3. The exhaust rocker pushrod begins upward travel (as in normal exhaust cycle) forcing the master piston upward and creating a high pressure oil flow to the delay piston.
4. The delay piston moves and compresses the plenum oil to high pressure. The delay piston and plenum act as a high pressure “spring” to activate the slave piston at the appropriate time.
5. The master piston continues moving upward and at the appropriate time, opens the trigger valve.
6. High pressure oil flows from the delay piston through the trigger valve to the slave piston.
7. The slave piston moves down, contacts the exhaust valve bridge and opens the exhaust valves releasing compressed cylinder air to the exhaust manifold.
8. Compressed air escapes to atmosphere, and energy spent compressing air is lost, providing retarding power.
9. The master piston moves down, the slave piston retracts and the trigger resets, completing the compression braking cycle.

Slave Piston Adjustment

For correct slave piston adjustment procedures and settings, refer to specific installation manual and current service publications.

Trigger Valve Adjustment

NOTE:

REMOVE TRIGGER CAPS AND SPRINGS FROM ALL CYLINDERS BEFORE ADJUSTING TRIGGER.

Trigger valve travel adjustment is set according to the settings shown in the following chart:

Trigger Adjustment

Cylinder No.	Pre-1991 Model Year	1991 and later Model Year 34066 and 3406C 400 HP	1991 and later Model Year All Others
1	0.100"	0.130"	0.100"
2, 3, 4, 5, 6	0.100"	0.095"	0.100"
ALl adjustments are ± 0.003"			

CHART 4

⚠ CAUTION

CYLINDER NO. 1 TRIGGER VALVE SETTING ON 1991 AND LATER MODEL YEAR ENGINES WITH 400 HORSEPOWER IS DIFFERENT THAN FOR THE OTHER CYLINDERS ON THAT ENGINE.

NOTE:

TRIGGER VALVE ADJUSTMENT AS WELL AS SIAVE PISTON ADJUSTMENT MUST BE MADE ANY TIIME THE BRAKE HOUSINGS ARE REMOVED AND REPLACED.

After the engine valves and slave pistons are adjusted on all cylinders, the trigger valves should be adjusted using the trigger adjusting group shown in Fig. 1.5.7.

⚠ CAUTION

MAKE THIS ADJUSTMENT CAREFULLY AND ACCURATELY TO ASSURE MAXIMUM ENGINE BRAKE PERFORMANCE AND TO PREVENT POSSIBLE ENGINE DAMAGE. THE JACOBS TRIGGER ADJUSTMENT GROUP IS REQUIRED FOR THIS ADJUSTMENT.

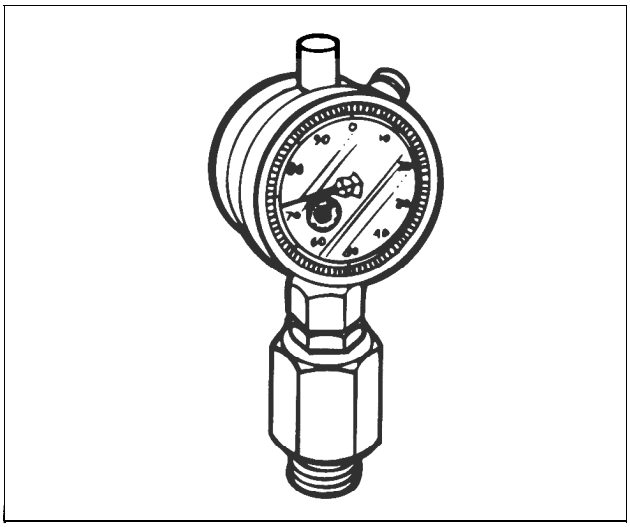


FIG. 1.5.7

1. Remove trigger caps and springs from ALL cylinders before adjusting the trigger. Do not remove trigger valve (see Fig. 1.5.8).

   The first trigger adjustment should be made on the cylinder last adjusted for slave piston lash.

FIG. 1.5.8

2. Install the dial indicator assembly into the trigger valve bore (see Fig. 1.5.9). Hand tighten, metal to metal contact only,

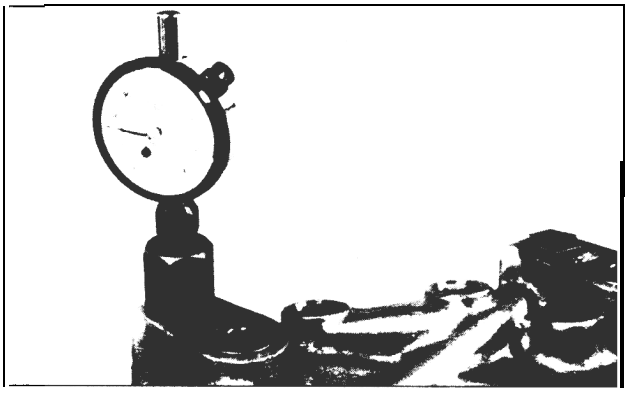


FIG. 1.5.9

indicator extension will contact the trigger valve and push the master piston down slightly (see Fig. 1.5.10).

NOTE:

THE MASTER PISTON MUST NOT COME IN CONTACT WITH THE EXHAUST ROCKER ADJUSTING SCREW AT THIS TIME.

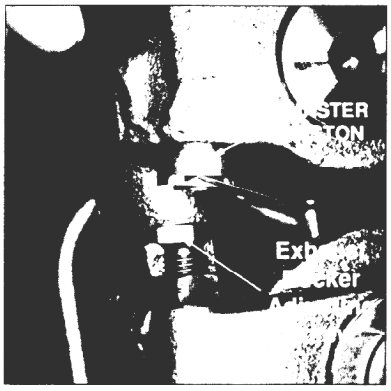


FIG. 1.5.10

3. Set the indicator to zero.

4. Rotate the engine crankshaft slowly in the direction of rotation. The exhaust rocker adjusting screw will contact the master piston and the dial indicator needle will begin to move. Record the maximum travel of the indicator.

   Travel must be set according to Trigger Adjustment Chart (Chart 3) on page 1.5.4.

5. Use the following procedure to adjust the trigger travel. The indicator travel must be within ±0.003° of specific trigger adjustment as shown in the chart on page 1.5.4.

If necessary to further adjust trigger travel:

A. Remove the dial indicator/adapter assembly and insert a long 5/32" hex key wrench through the trigger valve bore and into the master piston assembly (see Fig. 1.5.11).

FIG. 1.5.11

B. Insert the Jacobs master piston holding wedge between the master piston and exhaust rocker adjusting screw. Push the wedge in until the master piston bottoms in its bore (see Fig. 1,5.12). This will prevent the master piston from turning while the trigger adjustment is being made.

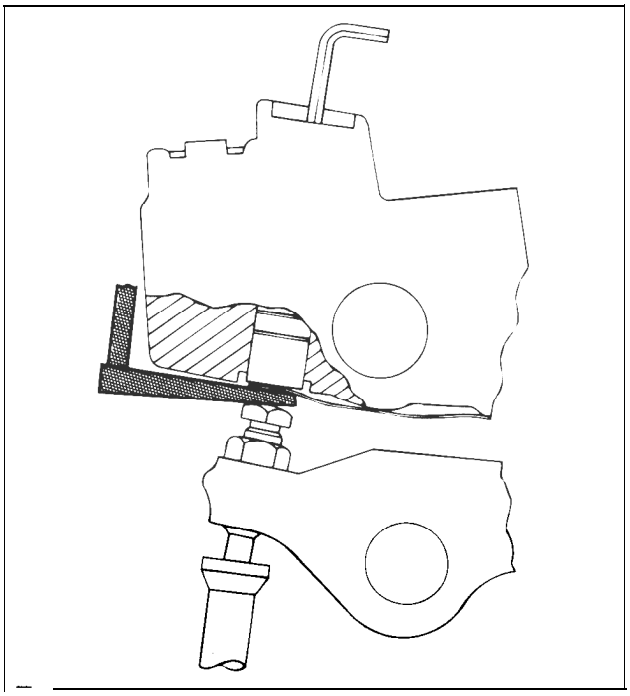


FIG. 1.5.8

C. Push down on the hex key wrench. This unlocks the adjusting screw from the hex pin (see Figs. 1.5.13 and 1.5.14, next page).

D. Refer to the original recorded travel found in Step 4 on previous page and adjust by pressing the hex key wrench against spring pressure. Maintain pressure while turning clockwise to decrease indicator travel or counterclockwise to increase indicator travel. Each hex (60°) equals approximately 0.005" indicator (trigger) travel.

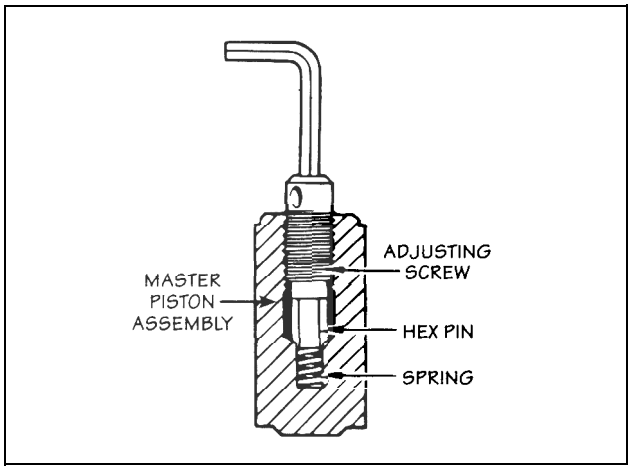


FIG. 1.5.13

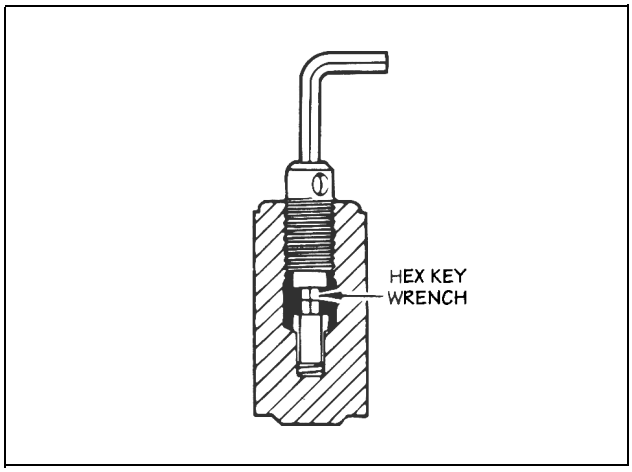


FIG. 1.5.14

E. Remove the hex key wrench. The adjusting screw must be locked. If the adjusting screw is not locked (screw can turn), rotate the screw slightly until the hex pin snaps into the adjusting screw. The screw is now locked in position.

⚠ CAUTION

SPRING PRESSURE ON THE HEX PIN SHOULD LOCK THE ADJUSTING SCREW IN POSITION WHEN PRESSURE ON THE HEX KEY WRENCH IS REMOVED. IF THE SCREW IS NOT LOCKED, THE ADJUSTMENT CAN CHANGE AND POSSIBLE ENGINE OR ENGINE BRAKE DAMAGE CAN RESULT.

Reinstall dial indicator assembly. Recheck trigger travel by rotating engine crankshaft back and forth. Repeat setting procedure, if necessary.

F. Replace trigger spring and cap. Tighten cap to 35 lb.-ft. (47 N•m).

G. Continue adjustment of remaining cylinders in the engine firing order. Recheck torque on all six trigger caps.

Models 317D/317E

The Model 317D Jake Brake engine retarder has been designed and approved for use on pre-1991 and 1991 model year 3176 Caterpillar engines. The Model 317D replaces Models C317, C317A and 317B.

The Model 317E Jake Brake engine retarder has been designed and approved for use on 1992 and later 3176 engine applications. The Model 317E replaces the Model 317C.

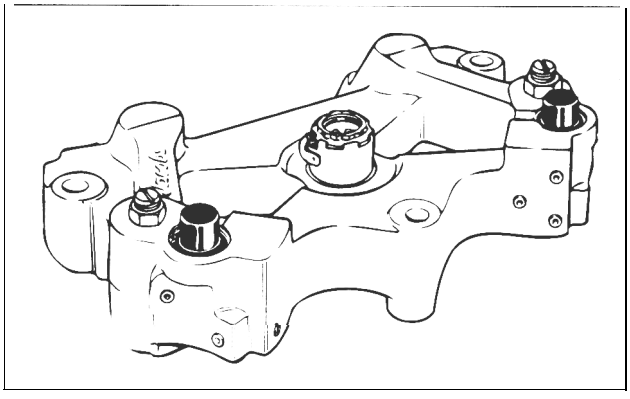


FIG. 1.5.15

Power-Lash®

To ensure optimum exhaust valve opening during engine brake operation, a Power-Lash assembly is incorporated in the slave piston adjusting screw.

A. The hole in the slave piston is sealed by a plunger in the Power-Lash. A spring holds the plunger extended for the desired travel of the slave piston (Fig. A, next page).

B. When the desired travel of the slave piston and exhaust valve opening is achieved, the hole is uncovered and the high pressure oil escapes to the area below the control valve (Fig. B).

C. The control valve moves up, compressing the stop (large) spring, providing a small volume of "stored" oil, ready for the next engine brake cycle. The reduced oil pressure allows the slave piston to return to its starting position, against the slave" piston screw (Fig. C).

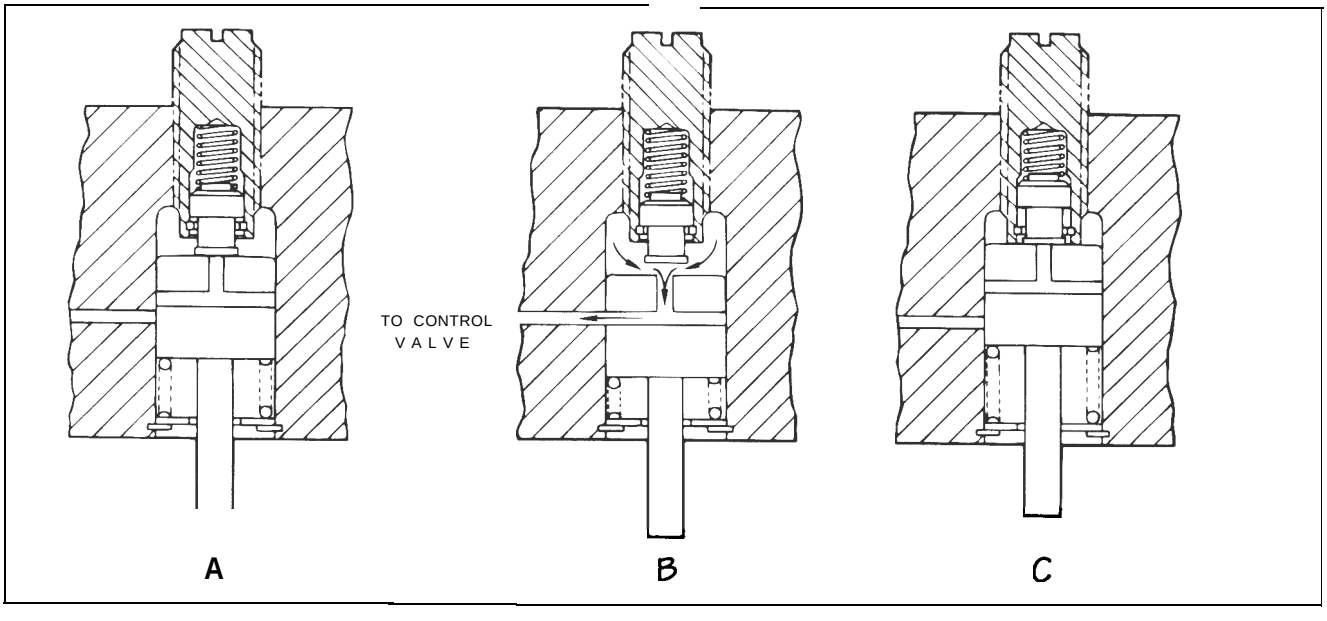


FIG. 1.5.16

Housing Assembly Differences

Models C317/C317A/317B/317C

Mounting methods for the C317 and C317A housings are different because of the height difference shown in Figs. 1.5.17 and 1.5.18. See brake housing installation section for specific installation procedures.

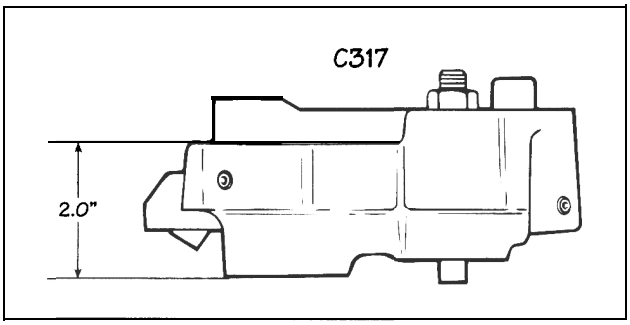


FIG. 1.5.17

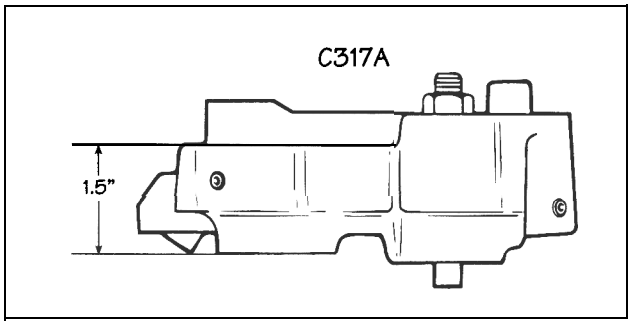


FIG. 1.5.18

The clip valve, P/N 014811, originally used with the C317 and C317A housings has been superseded by the Power-Lash™ assembly. For proper part numbers for the Power-Lash for Models C317, C317A, 317B and 317C, refer to Jacobs current parts manuals and service literature. Part numbers are located on the top of the screw body.

The master piston assembly for Models C317 and C317A is shown in Fig. 1.5.19, with the master piston assembly for Models 317B and 317C shown in the inset. Master pistons and housings are not interchangeable.

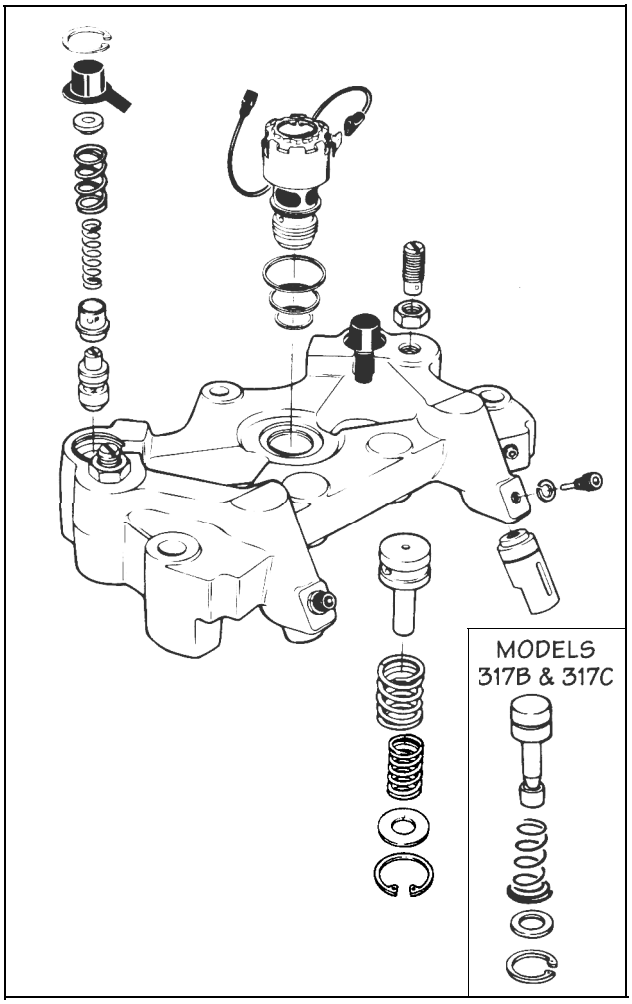


FIG. 1.5.19

Model C317 Only

NOTE:

THE FOLLOWING SIX STEPS APPLY TO MODEL C317 HOUSINGS ONLY AND NOT TO THE C317A

The extended stud, P/N 016088, has been replaced by bolt, P/N 014800. It is recommended that 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.

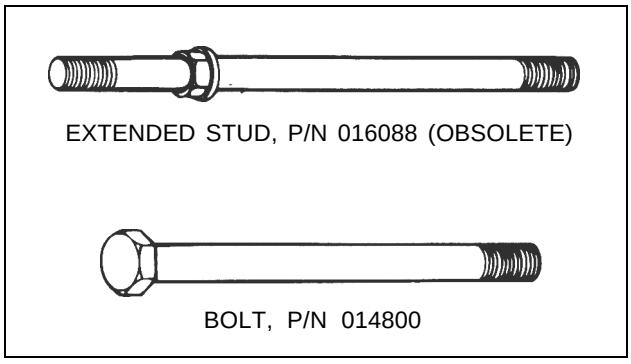


FIG. 1.5.20

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 014600 CAPSCREW WITH 2" SPACERS, JACOBS P/N 017535. TORQUE TO 70 LB.-IT. (9 N•M).

FIG. 1.5.21

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 lb.-ft. (95 N•m).
6. Tighten the bolt at the head bolt spacer to 41 lb.-ft. (55 N•m).

For Models C317A/317B/317C

Install the mounting stud assemblies in the rocker brackets and torque to 70 lb.-ft. (95 N•m). Adjust the injectors and valves per Caterpillar specifications.

Adjust the engine brake slave piston clearance with the valves closed to the clearance shown below:

Slave Piston Adjustment

For correct slave piston adjustment procedures and settings, refer to specific installation manual and current service publications.

Mounting Studs

The current mounting stud used with Model C336 and 336A housings is P/N 017156 (see Fig. 1.5.22). Bolt, P/N 016895, and spacer, P/N 012804, was previously used with the Model C336. P/N 016895 and 012804 are available as service parts.

Stud, P/N 016809, formerly used with the Model C336, has been superseded by stud, P/N017156.

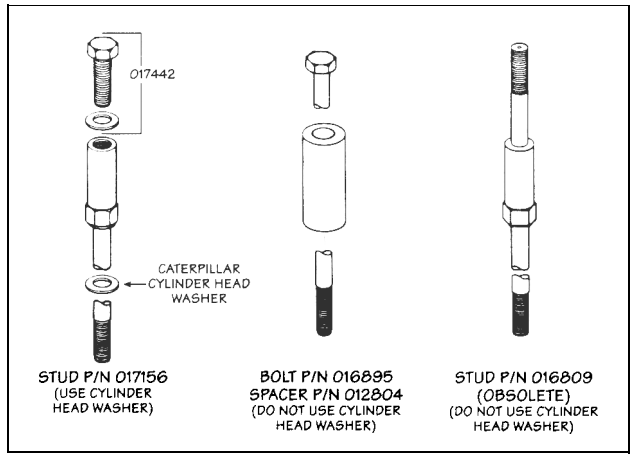


FIG. 1.5.22

Models C336/336A

The Model C336 Jake Brake Engine Brake is approved for use on Caterpillar 3306B engines with serial numbers greater than 63Z3300 and 3306 engines with serial numbers greater than 76R6115.

The Model 336A Jake Brake Engine Brake is approved for use on Caterpillar 3306C engines with serial number 7RJO0116 or greater and Caterpillar 3306C engines with a serial number prefix of 9TL.

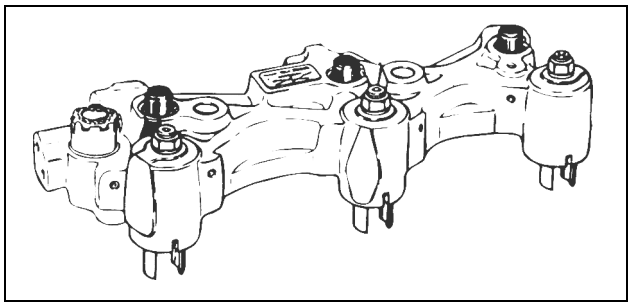


FIG. 1.5.23

Master-Slave Circuit Relationship Listed in Engine Firing Order

Location of Master Piston	Location of Slave Piston
Actuates	
No. 1 Pushrod	No. 3 Exhaust Valve
No. 5 Pushrod	No. 6 Exhaust Valve
No. 3 Pushrod	No. 2 Exhaust Valve
No. 6 Pushrod	No. 4 Exhaust Valve
No. 2 Pushrod	No. 1 Exhaust Valve
No. 4 Pushrod	No. 5 Exhaust Valve

CHART 5

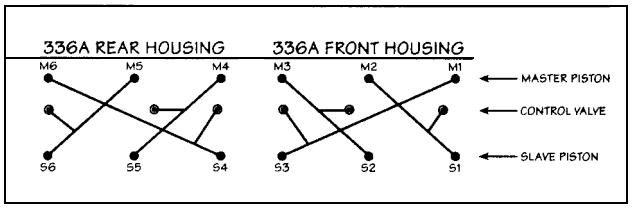


CHART 6

Exhaust Valve Stem Caps

The valve cap shown in Fig. 1.5.24 is currently used for Models C336 and 336A engine brakes. It can be used as a replacement part, when necessary, for the former cap used with the Model C336. The valve cap shown in Fig. 1.5.25 was previously used in the Model C336 engine brake

⚠ CAUTION

THE VALVE CAP SHOWN IN FIG. 1.5.25 MUST NOT BE USED IN MODEL 336A ENGINE BRAKES. SERIOUS ENGINE DAMAGE MAY RESULT.

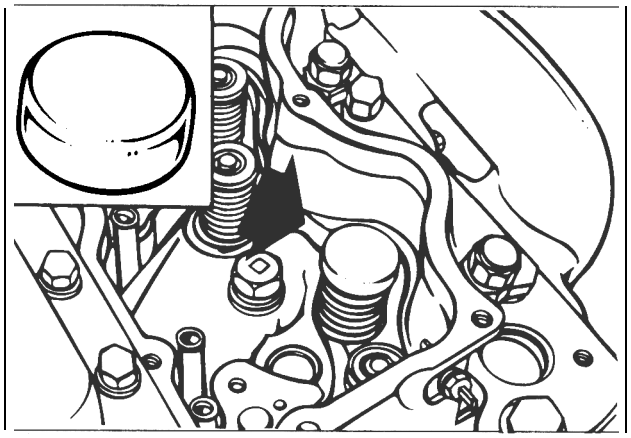


FIG. 1.5.24

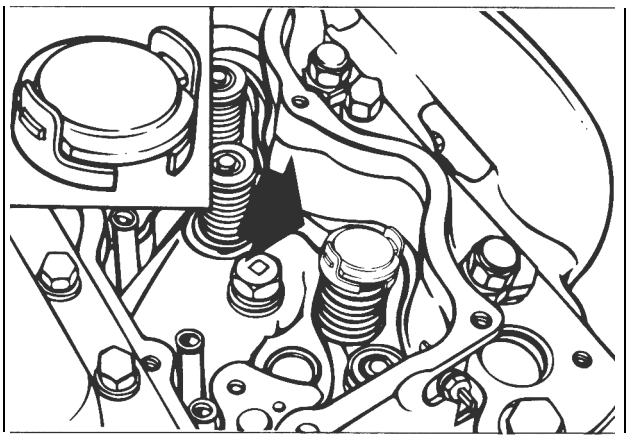


FIG. 1.5.25

Slave Piston Clearance Settings

Model C336 only:

The C336 uses the adjusting gage shown in Fig. 1.5.26. See Installation Manual and current sewice publications for slave piston clearance setting.

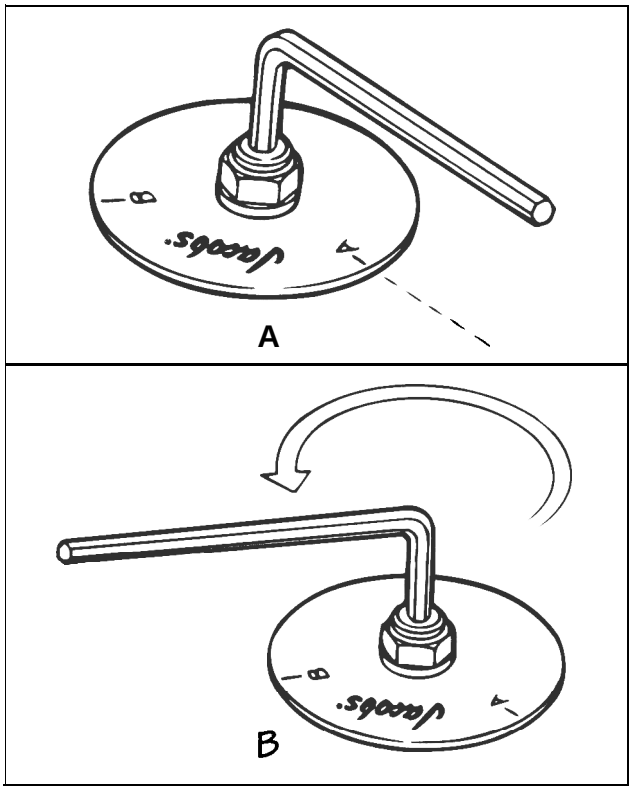


FIG. 1.5.26

Model 336A only:

Place the Jacobs lash adjusting gage (refer to the current installation manuals for proper slave piston clearance setling) between the valve cap and slave piston foot (see Fig. 1.5.27).

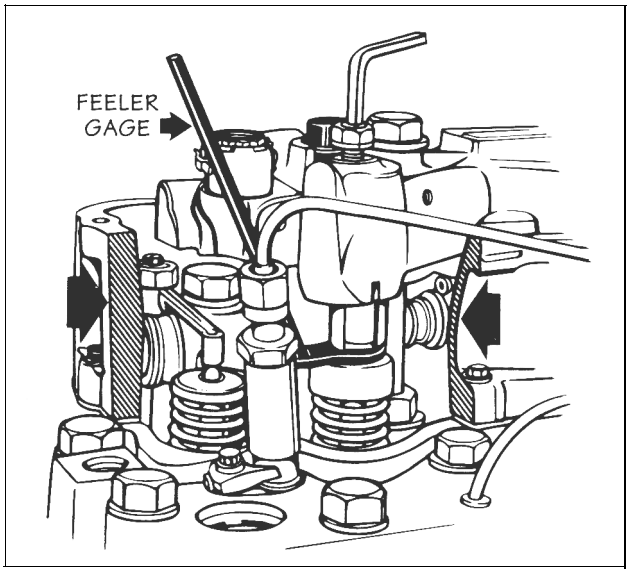


FIG. 1.5.27

CAUTION

BE SURE THAT THE FEELER GAGE IS FULLY ENGAGED UNDER BOTH SLAVE PISTON FEET (SEE FIG. 1.5.28). FAILURE TO PROPERLY USE TOOL MAY RESULT IN INCORRECT SLAVE LASH WHICH WILL LEAD TO POOR PERFORMANCE AND/OR ENGINE/ENGINE BRAKE DAMAGE.

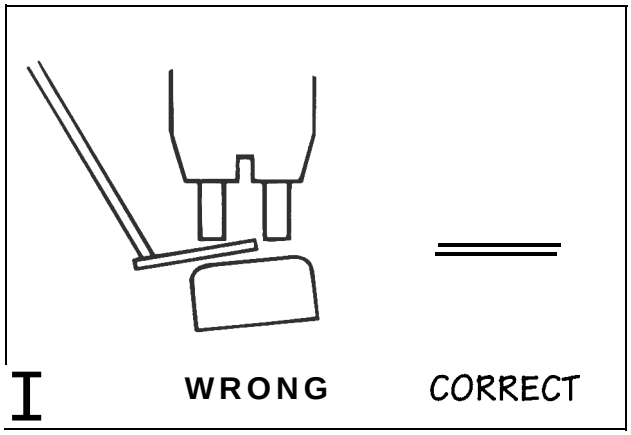


FIG. 1.5.28

Turn the adjusting screw clockwise until a slight drag is detected. Hold screw in this position and tighten locknut to 25 lb.-ft. (35 N•m).

NOTES

1.6 Engine Brakes for Detroit Diesel Engines

General Application Information

- 71A/92A (Fig. 1.6.1): used on all 4, 6, 8, 12 and 16 cylinder engines whether naturally aspirated, turbocharged, TA or TTA engines

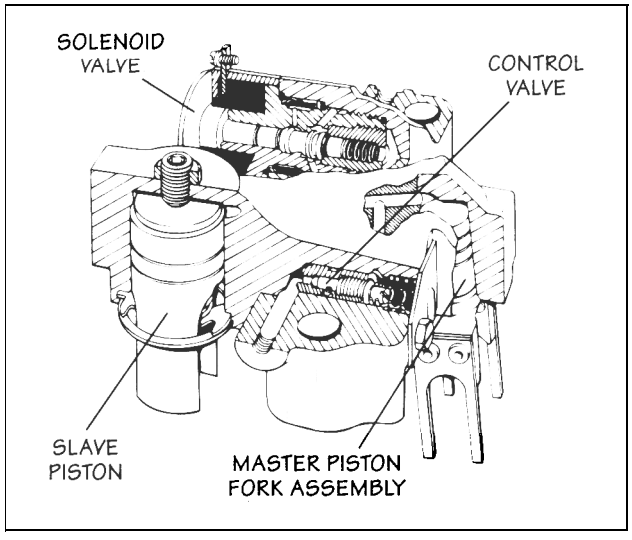


FIG. 1.6.1

- 53A (Fig. 1.6.2): Used on the following Detroit Diesel Engine Models: 3-53,4-53, 6V-53, 8V-53

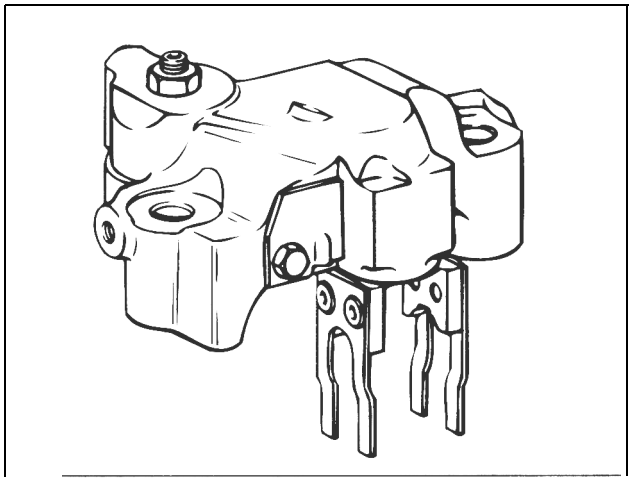


FIG. 1.6.2

Adjustment of Engine Brake Slave Pistons

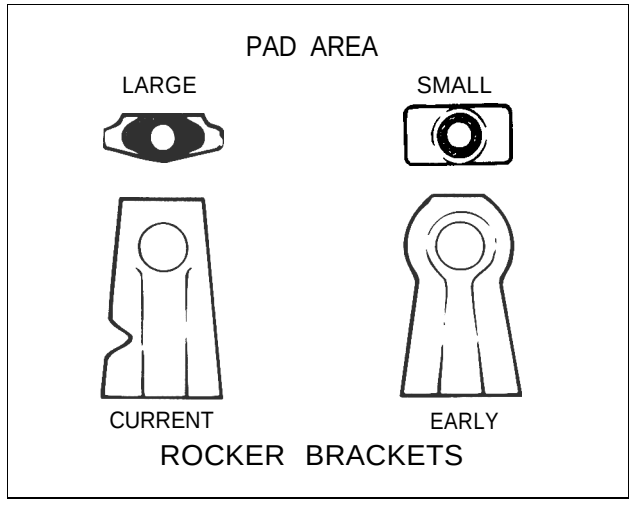


FIG. 1.6.3

CAUTION

FOLLOW ENGINE BRAKE ADJUSTMENT PROCEDURES CAREFULLY TO PREVENT ENGINE DAMAGE BY PISTON TO VALVE CONTACT. BEFORE MAKING SLAVE PISTON ADJUSTMENTS, MAKE SURE EXHAUST VALVES ARE CLOSED AND INJECTOR IS IN THE DELIVERY POSITION.

Slave Piston Settings: Model 7l/92A

Slave piston clearance must be set according to type of housing and rocker brackets. See Fig. 1.6.3. Refer to the following chart:

Housing/Bracket Type	Slave Piston Setting
Rocker Brackets with large pad area and 71A/92A engine brake housings	0.059"
All other combinations of brackets and housings	0.064"

⚠ CAUTION

DO NOT USE THE 0.059" SETTING WITH THE FORMER DETROIT DIESEL ROCKER BRACKETS OR WITH THE EARLIER MODEL 71/92 ENGINE BRAKE. ENGINE OR ENGINE BRAKE FAILURES WILL RESULT. THOSE APPLICATIONS MUST CONTINUE TO USE THE 0.064 INCH SLAVE PISTON SETTING.

Slave Piston Adjustment: Model 53A

The Model 53A slave piston adjustment is done by a turns method. See the Model 53A Installation Manual for procedures.

Special Features/ Procedures

Exhaust Valve Bridges

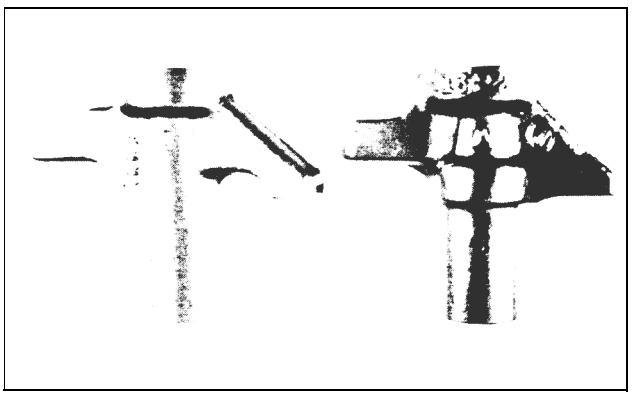


FIG. 1.6.4

The differences in the profile shape and the distance between valve stem contact points for Models 71A and 92A engine brake bridges can be seen in Fig. 1.6.4. Models 71A and 92A engine brake kits are identical except for bridge differences.

DDEC Fuel Pipes

DDEC fuel pipes (Fig. 1.6.5) must be removed prior to engine brake housing removal. Check fuel pipes for damage especially at the fitting area and replace if necessary. Fuel pipes may be reused if in good condition

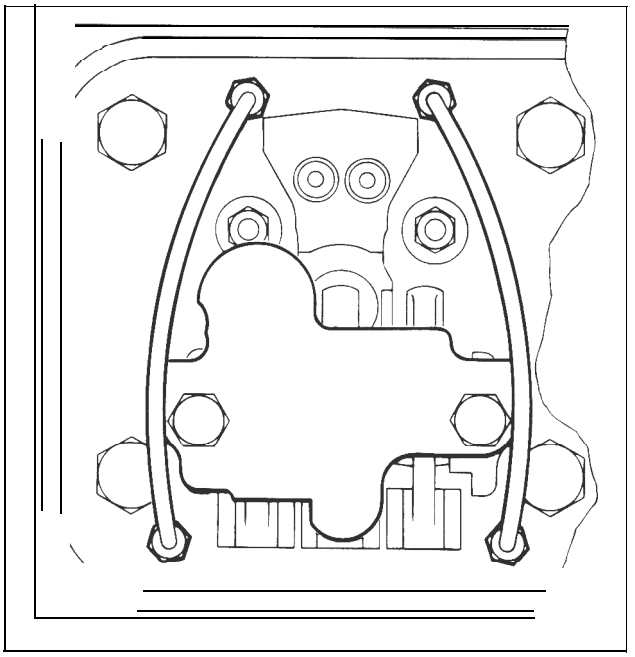


FIG. 1.6.5

Fuel Pipes - Non DDEC Engines

The former flare type fuel pipes (Fig. 1.6.6) are not reusable. New O-ring style fuel pipes with attaching parts, must be installed in place of the flare type fuel pipes.

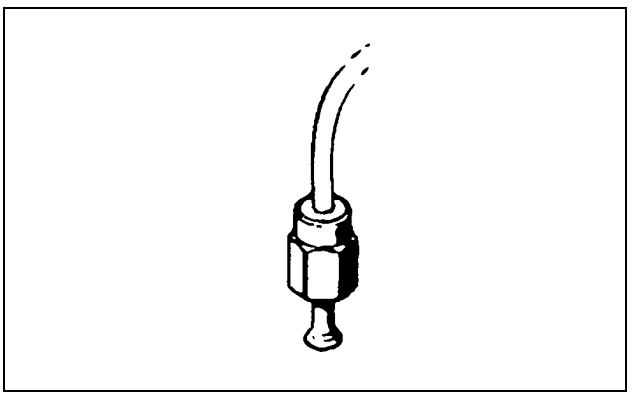


FIG. 1.6.6

Fuel Pipe Installation

NOTE:

IT IS NECESSARY TO REMOVE INJECTORS WHICH HAVE BEEN OPERATED IN AN ENGINE BEFORE REPLACING FILTER CAPS.

Non-DDEC Engines

Replace flare style fuel pipes with O-ring style fuel pipes. In the following instructions, numbers in parentheses refer to Fig. 1.6.7 and Fig. 1.6.8.

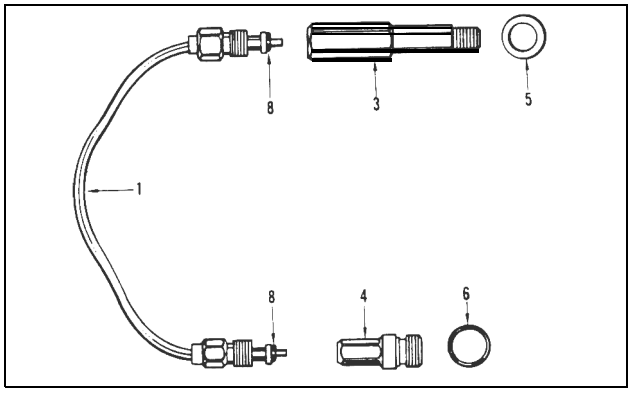


FIG. 1.6.7

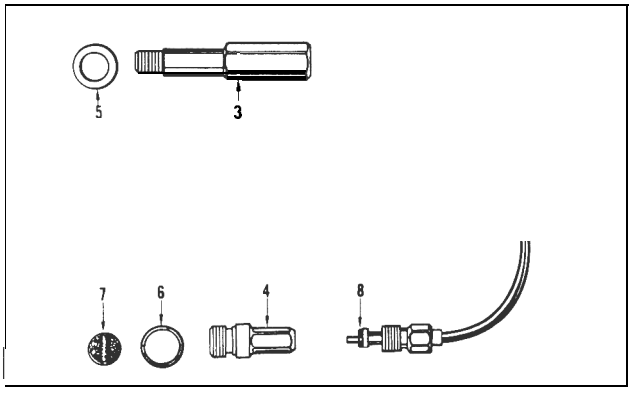


FIG. 1.6.8

1. Remove injectors according to instructions in the DDC engine service manual. Remove fuel connectors from cylinder head.
2. Install the new connectors (3) with washers (5) into the cylinder head (2 per cylinder) (see Fig. 1.6.9). Torque the connectors to 40 - 45 lb.-ft. (54 - 61 N•m).

FIG. 1.6.6

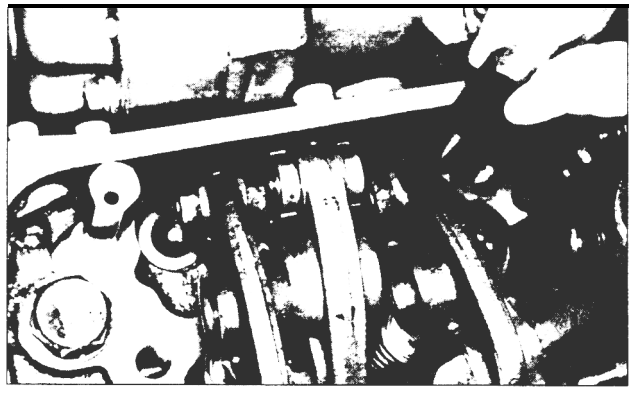


FIG. 1.6.9

3. Remove injector filter caps, washers, gaskets/fuel inlet filters.
4. Install the new filter (7) into the inlet port of the injector, grooved side up. The injector inlet port is located above the control rack (see Fig. 1.6.10).

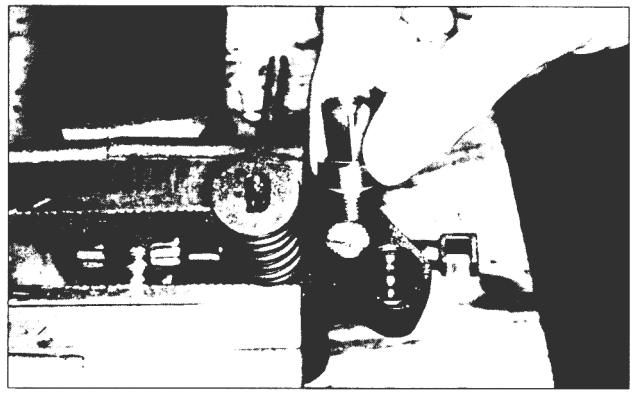


FIG. 1.6.10

5. Install the new fuel injector caps (4) and gaskets (6) into the inlet and return ports of the injector. Torque the caps to 60 - 70 lb.-ft. (82 - 95 N•m). Use a deep well socket and torque wrench.
6. Install and adjust the fuel injectors according to instructions in the DDC engine service manual.
7. Remove the protective caps from the fuel pipes.

NOTE:

THE O-RINGS (8) MUST BE INSTALLED ON THE FUEL PIPES.

8. Lubricate the O-rings with clean lube oil and install the short (inlet) (2) and long (return) (1) fuel pipes.

⚠ CAUTION

SET THE PIPE ENDS INTO THE FITTINGS. HAND TIGHTEN THE FUEL PIPE NUTS. DO NOT BEND FUEL PIPES (SEE FIG 1.6.11). IF THE CONNECTIONS DO NOT FIT EASILY INTO THE FITTINGS OR, IF THERE IS INTERFERENCE WITH THE ENGINE BRAKE HOUSING, REPLACE THE FUEL PIPES. BENDING THE FUEL PIPES MAY RESULT IN FUEL LEAKAGE AND SEVERE ENGINE DAMAGE.

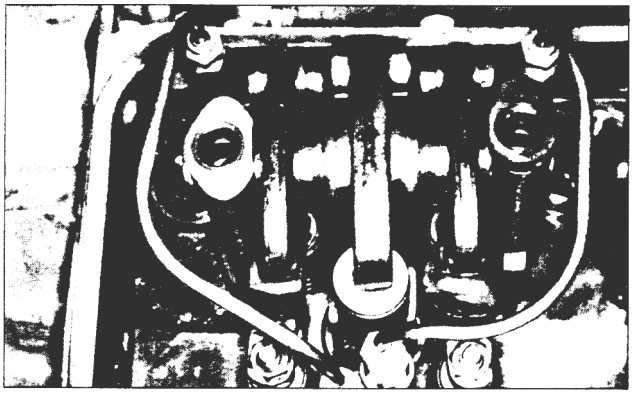


FIG. 1.6.11

9. Torque the fuel pipe nuts to 160-200 lb.-in. (18 - 23 N•m) using a fuel pipe nut socket and torque wrench.

Fast Idle Buffer Switch

This type of switch is installed to retain the fast idle feature and automatic engine brake operation.

Follow the standard buffer screw plunger and switch assembly installation.

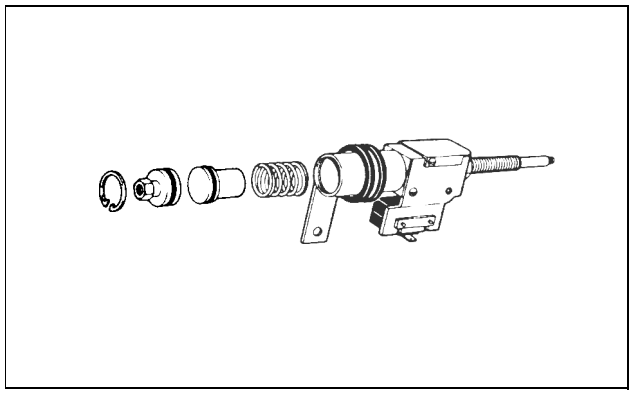


FIG. 1.6.12

1. Attach the fast idle switch assembly to the buffer screw attaching nut.
2. Adjust the switch bracket clamp to line up with the Detroit Diesel housing-to-blower bolt (Fig. 1.6.13).

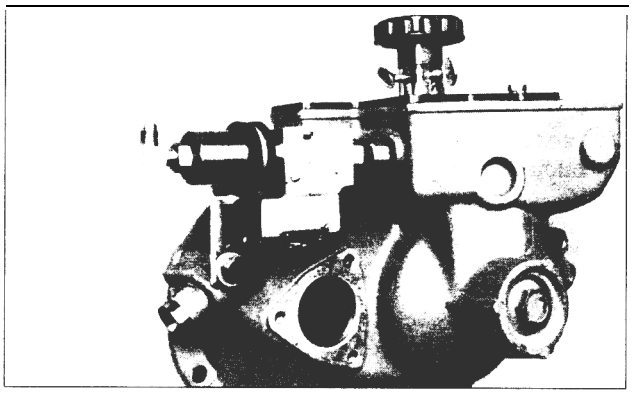


FIG. 1.6.13

3. Remove the bolt and washer and secure the switch by placing the mounting bracket between the washer and bolt.
4. Tighten the bolt and clamp.
5. Install the air tube elbow into the inlet plug and attach the air tube between the elbow and the fast idle limiting air cylinder on top of the governor housing.

With the fast idle buffer switch properly installed, the engine brake will operate only during deceleration and will automatically shut off when fast idle activation occurs.

Oil Connectors

Poor performance problems may be caused by improperly installed or broken oil connectors. Pay particular attention to this area during troubleshooting.

1. Reposition the seal ring in the head of the oil connector to make sure it fits into the recessed hex head of the connector screw (Fig. 1.6.14).

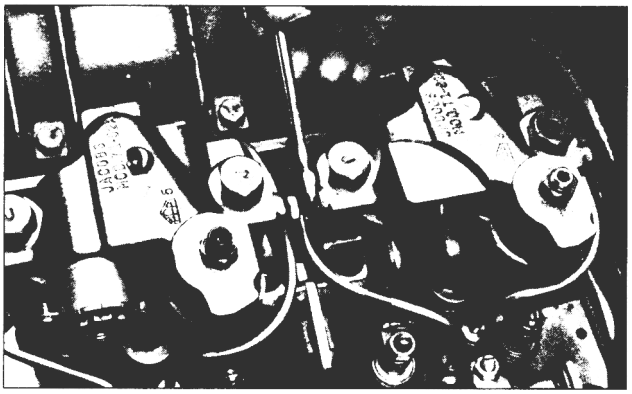


FIG. 1.6.14

4. Hold the oil connector in this position and carefully lock the lock nut. Use two short open end wrenches (Fig. 1.6.15). Remember, too much torque on these connectors will cause them to crack.

FIG. 1.6.15

Clevis for Injector Rocker Lever

In 1978, Detroit Diesel began using a larger clevis for the injector rocker lever. This clevis and the standard Jacobs fork assembly made an overall height greater than acceptable. Interference with the bottom of the engine brake housing could be damaging and an engine brake power loss could result.

When installing an older engine brake on a new engine or using older spare parts, special attention must be given in this area. The current fork assembly, P/N 003337, and spring, P/N 009505, can be used on both the high and standard clevises. It is **strongly recommended** that old housings be updated to the P/N 003337 fork and P/N 009505 spring combination.

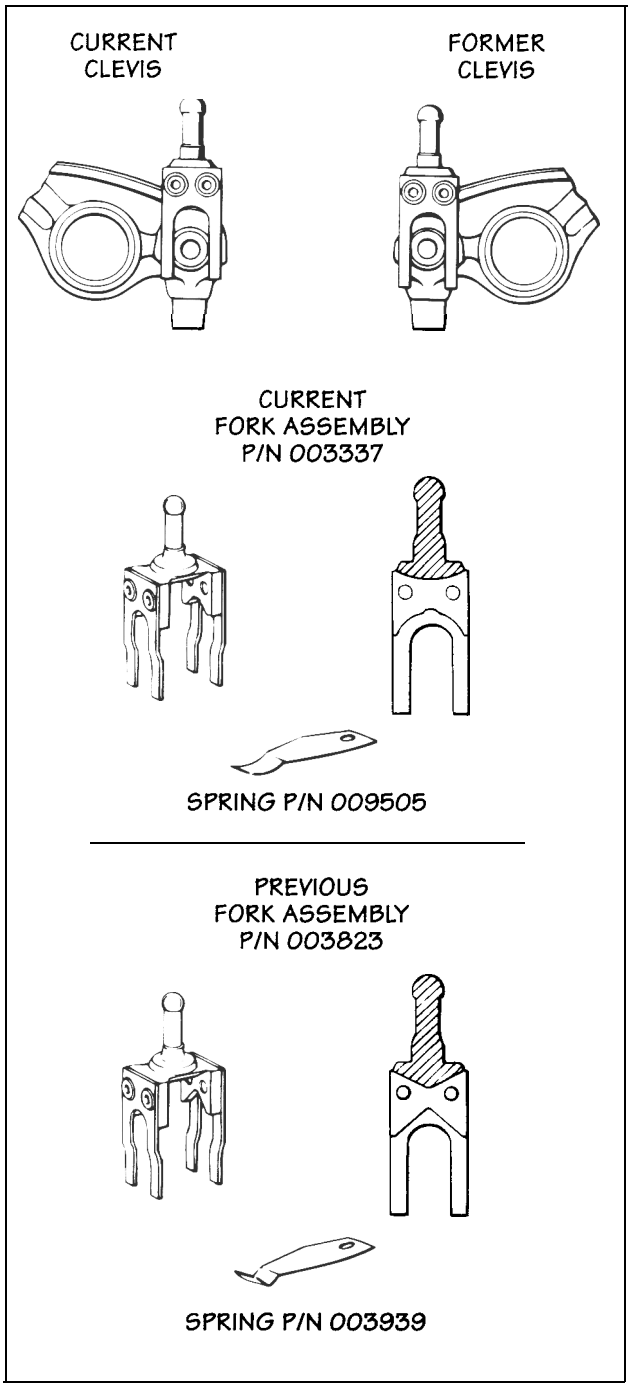


FIG. 1.6.16

Two-Valve Head

Detroit Diesel also makes a two-valve cylinder head design. For this design, the Jacobs exhaust bridge is replaced with a Jacobs valve stem cap.

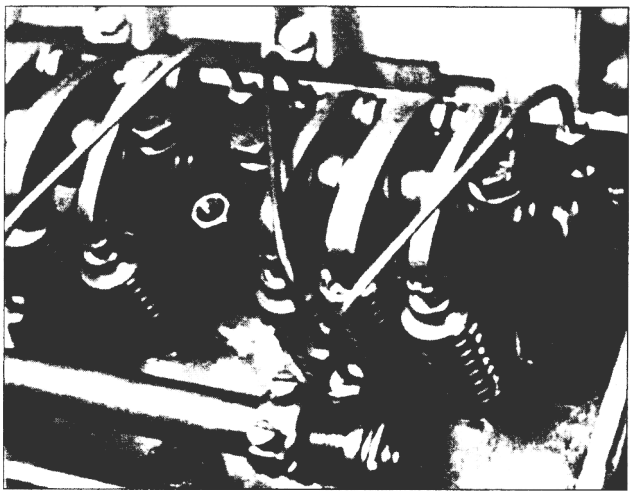


FIG. 1.6.17

1. On engines equipped with high mount injector clamps, remove the clamp by removing the bolt and special washer. Replace with a Jacobs high mount clamp and use the same washer and bolt (Fig. 1.6.18). Tighten the bolt to 25 lb.-ft. (35 NŽm). The Jacobs clamp can be identified by a small milled section on one side. This provides clearance for the exhaust valve stem cap.

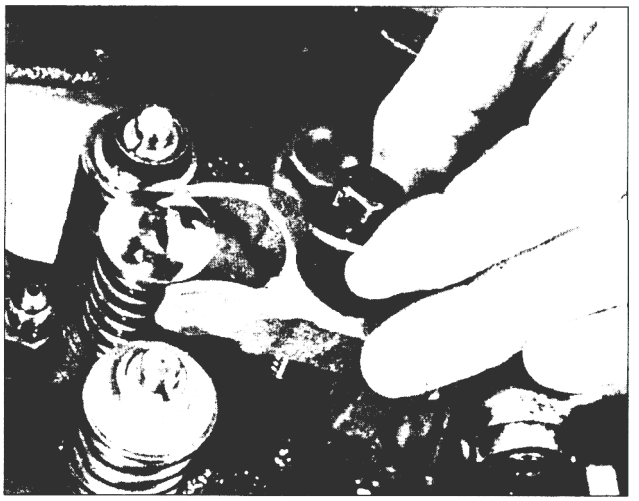


FIG. 1.6.18

2. Install Jacobs valve stem caps on right-hand exhaust valves (one per cylinder) (Fig. 1.6.19). Press caps firmly over valve springs. Hexagon cover studs must be removed if located near this valve.

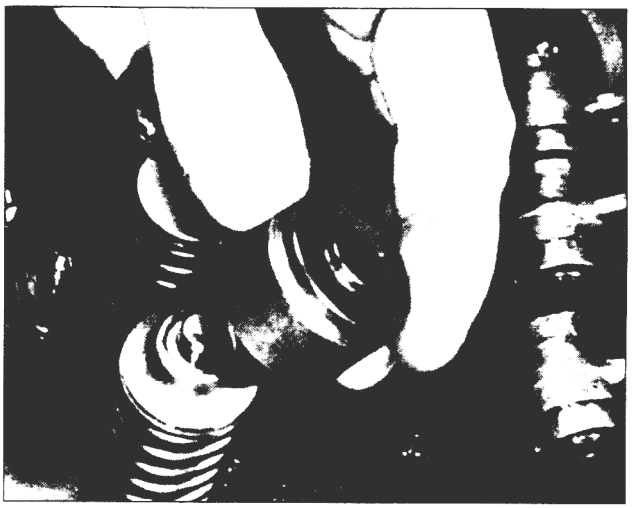


FIG. 1.6.19

3. Using the Jacobs clamping tool, back off the thumb screw. Install the tool squarely over the valve stem cap with its feet under the exposed coil of the valve spring (Fig. 1.6.20). Tighten the thumb screw to seat the cap. Remove the tool.

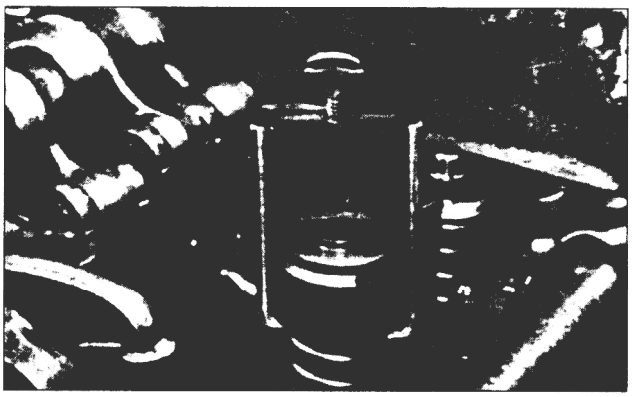


FIG. 1.6.20

Models 760/760A/765 Engine Brakes

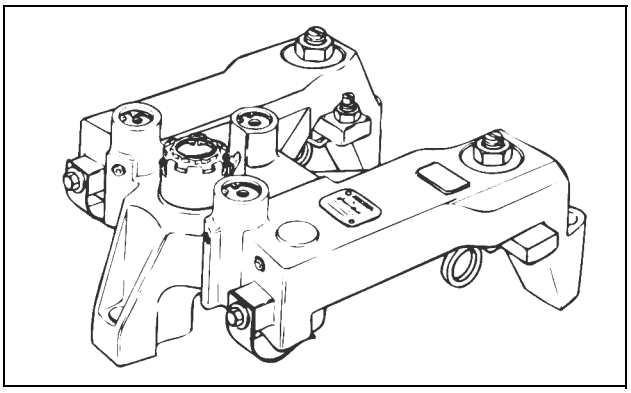


FIG. 1.6.21

Engine Identification

Engine model identification is on the name tag located on the side of the valve cover and stamped on the cylinder block beneath the intake manifold.

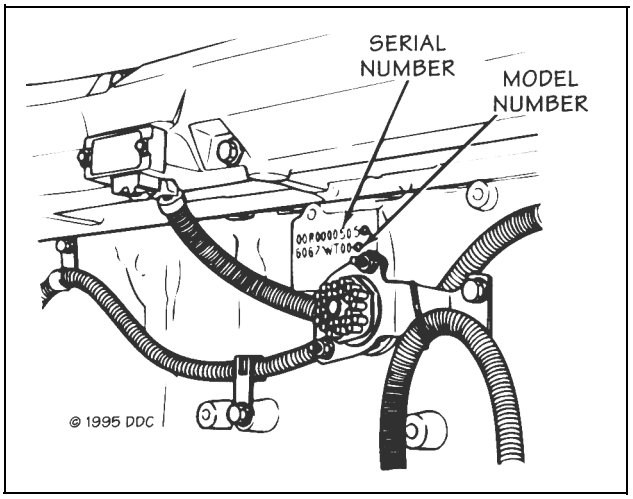


FIG. 1.6.22

A “G” is the model number indicates 12.7 liter displacement; a “W” indicates 11.1 liter displacement. See the typical model number below:

6 0 6 7 **G** U **6 0**

Displacement	Model Year
G = 12.7	40 = Pre 1991
W = 11.1	60 = 1991 and later
	28 = 1991 and later (Coach)

Application Information

Model No.	Model Year	Application	Jake Brake Model
6067WU40	Pre’91	Truck	760A
6067GU40	Pre’91	Truck	760A
6067WU60	’91 & later	Truck	760A
6067GU60	‘91 & later	Truck	765
6067GU28	‘91 & later	Coach	765
6067GU91	‘91 & later	Military	765
6067WK60	‘91 & later	Truck	760A
6067GK60	‘91 & later	Truck	765
6067GK28	’91 & later	Coach	765

Slave Piston Adjustment

Models 760/760A/765 require a single-blade feeler gauge for slave piston adjustment. For correct adjustment procedures, clearance settings and feeler gauge part numbers, see Jacobs installation and parts manuals and service publications.

Housing Mounting Bolts

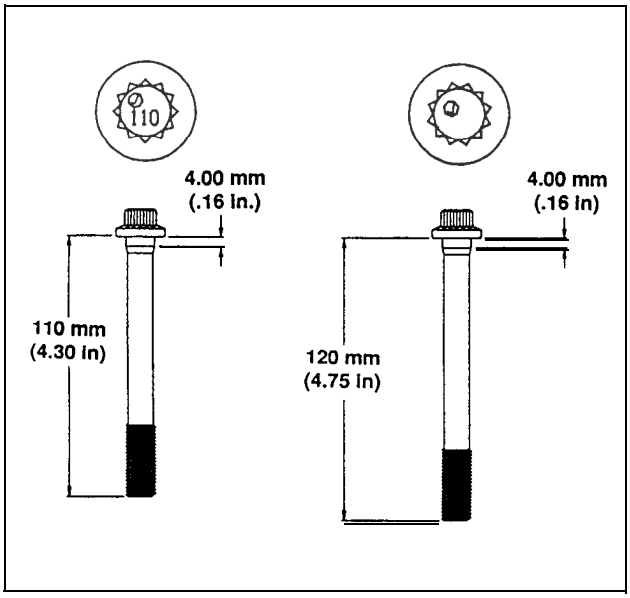


FIG. 1.6.23

CAUTION

IT IS IMPERATIVE THAT THE CORRECT JACOBS BOLTS BE USED FOR THE ENGINE BRAKE HOUSING BEING INSTALLED. INSTALLATION OF INCORRECT BOLTS WILL RESULT IN ENGINE AND ENGINE BRAKE DAMAGE.

Model 760: Use one 120 mm bolt, P/N 012995, and two 110 mm bolts, P/N 016345, for each housing.

Models 760A and 765: Use three 110 mm bolts, P/N 016345, for each housing.

Follow the instructions in the Installation Manual, P/N 014328, for correct application and torque information.

The Detroit Diesel rocker arm shaft bolt used on Series 60 engines has a shoulder that is much longer than the Jacobs bolt and has the logo (spinning arrows) and vendor ID (F-C) on its head (see Fig. 1.6.24). This bolt MUST NOT be used for the engine brake housing hold down.

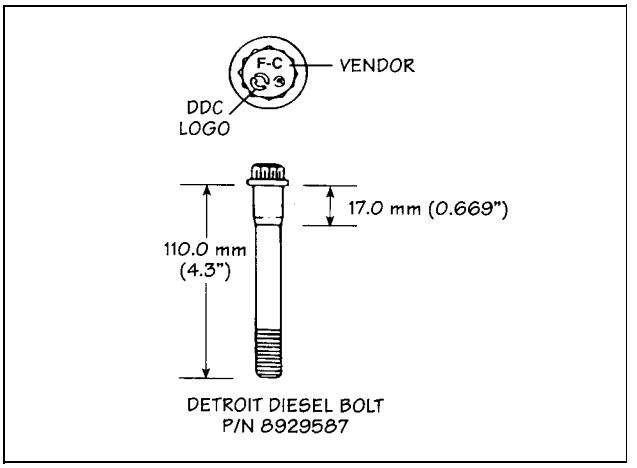


FIG. 1.6.24

CAUTION

IF THE DETROIT DIESEL BOLT IS MISTAKENLY USED FOR ENGINE BRAKE HOLD DOWN, THE LONGER SHOULDER ON THE BOLT WILL RESTRICT OIL SUPPLY TO THE HOUSING AND PREVENT PROPER BRAKE OPERATION.

Ball Check Valve (Model 760 Only)

Remove the plug to remove the ball check valve and spring, Inspect parts for wear or damage and replace, if necessary. Reinstall the parts in the proper sequence (see Fig. 1.6.25).

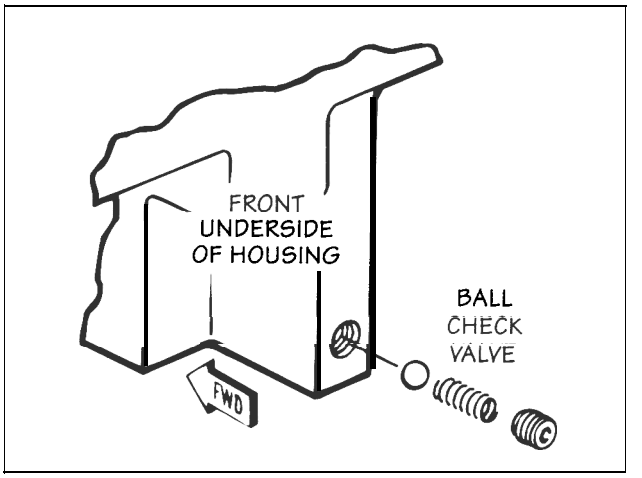
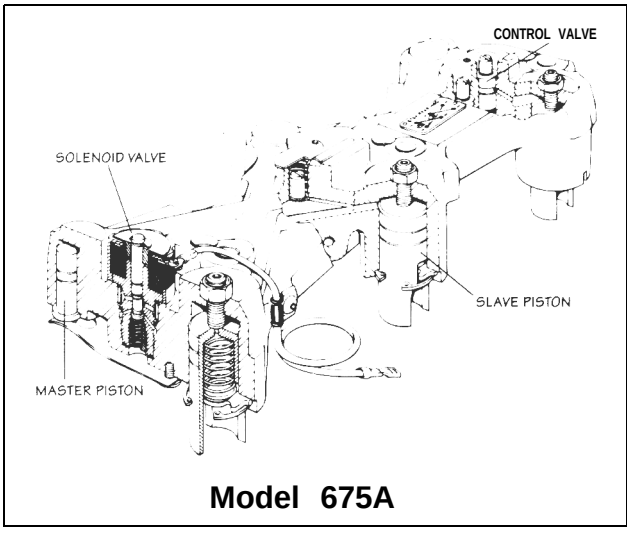


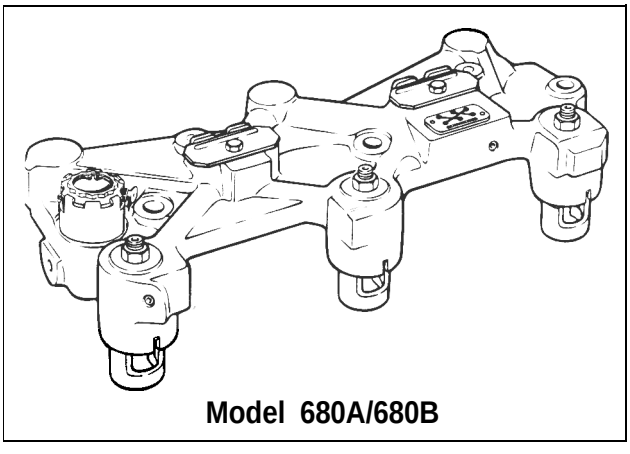
FIG. 1.6.25

1.7 Engine Brakes for Mack Engines



Model 675A

FIG. 1.7.1



Model 680A/680B

FIG. 1.7.2

General Application Information

The Model 680B Jake Brake engine retarder is designed and approved for use on Mack E7 engines.

The Model 680A Jake Brake engine retarder is designed and approved for use on Mack E6 engines with four-valve cylinder head configuration.

The Model 675A Jake Brake engine retarder is designed and approved for use on all Mack 6 cylinder 672 and 711 CID automotive engines: E6, EC6, EM6 and EMC6. The Model 675A replaces the Model 675 in the Jacobs engine brake product line.

Special Features/ Procedures

Valve Stem Caps: Models 675 and 675A

NOTE:

IATER PRODUCTION ENGINES HAVE 0.345" (11.1 MM) DIAMETER VALVE STEMS. USE JACOBS VALVE STEM CAP, P/N 009263, ON THESE ENGINES. MACK ENGINES WITH SERIAL NUMBERS BELOW 9V6755 CAN HAVE LARGER DIAMETER EXHAUST VALVE STEMS, 0.486" (1 2.3 MM). JACOBS VALVE STEM CAP, P/N 002032, MUST BE USED ON THESE EARLIER ENGINES.

Place the Jacobs valve stem caps on top of each exhaust valve.

FIG. 1.7.3

Slave Piston Adjusting Screw

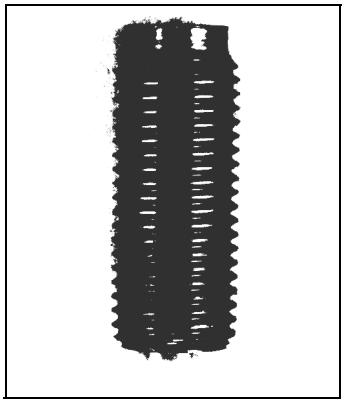


FIG. 1.7.4

NOTE:

EARLY MODEL 675A PRODUCTION HOUSINGS (S/N B-370476 AND LOWER) AND ALL 675 HOUSINGS USE SOLID ADJUSTING SCREWS AND SLAVE PISTONS WITH NO HOLES.

MODEL 675A HOUSINGS (S/N B-370477 AND GREATER) HAVE ADJUSTING SCREWS WITH SPRING-LOADED PLUNGERS AND SLAVE PISTONS WITH HOLES

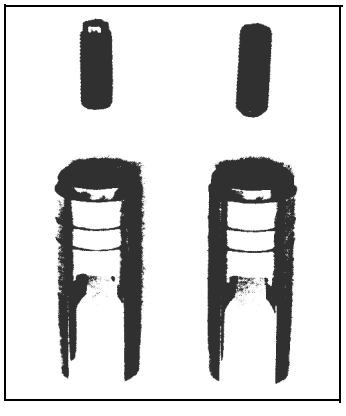


FIG. 1.7.5

⚠ CAUTION

ADJUSTING SCREWS AND SLAVE PISTONS MUST NOT BE INTERMIXED.

NOTE:

THE SPRING-LOADED PLUNGER IS DESIGNED TO PREVENT SLAVE PISTON OVERTRAVEL IN THE EVENT OF EXCESSIVE ENGINE OIL PRESSURE OR RESTRICTED SLAVE PISTON MOVEMENT.

Inspect the plastic plunger in the Model 675 adjusting screw. It should move freely in the screw. Clean or replace the entire screw if the plunger does not move freely.

Oil Supply Screw: Models 675 and 675A

NOTE:

ENGINES MANUFACTURED PRIOR TO MARCH, 1986, HAVE A 1 /4-20 THREADED HOLE FOR THE ROCKER SHAFT LOCKING SCREWS (SEE FIG. 1.7.6). THESE ENGINES REQUIRE JACOBS OIL SUPPLY SCREW, P/N 014043, AND WASHER, P/N 014104.

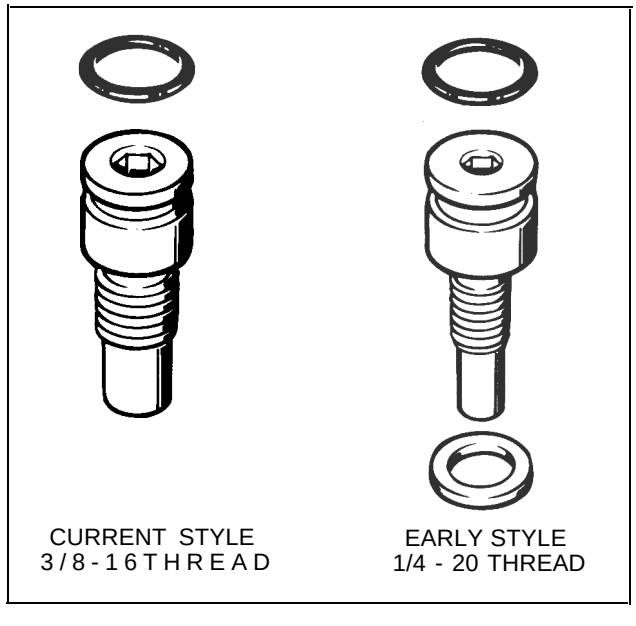


FIG. 1.7,6

Slave Piston Adjustment

Models 675 and 675A require a fork-type feeler gauge for slave piston to valve cap clearance setting. This is required to be sure the valve stem cap is level with the slave piston when adjustment is made.

For correct adjustment procedures, clearance settings and feeler gauge part numbers, see Jacobs' installation and parts manuals and service publications.

Exhaust Valve Yoke Replacement

Early Jacobs Model 680A/680B exhaust valve yokes have SAE threads. Current production yokes have metric threads. Be sure to use the correct screws and nuts for replacement parts.

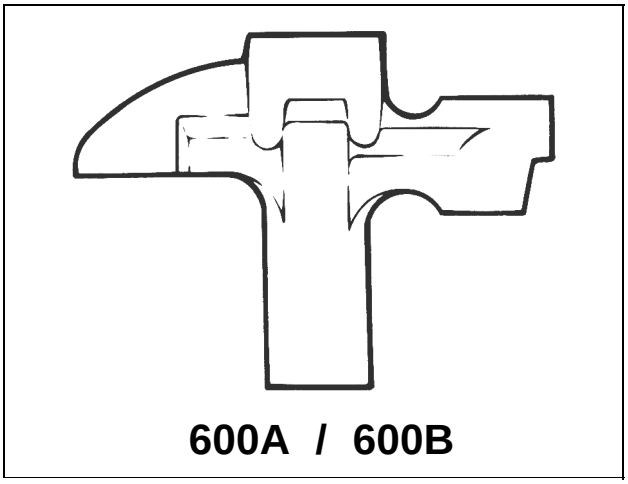


FIG. 1.7.7

NOTES

Section 2: Preventive Maintenance

Introduction

The Jacobs Engine Brake is typically a trouble-free device. However, inspections are necessary and some maintenance is required. The mileage and hours intervals presented here are intended as a guide for establishing a routine of lake Brake inspection and maintenance in conjunction with scheduled engine maintenance.

Severe driving conditions, types of roads and driving areas will affect the length of time between scheduled maintenance. Engines exposed to severe applications and operating environments may require more frequent preventive maintenance, thereby altering engine retarder maintenance intervals as well.

The Recommended Preventive Maintenance Schedule shown below is applicable to all engine brake models.

Recommended Preventive Maintenance Schedule

Part	12 Months 100,000 Miles 3,000 Hours	36 Months 300,000 Miles 9,000 Hours	60 Months 500,000 Miles 15,000 Hours
Wiring/Terminal Connections	I	I	I
Clutch/Throttle/Buffer	A	**A/R**	**A/R**
Safety Valve Screw Assembly	I	I	R
Solenoid Valves		I	R
Reset/Auto-Lash' Assembly		I	**I/R**
Crosshead/Bridges/Valve Stem Caps		I	**I/R**
Injector/Exhaust Rocker Arm Screws		I	**I/R**
Master Piston/Fork Assembly		I	**I/R**
Slave Pistons			I
External Hose Assembly		**I/R**	**I/R**
Housings		I	
Fuel Pipes		**I/R**	**I/R**
Hold-down Bolts		I	R
Accumulator Springs*		R	
Solenoid Harness*		R	**I/R**
Solenoid Seal Rings*		R	**I/R**
Control Valve Springs*		R	**I/R**
Control Valves*		R	**I/R**
Oil Seal Rings*	I	R	**I/R**
Master Piston Return Springs*	I	R	I
Terminal Lead Out*	I	R	I
Crosshead Pin Assembly*	I	R	I

I = inspect/correct as required **A** = Adjust **R** = Replace

* contained in tune-up kits

2.1 Inspection Criteria

Safety Valve Screw Assembly Inspection

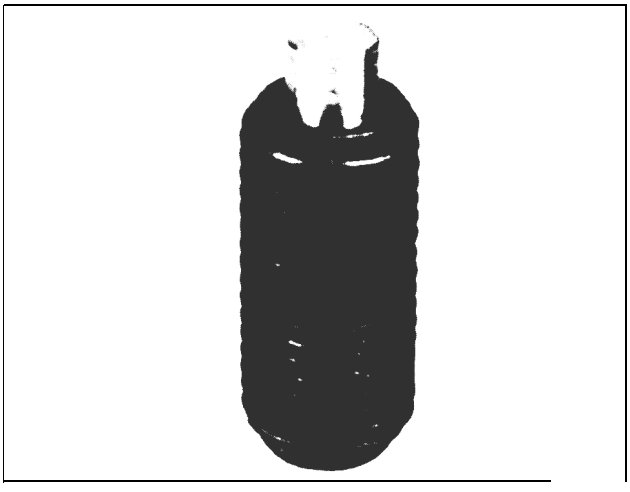


FIG. 2.1.1

1. Check the plunger in the safety valve screw. The plunger should protrude from the bottom of the screw, have light spring pressure apparent when depressed, and should move freely.
2. Inspect the area of the plunger which contacts the slave piston. The area should be flat and smooth.

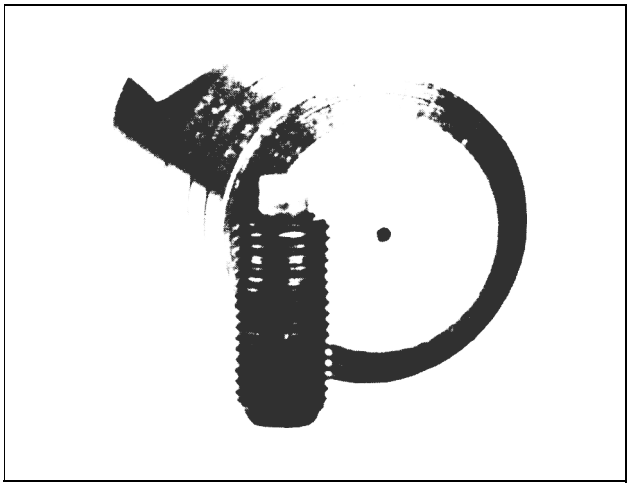


FIG. 2.1.2

3. Clean in an approved cleaning solvent and apply clean engine oil at reinstallation.
4. Ensure that the hole in the slave piston is visible through the threaded screw hole in the housing and aligns with the plunger.

NOTE:

THE SCREW ASSEMBLY CANNOT BE DISASSEMBLED IN THE FIELD.

Exhaust Crosshead/ Bridge or Valve Stem Cap Inspection

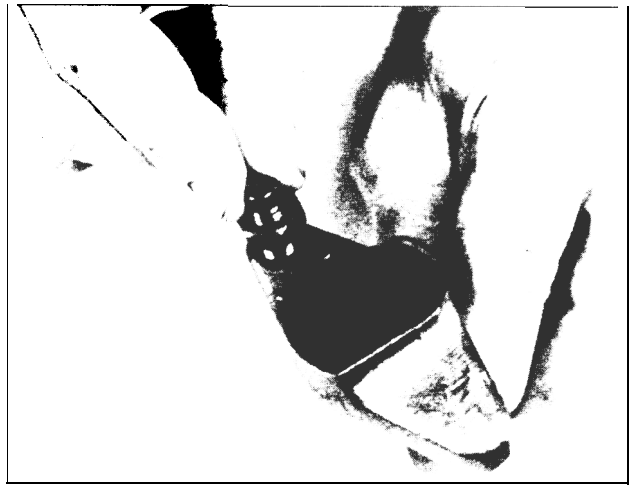


FIG. 2.1.3

1. Check the hardened surface on the Jacobs exhaust crosshead/bridge/valve stem cap for excessive wear at either the point of rocker lever contact or slave piston contact. If the wear is 0.004" deep or more, the crosshead/bridge/cap must be replaced.

FIG. 2.1.4

2. Inspect the area of the valve stem cap that surrounds the valve stem for cracks or excessive wear. If any of these defects are visible, replace the valve stem cap.

3. Check the crosshead/bridge bore and valve stem contact areas. Ensure that they comply with applicable engine manufacturer's service parameters.

Master Piston Inspection

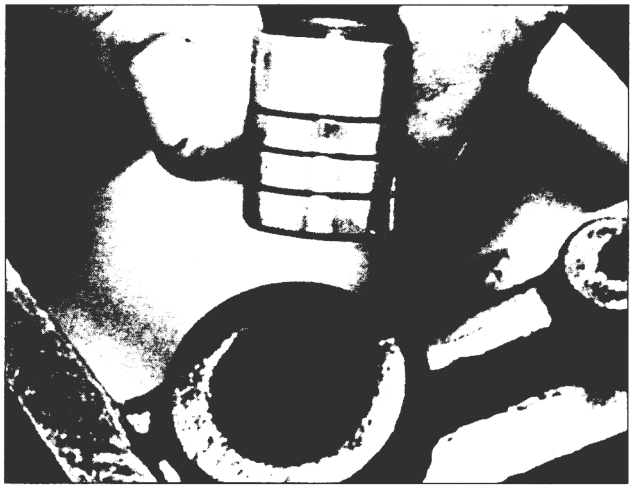


FIG. 2.1.5

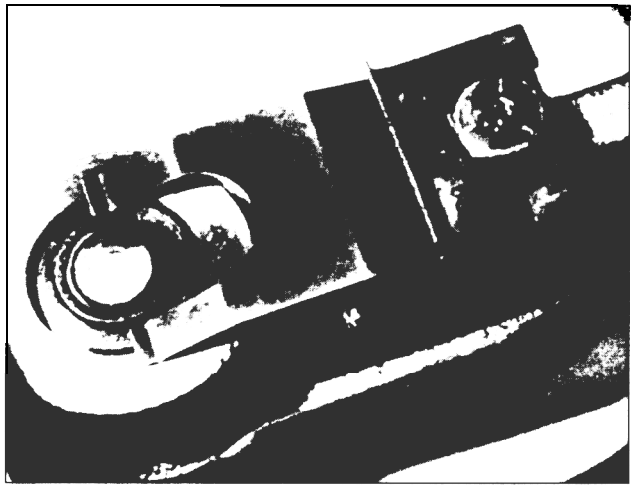


FIG. 2.1.6

1. Remove the master piston from the bore using needle nose pliers. The master piston should move smoothly in the bore. If binding occurs, check for burrs or contaminants in the oil. The sides of the master piston may shown some polish but should not show extensive scoring, grooving or wear.

2. Inspect the hard face surface. Pitted, chipped, cracked or galled pistons should be replaced.

3. Coat the master piston with clean engine oil before reinstalling.

Injector/Exhaust Rocker Arm Adjusting Screw Inspection

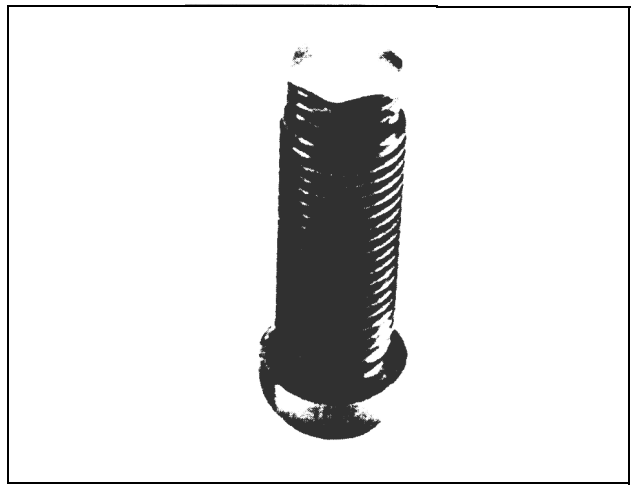


FIG. 2..1.7

1. Check both the hex head and spherical (ball) end surface of the adjusting screws. The spherical end should be checked for proper contour and smooth appearance.

2. Check the hex head for excessive wear. If a depression. 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.

Slave Piston Inspection

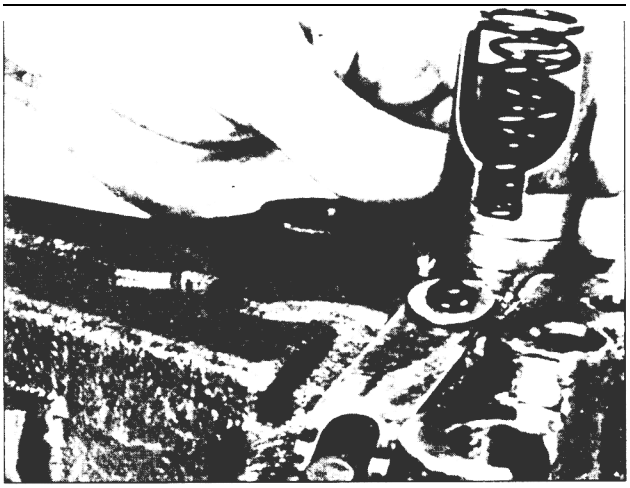


FIG. 2.1.8

WARNING

WEAR SAFETY GLASSES. FOLLOW INSTRUCTIONS CAREFULLY THE SLAVE PISTON IS RETAINED BY A SPRING UNDER HEAVY COMPRESSION. IF INSTRUCTIONS ARE NOT FOLLOWED AND PROPER TOOLS ARE NOT USED, THE SPRING COULD BE DISCHARGED WITH ENOUGH FORCE TO CAUSE PERSONAL INJURY.

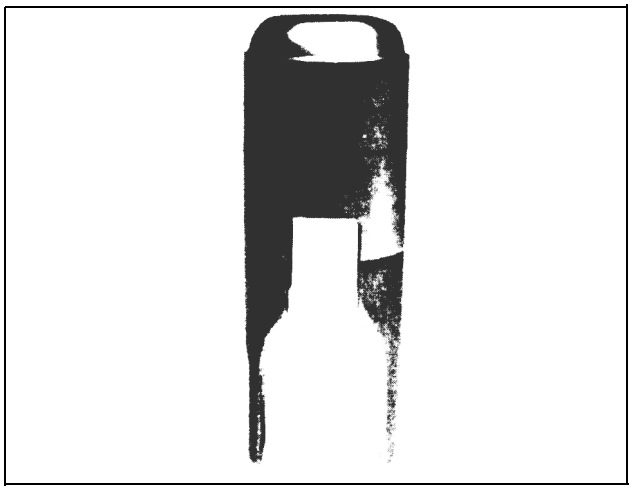


FIG. 2.1.9

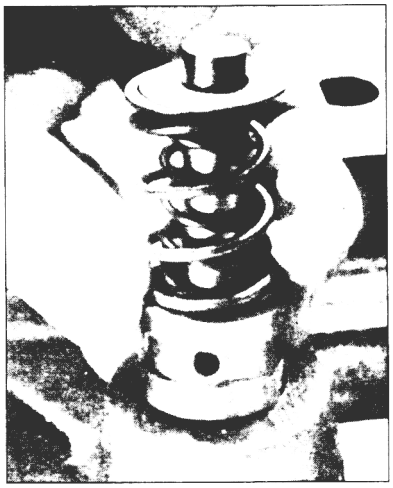


FIG. 2.1.10

1. Check for nicks or burrs that could cause binding. Clean the piston in an approved cleaning solvent. Replace the piston if the ground surtace on the outside diameter looks questionable.
2. Run a small wire through the bleed holes in the single-valve and Caterpillar and Mack engine brakes.

Crosshead Screw and Pin Assembly Inspection (Single-valve Opening)

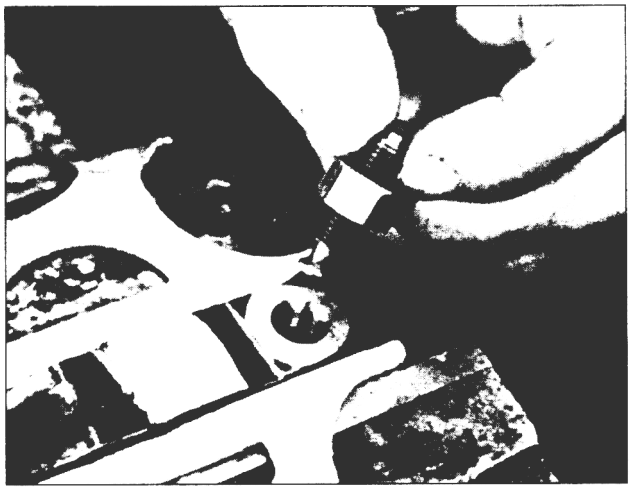


FIG. 2.1.11

Inspect the crosshead pin assembly for the following:

1. Snap ting or grip ring present.
2. Cracks in screw body.
3. Wear on pin where valve stem is contacted.
4. Wear on screw where valve stem is contacted.
5. Bent pin.
6. Cracks in pin.

If any of these conditions are found, the pin assembly must be replaced. Also examine the slave piston for signs of wear at the contact point with the pin assembly.

Slave Piston Adjusting Screws Inspection

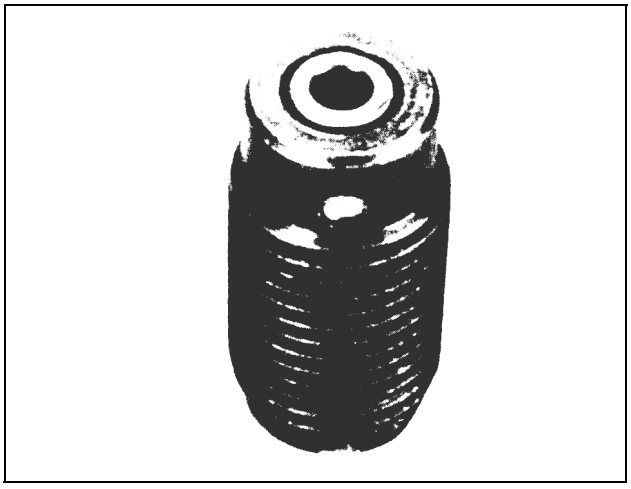


FIG. 2.1.12

Different types of slave piston adjusting screws are used in the various engine brake model housings. These parts are very similar in appearance but must only be used in their designated housings. Refer to current parts and service publications for correct applications.

Part numbers for the Auto-Lash®, Power-Lash® and reset screws are located on the top of the screw body. The screw body has a 1/2 x 20 thread.

The safety valve has a plunger protruding from the bottom of the screw. The screw body has a 3/8 x 24 thread.

1. Inspect Auto-Lash' for proper plunger protrusion. Inspect for strong spring resistance when depressing plunger. Look for cracks in the screw body and replace the Auto-Lash if any cracks are found.

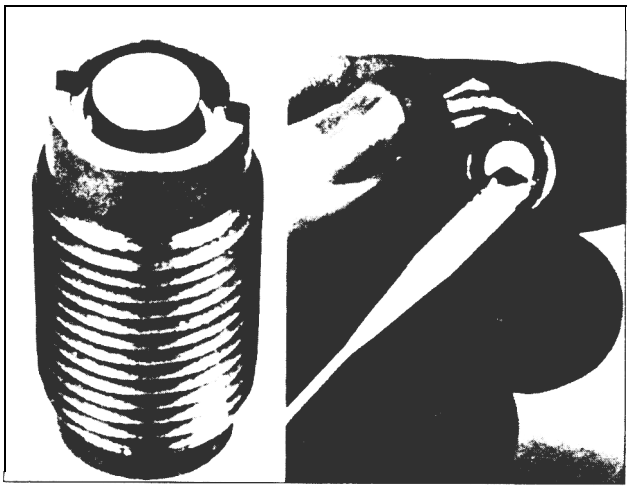


FIG. 2.1.13

2. Inspect the slave piston adjusting screw. The plunger should have light spring pressure apparent when depressed and should move freely. Be sure the retaining ring is fully engaged in its groove.
3. Clean in an approved cleaning solvent. Replace the entire screw if necessary.

⚠ CAUTION

MAKE NO ATTEMPT TO READJUST OR TAMPER WITH THE ADJUSTING SCREW. THIS COULD RESULT IN ENGINE DAMAGE.

Control Valve Inspection

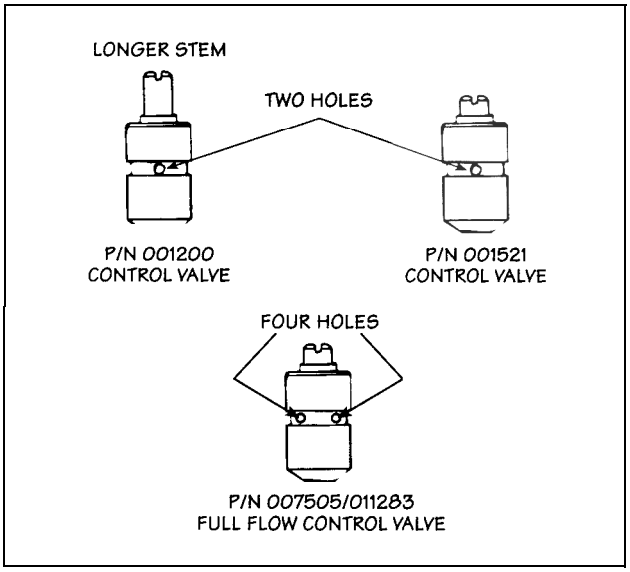


FIG. 2.1.14

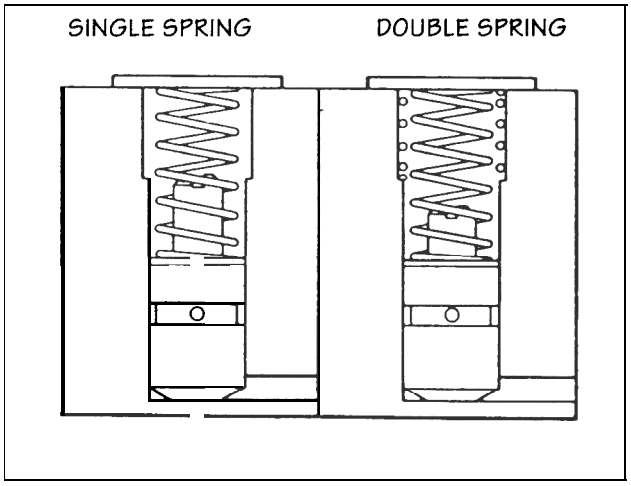


FIG. 2.1.15

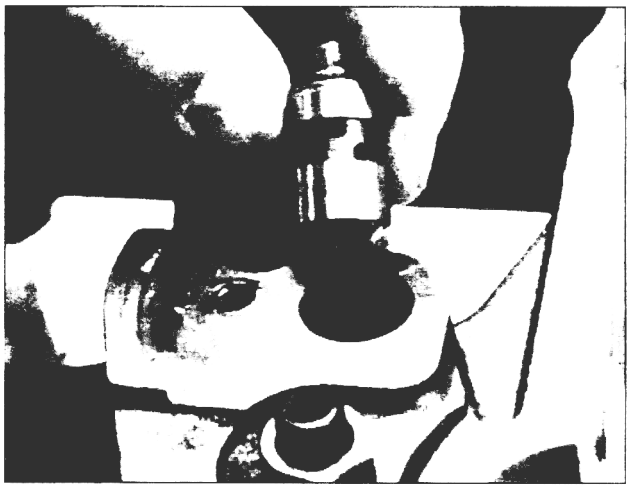


FIG. 2.1.16

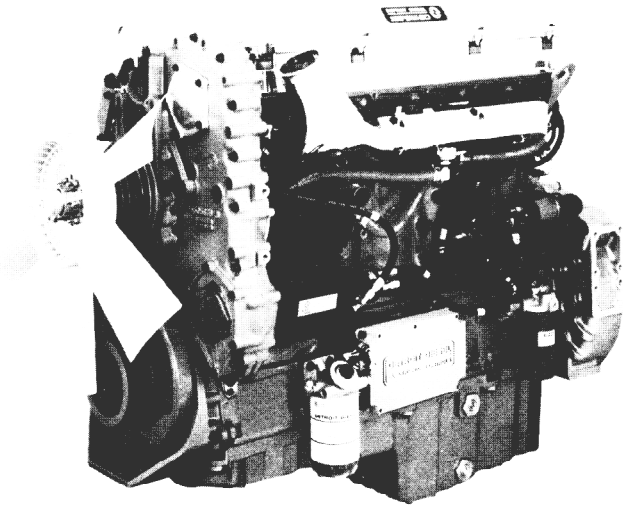
1. Check to see that control valves move freely in their bores.
2. Wash control valves with an approved cleaning solvent. Insert a wire in the entrance hole in the base of the control valve to make sure the check ball is free and has light spring pressure.
3. Dip the control valves in clean lube oil.
4. Hold the valve at the top of its bore and release. When released, the valve should slowly settle under its own weight to the bore bottom. If binding occurs or the check ball is stuck, replace the control valve.

NOTES

DETROIT DIESEL

Automotive 370-500 BHP

SERIES 60®



General Specifications

Basic Engine	4 cycle
Model	6067GK60
Number of Cylinders	6 Inline
Air System	Turbocharged Air-to-Air Charge Cooling
Control	DDEC
Bore and Stroke	5. 12 in x 6.30 in (130 mm x 160 mm)
Displacement	778 cu in (12.7 liters)
Compression Ratio	15.0 to 1
Length	57 in (1448 mm)
Width	34 in (864 mm)
Height	50 in (1273 mm)
Weight (dry)	2630 lbs (1193 kg)

Rated Power Output

Maximum BHP @ RPM	Peak Torque @ RPM
430HP FAMILY	
370HP (276 kW) @ 1800	1450 lb ft (1966 N•m) @ 1200
400HP (298 kW) @ 1800	1450 lb ft (1966 N•m) @ 1200
430HP (320 kW) @ 1800	1450 lb ft (1966 N•m) @ 1200
370/400HP (276/298 kW) @ 1800	1450 lb ft (1966 N•m) @ 1200 CP
370HP (276 kW) @ 1800	1450 lb ff (1966 N•m) @ 1200
400HP (298 kW\ @1800	1450 lb fl (1966 N•m) @ 1200
430HP (320 kW) @ 1800	1450 lb.ft (1966 N•mj@ 1200
370/430HP (276/320 kW) @ 1800	1450 lb.ft (1966 N•m)@ 1200 CP
370HP (276kW)@2100	1450 lb. ft (1966 N•m) @ 1200
400HP(298 kW)@2100	1450 lb. ft (1966 N•m) @ 1200
430HP (320kW)@2100	1450 lb. ft. (1966 N•m) @ 1200
370/430HP (276/320 kW) @ 2100	1450 lb. ft. (1966 N•m) @ 1200 CP
370HP (276 kW) @ 1800	1550 lb ft (2101 N•m) @ 1200
400HP (298 kW) @ 1800	1550 lb ft (2101 N•m) @ 1200
430HP (320 kW) @ 1800	1550 lb ft (2101 N•m) @ 1200
370/430HP (276/320 kW) @ 1800	1550 lb ft (2101 N•m) @ 1200 CP
430HP (320 kW) @ 1800	1550 lb ft (2101 N•m) @ 1200
430/470HP (320/350 kW) @ 1800	1550 lb ft (2101 N•m) @ 1200 CP
430HP (320kW)@2100	1550 lb. ft (2101 N•m) @ 1200
430/470HP (320/350kW) 2100	1550 lb. ft (2101 N•m) @ 1200 CP
470HP FAMILY	
470HP (350 kW) @ 1800*	1550 lb ft (2101 N•m) @ 1200
470HP (350 kW) @ 2100*	1550 lb ft (2101 N•m) @ 1200
470HP (350 kW) @ 2100*	1450 lb ft (2101 Nom)@ 1200
500HP @ 1800RPM*	1550 lb ft (2101 N•m) @ 1200
500HP@2100RPM*	1550 lb ff (2101 N•m) @ 1200

Equipment Specifications

DDEC — Detroit Diesel Electronic Controls are standard on all Series 60 engines. This electronic unit fuel injector and engine management control system is the most advanced system available in the industry DDEC includes state-of-the-art diagnostics for critical engine functions.

Overhead **Camshaft** —This design optimizes intake and exhaust air passages in the cylinder head for easier breathing, and minimizes valve train losses by eliminating the need for push rods.

Short **Ports** —The cylinder head has very short intake and exhaust ports for efficient air flow, low pumping losses and reduced heat transfer.

Iron Crosshead piston —The top ring can be placed much closer to the top of the iron crosshead piston. This reduces the dead volume above the top ring and improves fuel economy.

Injector Rocker Arm with Ceramic **Rollers** —The cam follower roller in the Series 60 injector rocker arm is made of silicon nitride. The low wear properties of this ceramic makes it possible to operate at very high injection pressures while maintaining long life of the roller. High injection pressure is one way Detroit Diesel is able to meet the stringent particulate and smoke emission standards without altertreatments.

Bearing —The Series 60 features large main and connecting rod bearings for long life.

Eight Head Bolts per Cylinder —The head bolts provide a uniform load on the gasket and liner to reduce stress on the liner flange and block counterbore.

High Efficiency Tullmcharger —Combined with a pulse-recovery exhaust manifold, the high efficiency turbocharger provides an efficient transfer of energy for improved fuel economy.

Cruise Power —This feature allows you to take advantage of additional torque and better performance when operating your truck in cruise control. The full rated torque is available when operating in cruise control, or in the PTO mode to improve performance. The higher torque improves drivability in hilly terrain and can improve fuel economy because fewer shifts are required and the engine operates closer to its optimum efficiency.

Top Liner Coolin —The Series 60 features top liner coding. This has been accomplished by machining a coolant channel high up on the block, so that the top of the liner is surrounded by coolant, resulting in longer ring life

'49 *STATE RATINGS*

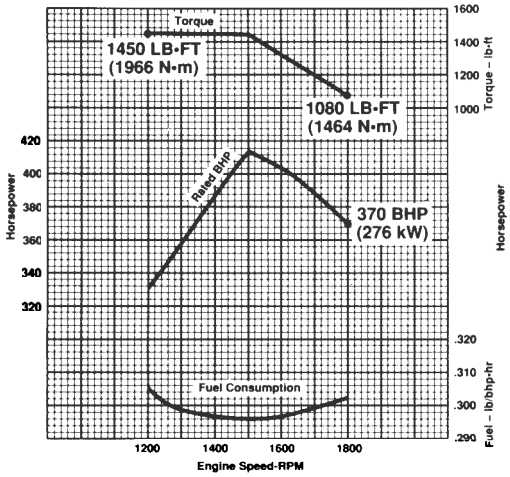
Photograph Illustrates a typical automotive engine

Rating conditions of SAE 77°F (25°C) and 2931 in Hg (99 kPa) Barometer (Dry)

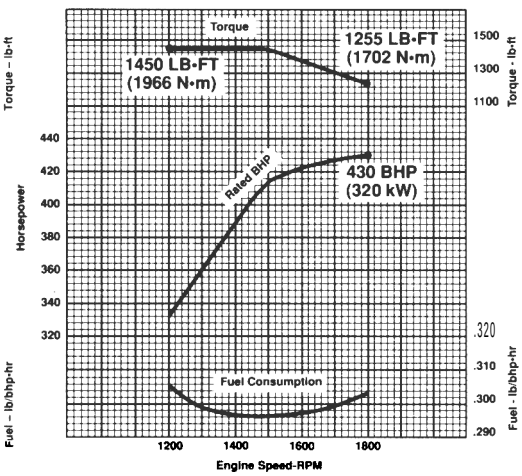
For a complete listing of standard and optional equipment, consult your itstributor or authorized Detroit Diesel Corporation representative

Performance Curves

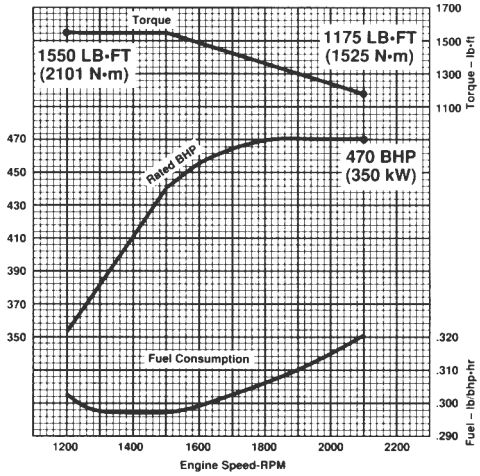
370 BHP



430 BHP



470 BHP



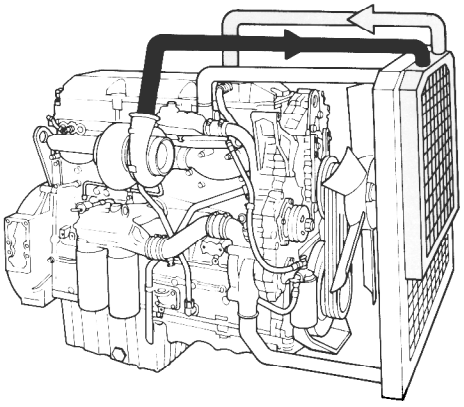
Rating Explanation

RATED BHP is the power rating for variable speed and load applications where full power is required intermittently.

FUEL CONSUMPTION CURVE shows fuel used in pounds per brake horsepower hour.

THIS RATING does not include power requirements for accessory and standard equipment.

Airp-to-Air Charge Cooling —To enhance fuel economy, the Series 60 has been designed to use air-to-air charge cooling. Air-to-air offers fuel economy gains of 2-5% over traditional intake air cooling systems, Incoming air is compressed by the turbocharger and directed to a finned heat exchanger in front of the vehicle's radiator. The heat exchanger uses no liquid coolant but relies Instead on ram air for cooling the charge air resulting in lower retake air temperature from approximately 300°F(149°C) to below 10O°F(38°C) This cooler air aids combustion, thereby increasing fuel economy



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Cool Air

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24 Hour Hot Line
Phone 1-800-445-1980

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CORPORATION

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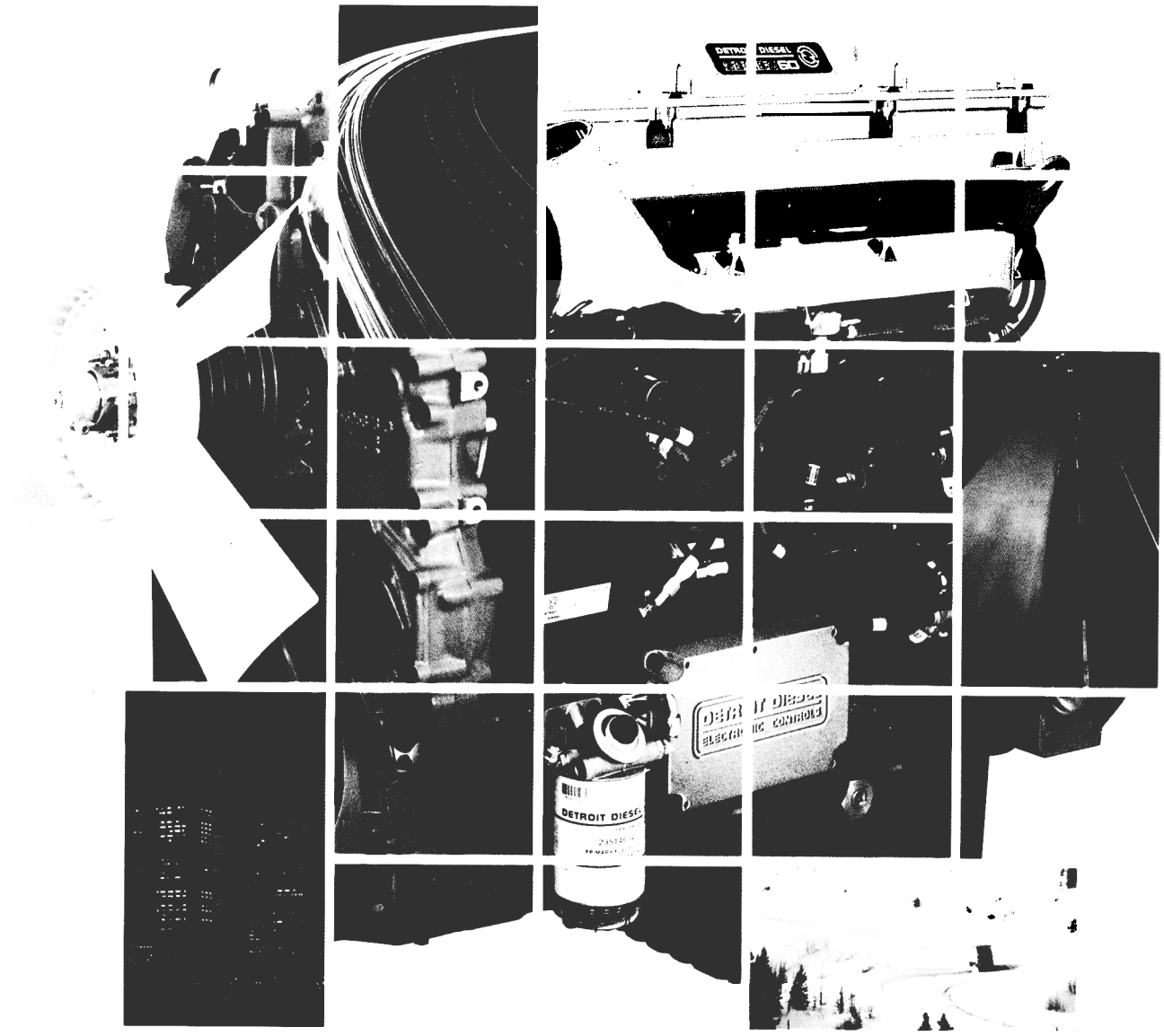
FAX: 313-592-7288

DETROIT DIESEL ISO CERTIFIED ORGANIZATION 9001 CORPORATION

3SA353 9504 As technical advancements continue, specifications will change. Printed in U.S.A.

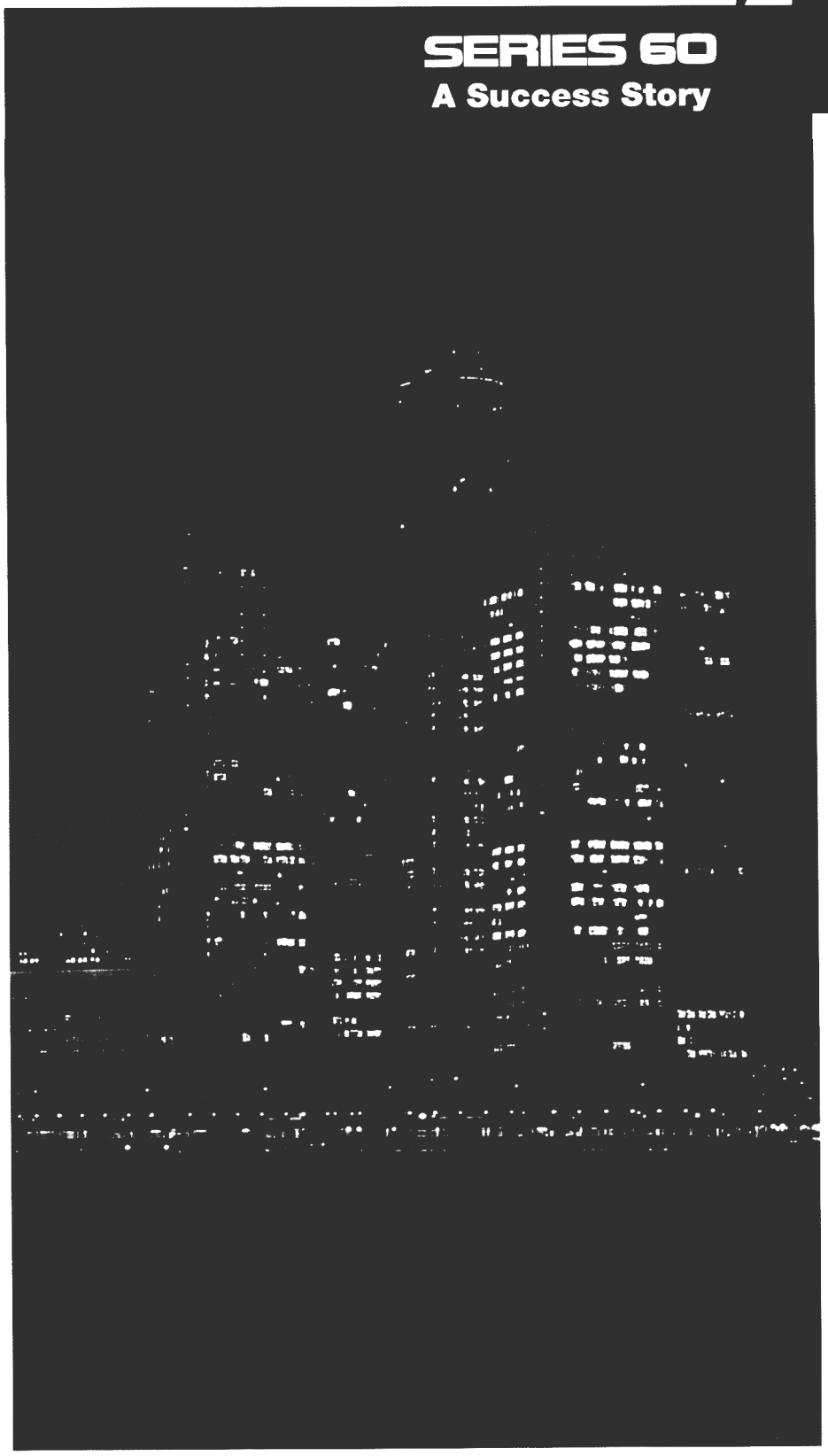
DETROIT DIESEL

SERIES 60®



Innovative Technologies

SERIES 60
A Success Story



The Detroit Diesel Series 60 engine has been a success from the start of production in 1987. The Series 60 was the first fully integrated heavy duty diesel engine wiTh electronic controls in the world. Since then, the Series 60 continues to set the standard with innovative technology and superior fuel economy in the competitive heavy duty diesel engine market.

The DDC Series 60 engine has become the most popular in the class 8 truck market. We continue to increase our rate of production to satisfy market demand. Our team of engineering, manufacturing, and sales personnel strive to reach 7 goals:

- Do it right the first time
- Lower operating costs
- Understand and respond to our customer needs
- Establish long-term relations with suppliers
- Generate a high level of quality and productivity
- Provide outstanding engine performance
- Improve on all these goals

Series 60 Horsepower

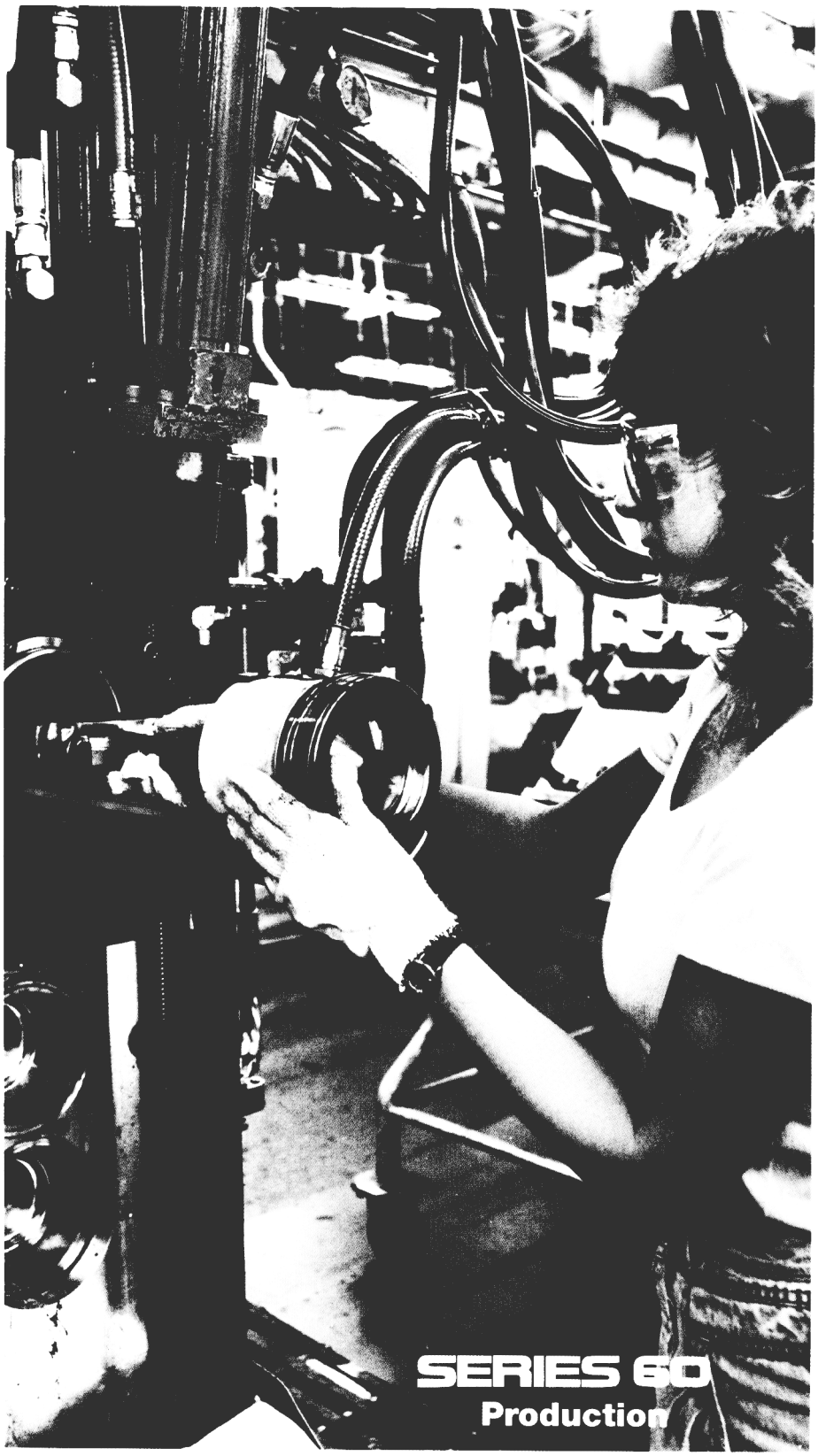
The Series 60 engine offers a wide range of horsepower and torque options to match your vehicle vocation. The ratings governed at 1800 rpm offer excellent fuel economy. While the engines governed at 2100 rpm provide a wider operating range for owner/operators and specialty applications using automatic transmissions. The extended torque

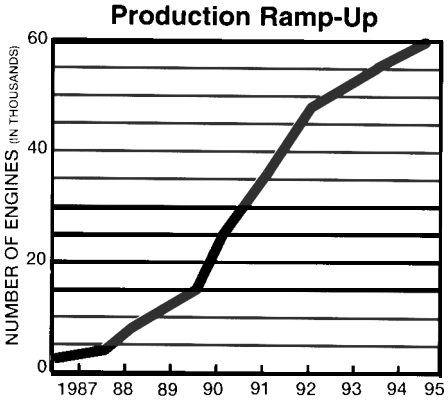
in our engine calibration allows the driver to pull hills without shifting gears. This strong performance makes the Series 60 appealing to vehicle operators.

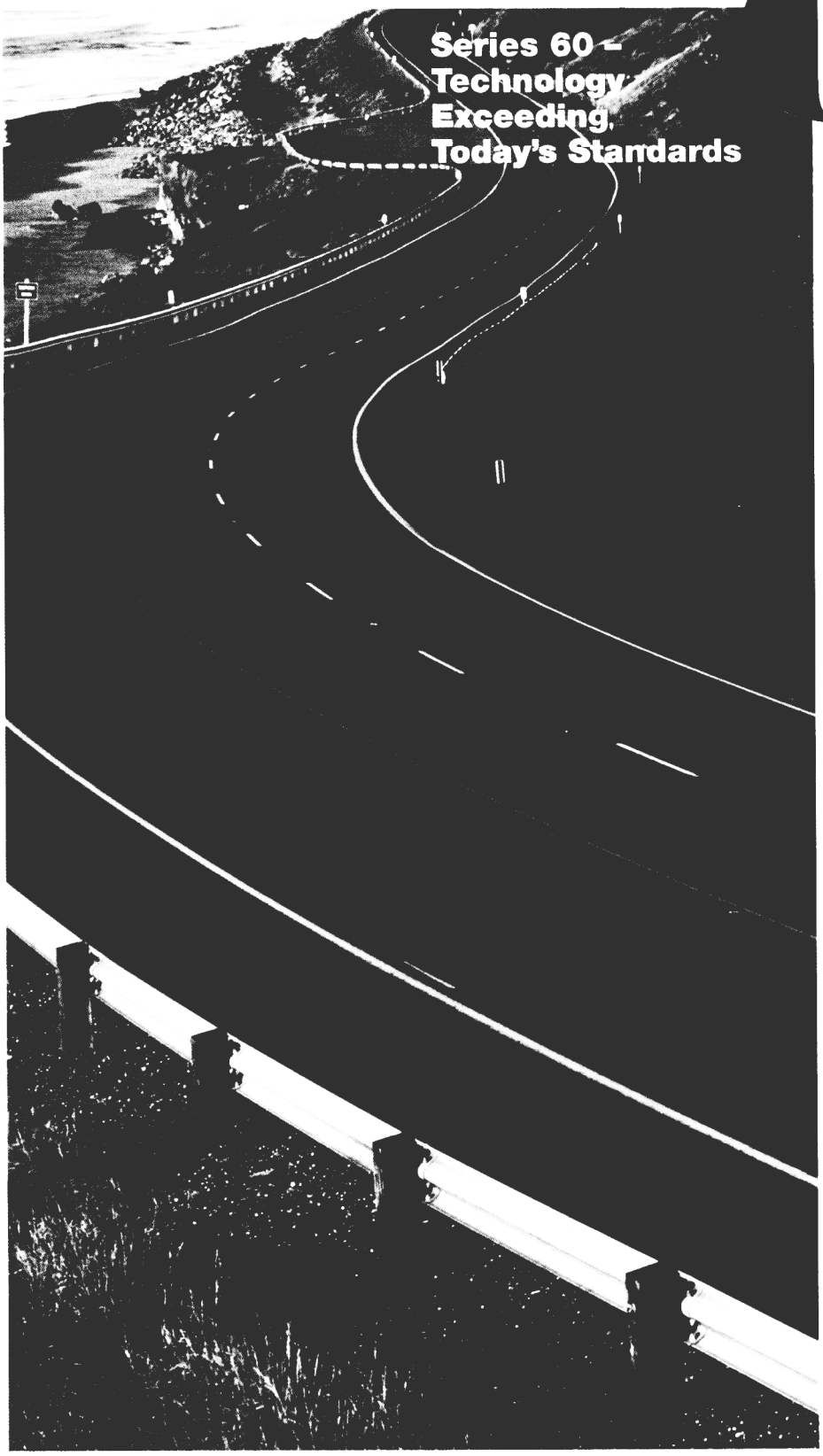
Detroit Diesel's Electronic Controls (DDEC) offers many features. Including a feature that allows a total of four horsepower ratings to be stored in one engine. The advantage to this is that horsepower can be changed for resale or as needed by just plugging the diagnostic data reader (DDR) into the vehicle dash, This feature enhances resale and is password protected.

Cruise Power

Cruise power allows you to take advantage of additional torque and better performance when operating your truck in cruise control. Full rated torque is available when operating in cruise control to improve performance, The higher torque improves driveability in hilly terrain and can improve fuel economy because fewer shifts are required and the engine operates closer to its optimum efficiency.







Series 60 – Technology Exceeding Today's Standards

Overhead Camshaft

DDC engineers optimized the design of the engine by incorporating an overhead camshaft. This eliminates push rods, lifters and 40 wear surfaces. The benefits of this design are:

- Stronger overhead design
- Fewer parts
- Easier to service
- Lower exhaust emissions
- Less internal engine friction
- Better fuel economy

Top Liner Cooling

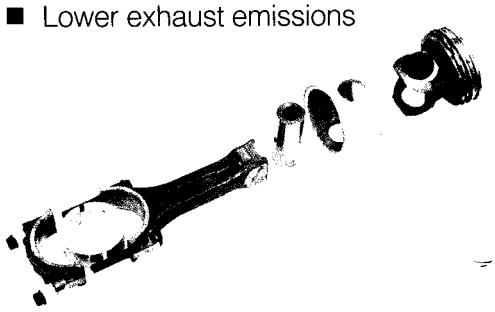
Detroit Diesel has a patented feature called top liner cooling. This is a channel machined in the top portion of the liner and block that allows engine coolant to flow around the liner. Why is this important?

- Cooler cylinder temperatures
- Longer ring life
- Longer piston life

Pistons

The two piece cast iron crosshead piston has small clearances to the plateau honed cast iron cylinder liner. This is possible since both parts are made of the same material. The benefits are:

- Stronger parts
- Less wear at cold start up
- Reduced noise
- Lower exhaust emissions



Cylinder Head Design

With the overhead cam design, the Series 60 has 8 headbolts per cylinder evenly spaced to provide a uniform clamping load, This design provides a one million pound clamping force to hold the head to the block, which eliminates head gasket leaks,

Intake and Exhaust

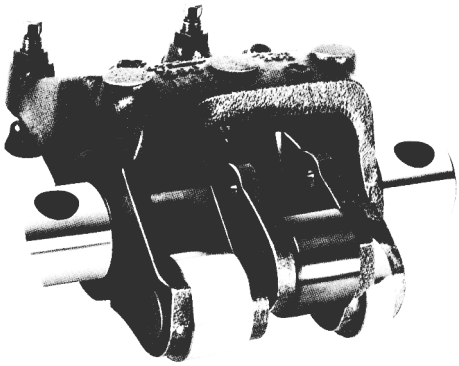
Our engineers kept the design of the intake and exhaust ports simple, Using an overhead cam and 4 valves per cylinder allows the engine to breathe freely. Air flows in one side of the engine and out the other. Why is this important?

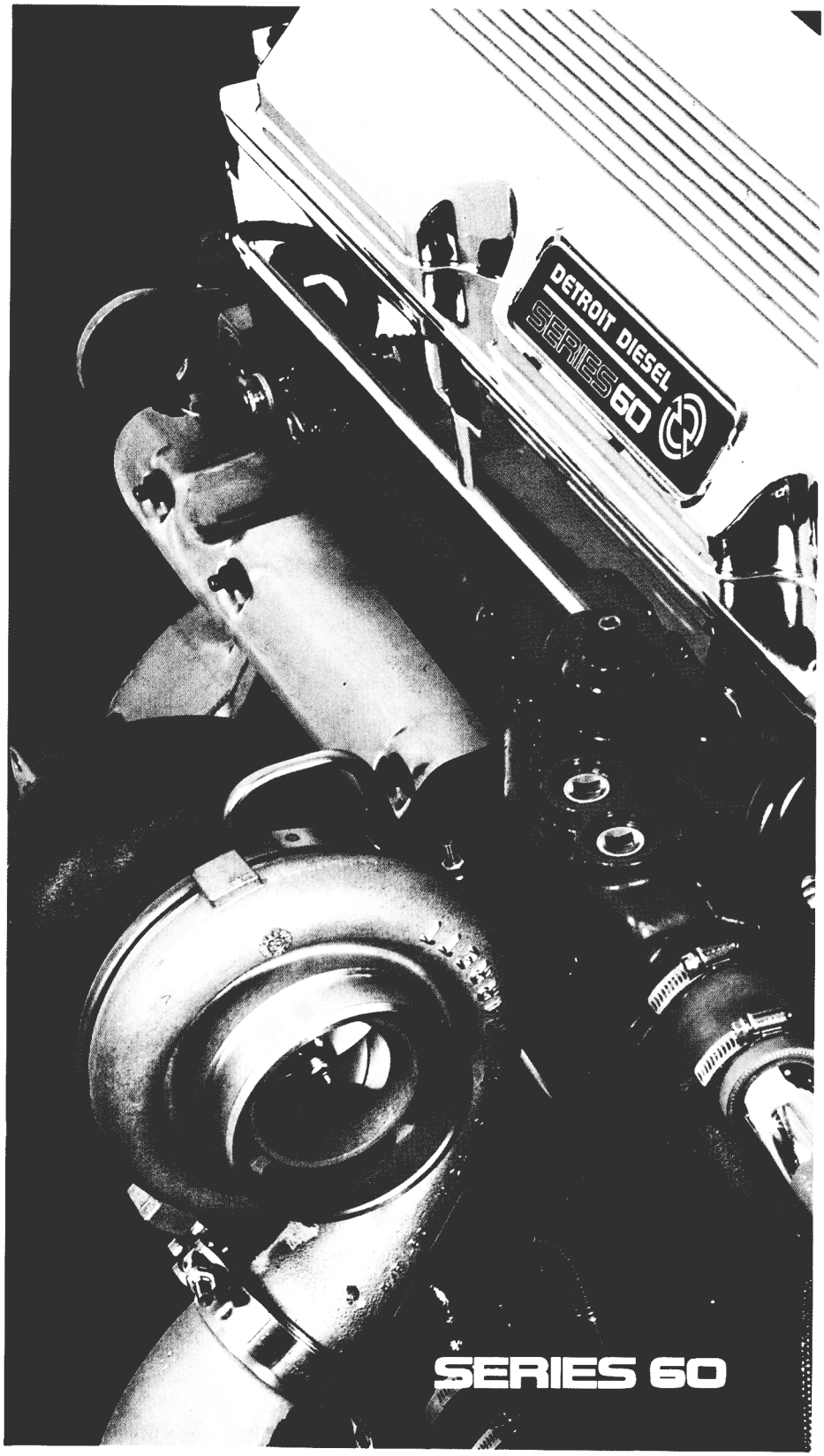
- Cooler running engine
- More efficient, so horsepower losses are lower

Ceramic Rollers

The cam follower roller in the Series 60 injector rocker arm is made of silicon nitride. This ceramic material has high strength and low wear properties. The advantages are:

- More durable
- Longer life





Detroit Diesel Electronic Controls DDEC 111

The Series 60 features integral electronic controls called Detroit Diesel Electronic Controls (DDEC Ill), Its major components are the Electronic Control Module (ECM), the Electronic Unit Injectors (EUI), and the engine sensors, The ECM is the computer that receives electronic inputs from the driver as well as engine mounted sensors. Engine speed information is used to control both the quantity of fuel injected and injection timing.

The EEPROM chip (Electronically Erasable Programmable Read Only Memory) is located in the ECM and contains the operating software. This software controls the horsepower, torque, and maximum engine speed. Additional software is programmed into the EEPROM to control the engine protection devices, vehicle speed limiting, and cruise control that can be set with a Diagnostic Data Reader (DDR) to optimize specific fleet requirements. A list of DDEC Ill sensors and features are shown in the chart on the next page.

Diagnostic Data Reader

The Leader In Electronic Injectors

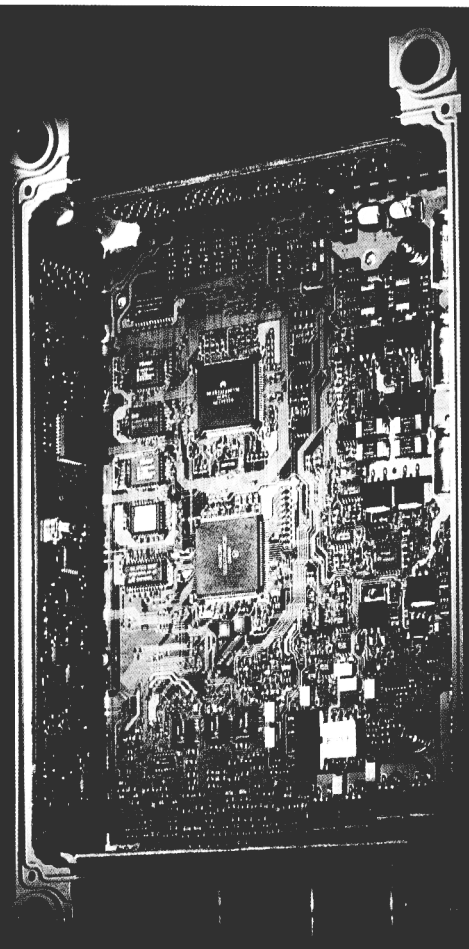
The electronic unit injector works on the same basic principle as the mechanical unit injector with the simple addition of an electronically controlled solenoid valve that meters fuel input.

Our electronic injectors are self-compensating and greatly reduces the need for tune-ups.

With electronic controls, fuel economy is improved and the exhaust emissions are kept low in the following ways:

- The electronic governor limits maximum RPM to a preset value, This allows for precise control over maximum vehicle speed,
- Variable injection timing provides exceptional fuel economy, by taking into consideration the temperature, load, speed and turbo boost.
- Electronic diagnostic procedures can be used to help locate specific problems.
- Since electronics control injection timing, as well as the quantity of fuel, the Series 60 can start unaided at 10"F(-12°C),
- The ECM controls the maximum vehicle speed within the most efficient engine operating range,

Electronic Unit Injector



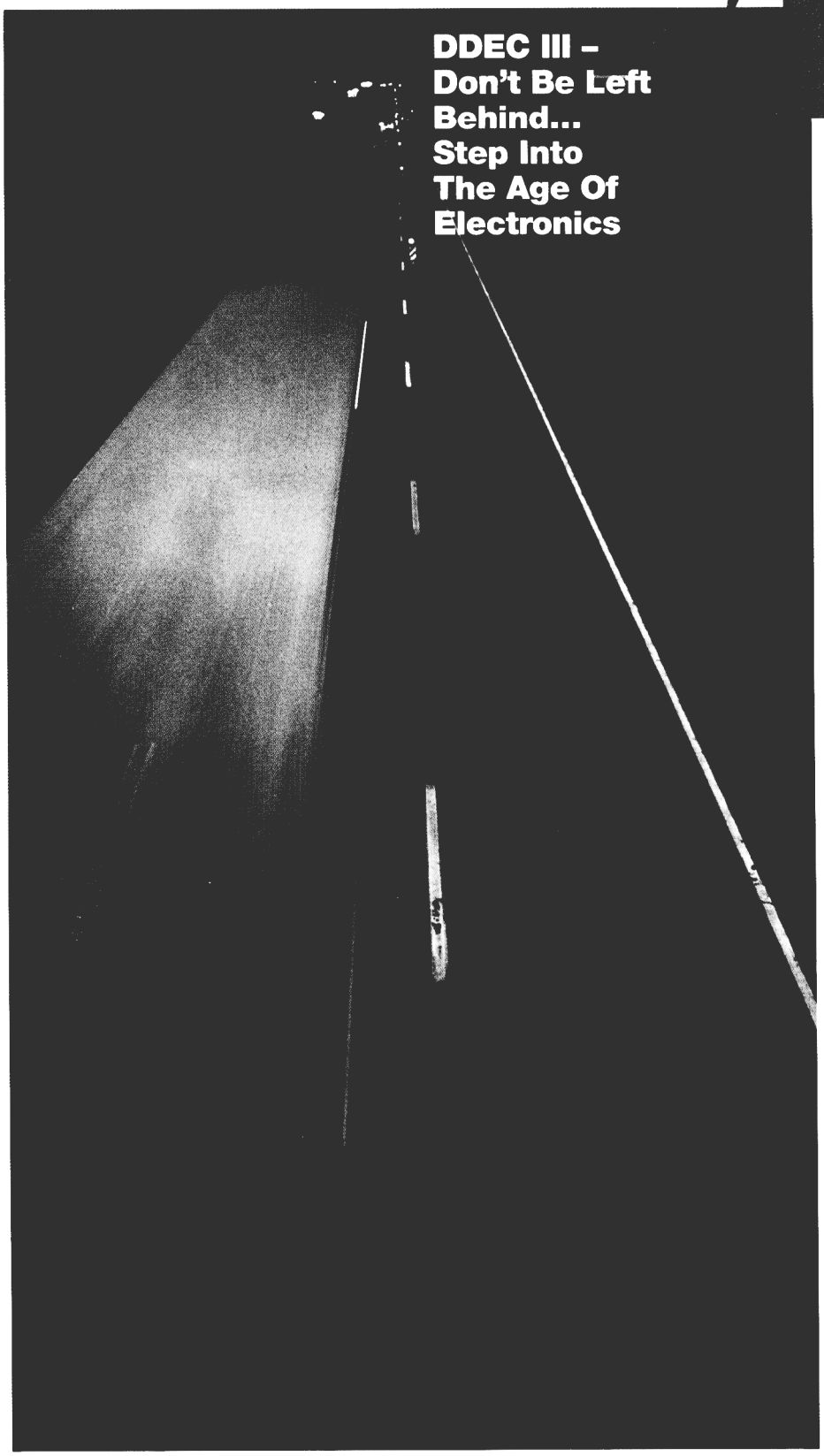
DDEC III ECM

DDEC III sensors:

- Coolant temperature
- Oil temperature
- Oil pressure
- Coolant level
- Throttle position
- Speed, timing
- Air temperature (air intake manifold)
- Fuel pressure
- Turbo boost
- Vehicle speed

DDEC III software features:

- Cruise control
- Cruise power
- Controls on/off fans
- Controls engine braking
- Engine fan braking
- Vehicle speed limiting
- Cruise control automatic resume with double clutching
- Low DDEC voltage light
- Low coolant light
- Vehicle power shutdown
- Idle timer shutdown
- Manual fan control override
- Idle adjustment
- Customer password
- Horsepower password
- Maximum security
  - Locks out all changes to ECM
- Communication links SAE J1587, J1922, J1939
- Progressive shifting
- Pressure governor
- Starter lockout
- Engine protection
- Starter lockout deceleration light
- Firetruck controls
- Ether start controls
- Optimized idle
- Air temperature shutdown



DDEC III – Don't Be Left Behind... Step Into The Age Of Electronics

The DDEC ECM provides state-of-the-art control and monitoring, as well as a stored summary of engine performance. ProDriver™ takes the process further by providing the driver and fleet manager with access to the vital data provided by DDEC via the SAE diagnostic data link. The concept is further extended with the Data Logger™, which provides monitoring of the engine and other electronic systems, combined with substantial storage capacity, fuel tax data collection, flexible data extraction and communication capabilities. Pro Manager™ PC software extracts and analyzes data from the DDEC ECM, ProDriver and Data Logger systems. This comprehensive "expert" analysis allows managers to take action immediately, instead of spending hours trying to analyze the situation.

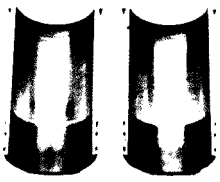
Data Hub Family of Products

- TRAC software
- ProDriver
- Data Logger
- ECM Data Pages
- ProManager software

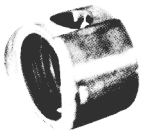
1,000,000 Miles

Most Series 60 engines that have accumulated over half a million miles have encountered few problems. Durability was substantiated when a Series 60 with over 1,000,000 miles was torn down and inspected. What was revealed at teardown?

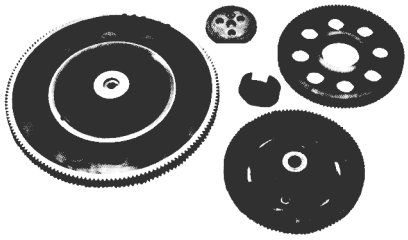
- Cylinder block and head had no distress or cracks.
- Gear case, oil pan, and major castings are reusable.
- Liners showed original honing marks,



- Liner seals showed no leakage,
- Pistons had no cracks or distress and minimal wear.

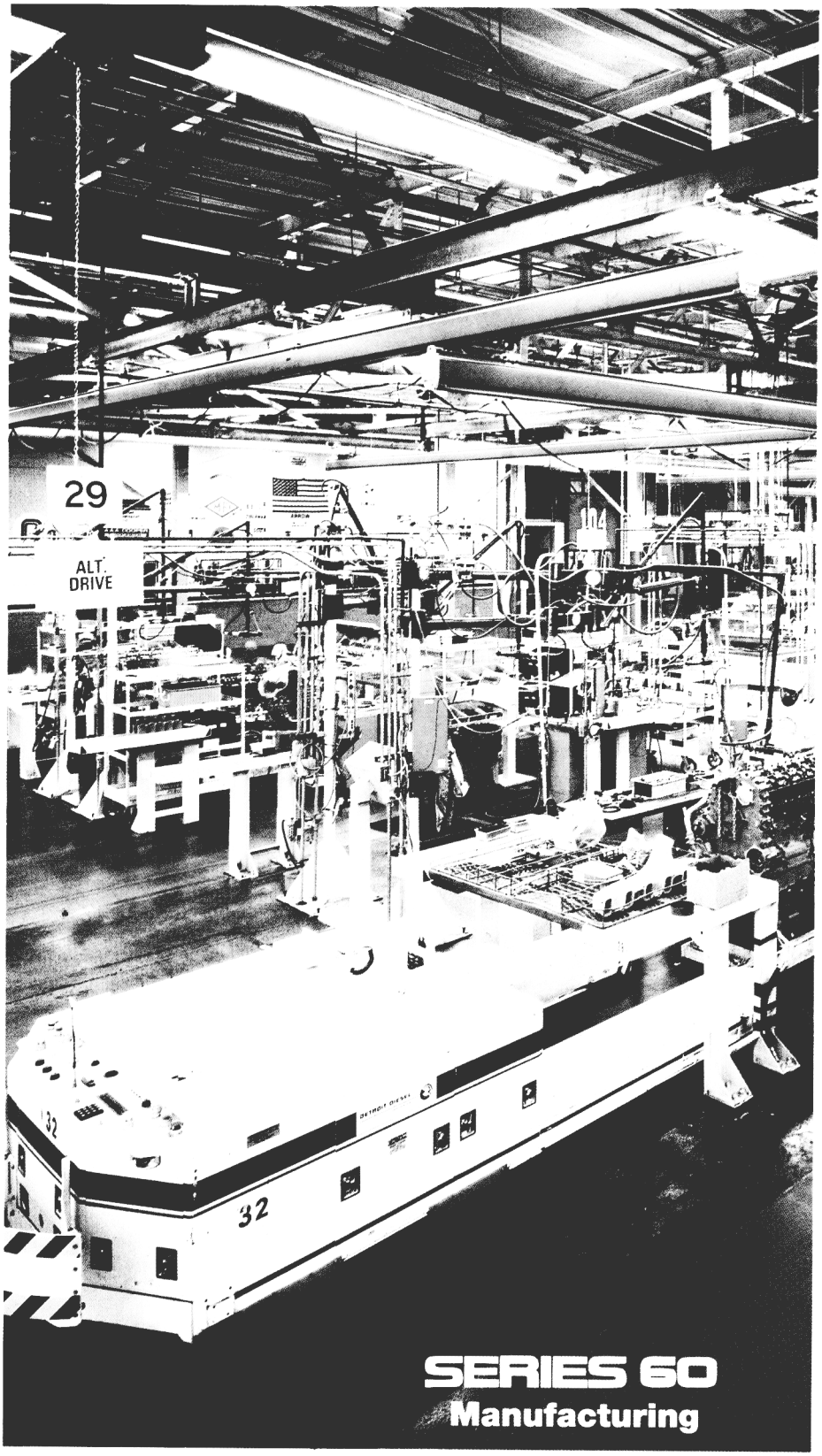


- Crankshaft was reusable.
- Gear train was in excellent reusable condition.



- Camshaft had no distress and only required grinding on one lobe.
- Valves showed very low wear.

The Series 60 manufacturing process contributes to the high level of quality and durability of the Series 60.

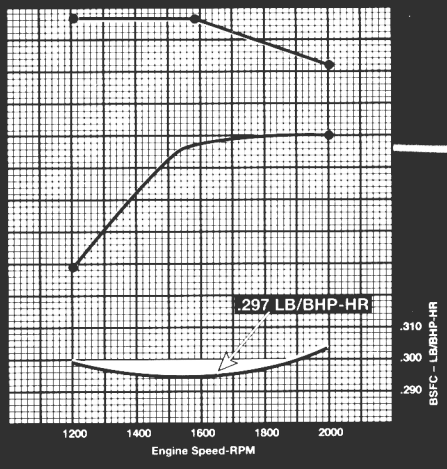


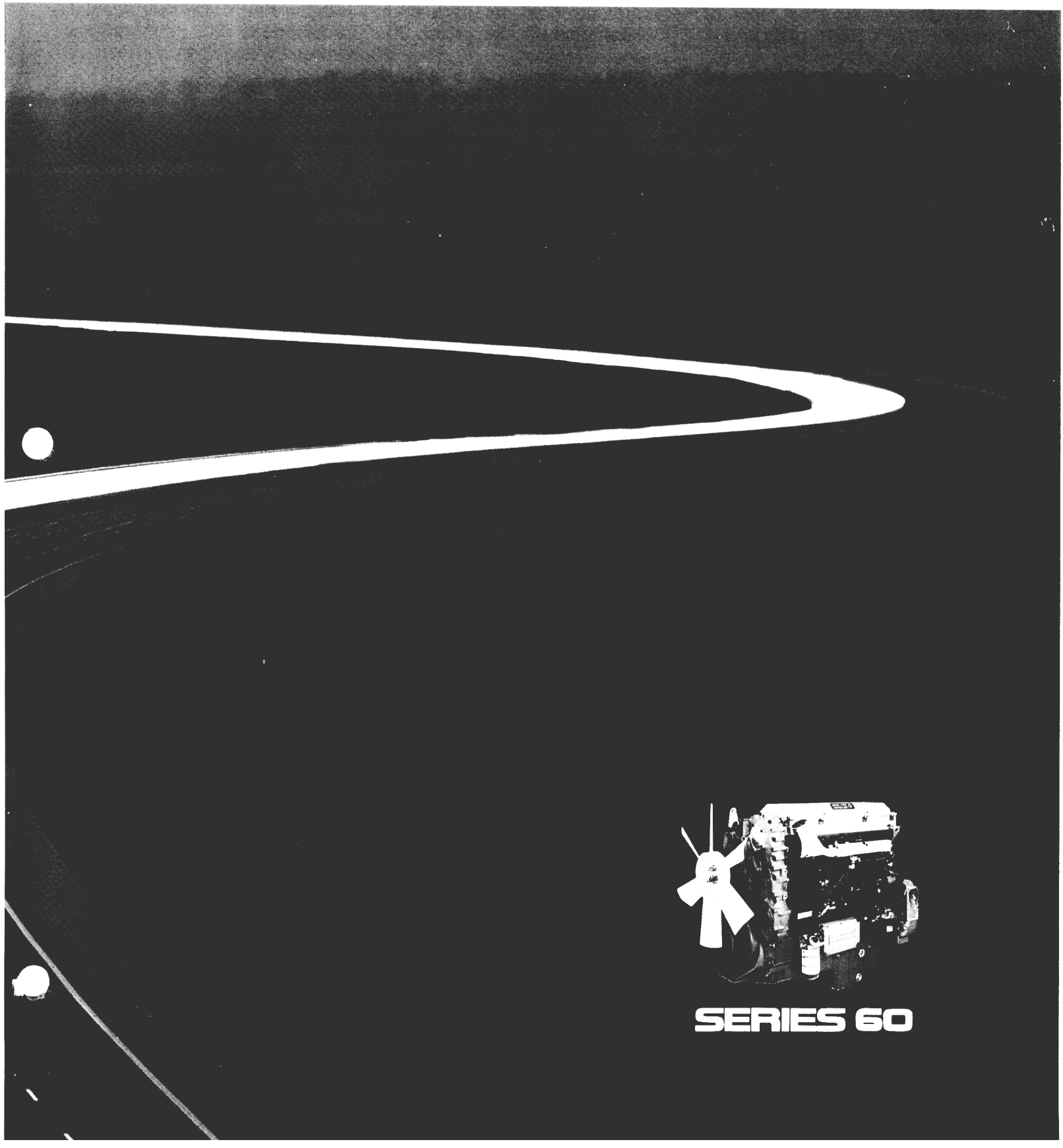
Superior Fuel Economy

Detroit Diesel has broken the 0.300 brake specific fuel consumption (BSFC) barrier. This is a milestone in heavy duty diesel engine technology. The Series 60 is the first engine in the world to achieve this exceptional level of performance. Customers average 6-8 mpg with heavy loads. With lighter loads, the fuel economy is even more incredible. Our technology exceeds today's standards. Detroit Diesel is racing ahead, and we are not looking back!

Max BHP @ RPM	Peak Torque @ RPM
330HP FAMILY	
300HP @ 1800RPM	1150FT-LB @ 1200RPM
330HP @ 1800RPM	1150FT-LB @ 1200RPM
300/330HP @ 1800RPM	1150FT-LB @ 1200RPM CP
330HP @ 1800RPM	1250FT-LB @ 1200RPM
350HP @ 1800RPM	1250FT-LB @ 1200RPM
330/350HP @ 1800RPM	1250FT-LB @ 1200RPM CP
330HP @ 2100RPM	1250FT-LB @ 1200RPM
325HP @ 2100RPM**	1350FT-LB @ 1200RPM
325/350HP @ 2100RPM**	1350FT-LB @ 1200RPM
330HP @ 2100RPM	1350FT-LB @ 1200RPM
365HP FAMILY	
330HP @ 1800RPM	1350FT-LB @ 1200RPM
350HP @ 1800RPM	1350FT-LB @ 1200RPM
365HP @ 1800RPM	1350FT-LB @ 1200RPM
330/350HP @ 1800RPM	1350FT-LB @ 1200RPM CP
330HP @ 1800RPM	1350FT-LB @ 1200RPM
350HP @ 1800RPM	1350FT-LB @ 1200RPM
365HP @ 1800RPM	1350FT-LB @ 1200RPM
330/365HP @ 1800RPM	1350FT-LB @ 1200RPM CP
430HP FAMILY	
370HP @ 1800RPM	1450FT-LB @ 1200RPM
400HP @ 1800RPM	1450FT-LB @ 1200RPM
430HP @ 1800RPM	1450FT-LB @ 1200RPM
370/400 @ 1800RPM	1450FT-LB @ 1200RPM CP
370HP @ 1800RPM	1450FT-LB @ 1200RPM
400HP @ 1800RPM	1450FT-LB @ 1200RPM
430HP @ 1800RPM	1450FT-LB @ 1200RPM
370/430 @ 1800RPM	1450FT-LB @ 1200RPM CP
370HP @ 2100RPM	1450FT-LB @ 1200RPM
400HP @ 2100RPM	1450FT-LB @ 1200RPM
430HP @ 2100RPM	1450FT-LB @ 1200RPM
370/430 @ 2100RPM	1450FT-LB @ 1200RPM CP
370HP @ 1800RPM	1550FT-LB @ 1200RPM
400HP @ 1800RPM	1550FT-LB @ 1200RPM
430HP @ 1800RPM	1550FT-LB @ 1200RPM
370/430 @ 1800RPM	1550FT-LB @ 1200RPM CP
430HP @ 1800RPM	1550FT-LB @ 1200RPM
430/470 @ 1800RPM	1550FT-LB @ 1200RPM CP
430HP @ 2100RPM	1550FT-LB @ 1200RPM
430/470 @ 2100RPM	1550FT-LB @ 1200RPM CP
470HP FAMILY	
470HP @ 1800RPM*	1550FT-LB @ 1200RPM
470HP @ 2100RPM*	1550FT-LB @ 1200RPM
470HP @ 2100RPM*	1450FT-LB @ 1200RPM
500HP @ 2100RPM**	1450FT-LB @ 1200RPM
500HP @ 1800RPM*	1550FT-LB @ 1200RPM
500HP @ 2100RPM*	1550FT-LB @ 1200RPM

*49 STATE RATINGS
**BUS RATINGS ONLY





SERIES 60

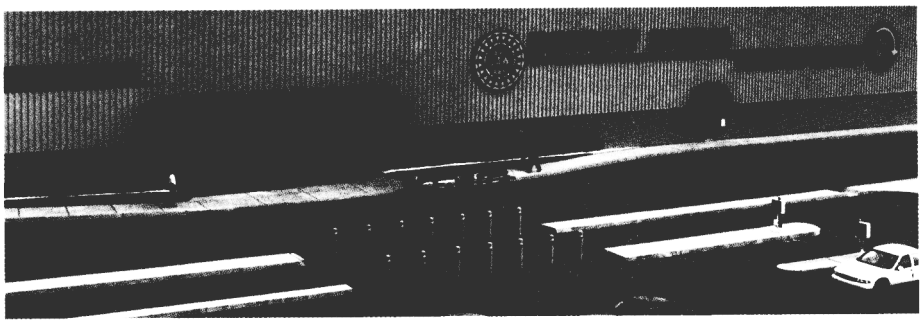
Parts and Training Support

Your dealer maintains a stock of quality Detroit Diesel parts and is ready to respond to your needs. Service personnel have been trained by our DDC distributors or at our world class training headquarters. They are experts in the proper application, care and maintenance of your Series 60 engine.

You can participate in an extensive engine maintenance and overhaul training program in our training facilities. You will leave with the insight and skills needed to diagnose and troubleshoot almost any engine malfunction on the spot.

Detroit Diesel Corporation is committed to providing excellent service for customers. Nowhere is this commitment more evident than in our Series 60 engine.

Detroit Diesel Parts Center, Canton, Ohio



Detroit Diesel Training Center, Redford, Michigan

We Back What We Build

To show our confidence, the Series 60 engine carries a two-year, unlimited mileage warranty. In addition, you can purchase extended service coverage up to five years/500,000 miles. For complete warranty detail see your authorized DDC distributor or dealer.

Series 60
24 Hour Hot Line
Phone 1-800-445-1980

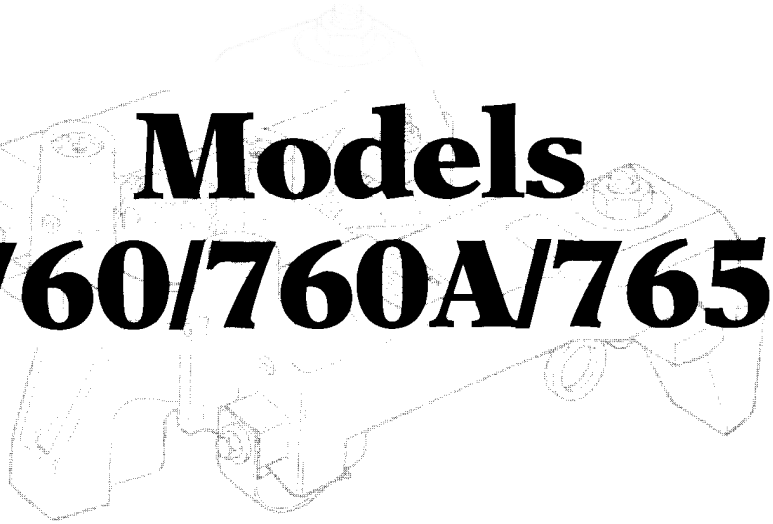
DETROIT DIESEL® CORPORATION

13400 Outer Drive, West / Detroit, Michigan 48239-4001
Telephone: 313-592-5000
FAX: 313-592-7288

DETROIT DIESEL ISO CERTIFIED ORGANIZATION 9001 CORPORATION

JAKE BRAKE®

INSTALLATION



Models 760/760A/765

The Models 760/760A/765 Jake Brake® engine retarders are designed and approved for use on Detroit Diesel® Series 60® engines. For specific engine application information, see page 4 of this manual. 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 applications and updated information.

Section 1: Introduction

Housing Identification

The model, part number and serial number (A) are located on the nameplate at the top of each housing (see Fig. 1).

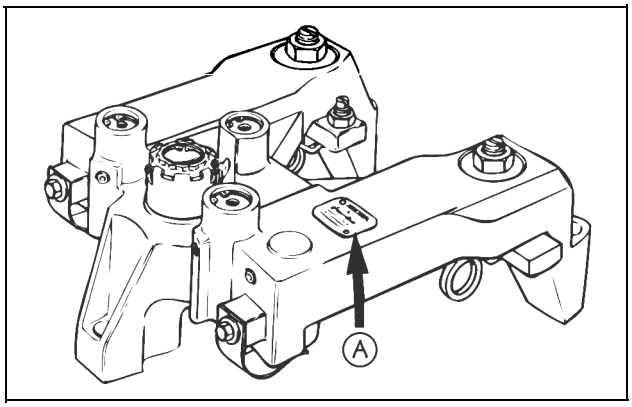


FIG. 1

Engine Identification

Engine model identification, serial number (A) and model number (B), is on the name tag located on the side of the valve cover and stamped on the cylinder block beneath the intake manifold (see Fig. 2).

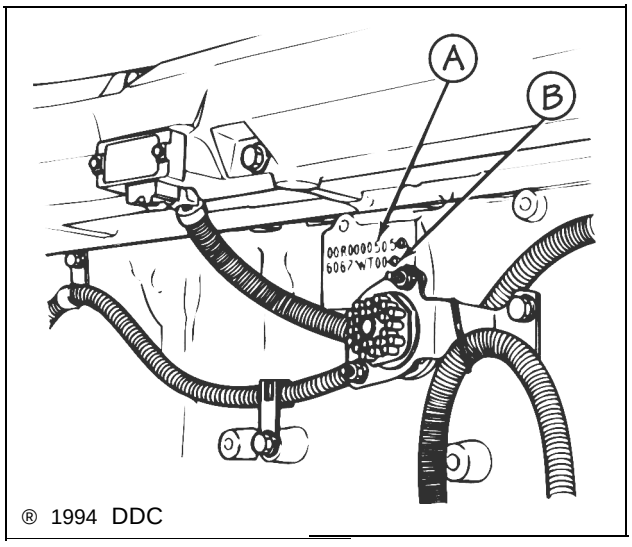


FIG. 2

Special Tools

General

15 mm -12 point Socket
12 mm -12 point Socket
3/1 6“ Hex Wrench

Kent Moore

Expander Tool	P/N J-36347
Injector Height Gage	P/N J-35637A

Detroit Diesel

Series 60 Engine Service Manual

Jacobs

Feeler Gage, 0.020” (0.508 mm)	P/N 017278
Feeler Gage, 0.026” (0.660 mm)	P/N 017671

Recommended Torque Values

Housing Hold-down Cap Screws	100 lb.-ft. (136 N•m) (lubricated with engine oil)
Slave Piston Adjusting Screw Locknut	25 lb.-ft. (35 N•m)
Slave Piston Leveling Screw Locknut	35 lb.-ft. (47 N*m)
Solenoid Valve	110 lb.-in. (12.4 N•m)
Master Piston Spring Cap Screw	100 lb.-in. (10 N•m)

Engine Covers

The engine brake has been designed to fit on the Series 60 engine with no additional valve cover spacers. There are three styles of valve covers for the Series 60 engine. On engines equipped with a two-piece aluminum valve cover, it is NOT necessary to remove the lower valve cover to install the engine brake. However, one style upper valve cover may require modification at the breather housing location (inside) for engine brake clearance. See pages 20-21 for styles and instructions.

Section 2A: Engine Preparation Series 60 Engines with DDEC II

Clean the engine thoroughly and remove the rocker cover and gasket. Note the location of the rocker arm shaft (A), the exhaust valve rocker arm (B), the fuel injector rocker arm (C), and the intake valve rocker arm (D) (see Fig. 3).

NOTE:

IF THE ENGINE IS EQUIPPED WITH AN ALUMINUM TWO-PIECE VALVE COVER, REMOVE ONLY THE UPPER VALVE COVER TO INSTALL THE ENGINE BRAKE.

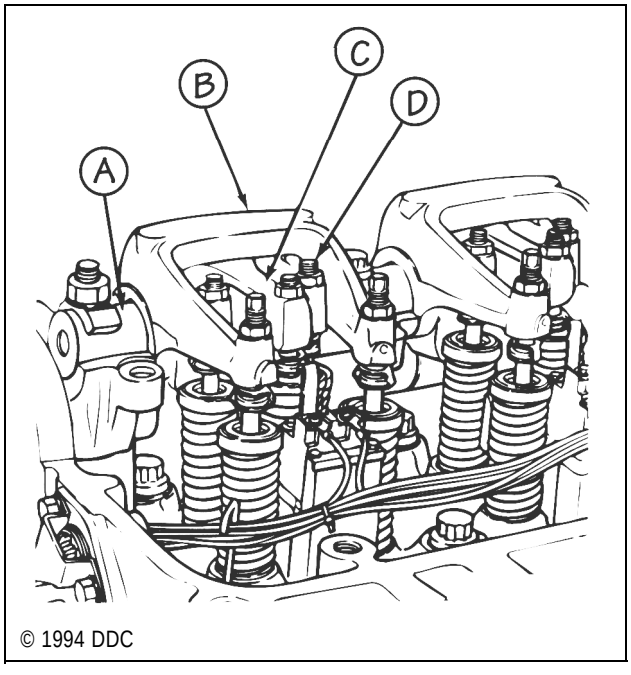


FIG. 3

Undercover Wire Harness Installation

Before installing the engine brake housings, install the undercover wire harness (see Fig. 4). Letters in the illustrations refer to specific components explained in detail below.

1. Remove the mounting flange cover (A) for the Electronic Unit Injector (EUI) harness (see Fig. 5).
2. Insert the blue wire and the yellow wire from the wire harness, Jacobs P/N 017393, through two of the access holes in the grommet (B) located at the rear of the cylinder head. Insert wires from outside in.

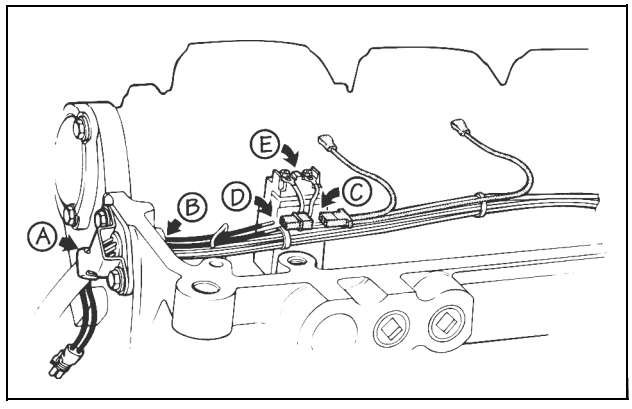


FIG. 4

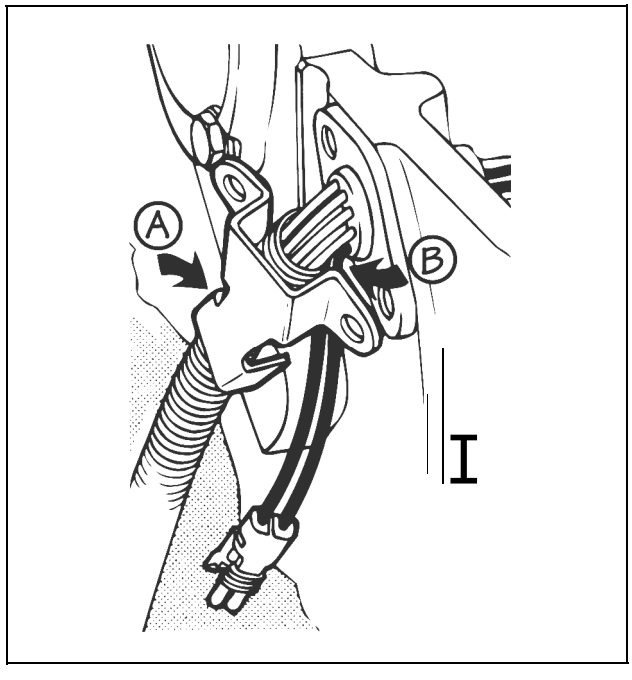


FIG. 5

NOTES:

ONCE THE WIRES ARE INSERTED THROUGH THE GROMMET, THEY CANNOT BE REMOVED DUE TO THE TERMINAL LOCKING TANGS.

TO PREVENT OIL LEAKAGE, APPLY A SMALL QUANTITY OF RTV (OR EQUIVALENT) ON THE OUTBOARD SIDE OF THE GROMMET WHERE THE PLUGS WERE REMOVED FROM THE ACCESS HOLES.

Section 2B: Engine Preparation Series 60 Engines with DDEC III

Clean the engine thoroughly and remove the rocker cover and gasket. Note the location of the rocker arm shaft (A), the exhaust valve rocker arm (B), the fuel injector rocker arm (C), and the intake valve rocker arm (D) (see Fig. 9).

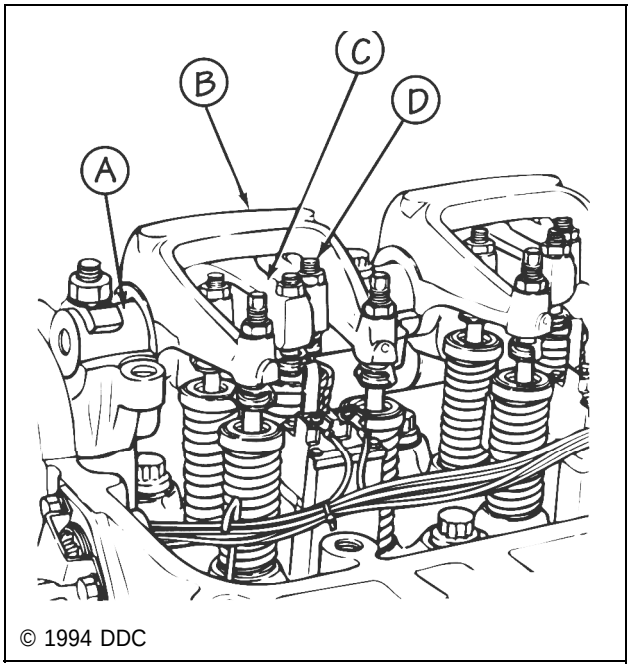


FIG. 9

NOTE:

IF THE ENGINE IS EQUIPPED WITH AN ALUMINUM TWO-PIECE VALVE COVER, REMOVE ONLY THE UPPER VALVE COVER TO INSTALL THE ENGINE BRAKE.

Undercover Wire Harness Installation (Retrofit)

Before installing the engine brake housings, install the undercover wire harness (see Fig. 10). Letters in the illustrations refer to specific components explained in detail below.

1. Remove the mounting flange cover (A) from the Electronic Unit Injector (EUI) harness (see Fig. 11).
2. Insert the blue and yellow wires from the wire harness, Jacobs P/N 020217, through two of the access holes in the grommet (B) located at the rear of the cylinder head. Insert the wires from the outside in.

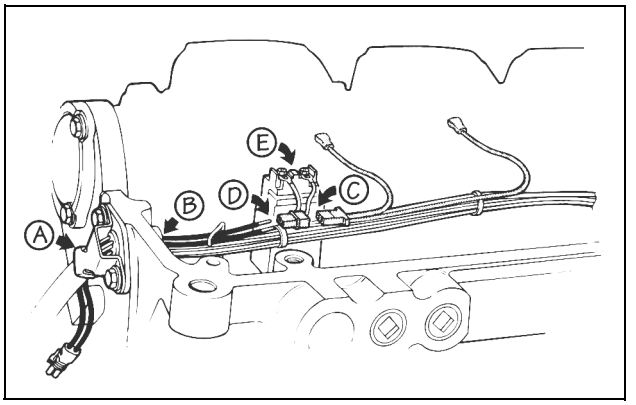


FIG. 10

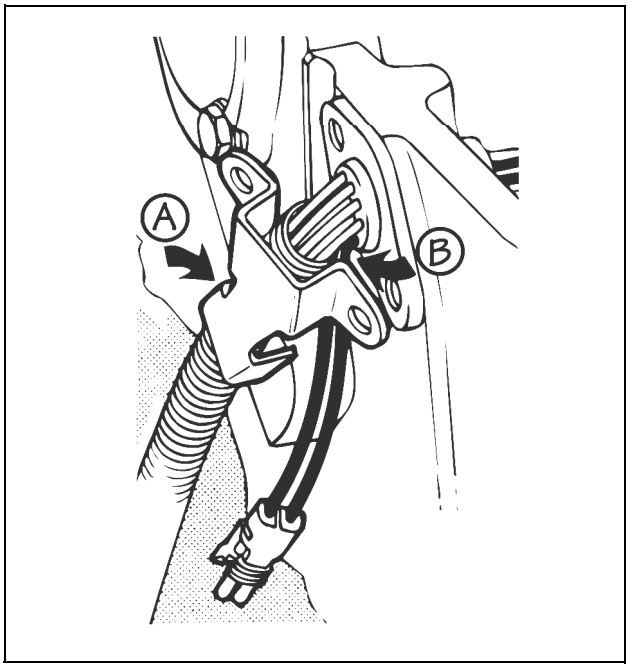


FIG. 11

NOTE:

ONCE THE WIRES ARE INSERTED THROUGH THE GROMMET, THEY CANNOT BE REMOVED DUE TO THE TERMINAL LOCKING TANGS.

TO PREVENT OIL LEAKAGE, APPLY A SMALL QUANTITY OF RTV (OR EQUIVALENT) ON THE OUTBOARD SIDE OF THE GROMMET WHERE THE PLUGS WERE REMOVED FROM THE ACCESS HOLES.

Section 3: Brake Housing Installation

1. Remove the three bearing cap bolts (locations number 2,4 and 6) on the intake manifold side, as shown by the arrows in Fig. 15.

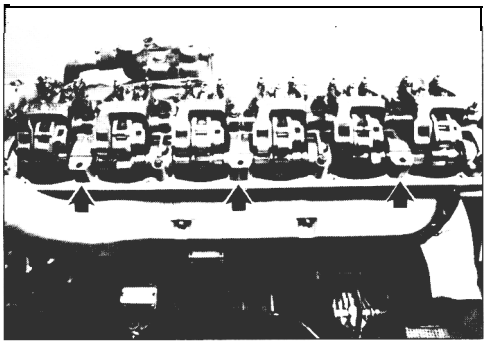


FIG. 15

CAUTION

ATTACH A LENGTH OF TUBING TO A BLOW GUN NOZZLE AND BLOW OUT THE OIL FROM THE BOLT HOLES. COVER THE HOLES WITH HAND TOWELS TO MINIMIZE OIL SPRAY. REMOVING THE OIL FROM THE BOLT HOLES PREVENTS THE CYLINDER HEAD FROM CRACKING WHEN TIGHTENING THE BOLTS.

WARNING

EYE PROTECTION MUST BE WORN WHILE BLOWING THE OIL FROM THE BOLT HOLES. PERSONAL INJURY MAY RESULT IF SAFERY GLASSES ARE NOT WORN.

2. Place the two spacer bars on the exhaust manifold sick of the cylinder head with the “out” markings adjoining each other and facing the exhaust manifold (A) (see Figs. 16 and 17).

3. Place the three engine brake housings over the rocker shafts with the solenoid valves toward the camshaft side of the engine.

NOTE:

BE SURE HOUSINGS DO NOT INTERFERE WITH WIRING HARNESS.

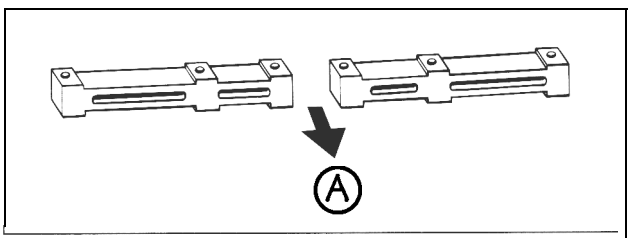


FIG. 16

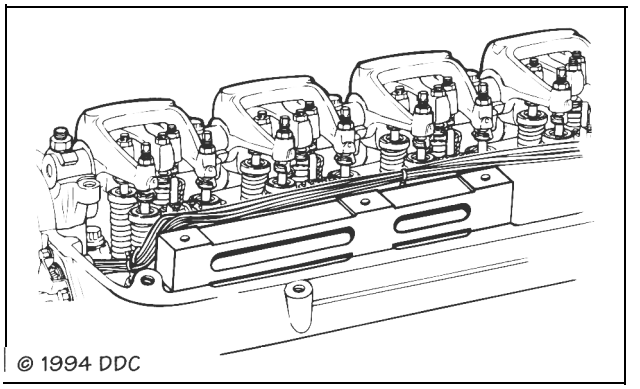


FIG. 17

Model 760 Only

CAUTION

THE MODEL 760 USES TWO LENGTHS OF MOUNTING BOLTS. SIX (120 MM) BOLTS ARE TO BE INSTALLED ON THE EXHAUST SIDE OF THE ENGINE. THREE (110 MM) BOLTS ARE TO BE INSTALLED ON THE CAMSHAH SIDE OF THE ENGINE. FAILURE TO DO SO WILL RESULT IN SERIOUS ENGINE DAMAGE.

4a. Install one washer onto each 4-3/4” (120 mm) long bolt and insert into brake housing on the exhaust manifold side (two per housing) (see Fig. 18).

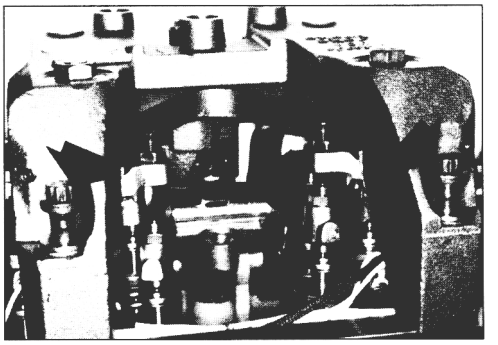


FIG. 10

Install one washer on the 4-3/8” (110 mm) long bolt and insert into brake housing at the camshaft side (one per housing) (see Fig. 19).

2. Place the **correct** feeler gage between the solid side of the **slave piston** (the side without the leveling screw) and the exhaust rocker arm adjusting screw.

3. Turn the slave piston adjusting screw clockwise until a **slight drag** is felt on the feeler gage (see Fig. 22).

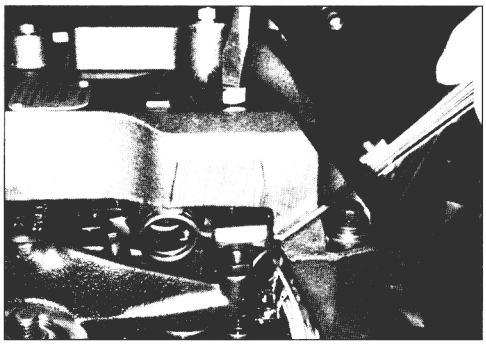


FIG. 22

4. Hold the screw in this position and tighten the locknut to 25 lb.-ft. (35 NŽm). Check the adjustment and repeat if necessary. The slave piston adjusting screws are not to be disassembled.

5. Follow the same procedure and set the same clearance between the slave piston leveling screw and the rocker arm adjusting screw (see Fig. 23).

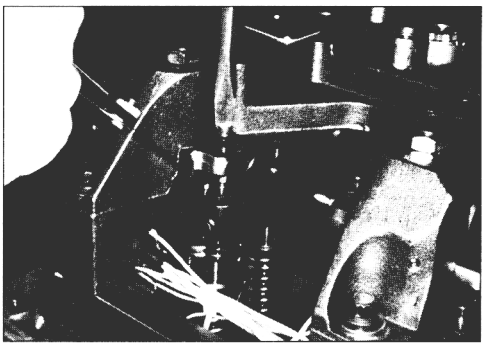


FIG. 23

6. Hold the leveling screw in this position and tighten the locknut to 35 lb.-ft. (47 NŽm). Check adjustment and reset, if necessary.

7. Repeat the adjustment procedures in steps 1 through 6 for the remaining cylinders. Bar over the engine when necessary to put the exhaust valves in the closed position for slave piston adjustment.

Section 4A: Control System Installation Series 60 Engines with DDEC II

Clutch Switch

1. Mount the clutch switch in the most convenient or accessible location possible. Locations may include in the cab under the dash, under the floor wheel well location, or in the area of the bell housing.

2. Install the switch with the switch actuator arm in contact with the clutch pedal arm or other clutch member (see Fig. 24). The optional overtravel bracket (A) is not included in the clutch switch group.

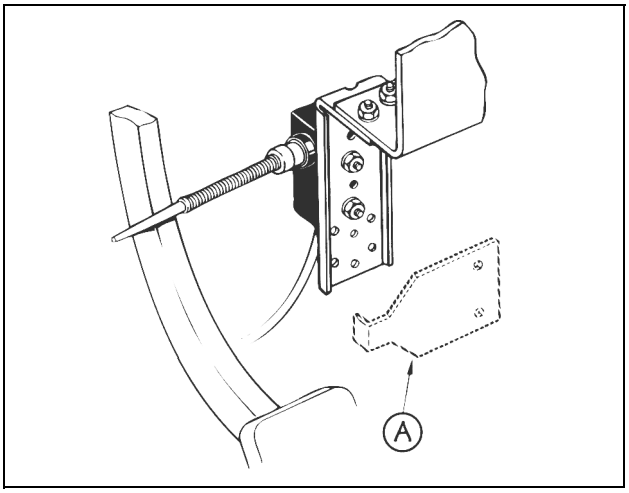


FIG. 24

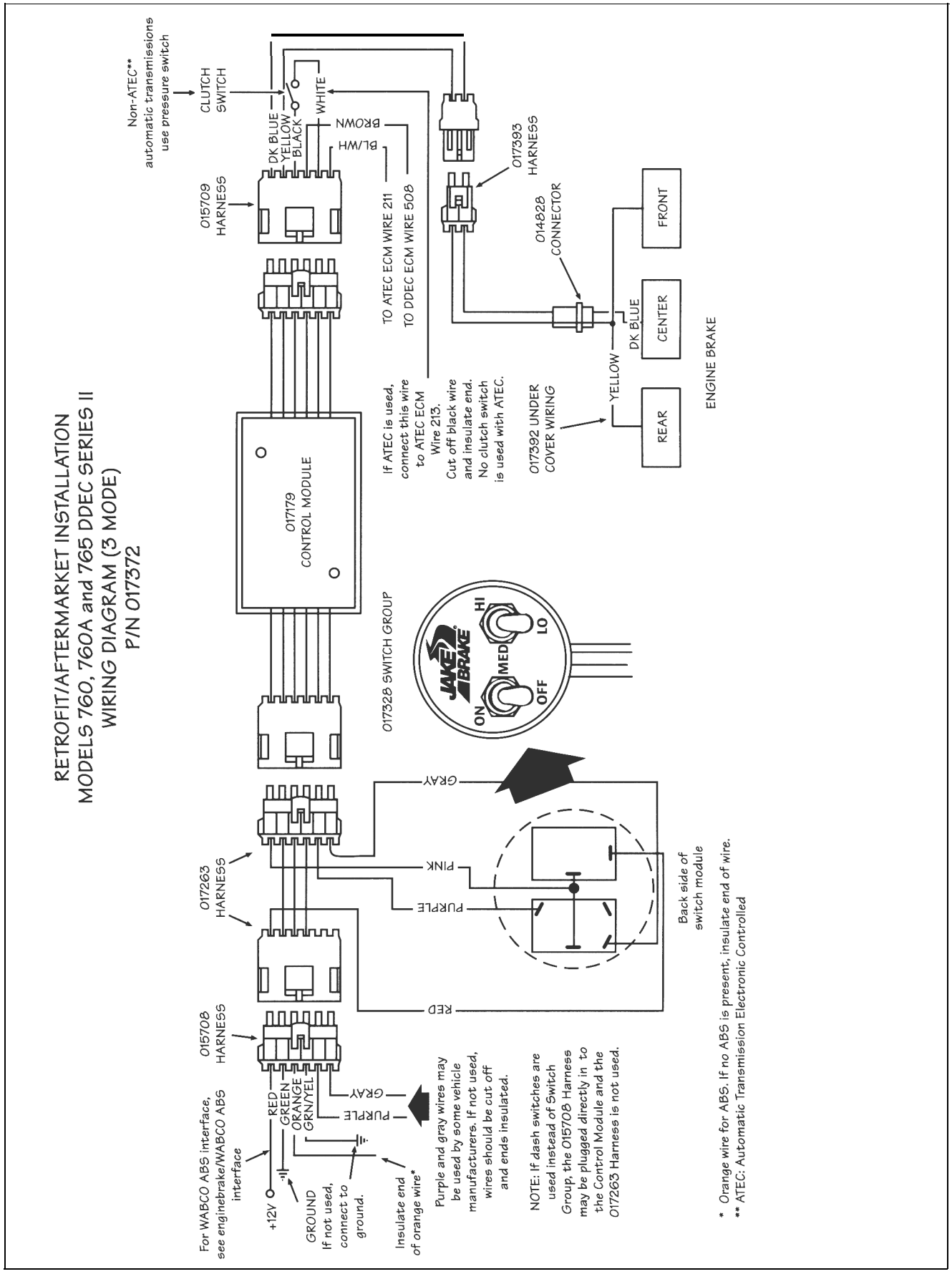

RETROFIT/AFTERMARKET INSTALLATION
MODELS 760, 760A and 765 DDEC SERIES II
WIRING DIAGRAM (3 MODE)
P/N 017372
Non-ATEC** automatic transmissions use pressure switch
CLUTCH SWITCH
DK BLUE
YELLOW
BLACK
WHITE
BROWN
BL/WH
015709 HARNESS
TO ATEC ECM WIRE 211
TO DDEC ECM WIRE 508
017393 HARNESS
014828 CONNECTOR
017179 CONTROL MODULE
If ATEC is used, connect this wire to ATEC ECM Wire 213. Cut off black wire and insulate end. No clutch switch is used with ATEC.
017392 UNDER COVER WIRING
YELLOW
DK BLUE
FRONT
CENTER
REAR
ENGINE BRAKE
017328 SWITCH GROUP
JAKE BRAKE
HI
LO
MED
OFF
ON
GRAY
PINK
PURPLE
017263 HARNESS
Back side of switch module
RED
015708 HARNESS
For WABCO ABS interface, see enginebrake/WABCO ABS interface
+12V
RED
GREEN
ORANGE
GRN/YEL
GRAY
PURPLE
GROUND If not used, connect to ground.
Insulate end of orange wire*
Purple and gray wires may be used by some vehicle manufacturers. If not used, wires should be cut off and ends insulated.
NOTE: If dash switches are used instead of Switch Group, the 015708 Harness may be plugged directly in to the Control Module and the 017263 Harness is not used.
* Orange wire for ABS. If no ABS is present, insulate end of wire.
** ATEC: Automatic Transmission Electronic Controlled

FIG. 20

Refer to the wiring diagrams on the previous pages for the following electrical connections.

Wire Harness

1. Connect the wire harness, P/N 015708, to the Weatherpack® connector on the in-line harness, P/N 017263. Connect the other side of the in-line harness to the Weatherpack connector on the control module.
2. Connect the GREEN wire to the negative (-) battery terminal.

⚠WARNING

IT IS VERY IMPORTANT THAT THE GREEN WIRE BE CONNECTED TO A GOOD GROUND. 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 NEGATIVE (-) BATTERY TERMINAL. 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.

3. Connect the RED wire to a 10-amp circuit breaker that is controlled by the key switch.
4. The ORANGE wire is provided for use on future electronic equipment. For current applications, insulate the end and store the wire.
5. The GREEN/YELLOW wire is also for future use and should be securely connected to the ground.
6. If the optional dash switches are used in place of the Jacobs dash switch assembly, connect the PURPLE and GRAY wires as shown in the wiring diagram for “optional dash switches”.

NOTE:

THE 017263 HARNESS IS NOT REQUIRED WITH THE OPTIONAL DASH SWITCHES. CONNECT THE 15708 HARNESS DIRECTLY TO THE 017179 CONTROL MODULE.

Harness

1. Connect harness, P/N 015709, to the control module.
2. BLUE/WHITE wire: For installations with standard transmissions, insulate the end and store the wire. If an automatic transmission is used, connect the BLUE/ WHITE wire to the ATEC wire number 211.

NOTES:

FOR ALLISON ELECTRONIC TRANSMISSION APPLICATIONS (ATEC), CHECK THAT THE BLUE/WHITE WIRE ON WIRE HARNESS 015709 IS CONNECTED TO ATEC ECM WIRE NUMBER 211.

FOR NON-ELECTRONIC ALLISON AUTOMATIC TRANSMISSION APPLICATIONS, A PRESSURE SWITCH MUST BE USED TO SENSE LOCK-UP IN THE TRANSMISSION. THE PRESSURE SWITCH TAKES THE PLACE OF THE CLUTCH SWITCH. THE BLACK WIRE AND WHITE WIRE SHOULD BE CONNECTED TO THE PRESSURE SWITCH TO SENSE TRANSMISSION LOCKUP.

3. Connect the BROWN wire to the DDEC ECM wire number 508.
4. The WHITE wire and BLACK wire are connected to the clutch switch.
5. The DARK BLUE wire and YELLOW wire are connected to a shroud which connects to the solenoid external wire harness, P/N 017393. The solenoid internal wire harness was installed earlier (see page 6).

Undercover Wiring

Connect the three wires to the solenoid valves.

- Short YELLOW wire to the rear housing.
- BLUE wire to the center housing.
- Long YELLOW wire to the front housing.

NOTES:

THE DDC FACTORY INSTALLED LONG AND SHORT WIRES ARE EITHER RED OR WHITE. THE JACOBS WIRES ARE YELLOW AND BLUE.

A TWO-HOUSING JAKE BRAKE INSTALLATION WILL HAVE ONE YELLOW AND ONE BLUE WIRE. THE YELLOW WIRE SHOULD BE CONNECTED TO THE REAR HOUSING, AND THE BLUE WIRE SHOULD BE CONNECTED TO THE FRONT HOUSING (SEE FIG. 29, PAGE 14).

Store any excess wire along the injector wire harness and secure with plastic wire ties.