



Jacobs Vehicle Systems™

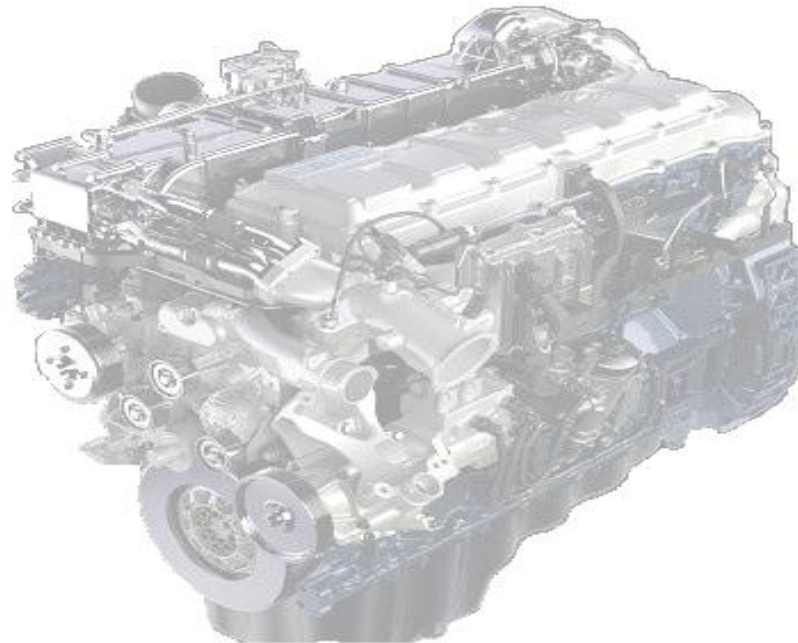


The Journey Continues



MAXXFORCE®

ENGINE BRAKE BY Jacobs®



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➤ Description

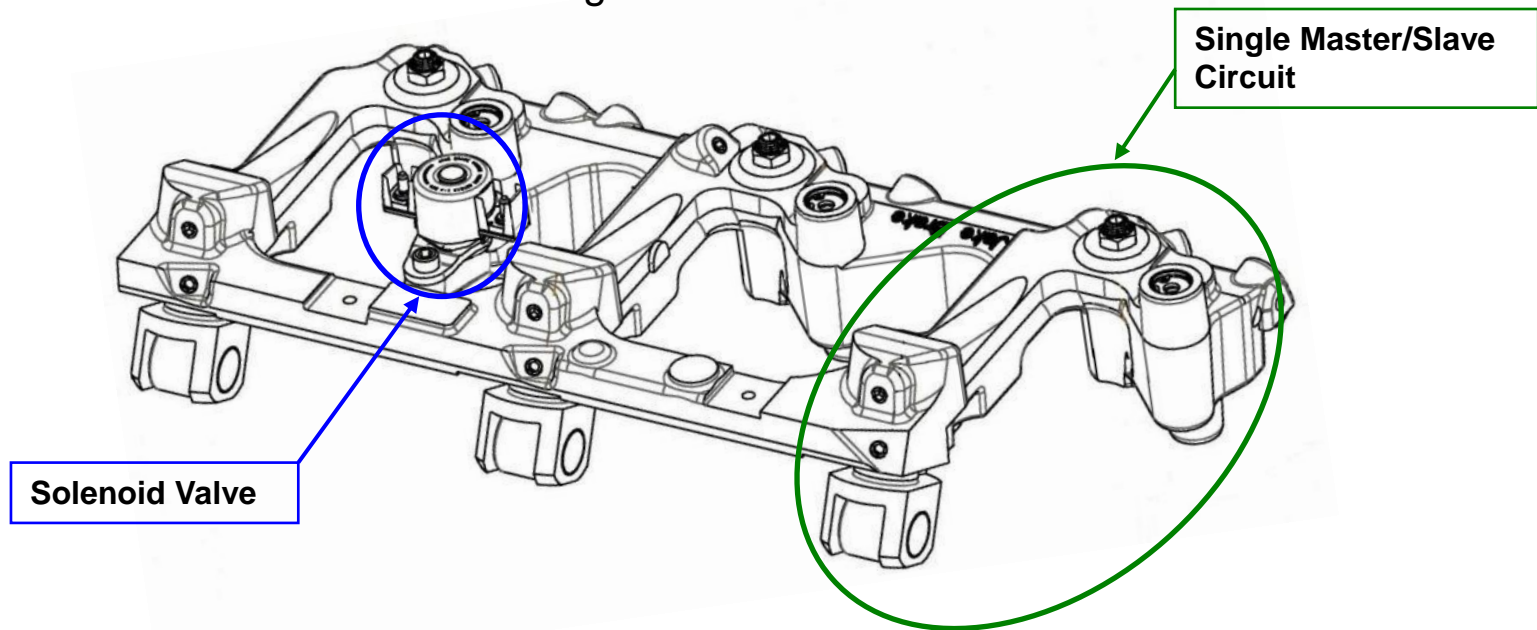
- Safety Precautions
- Jake Brake, Installation and Removal
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- Jake Brake Specification
- Parts Listing
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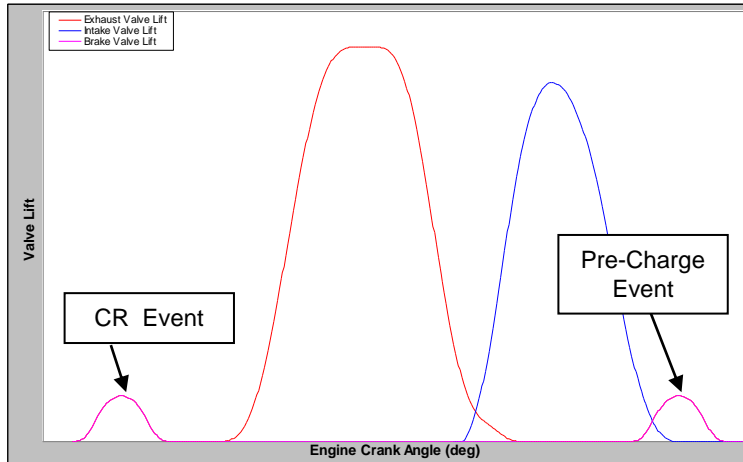


- The Model 5783A & 5783 Engine Brakes work on the Compression Release (CR) principle, acting on a single exhaust valve per cylinder.
 - A Dedicated Cam Lobe for engine brake operation has been added to the camshaft.
 - Dedicated Cam Lobe refers to actuation of the “Compression Release” event being driven by a specially designed cam lobe which is used only during engine braking. This provides the most accurate timing for the CR operation.
 - The engine brake is a bolt on style, two housings per engine.
- The Model 5783A was released in the 4th quarter of 2011, and was a running change to the previous Model 5783.
- The difference between the Model 5783A and Model 5783 is in the Master Pistons. The 5783A has retracted Master Pistons, in the up (retracted) position when brake is off, which improves hydraulic response. The Model 5783 has Master Pistons that are in continuous contact with the dedicated cam lobe.
- The Model 5783A is a direct replacement for all Model 5783 applications, and if necessary, can be used to replace a Model 5783 housing assembly (one or both housings).
- The Jacobs Model 5783A Engine Brake can either be ordered Factory Direct or Aftermarket option for installation at a later date.
- The Model 5783A, like the Model 5783, can be used on both the MaxxFoer 11L & 13L, 2010 emission certified engines. It cannot be installed on earlier MY engines.



- The Engine Brake System consists of:
 - Two housing assemblies, which use a Master/Slave Piston circuit.
 - Each Housing (pictured below) has one Solenoid Valve, and three Master/Slave Braking Circuits.
 - Six Exhaust bridges with actuating pins.
 - Twelve hold down cap screws.
 - One Camshaft with dedicated Engine Brake Cam Lobes.

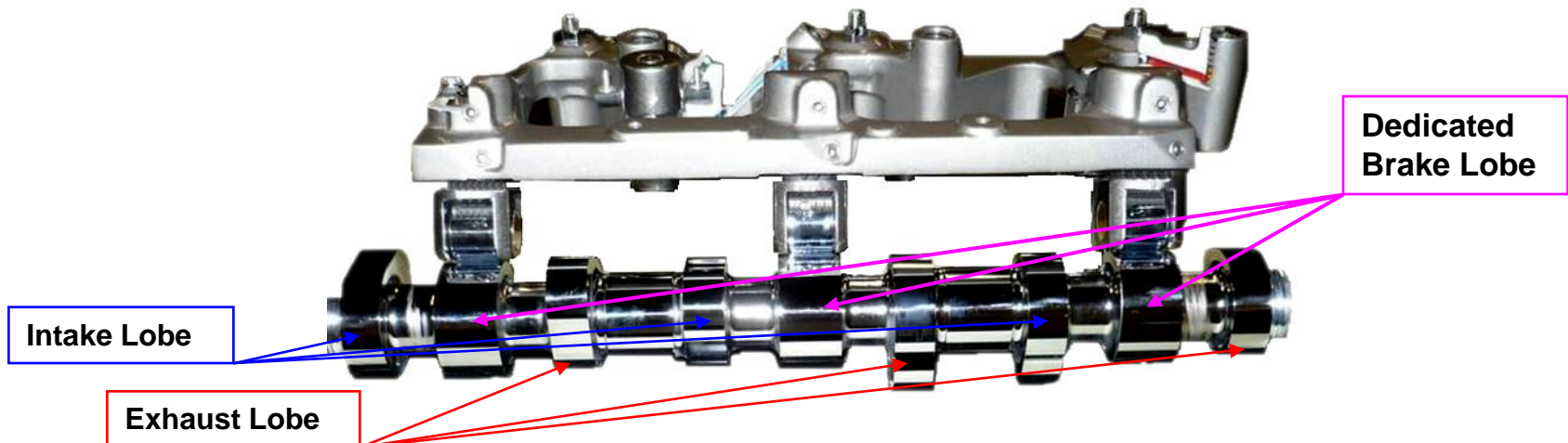




Dedicated Cam System

The engine Camshaft, has three cam lobes per cylinder, two which provide motion for the exhaust and intake rocker levers, and one which is “**Dedicated**” for engine braking valve motion. The braking cam lobe provides for two events per cycle,

- 1) A Pre-Charge event, opening the exhaust valve during the intake stroke, and
- 2) A Compression Release event, opening the exhaust valve towards the end of the compression stroke.





Compression Release is accomplished by opening an exhaust valve near the top of the normal compression stroke (Top Dead Center). This releases the compressed cylinder charge to the exhaust system “Compression Release”.

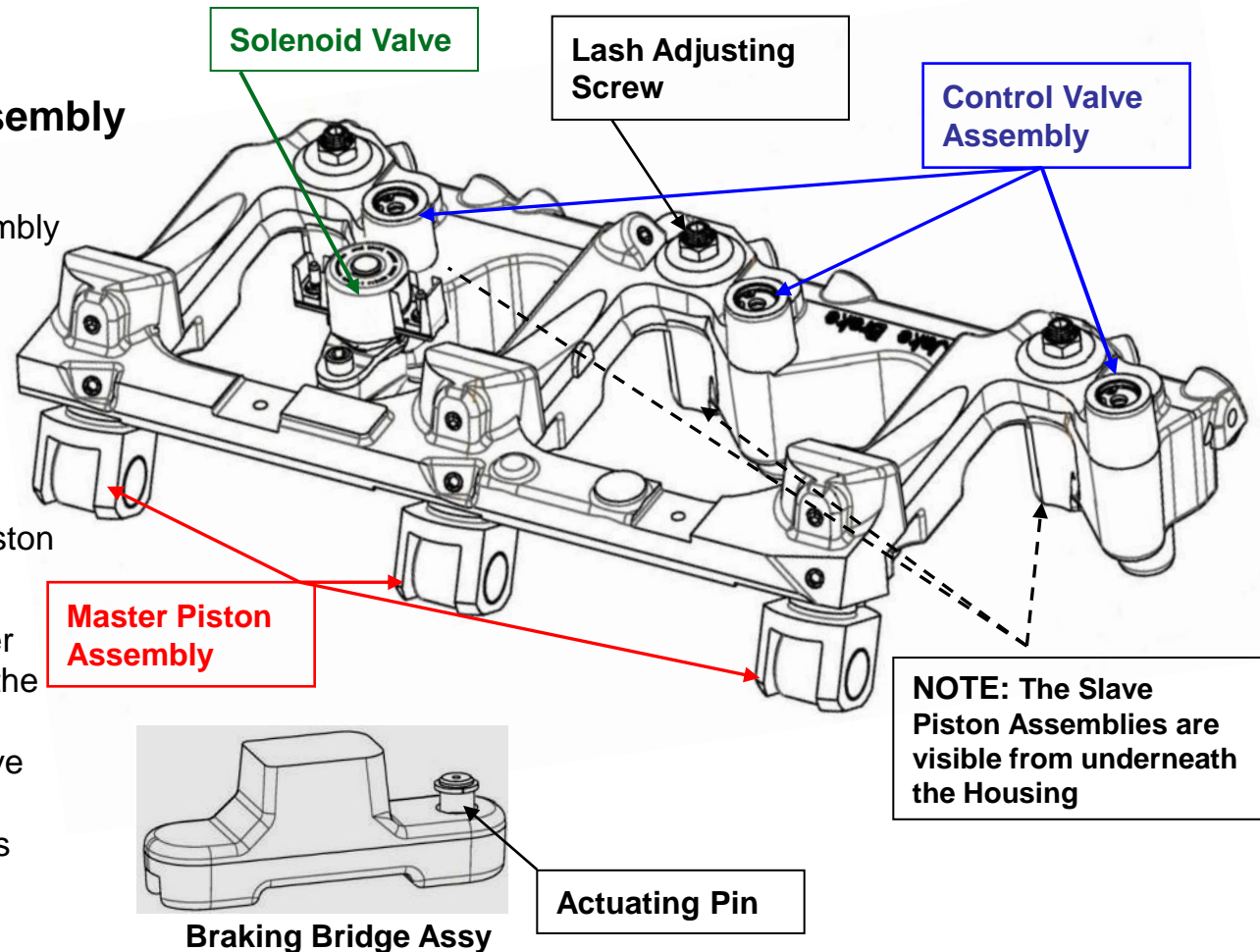
- When the engine brake is activated, one exhaust valve is opened for a short period during the intake stroke allowing the exhaust gas flow in to “Pre-Charge” the cylinder. This helps increase the compression pressure during the compression stroke, which increases the braking effect. Near the top of the compression stroke (TDC) the exhaust valve is opened a second time releasing compressed cylinder charge.
- The blow-down of compressed air prevents the return of energy to the piston on the expansion stroke.
- The effect is a net energy loss since work done in compressing the cylinder charge is not returned during the expansion stroke.
- The engine brake system can only be activated in the engine overrun mode, closed throttle or “no Fuel” condition, and with the transmission clutch engaged, or the torque converter in lock-up for automatic transmissions.



Component Description:

Engine Brake Housing Assembly

- The Engine Brake Housing Assembly contains a Solenoid Valve, Control Valve Assemblies, Master Piston Assemblies and Slave Piston Assemblies.
- During positive power, the Master Piston is retracted away from the braking cam lobe, and the slave piston is also fully retracted.
- During Engine Braking, the Master Piston extends to meet and follow the brake cam motion, and the lift is hydraulically transferred to the Slave Piston, which acting on the braking exhaust bridge actuating pin, opens one of the two exhaust valves.

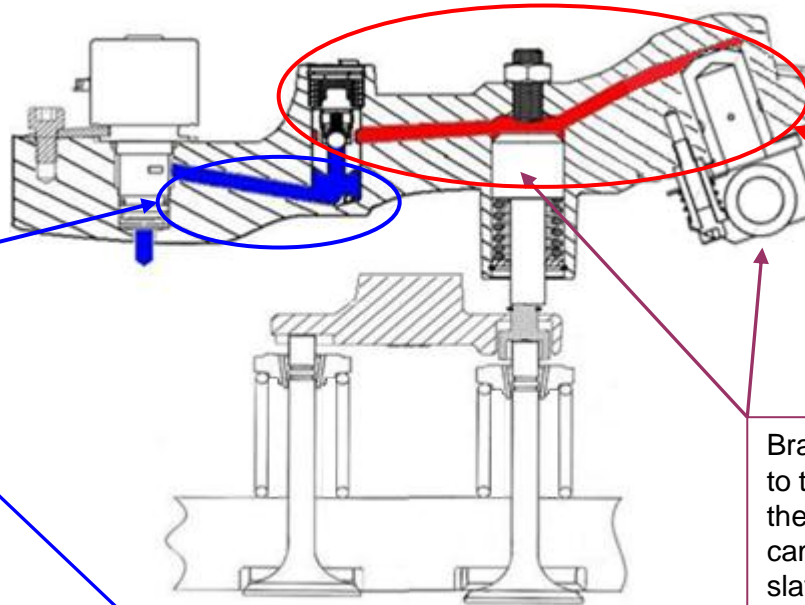




Functional:

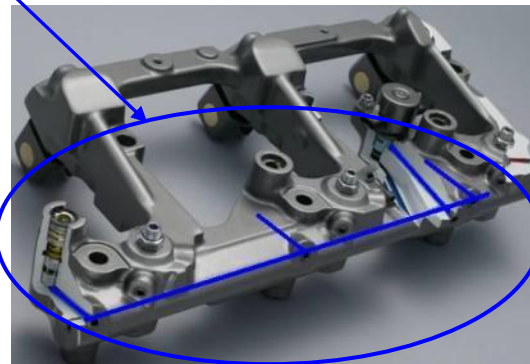
With the Solenoid activated, engine oil (shown in blue), passes through to the bottom of the Control Valve moving the Control Valve up, compressing the inner control valve spring to index with the high pressure passage in the housing

Engine Oil Supplied from Center Mounting Bolt Position



The oil passes through the Control Valve and fills the passageways between the Master and Slave pistons. The Control Valve, ball check, prevents the oil escaping creating a closed high pressure circuit (shown in red)

Braking Cam motion is transferred to the Master piston which increases the oil pressure and transfers the cam motion hydraulically to the slave piston to open the engine exhaust valve. Creating the "Compression Release"





Retrofit Requirement:

If the engine brake did not come factory installed it is possible to have it Dealer Installed. All EPA certified 2010 engines are supplied with a camshaft that has the Dedicated Brake Cam Lobe. (**Note:** earlier than EPA certified 2010 engine cannot be retrofitted)

The parts required for aftermarket installation are:

Part Description	Navistar P/N	Quantity
Brake Housing Assembly	3007628C93	2
Exhaust Bridge with Actuating Pin (These replace the standard non-brake parts)	3007627C1	6
Mounting Bolt M12 X 100mm* (Internal Hex)	30996R1	6
Mounting Bolt M10 X 90mm* (Flanged External Hex)	1822018C1	6
Braking Option Electrical Harness* (This replaces the standard injector harness)	3007472C91	1
Dash controls*	As Required	A/R

The Engine ECU will need to be updated with the Engine Braking profile.

* Supplied by NAVISTAR



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The following symbols in this training program signal potentially dangerous conditions to the mechanic or equipment. Know these conditions can exist, and take the necessary steps to protect personnel as well as equipment.

! WARNING !

- THIS SYMBOL WARNS OF POSSIBLE PERSONAL INJURY

! CAUTION !

- THIS SYMBOL REFERS TO POSSIBLE EQUIPMENT DAMAGE

NOTE

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

Fuel, electrical equipment, exhaust gases and moving engine parts present potential hazards that could result in personal injury.

Take care when installing an engine brake.



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Removal: **WARNING !** Ensure that the engine is clean and at ambient temperature before starting removal. For Safety disconnect the battery-starting system, a number of engine components remain live with the ignition on. Component damage and/or personal injury may occur.

- Remove any necessary parts to allow for the removal of the upper valve cover, undo the 17 - 8mm valve cover bolts and remove the “upper” valve cover. (See Fig 1)
- Disconnect the “Brake Solenoid” harness from the 2 Engine Brake Solenoids, one in each engine brake housing. (See Fig 2) Cut the three cable ties to release the harness, DO NOT PULL OUT THE FIR TREE CLIPS. The Solenoid harness is part of the “Injector Harness”

NOTE *The solenoid has a constant + battery connection, with ignition on.*

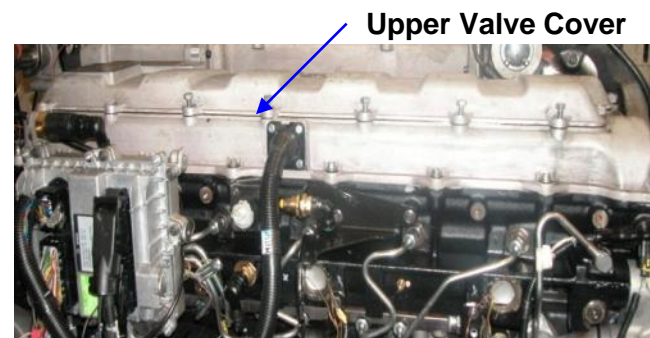


Fig 1

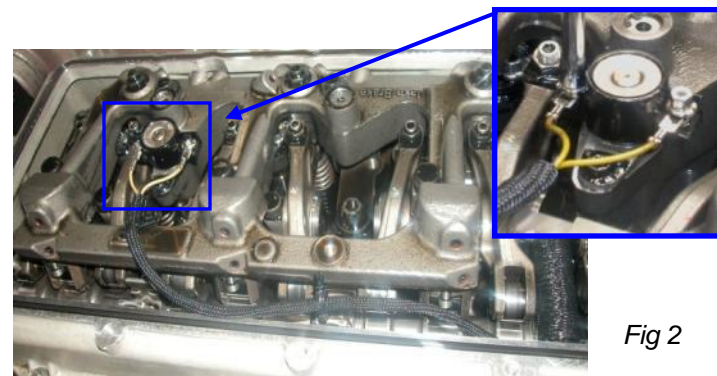


Fig 2



Model 5783A Engine Brake Installation and Removal

- Loosen the 6 engine brake hold-down cap screws from each housing, and remove them. (See Fig 3)
“3 - M12 x 100mm and 3 - M10 x 90mm”

NOTE The M12 are Internal Hex Heads, and the M10 are Flanged External Hex Heads.

- Remove the 2 housings from the engine (See Fig 4).

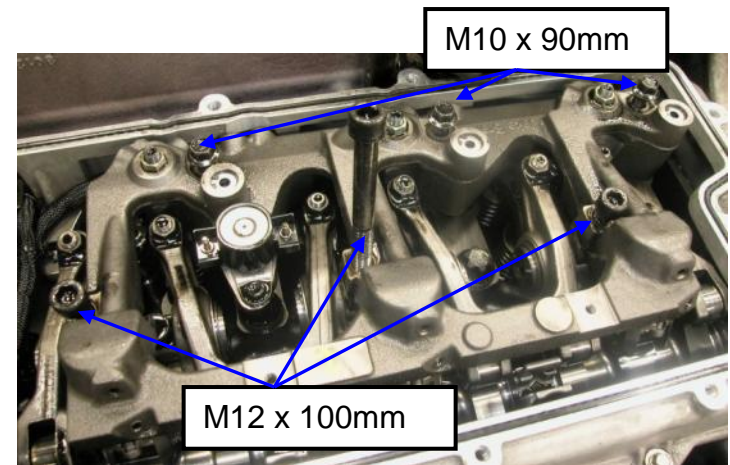


Fig 3

NOTE Both Brake Housings are the same part number. Ensure that they are re-installed in the same position on the engine.



One Housing Removed

Fig 4



- Remove the remaining hold down cap screws from the pedestals. (See Fig 5)

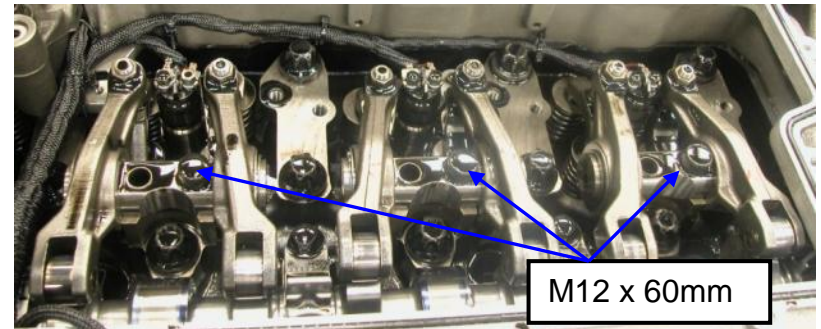


Fig 5

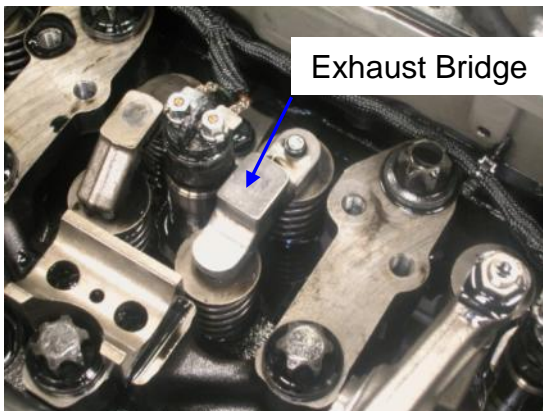


Fig 6

- The Intake and Exhaust Rocker Arm assemblies can now be removed to gain access to the exhaust bridge with actuating pin. (See Fig 6)

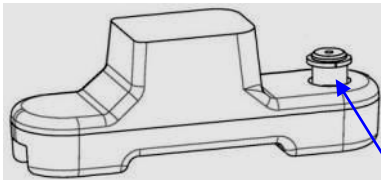
NOTE Ensure that the rocker arm assemblies are kept in the order as they are removed from the engine as it is essential that they be re-installed in the same positions.

- The exhaust bridges can now be inspected to ensure that the actuating pin moves freely, that it is captured within the bridge, and there is no indication of cracking, galling or fretting on the contact surfaces of the actuating pin.
- The actuating pin is a part of the exhaust bridge and cannot be removed or replaced. If there is a problem, the exhaust bridge must be replaced as an assembly.



Installation: !CAUTION Ensure that the valve bridges, rocker assemblies, and engine brake housings are reinstalled in the same position as they were removed. This will ensure that the contact areas stay matched together.

(Braking) Bridge Assembly



Actuating Pin

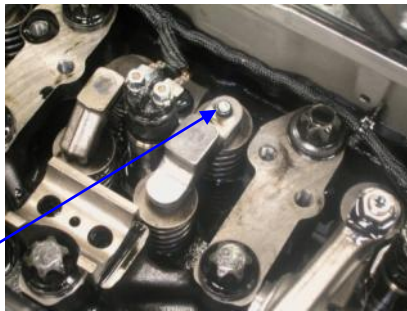
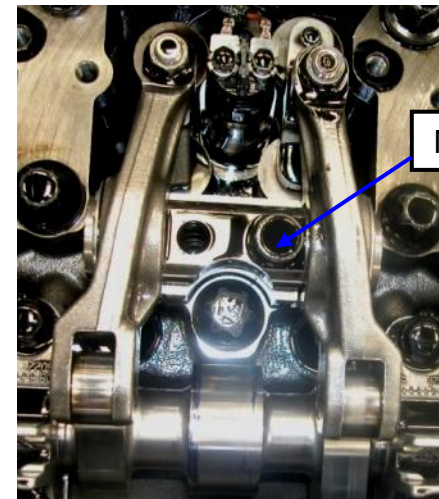


Fig 7

- Reinstall the rocker arm assemblies and reinstall the single M12 x 60 mm hold down cap screw in the same position as removed, nearest to the exhaust rocker arm. (See Fig 8)
- Tighten the internal hex cap screw and torque to 105 Nm (77lb-ft)

- Install the exhaust bridge with actuating pin over the exhaust valve stems so that the actuating pin sits over the outboard exhaust valve stem. Ensure that both valve stems are properly seated into pockets of the bridge. (See Fig 7)



M12x60mm

Fig 8



Model 5783A Engine Brake Installation and Removal

- Check that the slave piston adjusting screw is backed out, (See *Fig 9*) and that the slave piston is retracted, to ensure clearance between the slave piston and exhaust bridge actuating pin.
- Carefully install the engine brake housings in their original positions (see *Fig 10*). This will ensure that the contact area of the master piston roller and the camshaft lobe stay matched together.

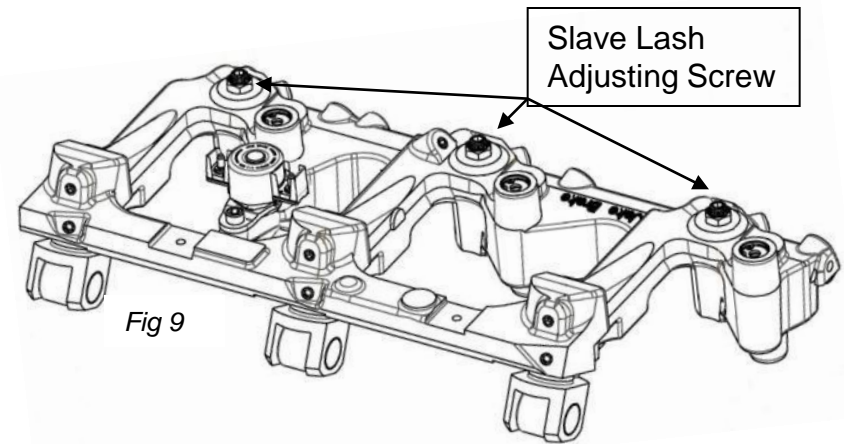


Fig 10

- Ensure the slave piston is oriented over the exhaust bridge actuating pin.
- Ensure the master piston roller is aligned with the dedicated camshaft lobe.



Model 5783A Engine Brake Installation and Removal

- Install the three M10 X 90mm bolts through the perimeter housing bolt holes. (See Fig 11)

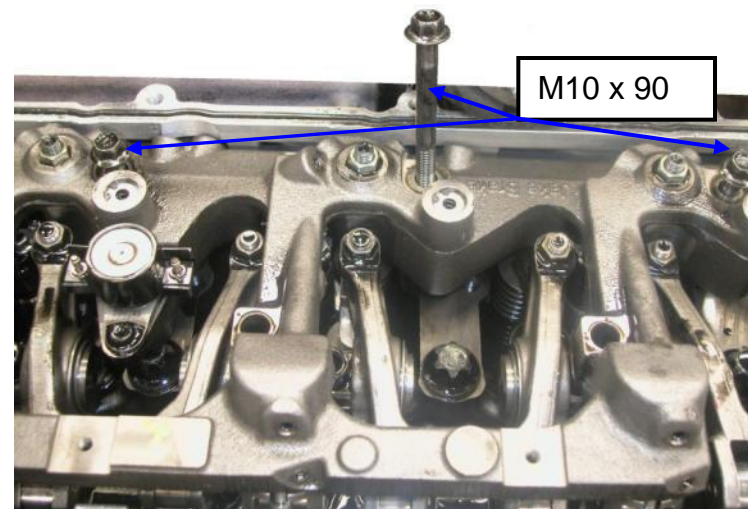


Fig 11

- Install the three M12 X 100mm long, socket head cap screws through the mid-housing bolt holes and into the rocker pedestal bolt holes. (See Fig 12)

NOTE Oil Supply to the engine brake is via the center M12 bolt hole location.

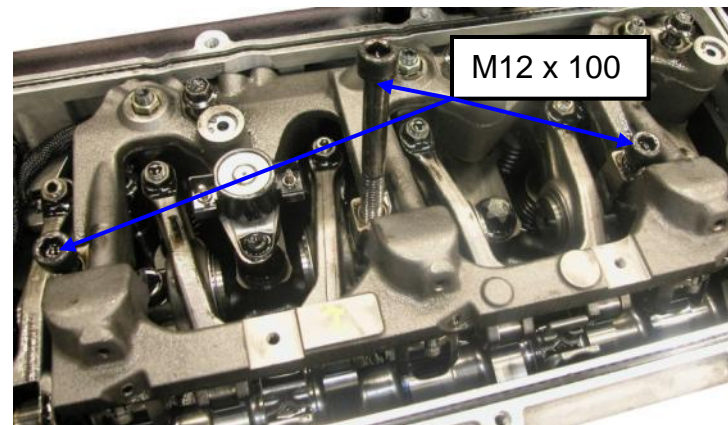
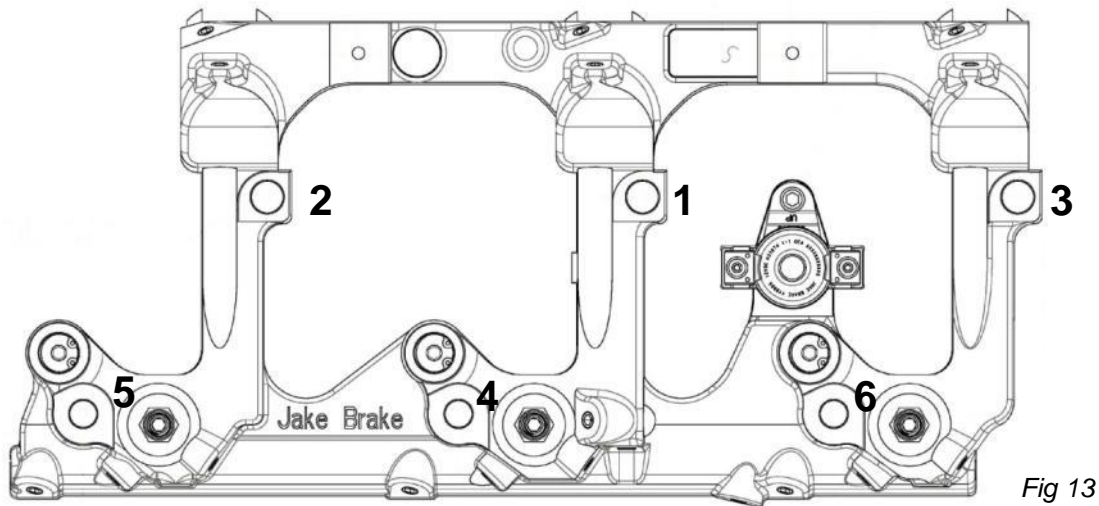


Fig 12



- Loosely tighten both brake housings making sure that the slave pistons are centered over exhaust bridge actuating pins, and master pistons are in contact with the brake cam lobes
- Tighten the hold-down bolts in the following sequence, M12 starting at the center, then M10 starting at the center: (See Fig 13)



- Torque the three M12 X 100 mm Socket head cap screws to 105 Nm (77lb-ft)
- Torque the three M10 X 90mm Hex flanged head screws to 75 Nm (55lb-ft)



Model 5783A Engine Brake Installation and Removal

- Attach the solenoid harnesses (See Fig 14) to the solenoids these are part of the injector harness. Hold the terminals stationary to avoid twisting and tighten the connector nuts to 3.5 Nm (31 in-lbs)

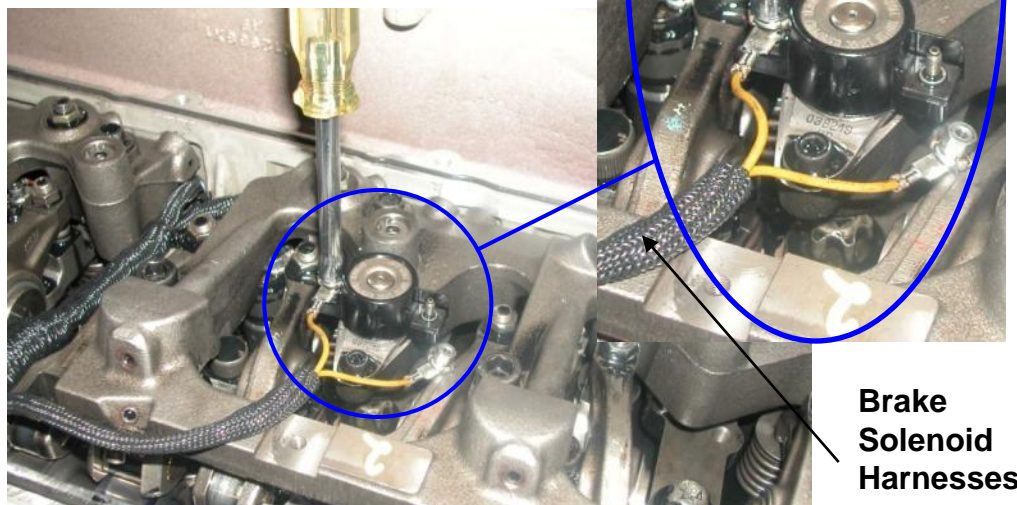


Fig 14

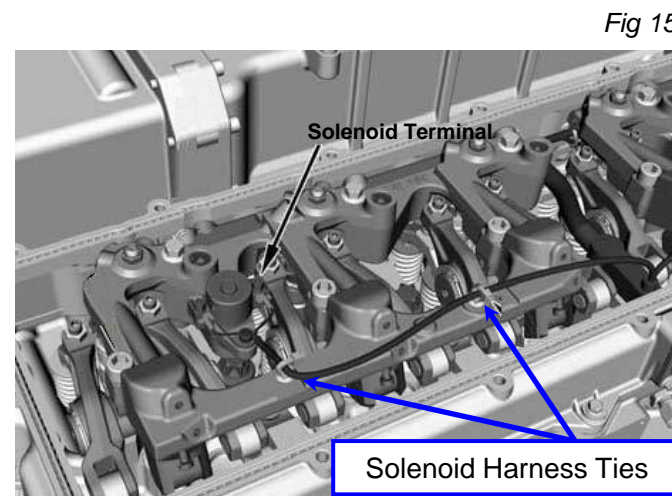


Fig 15

- Secure the solenoid harnesses to the brake housings “Fir Tree” clips using new tie straps (3) to ensure that the harness is kept away from all moving engine parts, camshaft and rockers. (See Fig 15)



Intake & Exhaust Valve Lash Adjustment

- Adjust the engine Intake and Exhaust valves before setting the engine brake adjustment.

NOTE Check the latest Navistar Service Information for the correct procedure and specifications.

Procedure: Using the Navistar Engine Rotating tool ZTSE6060 rotate the engine until Cylinder 1 is at TDC, Valves Closed. Adjust both the Intake and Exhaust Valves with the Engine Piston at TDC.

1. Loosen the Intake Valve Lash adjustment M10 locknut.
2. Insert a 0.5mm (.0196 in) feeler gage between the valve bridge and the adjusting screw.
3. Tighten the adjusting screw until a slight drag is felt.
4. Holding the adjusting screw in position tighten the locknut to 45 Nm (33 lb-ft).
5. Loosen the exhaust valve lash adjustment M10 locknut.
6. Insert a 0.8mm (.0314 in) feeler gage between the valve bridge and the adjusting screw.
7. Tighten the adjusting screw until a slight drag is felt.
8. Holding the adjusting screw in position tighten the lock nut to 45 Nm (33 lb-ft).
9. Rotate the engine clockwise to align cylinder 5,3,6,2, and 4 at TDC one at a time and set the remaining cylinders valves.

NOTE The Brake Lash can be set directly after the exhaust lash is set.



Brake Valve Lash Adjustment

NOTE Check the Jacobs or Navistar Service Information for the latest specifications.

Procedure: Rotate the engine using the Engine Rotating tool ZTSE6060, until the exhaust valves on the cylinder to be adjusted are closed, and the exhaust bridge is loose, not in contact with the exhaust rocker.

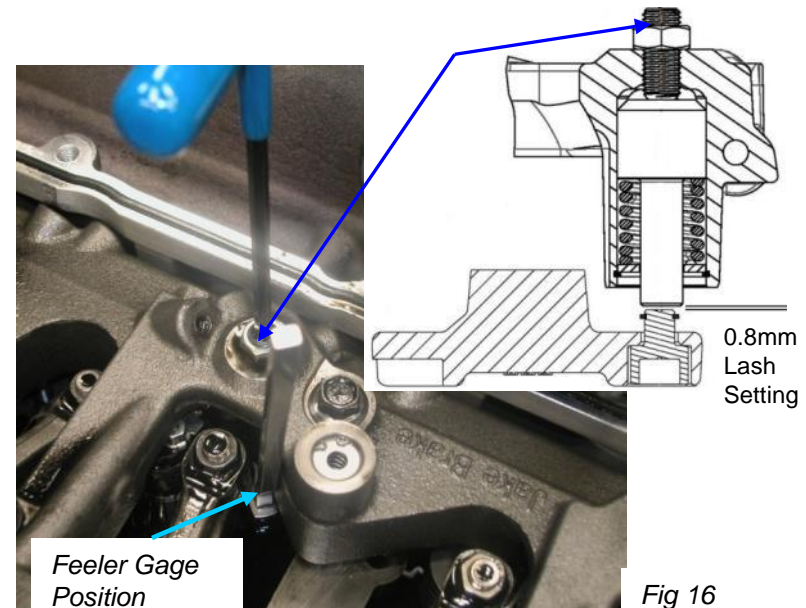
1. Loosen the engine brake adjusting screw lock nut and back the adjusting screw out several turns.
2. Place 0.8mm feeler gauge between the engine brake slave piston and the top of the exhaust bridge actuating pin. Turn in the adjusting screw until there is a “drag” on the feeler gauge. (See Fig 16)

3. Tighten the locknut while holding the adjusting screw, torque the adjusting screw locknut to 25 Nm (18 lb-ft).

NOTE Slave Lash Adjustment is Critical

4. Rotate the engine until the next cylinder exhaust valves are closed, and set the next brake lash, continue until all engine brake slave pistons are set.

NOTE It is possible to set more than one cylinder at any time, providing the exhaust bridge is loose





Once the installation is complete and the valve lash settings are set, carry out a visual inspection to ensure all wiring is attached and free of any moving parts.

Make sure no tools have been left on the engine!

Fit the upper valve cover, install and tighten the valve cover bolts that hold the rocker cover. Start the engine and check for correct brake operation.

Bleeding the Engine Brake

- The engine brake is a “self bleeding” system to ensure the correct operation. Start the engine and let it run for 5 to 10 minutes to ensure proper operating temperature.
- Turn the brake on, accelerate the engine to approximately 1800 RPM, and release the throttle. Repeat this several times to bleed the engine brake system.
- Check for correct operation, i.e. smooth engine blow down.





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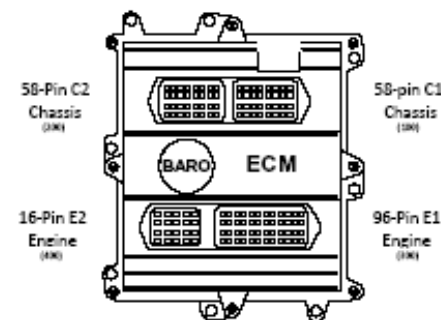


- In order for the Engine Brake to operate properly, the Engine Brake requires a supply of hydraulic fluid “engine oil” and a signal “supply voltage” from the solenoid valves.
- The wiring and Control System is the responsibility of the engine/vehicle manufacturer. The engine ECU (Electronic Control Unit) monitors the necessary parameters required for the engine brake operation. Typically: No Fuel mode (throttle off), Clutch / Transmission Engaged, Engine Oil Temperature above 160°F, and Engine speed above 1,000 RPM. Also vehicle brake ABS system should be interfaced.
- The Driver has overall control of the system, i.e. On / Off and levels of retardation. The ECU then supplies a signal to the Engine Brakes Solenoid Valves when operation is required. The engine brake has three levels of retardation, a low position, a medium position, and a high position.
 - **High** 2 Housings (6 cylinders) Closed Waste-gate Turbo for High Boost
 - **Medium** 2 Housings (6 cylinders) Open Waste-gate Turbo for Medium Boost
 - **Low** 2 Housings (6 cylinders) Open Waste-gate Turbo for Low Boost
- The solenoids are, ignition on, positive power fed at all times, and the negative “ground” is switched by the ECM Controller.
- The Engine Brake low speed shut off is 1,000 RPM.



Wiring Diagram

Engine Brake wiring is part of the Injector Harness, ECM Connection is via the 96 Pin E1 connector. (See below for Pin Connections)



ECM 96Pin E1 Connector

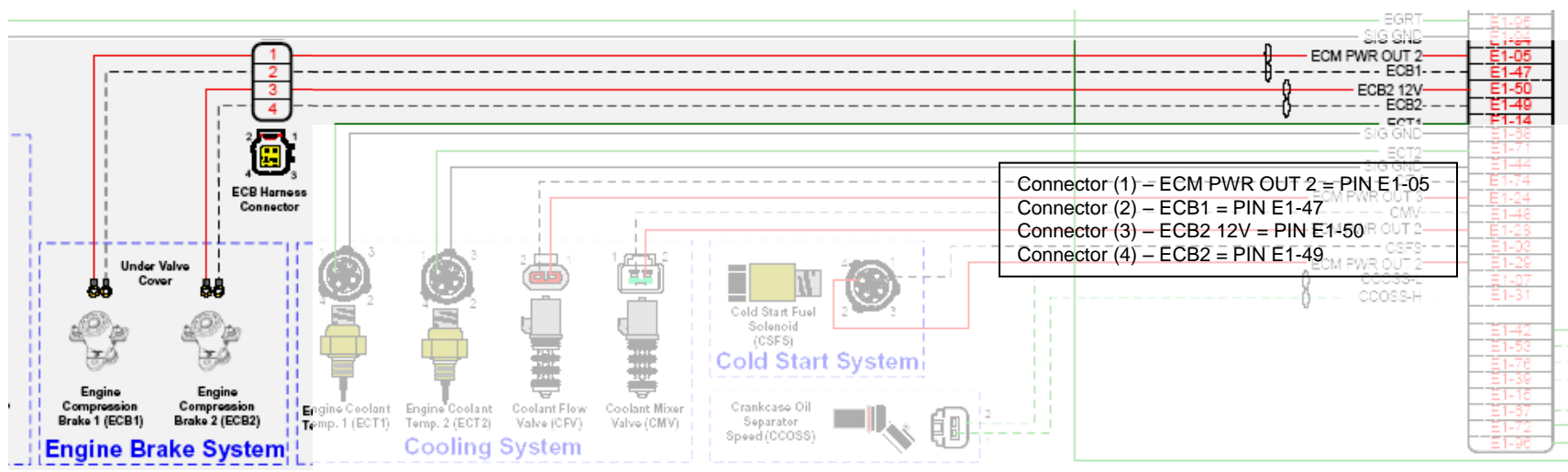


Fig 17



The following conditions **must be** met for the Engine Brake to be activated:

- ☐ Throttle @ < 4%
- ☐ ABS not active
- ☐ Engine not fueling
- ☐ Engine not in PTO mode
- ☐ Clutch pedal released (if equipped manual transmission)
- ☐ Torque convertor in lockup (automatic transmission)



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- Jacobs Engine Brake Systems are designed to be **low maintenance**. The main components are the Solenoid Valve, Control Valve group, Slave Piston group, Master Piston group, and Exhaust Bridge assembly. *Refer to Jacobs' Maintenance Schedule for these components.*
- Basic maintenance consists of the Brake Lash Adjustment, which will only need to be checked/adjusted at the relevant service period when the engine intake and exhaust valves are adjusted, or anytime the Engine Brake housing has been removed from the engine.
- There is no additional oil requirement, the “Brake System” is designed to match the oil change requirement of the base engine and as the oil usage is very small, no additional oil is required.
- Visual inspection of the system and external wiring / controls should be conducted during normal vehicle servicing and suggested service intervals.



Torque Settings and Lash Clearance

Torque Settings:

Rocker Shaft Mounting Bolts M12 x 60	105 Nm (77 lb-ft)
Brake Mounting Bolt M10 x 90mm Hex	75 Nm (55 lb-ft)
Brake Mounting Bolt M12 x 100mm Socket Head	105 Nm (77 lb-ft)
Brake Adjusting Screw Locknut	25 Nm (18 lb-ft)
Valve Adjusting Screw Locknut	45 Nm (33 lb-ft)
Solenoid Hold down Screw M6 x 10mm	12.5 Nm (110 in-lb)
Solenoid Wire Securing Nut	3.5 Nm (31 in-lb)
Upper Valve Cover Bolt M8	31 Nm (23 lb-ft)

Lash Clearance:

Intake Valve Lash	0.5 mm (0.0196 in)
Exhaust Valve Lash	0.8 mm (0.0314 in)
Engine Brake Lash	0.8 mm (0.0314 in)

Table 1

!CAUTION *Do not over-torque as this may damage the solenoid*



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Technical Specifications:

Supply Oil Pressure for Brake Operation	20 PSI – 55 PSI Over pressure shut-off 80 PSI
Solenoid Voltage Nominal	12 VDC
Solenoid Voltage Pull In	6.3 VDC Cold – 8.4 VDC Hot
Solenoid Amperage Draw at 50 PSI Supply Pressure	0.625 AMPS Pull in 0.41 Amps Constant
Solenoid Resistance at Cold	8.7 to 10.0 Ohms @ 25°C (77°F)
Hot	12 to 15.5 Ohms @ 121°C (250°F)
Time Delay in Engine Brake Actuation	Parameter programmable by Navistar

Table 2



Engine Brake Performance

MAXXFORCE 11				MAXXFORCE 13			
Speed	Power	Torque	Boost	Speed	Power	Torque	Boost
(RPM)	(HP)	(Nm)	(kPa)	(RPM)	(HP)	(Nm)	(kPa)
1100	93	602	50	1100	110	712	60
1300	144	789	90	1300	170	931	90
1500	203	964	110	1500	240	1139	120
1700	279	1169	140	1700	330	1382	150
1900	351	1316	150	1900	415	1556	160
2100	398	1350	140	2100	470	1594	150

Table 3

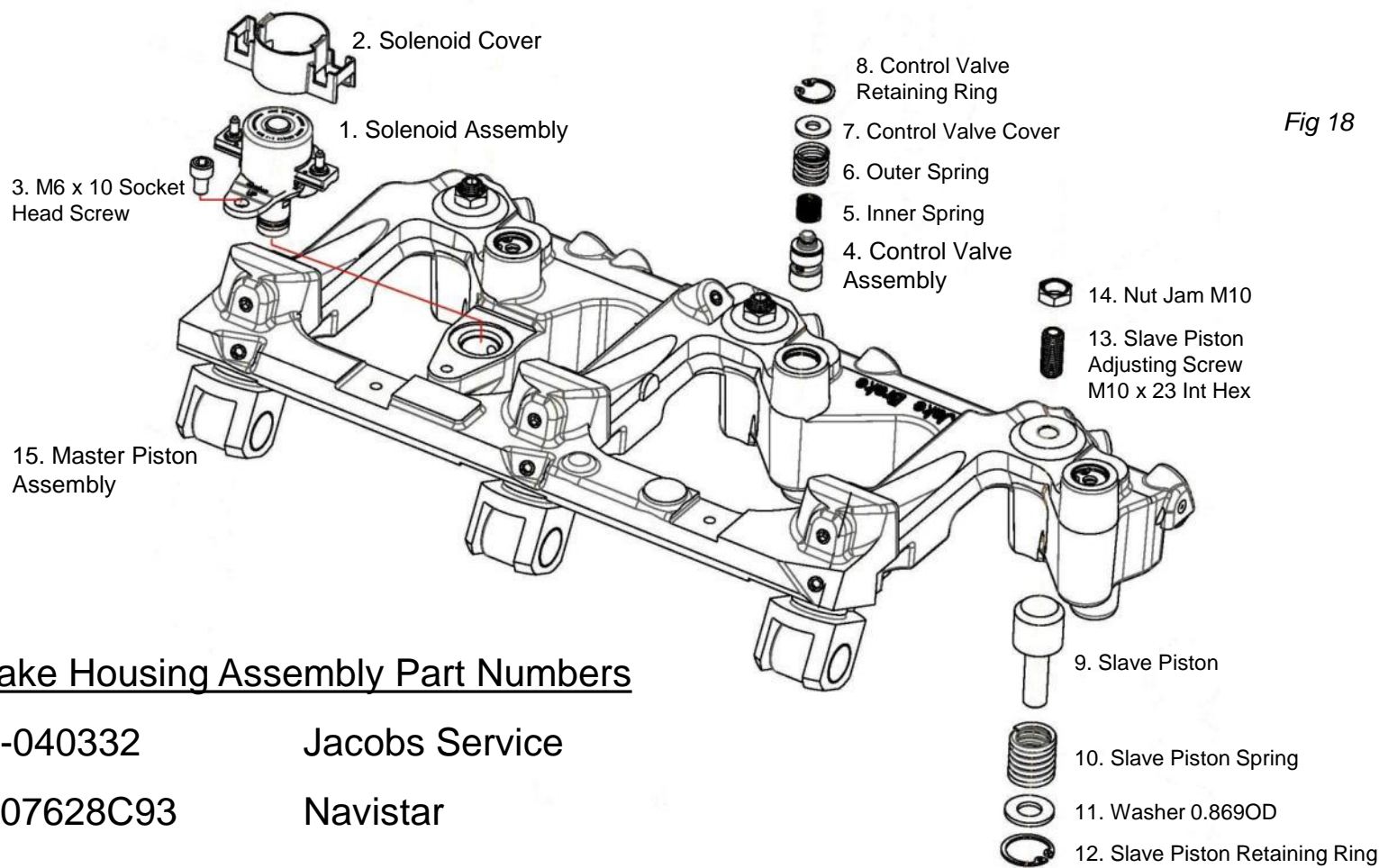
NOTE

Performance figures are for illustration purposes only. Boost figures are used to determine correct performance of the Engine Brake at the High setting.



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Brake Housing Assembly Part Numbers

00-040332 Jacobs Service

3007628C93 Navistar



<u>Description</u>	<u>Part Number</u>		<u>Quantity per Housing Assembly</u>	<u>Quantity per Engine</u>
	<i>Jacobs</i>	<i>Navistar</i>		
1. Housing Assembly 12vDL	00-040332	3007628C93	n/a	2
All part numbers below are shared between models 5783 and 5783A				
1a. Solenoid Group	00-039895	3008453C1	1	2
a. Solenoid 12VDC, D/L				
a1. Orings (2)				
a2. Inlet Screen				
b. Solenoid Cover Type II				
c. M6 x 10 Socket Head Screw				
1b. Control Valve Group	00-039893	3008454C2	3	6
a. Control Valve Assembly				
b. Inner Spring				
c. Outer Spring				
d. Cover				
e. Retaining Ring				
1c. Slave Piston Group	00-039894	3008452C1	3	6
a. Slave Piston				
b. Spring				
c. Washer				
d. Retaining Ring				
e. Adjusting Screw				
f. Jam Nut M10				
1d. Master Piston Assembly Group <i>not a serviceable group</i>			3	6
2. Bridge Assembly, Braking	00-039446	3007627C1	n/a	6

Table 4



Attaching Parts / Tools

Description	Part Number		Qty/Eng
	Jacobs	Navistar	
Bolt Hold-Down M12 x 100mm (Socket Head) Not Shown	n/a	30996R1	6
Bolt Hold-Down M10 x 90mm (Hex Flange-Head) Not Shown	n/a	1822018C1	6

Table 5

Special Tools

<u>Description</u>	<u>Part Number</u>
Engine Turning Tool	Navistar ZTSE 6060
Valve / Lash Adjusting Gage (.8mm)	Jacobs 01-040044
Slave Piston Removal Tool	Jacobs 01-025084
Oil Pressure Test Kit for Type I & II Solenoids	Jacobs 00-040049

Table 6

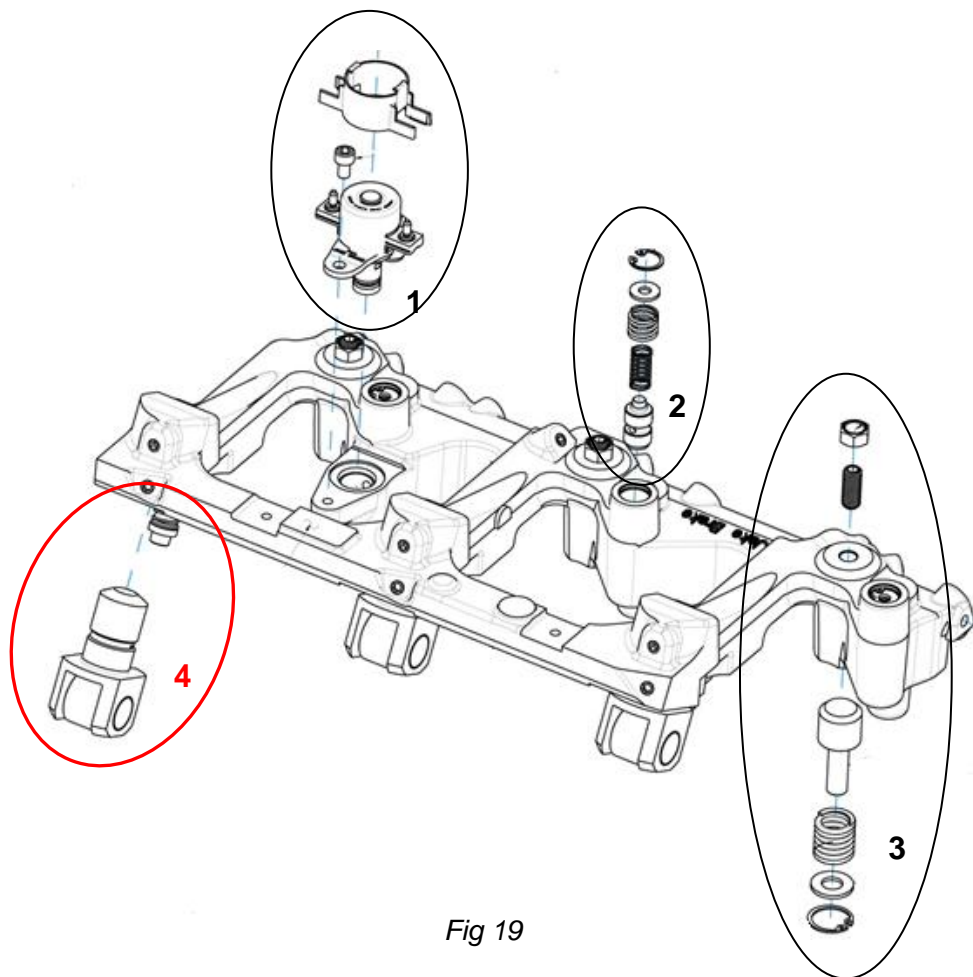


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(Engine Brake) Housing Assembly Exploded Schematic



1. Solenoid Valve Group
2. Control Valve Group
3. Slave Piston Group
4. Master Piston Group*

** not a serviceable group*

Fig 19



Solenoid Valve Group

Item Description

1. Solenoid 12 VDC, D/L
2. Cover
3. Mounting Screw M6 x 1
4. O-rings (2)
 1. ID .426 (JVS P/N 31139)
 2. ID .614 (JVS P/N 29421)
5. Inlet Screen

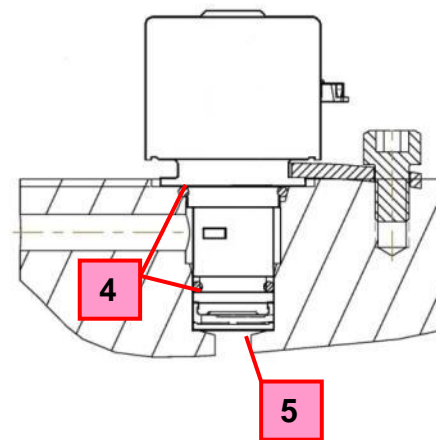
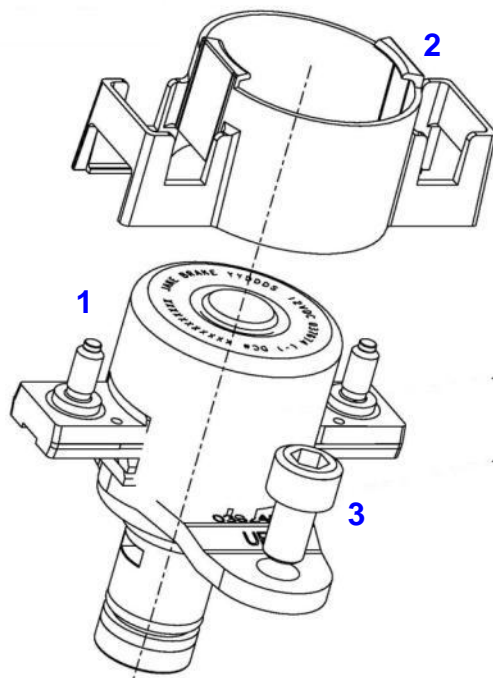


Fig 20

NOTE The solenoid assembly itself is a non-serviceable item. The Inlet Screen and O-rings, are serviceable and can be purchased independent of the Solenoid Group. The Solenoid Cover is also an independent, serviceable item which clips onto the top of the solenoid.



Solenoid Valve with Cover.

There is one Solenoid per Housing. The Solenoid is 12 VDC Dual Lead,

The Solenoid is an On-Off valve and controls the operation of the Brake.

The off position is controlled by engine oil pressure, not spring force.

The solenoid has a constant positive feed, and the ground is switched via the engine brake control circuit in the engine ECM.

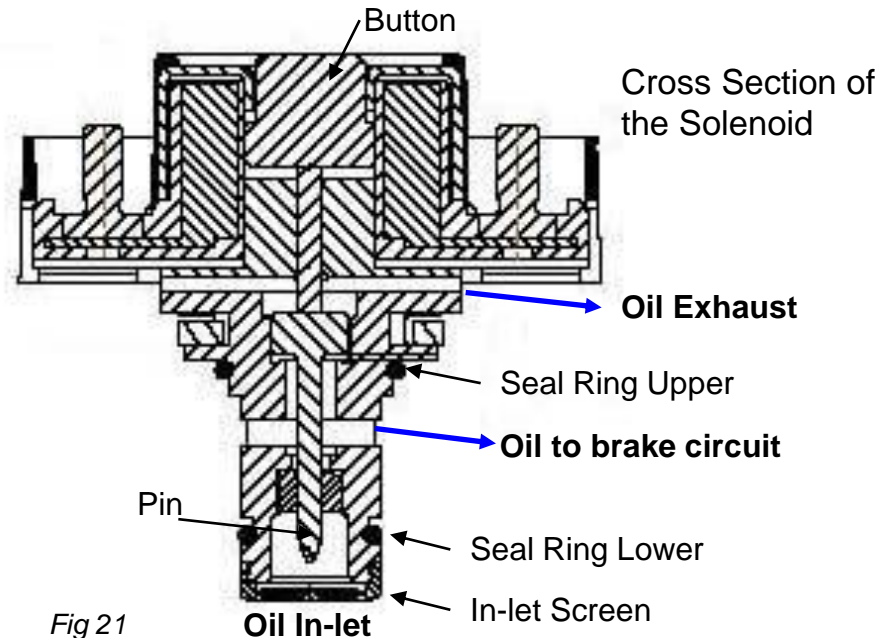


Fig 21

Removal: If not previously done, loosen the terminal connector nuts and disconnect the harness connector leads from the solenoid.

Loosen the 6mm x 10 socket head cap screw in the retaining clamp, and remove.

Remove the solenoid from the brake housing. This pulls out along with the solenoid cover.

Remove the upper and lower seal rings from solenoid and discard them. New ones should be fitted when reinstalling the solenoid.

Remove the oil inlet screen from the bottom of the solenoid. The inlet screen clips onto the solenoid..



Solenoid Valve with Cover.

Test Procedure: Ensure that the solenoid has a correctly functioning electrical circuit, See fault information.

Note: Beware the “Oil Exhaust” is from under the solenoid coil. Hot oil can be dangerous.

With the solenoid removed, check the operation of the pin assembly. This should be totally free. If not already done, remove the inlet screen, hold the solenoid with a thumb on the bottom pin and index finger on the button. The pin and button should move together freely. If the pin is sticking, replace the solenoid.

Note: Without the solenoid screen, small particles can seize the pin.

Installation:

Install new upper and lower o-ring seals to the solenoid body, and lubricate with clean engine oil. Clip a new oil in-let screen onto the solenoid, this is just a push on fit.

Ensure that the solenoid cover is installed on the solenoid, this slides over the solenoid body and locks in place. The cover is there to prevent any possible terminal short to the solenoid body.

Place the solenoid in position in the brake housing. Ensure that the solenoid is fully into the brake housing.

Install the M6 x 10 socket head cap screw, and carefully tighten to 12.5 Nm (110 in-lbs)

If the brake housing is installed on the engine, re-connect the wiring harness.



Control Valve Group: P/N 3008454C1

There are three Control Valve Groups in each Engine Brake Housing Assembly. The Control Valve group controls the oil within the Slave Piston/Master Piston circuit, preventing oil from escaping during the braking event.

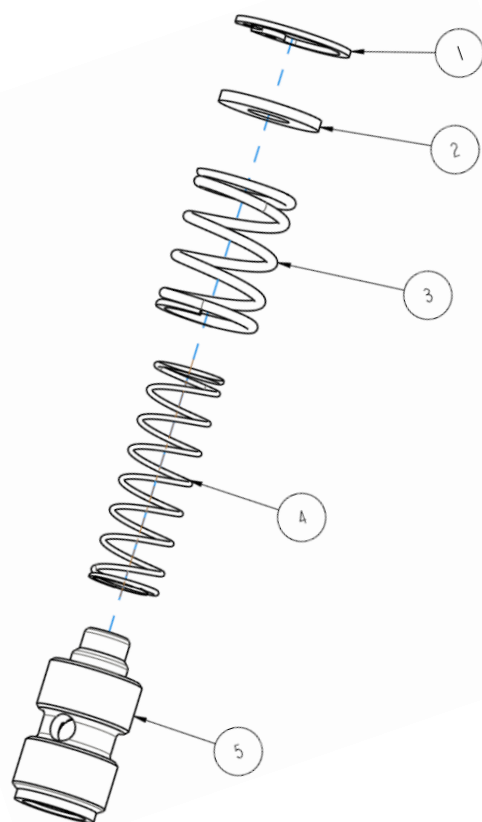
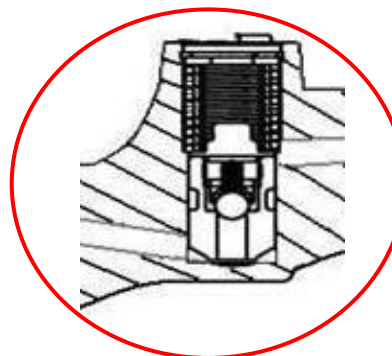


Fig 22

Control Valve
Off Position



Control Valve
On Position
"Filling"

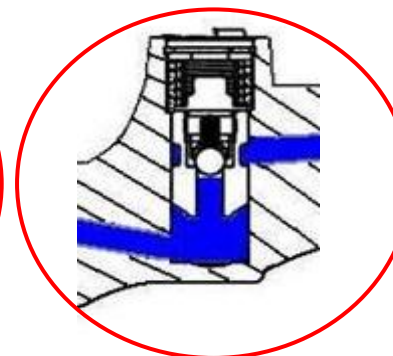


Fig 23

Item Description

- 1 Snap Ring – Control Valve Retaining
- 2 Control Valve Retaining Washer (Cover)
- 3 Outer Control Valve "Stop" Spring
- 4 Inner Control Valve Spring
- 5 Control Valve



Control Valve Group: P/N 3008454C1

Removal: The control valve is held under light spring pressure. To remove the control valve, compress the spring with a suitable hand tool on the control valve retaining washer (cover) to release the force on the snap ring and using retaining ring pliers, remove the snap-ring. Carefully release the spring tension and remove the snap ring and retaining washer (cover). Remove the two control valve springs. Using needle nose pliers, remove the control valve.

THE CONTROL VALVE ITSELF IS NOT A SERVICABLE PART AND SHOULD NOT BE DISASSEMBLED

Installation: Ensure that the control valve and control valve bore are clean. Lightly oil the control valve with clean engine oil and slide it into the bore, with the hex stud end up. **THE CONTROL VALVE SHOULD BE FREE AND NOT STICK AT ALL.** Place the two springs into the bore and using a suitable hand tool, install the retaining washer (cover) and using a suitable hand tool compress the spring until the snap-ring can be installed in the groove. **Remember to install the snap ring with the sharp side up “away from washer”.** Ensure the snap ring is fully in place, and rotate before releasing the spring pressure



Slave Piston Group: P/N 3008452C1

There are three Slave Piston Groups in each Engine Brake Housing Assembly. The Slave Piston transmits the braking event received from the Master Piston/Slave Piston hydraulic circuit to the Exhaust Valve via the Bridge Pin.

Item Description

- 1 Slave Piston Adjusting Screw and Lock Nut
- 2 Slave Piston
- 3 Slave Piston Spring
- 4 Slave Piston Retainer
- 5 Snap Ring – Slave Piston Retaining

! WARNING

THE SLAVE PISTON IS RETAINED UNDER HEAVY SPRING PRESSURE. WEAR SAFETY GLASSES, AND REMOVE THE SLAVE PISTON CAREFULLY FOLLOW THE INSTRUCTIONS AND USE THE PROPER TOOLS OR THE SPRING COULD BE DISCHARGED WITH ENOUGH FORCE TO CAUSE PERSONAL INJURY

To remove and reinstall the Slave Piston it is strongly recommended that the Slave Piston Removal Tool be used. Jacobs P/N 00-025084

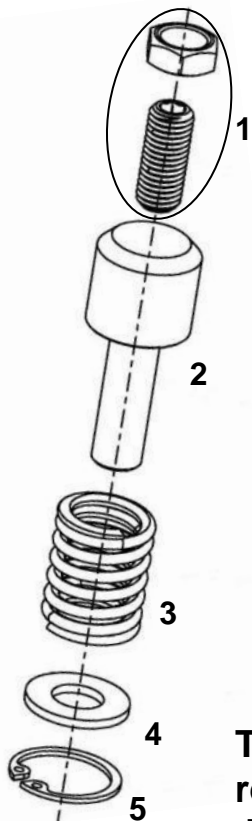


Fig 24

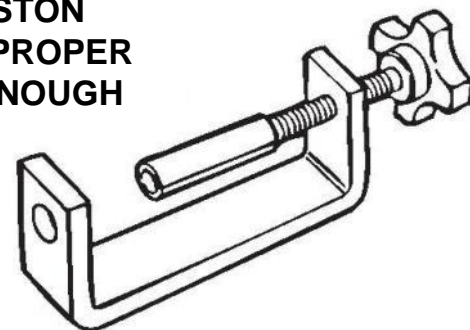


Fig 25



Slave Piston Group: P/N 3008452C1

Removal: Remove the adjusting screw locknut and back out the adjusting screw until the slave piston is fully retracted (screw is loose) Place the hole in the slave piston removal tool over the slave piston adjusting screw (*Fig 26*).

- While holding the tool in position, screw the holder down over the slave piston stem until the retainer is contacted. Continue until the retainer is depressed about 1mm, relieving the pressure against the retaining ring.

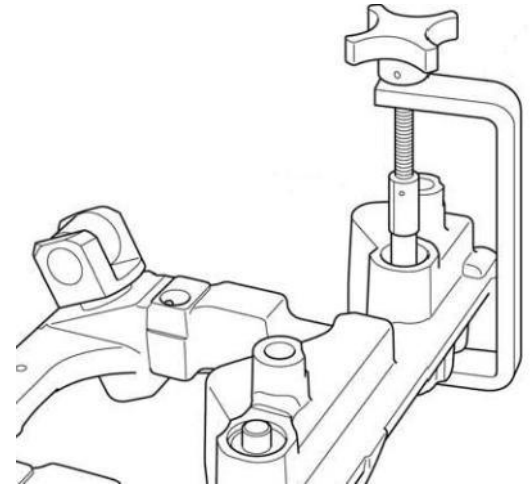


Fig 26

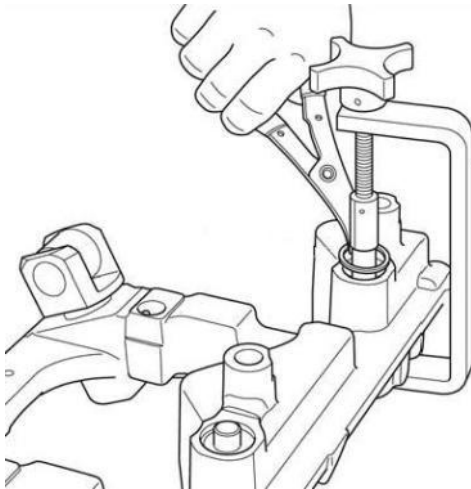


Fig 27

- Using retaining ring pliers remove the retaining ring (*Fig 27*). Back out the holder until the springs are loose, remove the tool.
- Remove the retainer, spring and slave piston.
- Clean the slave piston and bore and inspect for nicks or burrs and any binding in the bore.



Slave Piston Group: P/N 3008452C1

Installation: Apply clean engine oil on the slave piston, and install into the bore, checking that it is free and smooth through out the bore. Install the spring and retainer over the slave piston stem.

- Place the slave piston removing tool over the slave piston stem and adjusting screw, and compress the slave piston spring down until the retainer is about 1mm below the retaining groove. Care must be taken when compressing the slave piston spring.

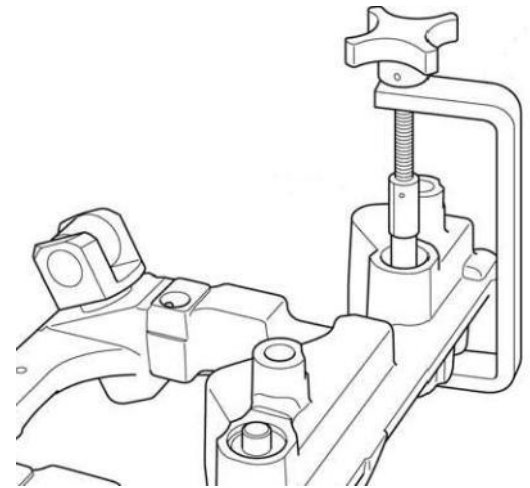


Fig 26

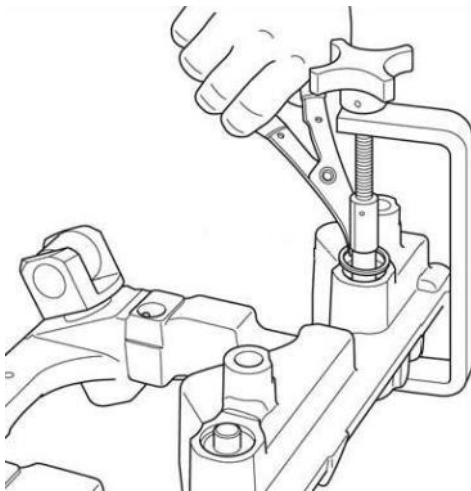


Fig 27

- Slide the retaining ring, sharp side up away from washer, over the threaded rod of the removal tool and reinstall the retaining ring in its groove. It is recommended that the retaining ring is turned about ¼ turn to ensure it is seated in the groove.
- **Be sure the retaining ring is fully engaged in the groove.**
- Remove the slave piston removal tool slowly to ensure proper seating of the retaining ring.
- Re-assemble the locknut, do not tighten.



Master Piston Group,

THE MASTER PISTON ASSEMBLY IS NOT A SERVICABLE GROUP. NO ATTEMPT SHOULD BE MADE TO DISASSEMBLE THIS GROUP FROM THE BRAKE HOUSING.

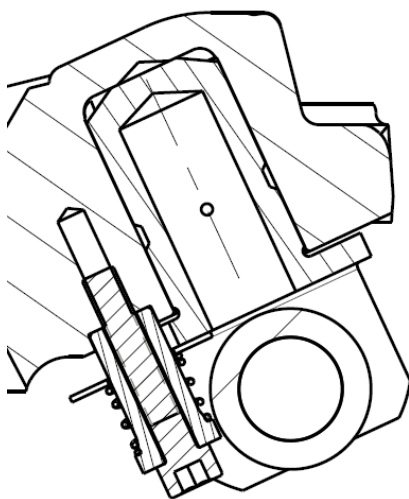


Fig 28

There are three Master Piston Groups in each Engine Brake Housing Assembly. The Master Piston transmits the braking event of the brake cam to the slave piston via the oil within the Master Piston/Slave Piston circuit.

- Ensure the master piston moves easily and freely in the bore with no sign of sticking or roughness.
- Check for spring tension, this is designed to retract the Master Piston Assembly fully and ensure that the roller is not in contact with the brake cam lobe when off.
- Inspect the Master piston roller for any signs of fretting, or galling. Inspect the cam lobe for any signs of distress.

NOTE: IF THE MASTER PISTON IS STICKING OR THE ROLLER IS DAMAGED THE HOUSING ASSEMBLY MUST BE REPLACED.

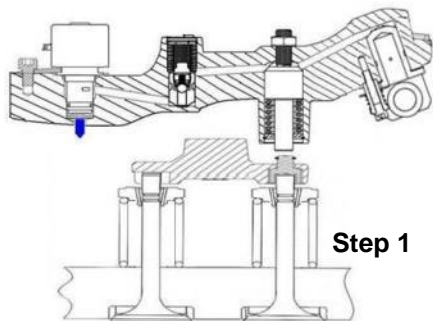


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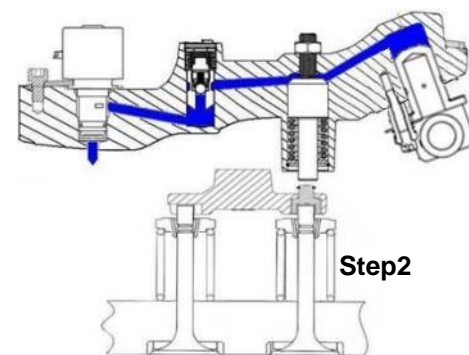


Theory of Operation

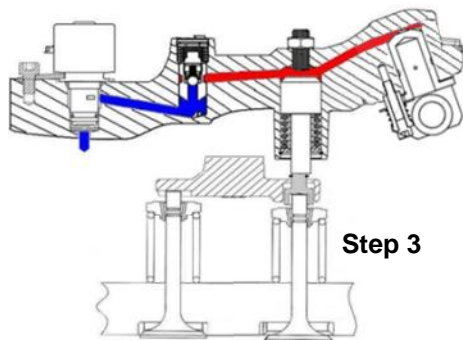


Step 1

Step 2. When activated, the solenoid valve opens permitting engine lube oil to flow under the normal lube system pressure through the control valve and into the drillings for both the master piston and slave piston circuits. Oil will continue filling the circuit until the master piston makes contact with the cam and follows the motion of the cam lobe (dedicated braking lobe), pushing the piston back into the housing forcing the oil out of the master piston bore.



Step2



Step 3

Step 3. When the high pressure oil flows back through the master piston, slave piston and control valve circuits, the check ball in the control valve seats, trapping oil in the circuit creating a closed link between the slave piston and master piston. With this closed hydraulic link created, the continued movement of the master piston following the cam profile, causes the pressure to increase to the point the slave piston now has the energy to momentarily opening the exhaust valve (single valve opening), while the engine piston is near its top dead center position, releasing compressed cylinder air out through the exhaust manifold.



PRELIMINARY CHECKS:

1. Before starting to troubleshoot, check the following:

- a) Oil level on dipstick. Over-full or under-full condition in crankcase will cause aeration in the engine brake hydraulic system. If oil 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.
- c) Turbocharger, air cooler, and piping. Any loss of intake manifold pressure will cause a reduction in the engine brake power output. This results in a customer complaint of reduced engine brake power.

2. Before inspecting the brake housing, remove over-engine equipment such as air intake and turbocharger crossover pipes, plus the valve mechanism upper covers.

- a) Inspect the pipe plugs on housing ends where applicable to make sure none are missing, 100 lb.-in. (11 N*m) torque. Use Jacobs pipe plugs, P/N 00-028317
- b) Look for any cracks in the engine brake housing
- c) Check for loose wiring connections at the solenoid valves and any brittle, cracked or damaged wiring.
- d) Check for loose or damaged hold down bolts
- e) Check the exhaust bridges and actuator pins. The pins should move freely with no signs of distress.
- f) Check engine brake slave piston lash setting (0.8mm) and engine valve lash settings (see applicable engine manufacturer's service literature).

Note: When operating the engine brake with the valve cover removed be aware that there will be a significant amount of oil spray in this area. This engine brake has separate drillings to lubricate the master piston roller area. This adds to the oil spray in the area, but does not indicate leakage or a problem with the oil supply needed for engine brake operations. These are two separate systems within the engine brake housing.

! WARNING !

**WEAR EYE PROTECTION AND DO NOT EXPOSE YOUR FACE OVER ENGINE AREA.
TAKE PRECAUTIONS TO PREVENT OIL LEAKAGE DOWN ON THE ENGINE.
WHenever the engine is running and valve covers are removed, oil
splashing in the engine brake area could cause personal injury**



Electrical System: The Engine Brake is controlled by the Engine ECM, refer to Navistar Fault Codes for external fault diagnosis.

Solenoid Valve: The Solenoid Valve cannot be overhauled or repaired in the field. If any solenoid problems other than seal rings or filter screen exist, 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 comparing the readings for each solenoid with the proper specifications (*Table 6*).

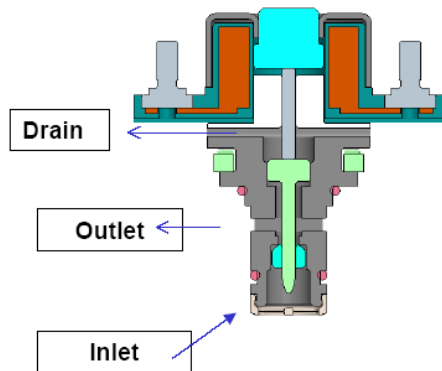


Fig 29

		Resistance (Ohms)		Current Draw (Amps)	Pull-in Voltage (minimum)	
P/N	Voltage	Cold (25°C)	Hot (60°C)	Oil Pressure (40-60 psig)	Cold (25°C)	Hot (60°C)
37674	12 VDC D/L	8.7 to 10.0	9.8 to 11.5	.6 to .7	6.3	7.0

Note: These estimates are taken at the solenoid terminal contacts and does not include the wiring harness

Table 6

! WARNING !

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



Electrical System: Continued – Solenoid Diagnostics

Problem: Engine brake does not turn on / slow to turn on

Electrical Evaluation:

Probable Cause: Supply voltage to solenoids 1 & 2 below 7.0 VDC minimum.

Correction: Check ECM input sensors – see manufactures repair procedures.

Probable Cause: Solenoid Failure

Check: Solenoid resistance to be between 8.7 - 10 OHMS at 77°F.

Check: Continuity between solenoid terminal contact to solenoid body should be “open” (no connection)

Correction: If solenoid is outside of above specification(s), replace solenoid valve(s).

Probable Cause: Harness Failure

Correction: Check continuity from each solenoid to engine ground. Must be “open” (no connection).

Repair harness as required.

Probable Cause: Supply voltage continues (should be 0 VDC between solenoid terminals).

Check: ECM input sensors – see manufactures repair procedures.

Probable Cause: Undercover wiring and solenoid connection short(s).

Check: Continuity from each solenoid terminal to engine ground, must be “open” (no connection).

Check: Remove the “ground” wire from the solenoid terminal. If the solenoid remains on, there may be a solenoid short. If the “hot” wire is switched to the other solenoid terminal and it does not turn on, there may be a solenoid short.

Correction: Replace wiring harness or solenoid as needed.



Electrical System: Continued – Solenoid Diagnostics

Problem: Engine brake does not turn off / slow to turn off

Mechanical Evaluation:

Probable Cause: Solenoid seal rings leaking.

Correction: Replace Upper and Lower seal rings.

Probable Cause: Debris in solenoid valve.

Correction: Flush solenoid valve and replace solenoid screen.

Correction: Shake solenoid, should hear a distinct rattle, indicating free component movement and move the poppet stem (the pin exposed on the bottom of the solenoid to confirm it moves freely. If not heard or poppet stem does not move freely, replace solenoid.

Probable Cause: Low engine oil pressure

Correction: Determine oil pressure at engine brakes housing using procedures given in this manual (see oil pressure requirements). If oil pressure is below specifications, (20 psi at engine brake housing, at engine operating temperature) engine should be repaired in accordance with the manufacturers' procedures.



Hydraulic-Mechanical:

The Oil Pressure test kit P/N 00-040049 can be used to determine engine oil pressure available for operation of the engine brake. Complete instructions are contained in the kit.

Engine Braking Boost should be checked with suitable equipment to ensure correct boost pressure and braking performance per Table 3.

Problem: Engine brake weak in effect or low on engine brake power

Probable Cause: Engine Brake out of adjustment

Correction: Check Engine Brake adjustment and readjust as needed, 0.8mm.

Probable Cause: Insufficient supply of oil pressure to operate engine brakes.

Correction: Measure supply oil pressure and ensure it is within specifications.

Probable Cause: Engine Boost Pressure Low while braking, below 22 psi @ 1900 rpm with the engine brake on high..

Check: Refer to Table 3 for pressure vs. boost at the high setting for proper output of turbocharger, check charge air cooler piping, exhaust manifold to turbo connections, EGR tubes, etc. for any leakage.

Correction: Repair leakage in accordance with the manufacturers' procedures.



Hydraulic-Mechanical: Continued –

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 procedure and lash setting, 0.8mm. Ensure that slave piston responds smoothly to the adjusting screw by loosening jam nut and screwing the screw through its full travel for full slave piston motion. Make sure piston travels full range without binding or sticking.

! WARNING !

REMOVE SLAVE PISTON CAREFULLY WHEN DISASSEMBLING. USE THE SLAVE PISTON REMOVAL TOOL P/N 00-025084. THE SLAVE PISTON SPRINGS ARE UNDER HEAVY COMPRESSION.

Probable Cause: Master piston not moving in bore.

Correction: Check the master piston in bore to ensure that they are free and not sticking. If any are sticking or rough in movement, replace the housing. Inspect lube oil for signs of contaminants. If any are present, replace oil and filters and correct cause of contamination. Ensure that the correct amount of oil pressure is getting to the master piston assembly, minimum of 20 psi. Check the oil pressure at the control valve bore using the Jacobs Oil Pressure test kit.



Hydraulic-Mechanical: Continued –

Problem: Engine brake slow to operate or weak in effect - Continued..

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: Outer control valve springs broken, or engine oil pressure extremely high.

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

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 pipe plug, P/N 00-028317.

NOTE: Do NOT remove any plugs that are NOT LEAKING. The Plugs are sealed with Loctite and normally should not be removed.



Hydraulic-Mechanical: Continued –

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

Note: *Required oil pressure, at engine brake housing, for proper engine brake operation is 20 to 55 PSI at engine operating temperature, between 1000 rpm's and governed engine speed.*

Probable Cause: Housing pipe plug (s) missing.

Correction: Check all housing pipe plugs, replace as needed, re-torque to 100 in. lbs. (11 N*m) torque.

Probable Cause: Aeration of lubricating oil.

Correction: Check for aeration of the oil. Activate, and then deactivate engine brake. Watch escape oil coming from the control valve cover. If there are air bubbles in the oil or if the oil is white and foamy, air is present in system. Aeration can be caused by the crankcase being too full of oil or too low on oil or a problem with the engine oil pump or pick up tube. 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.



Hydraulic-Mechanical: Continued –

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

Probable Cause: Worn engine rocker lever bushings.

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

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

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

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

Probable Cause: Control valve inner spring broken.

Correction: Replace inner spring.

Probable Cause: One or more control valves stuck in “on” or up position.

Check: Control valves for binding.

Correction: Remove and clean or replace if necessary. Inspect lube oil for contaminants.



Hydraulic-Mechanical: Continued –

Problem: Engine misses or loses power.

Probable Cause: Slave piston lash adjustment too tight.

Correction: Readjust slave piston clearance in accordance with appropriate lash setting (0.8 mm)

Probable Cause: Solenoid stuck in “on” position.

Correction: See solenoid diagnostics section.

Probable Cause: Control Valve sticking or dragging in bore.

Correction: Flush Control Valve/Control Valve bore and replace if necessary

Probable Cause: Broken Control Valve Spring.

Correction: Replace Control Valve spring.



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- **Warranty**



The Jacobs Engine Brake Product installed on a Navistar MAXXFORCE 11 and 13 liter engine will be warranted according to the published base warranty of the engine by application.

The service replacement parts warranty will be one year/unlimited miles, or remainder of the standard warranty, whichever is greater

All warranty will be administered through the Navistar warranty dealer network.



Product Identity:

- The engine brake housing is identified below: The serial number and other pertinent information is called out in the data etched into the engine brake housing. This information is necessary when filing a warranty claim.

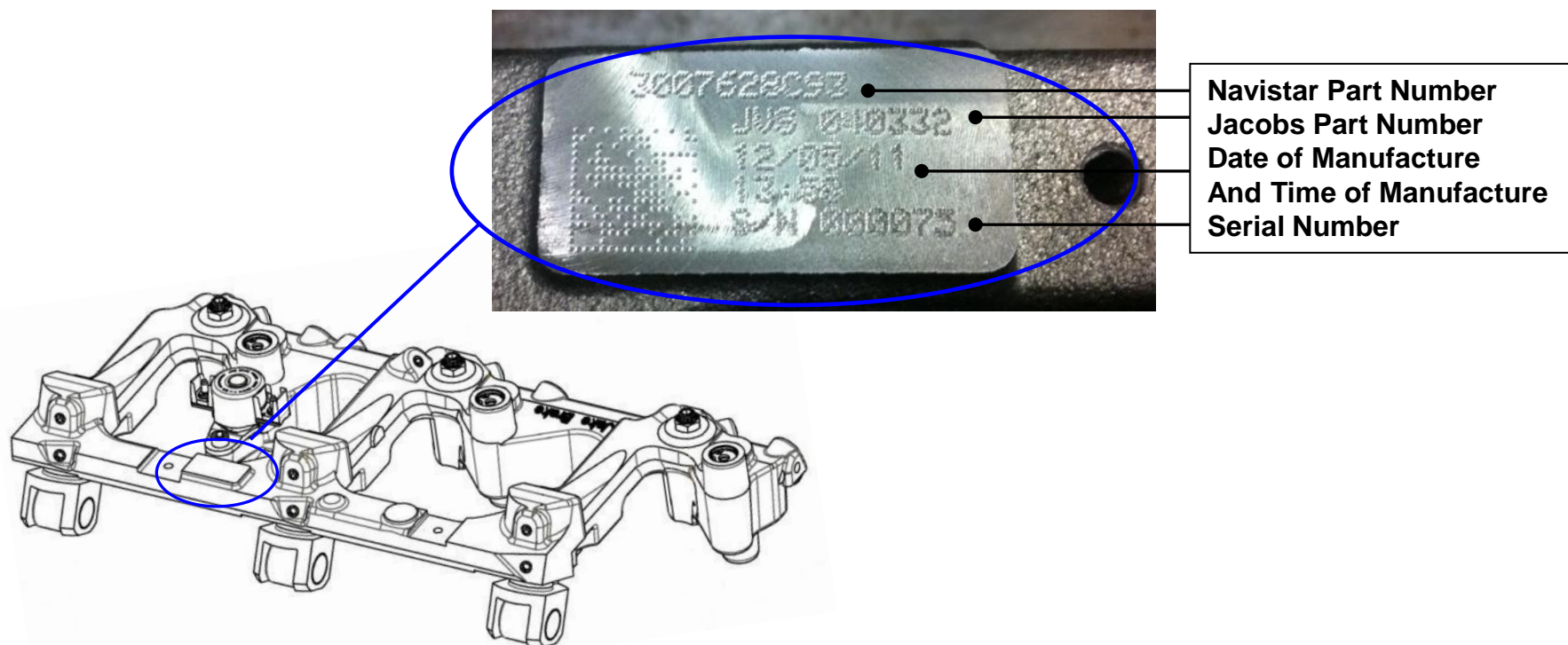
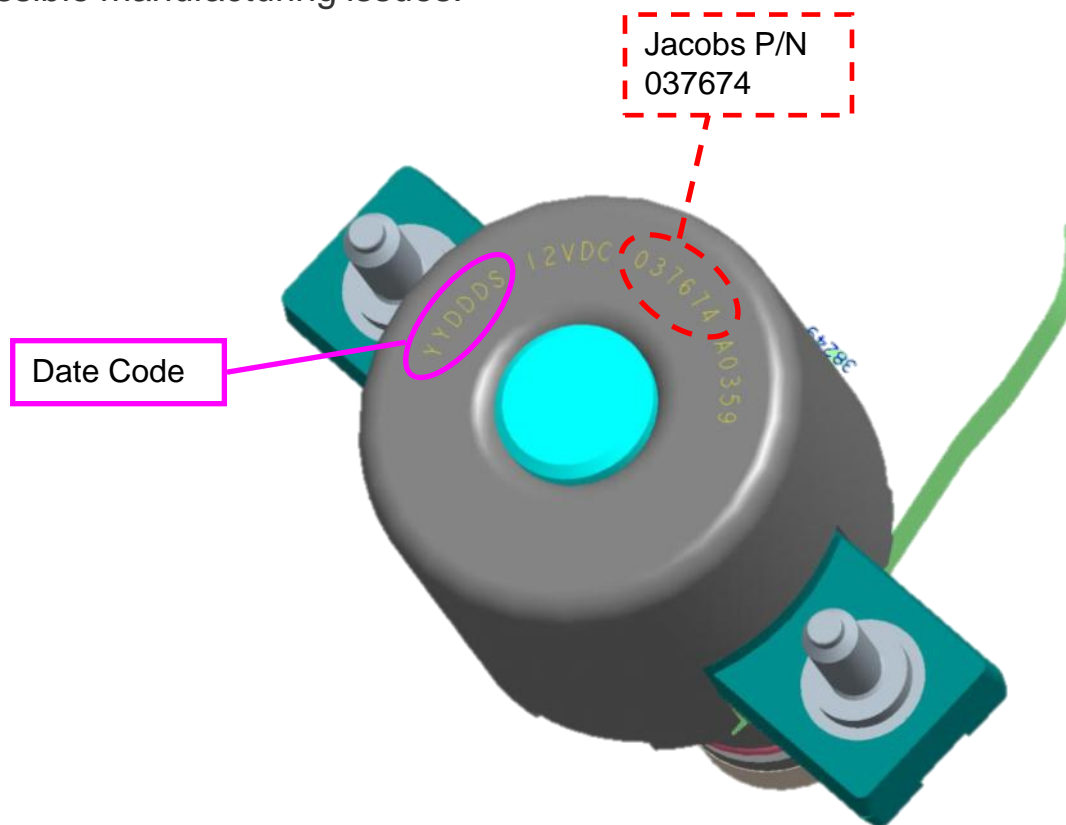


Fig 30



Product Identity:

- The engine brake solenoid is identified as below: The date code is needed to help identify possible manufacturing issues.



Solenoid Valve

Fig 31



Jacobs Vehicle Systems™

www.JacobsVehicleSystems.com