MITSUBISHI FORKLIFT TRUCKS

Service Manual

GM 4.3L, G6 Gasoline Engine

003103-up

For use with the FGC35K-FGC70K;
FG35-FG50; FG40K-FG50K Chassis Service Manuals.

99789-74120

FOREWORD

This service manual covers the GM 4.3L Gasoline Engine installed in Mitsubishi Forklift Trucks and gives detailed maintenance and repair information. For your convenience the instructions are grouped by systems as a ready reference.

The long productive life of your forklift truck(s) depends on regular and proper servicing. Servicing consistent with what you will learn from this service manual. Read the respective sections of this manual carefully and familiarize yourself with all the components before attempting to start a test, repair or rebuild job.

The descriptions, illustrations and specifications contained in this manual are for engines with serial numbers in effect at the time of printing. Mitsubishi Forklift Trucks reserves the right to change specifications or design without notice and without incurring obligation.

Whenever a question arises regarding this engine, or this manual, consult your Cat lift truck dealer for the latest available information.

For items pertaining to the chassis, refer to the Chassis Service Manual. This service manual covers the fuel system for units built before 01/01/2004. See fuel system supplements for units built after 01/01/2004.

Notes, Cautions, and Warnings

NOTES, CAUTIONS, and WARNINGS are used in this manual to emphasize important and critical instructions. They are used for the following conditions:

NOTE To highlight an essential operating procedure or condition.

⚠ CAUTION Operating procedures or practices that will result in damage to or destruction of the engine if not strictly observed.

⚠ WARNING Operating procedures or practices that will result in serious injury or loss of life if not correctly followed.

How to Read This Manual

Scope of Explanation

This book describes the service procedures for the engine removed from a vehicle.
For procedures concerning the removal of the engine from the vehicle and on-vehicle inspection and servicing, refer to the appropriate service manuals separately prepared for the individual models.

Maintenance and Servicing Procedures

(1) A diagram of the component parts is provided near the front of each section in order to give the reader a better understanding of the installed condition of component parts.

(2) The numbers provided within the diagram indicate the sequence for maintenance and servicing procedures; the symbol N indicates a non- reusable part; the tightening torque is provided wher e applicable.

- Removal Steps:
  The part designation number corresponds to the number in the illustration to indicate removal steps.
- Installation Steps:
  Specified in case installation is impossible in reverse order of removal steps. Omitted if installation is possible in reverse order of removal steps.
- Disassembly Steps:
  The part designation number corresponds to the number in the illustration to indicate disassembly steps.
- Reassembly Steps:
  Specified in case reassembly is impossible in reverse order of disassembly steps. Omitted if reassembly is possible in reverse order of disassembly steps.

Classification of Major Maintenance/Service Points

When there are major points relative to maintenance and servicing procedures (such as essential maintenance and service points, maintenance and service standard values, information regarding the use of special tools, etc.), these are arranged together as major maintenance and service points and explained in detail.

A Indicates there are essential points for removal or disassembly.

B Indicates there are essential points for installation or reassembly.

Symbols for Lubrication, Sealants and Adhesives

Information concerning the locations for lubrication and application of sealants and adhesives is provided, by using symbols, in the diagram of component parts, or on the page following the component parts page, and explained.

Grease
(multi-purpose grease unless there is a brand or type specified)

Sealant or adhesive

Brake fluid, automatic transmission fluid or air conditioner compressor oil

Engine oil or gear oil

Inspecting

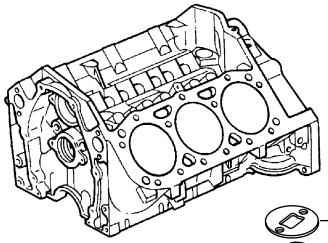
Only the inspections to be performed by using special tools or measuring instruments are covered. General service procedures not covered in this manual, such as visual inspections and cleaning of parts should always be performed during actual service operations.

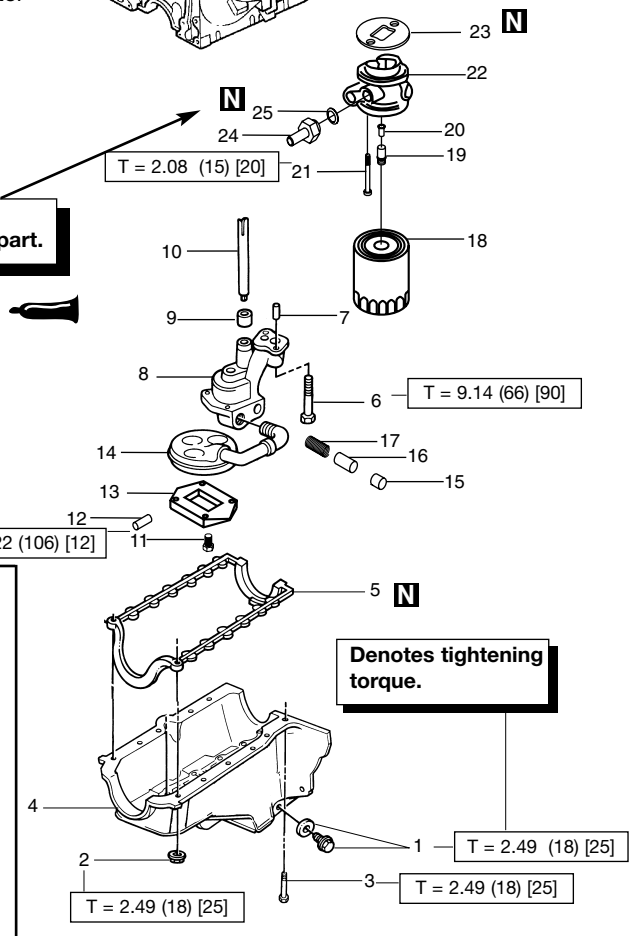
Removal and Installation

Unit: kgf-m (lb-ft) [N-m]
***kgf-m (lb-in.) [N-m]**

Removal steps

1. Plug
2. Nut
3. Bolt
4. Pan
5. Gasket
6. Bolt
7. Pin
8. Pump
9. Retainer
10. Shaft
11. Bolt
12. Pin
13. Cover
14. Screen (A)
15. Plug
16. Valve
17. Spring
18. Filter
19. Fitting
20. Valve
21. Bolt
22. Adapter - Oil Filter
23. Gasket
24. Connector
25. Gasket





Denotes nonreusable part.

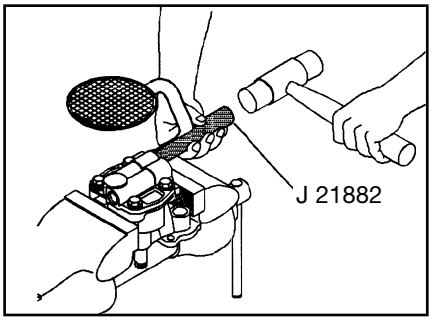
Lubricate all internal parts with engine oil during

Denotes tightening torque.

INSTALLATION OR REMOVAL SERVICE POINTS

(A) Install the oil pump screen.

- If removed, replace the oil pump screen. The oil pump screen must have a good press fit into the oil pump body.
- Mount the oil pump in a soft jawed vise.
- Apply sealer to the end of the pipe.
- Use the (J 21882) and a soft-faced hammer to tap the oil pump screen into the pump body. The screen must align parallel with the bottom of the oil pan when it is installed.



Operating procedures, cautions, etc., on removal, installation, disassembly and reassembly are described.

This alphabetical letter corresponds to a part that is indentified in the drawing on the first page of each section. The letter appears during an explanation of removal, installation, disassembly or reassembly steps.

⚠ WARNING

The OPERATION & MAINTENANCE MANUAL outlines the proper and safe lubrication and maintenance for the truck, as recommended by Mitsubishi Forklift Trucks.

Read and understand the OPERATION & MAINTENANCE MANUAL before performing any lubrication or maintenance. Improperly performed lubrication or maintenance procedures are dangerous and could result in injury or death.

Because the service mechanic may be unfamiliar with many of the systems on this truck it is important to use caution when performing service work. Knowledge of the system and/or components is important before the removal or disassembly of any component.

Because of the size of some of the truck components, the service mechanic should check the weights noted in this Manual. Use proper lifting procedures when removing any components.

Following is a list of basic precautions, cautions and notices that should always be observed.

1. Read and understand all warning plates and decals on the truck before operating, lubricating or repairing the part or system.
2. Always wear protective glasses and protective shoes when working around trucks. In particular, wear protective glasses when pounding on any part of the truck or its attachments with a hammer or sledge. Use welder's gloves, hood/goggles, apron and other protective clothing appropriate to the welding job being performed. Do not wear loose-fitting or torn clothing. Remove all rings from fingers when working on truck.
3. Do not work on any truck that is supported only by lift jacks or a hoist. Always use blocks or jack stands to support the truck before performing any disassembly.
4. Lower the forks or other implements to the ground before performing any work on the truck. If this cannot be done, make sure the forks or other implements are blocked correctly to prevent them from dropping unexpectedly.

⚠ WARNING

Do not operate this truck unless you have read and understand the instructions in the OPERATOR'S MANUAL. Improper truck operation is dangerous and could result in injury or death.

5. Use steps and grab handles (if applicable) when mounting or dismounting a truck. Clean any mud or debris from steps, walkways or work platforms before using. Always face truck when using steps, ladders and walkways. When it is not possible to use the designed access system, use ladders, scaffolds, or work platforms to perform safe repair operations.
6. To reduce the risk of back injury, use hoist when lifting components which weigh 23 kg (50 lb.) or more. Make sure all chains, hooks, slings, etc., are in good condition and are of the correct capacity. Be sure hooks are positioned correctly. Lifting eyes are not to be side loaded during a lifting operation.
7. To reduce the risk of burns, be alert for hot parts on trucks which have just been stopped and have hot fluids in lines, tubes and compartments.
8. Be careful when removing cover plates. Gradually back off the last two bolts or nuts located at opposite ends of the cover or device and pry cover loose to relieve any spring or other pressure before completely removing the last two bolts or nuts.
9. Be careful when removing filler caps, breather and plugs on the truck. Hold a rag over the cap or plug to prevent being sprayed or splashed by liquids under pressure. The danger is even greater if the truck has just been stopped because fluids can be hot.
10. Always use tools that are in good condition and understand how to correctly use them before performing any service work.
11. Reinstall all fasteners with same part number. Do not use a lesser quality fastener if replacements are necessary. Do not mix metric fasteners with standard nuts and bolts.
12. If possible, make all repairs with the truck parked on a level, hard surface. Block the truck so it does not roll while working on or under it.
13. Disconnect battery and discharge any capacitors (electric trucks) before starting to work on the truck. Hang "Do Not Operate" tag in the Operator's Compartment.

⚠ WARNING

14. Repairs which require welding should be performed only with the benefit of the appropriate reference information and by personnel adequately trained and knowledgeable in welding procedures. Determine the type of metal being welded and select correct welding procedure and electrodes, rods or wire to provide a weld metal strength equivalent at least to that of parent metal.
15. Do not damage wiring during removal operations. Do not reinstall damaged wiring. Reinstall the wiring so it will not be damaged in operation by contacting sharp corners, or by rubbing against an object or hot surface. Do not connect wiring to a line containing fluid.
16. Be sure all protective devices, including guards and shields, are properly installed and functioning correctly before starting a repair. If a guard or shield must be removed to perform the repair work, use extra caution.
17. When the mast needs to be in the raised position during maintenance and repairs, always support the mast and carriage to keep the carriage or attachments raised.
18. Loose or damaged fuel, lubricant and hydraulic lines, or tubes and hoses can cause fires. Do not bend or strike high pressure lines or install ones that are bent or damaged. Inspect lines, tubes and hoses carefully. Do not check for leaks with your hands. Pin hole (very small) leaks can result in a high velocity oil stream that will be invisible upon close inspection of the hose. This oil can penetrate the skin and cause serious injury. Use cardboard or paper to locate pin hole leaks.
19. Tighten connections to the correct torque. Make sure all heat shields, clamps and guards are installed correctly to avoid excessive heat, vibration or rubbing against other parts during operation. Shields must be correctly installed if they protect against oil spray onto hot exhaust components in the event of a line, tube, or seal failure.
20. Relieve all pressure in air, oil or water systems before any lines, fittings or related items are disconnected or removed. Always make sure all raised components are blocked correctly. Be alert for possible pressure when disconnecting any device from a system that uses pressure.
21. Do not operate a truck if any rotating part is damaged or contacts any other part during operation. Any high speed rotating component that has been damaged or altered should be checked for balance before reusing.

⚠ WARNING

22. Caution should be used to avoid breathing dust that may be generated when handling components containing asbestos fibers. If this dust is inhaled, it can be hazardous to your health.

    If dust containing asbestos is present, there are several common sense guidelines that should be followed.

    a. Never use compressed air for cleaning.
    b. Avoid brushing or grinding asbestos containing materials.
    c. For clean up, use wet methods or a vacuum equipped with a high efficiency particulate air (HEPA) filter.
    d. Use exhaust ventilation on permanent machining jobs.
    e Wear an approved respirator if there is no other way to control the dust.
    f. Comply with applicable rules and regulations for the work place.
    g. Follow environmental rules and regulations for disposal of asbestos.
    h. Avoid areas where asbestos particles may be in the air.

Precautions

Precautions for Disassembly and Assembly

This section contains basic safety precautions and outlines basic recommended procedures, some of which require special tools, devices or work methods.

However, the safety precautions contained herein are not for all service work. It is the responsibility of service personnel to know that specific requirements, precautions and work hazards exist and to discuss these with a foreman or supervisor.

Disassembly

1. Always use tools that are in good condition. Understand how to use them before performing any service work.
2. Use an overhaul stand or a work bench, if necessary. Also, use bins to keep engine parts in order of removal.
3. Lay down the disassembled and cleaned parts in the order in which they were removed to save time for assembly.
4. Pay attention to marks on assemblies, components and parts for their positions or directions. If necessary, add marks to aid in assembly.
5. During removal or cleaning, carefully check each part for any sign of faulty condition. Signs of wear or abnormalities that caused the engine to work abnormally are more easily and accurately spotted during removal or cleaning.
6. Get help when lifting or carrying a part that is too heavy or awkward for one person to handle. If necessary, use a jack or a hoist.

Separating Parts

Important: Many internal engine components will develop specific wear patterns on their friction surfaces.

When disassembling the engine, internal components MUST be separated, marked and organized in a way to ensure reinstallation to the original location and position.

Mark or identify the following components:

- Piston and the piston pin
- Piston to the specific cylinder bore
- Piston rings to the specific cylinder bore
- Connecting rod to the crankshaft journal
- Connecting rod to connecting rod cap
- Crankshaft bearings and connecting rod bearings
- Engine camshaft and valve lifters
- Valve lifters, valve rocker arms and valve rocker arm supports
- Valve to valve guide
- Valve spring to cylinder head location
- Engine block bearing cap location and direction
- Oil pump drive and driven gears

Replacing Engine Gaskets

Gasket Reuse and Applying Sealant

- Do not reuse any gasket unless specified.
- Gaskets that can be reused will be identified in the service procedure.
- Do not apply sealant to any gasket or sealing surface unless specified in the service procedure.

Separating Components

- Use a rubber mallet in order to separate the components.
- Bump the part sideways in order to loosen the components.
- Bumping of the component should be done at bends or reinforced areas of the component to prevent distortion of the components.

Cleaning Gasket Surfaces

- Use care to avoid gouging or scraping the sealing surfaces.
- Use a plastic or wood scraper in order to remove all the sealant from the components.
- Do not use any other method or technique to remove the sealant or the gasket material from a part.
- Do not use abrasive pads, sand paper or power tools to clean the gasket surfaces.
    - These methods of cleaning can cause damage to the component sealing surfaces.
    - Abrasive pads also produce a fine grit that the oil filter cannot remove from the engine oil.

      This fine grit is abrasive and can cause internal engine damage.

Service Prior to Assembly

- Dirt will cause premature wear of the rebuilt engine. Clean all the component.
- Use the proper tools to measure the components when checking for excessive wear. Components not within the manufacturer's specification must be repaired or replaced.
- When the components are re-installed into an engine, return the components to the original location, position and direction.
- During assembly, lubricate all the moving parts with clean engine oil (unless otherwise specified). The engine oil will provide the initial lubrication when the engine is first started.

Assembling Components

- Assemble components using only the sealant (or equivalent) that is specified in the service procedure.
- Sealing surfaces must be clean and free of debris or oil.
- Specific components such as crankshaft oil seals or valve stem oil seals may require lubrication during assembly.
- Components requiring lubrication will be identified in the service procedure.
- Apply only the amount of sealant specified in the service procedure to a component.
- Do not allow the sealant to enter into any blind threaded holes, as the sealant may prevent the fastener from clamping properly or cause component damage when tightened.
- Tighten fasteners to the proper specifications. DO NOT overtighten the fasteners.

Assembly
Cleanliness and Care

This engine is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in ten thousandths of an inch. Care and cleanliness are important when any internal engine parts are serviced. During assembly, a liberal coating of engine oil should be applied to friction areas to protect and lubricate the surfaces on initial operation. Throughout this section, it should be understood that proper cleaning and protection of truck surfaces and friction areas are part of the repair procedure. This is considered standard shop practice, even if not specifically stated.

When valve train components are removed for service, they should be retained in order. At the time of installation, they should be installed in the same locations and with the same mating surface as when removed.

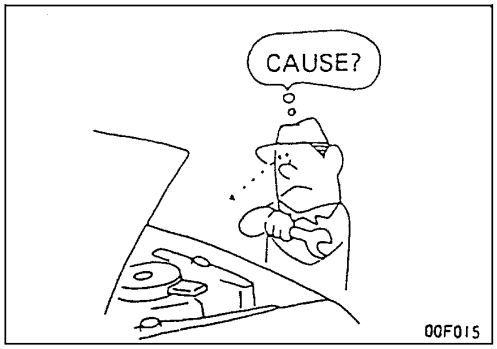
1. Wash all parts, except for oil seals, O-rings, rubber sheets, etc., with cleaning solvent and dry them with air pressure.
2. Always use tools that are in good condition and be sure you understand how to use them before performing any service work.
3. Use only good-quality lubricants. Be sure to apply a coat of oil, grease or sealant to parts as specified.
4. Be sure to use a torque wrench to tighten parts for which torques are specified.
5. Replace gaskets and packings with new ones.

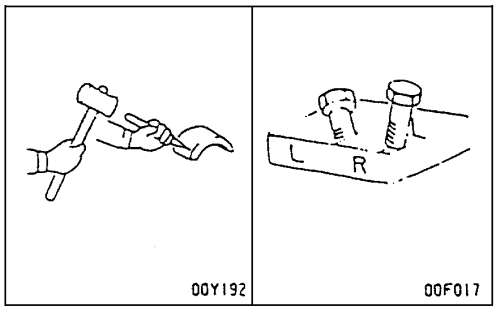
Tools and Equipment

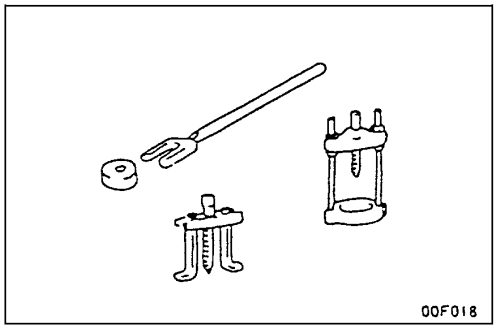
Special tools are listed and illustrated throughout this manual. The tools (or equivalents) are specially designed to quickly and safely accomplish the operations for which the tools are intended. The use of special tools will also minimize possible damage to engine components. Some precision measuring tools are required for inspection of certain critical components. Torque wrenches and a torque angle meter are necessary for the proper tightening of various fasteners.

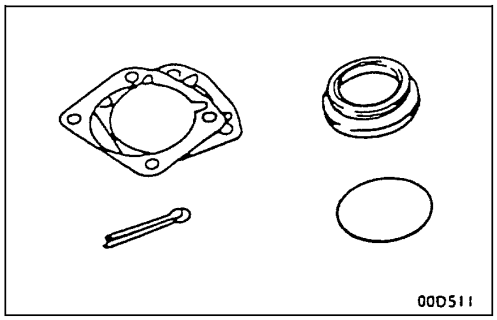
To properly service the engine assembly, the following items should be readily available:

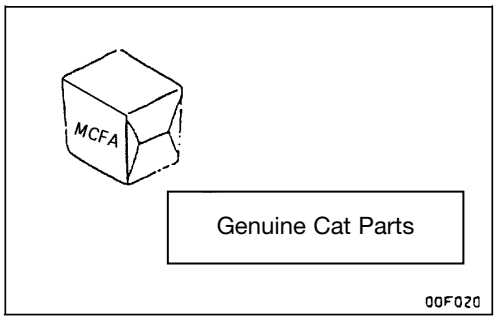
- Approved eye protection and safety gloves
- A clean, well-lit, work area
- A suitable parts cleaning tank
- A compressed air supply
- Trays or storage containers to keep parts and fasteners organized
- An adequate set of hand tools
- Approved engine repair stand
- An approved engine lifting device that will adequately support the weight of the components











General Precautions

Removal and Disassembly

Confirm the location of the faulty part and find the probable cause of the trouble. Then decide whether removal or disassembly is required. If so, carry out the removal or disassembly according to the steps shown in this service manual.

To prevent erroneous installation and to facilitate installation work, punch or draw alignment marks in places where neither function nor appearance is affected.

Make a distinction between the items removed from one assembly and those removed from another assembly, especially when disassembling a unit having a large number of component parts or when disassembling two or more similar parts. Always do the following:

1. Keep the removed parts in order.
2. Make a distinction between the parts to be replaced and the parts to be reused.
3. When replacing bolts and nuts, use only ones of the specified size.

Special Tools

When specified, be sure to use the special tools for the specific service work. Using other tools may cause damage to parts and/or injury to workers.

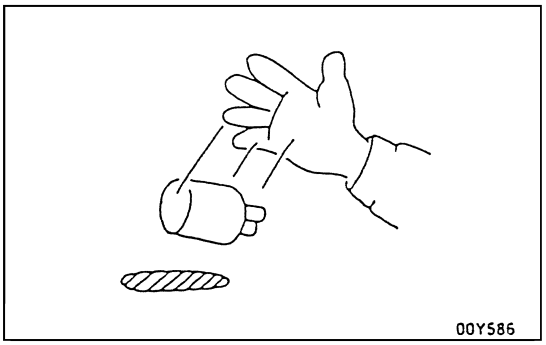
Non-reusable Parts

Whenever any of the following parts are removed, be sure to replace them with new ones.

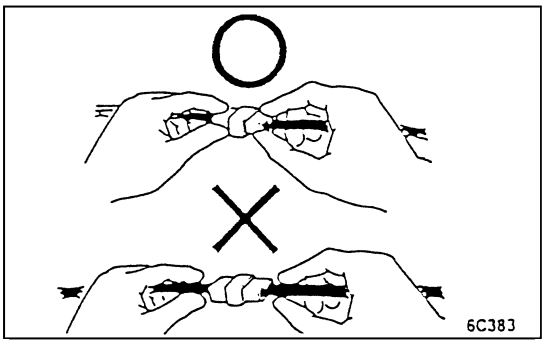
1. Oil seals
2. Gaskets (except rocker cover gasket)
3. Packings
4. O-rings
5. Lock washers
6. Split pins

Recommended Replacement Parts

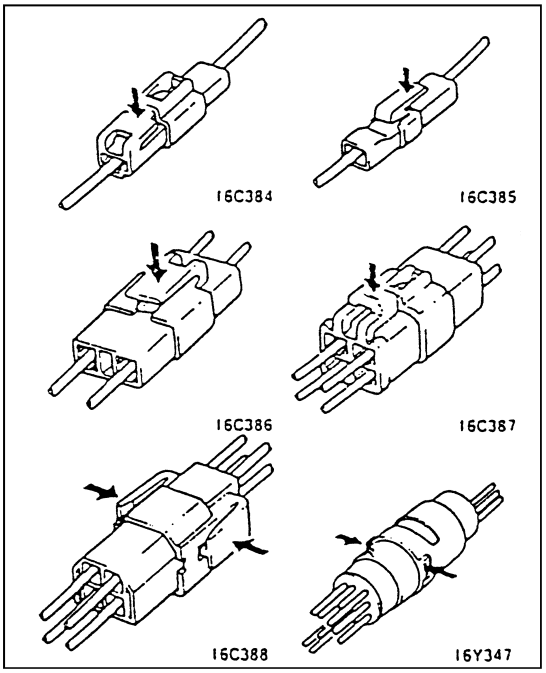
1. For replacement parts, use only genuine Cat parts.
2. Use of the available sets and kits of service parts is recommended.
3. To unify parts, or for other reasons, service parts are subject to change. When replacing parts in the engine, carefully check for possible modifications by referring to the updated parts catalog for the specific engine.



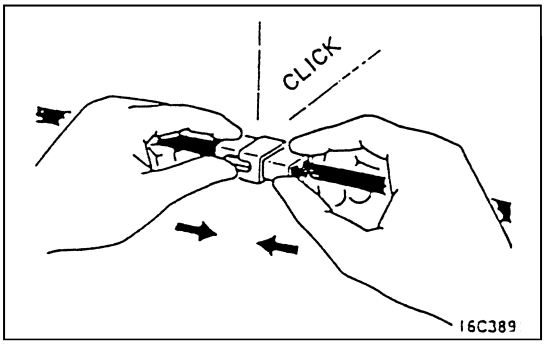
Handling of Electrical System
Shocks are harmful to sensors and relays. Never drop or throw them.



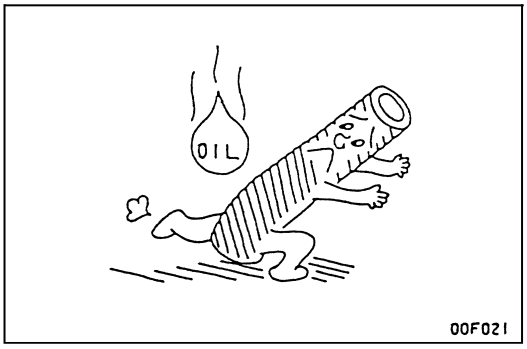
When disconnecting a connector, do not pull the harness. Hold the halves of the connector to separate them from each other.



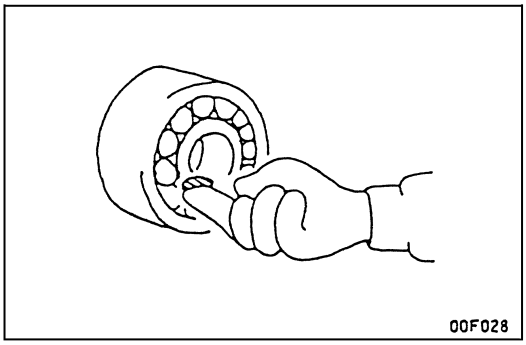
When disconnecting a lock type connector, push the lock lever(s) in the direction(s) shown by the arrow(s).



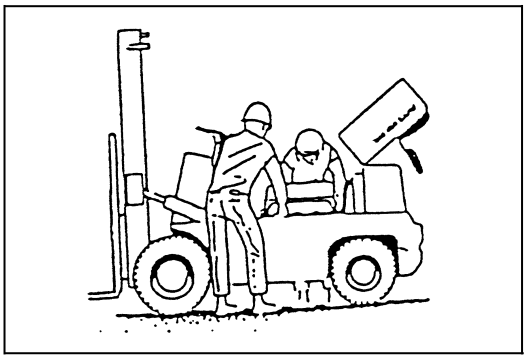
When connecting a lock type connector, push the plug into the socket until it clicks.



Handling of Rubber Hoses and Tubes
Take care not to spill gasoline or oil on rubber hoses or tubes, otherwise the rubber is likely to deteriorate.



Greasing
During assembly or installation, coat the designated surfaces with the specified grease or oil.



Cooperation
When two or more persons work together, each worker should pay attention to the safety of the other(s).

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Determining When to Overhaul the Engine

Deciding when to overhaul the engine is determined by considering the following factors:

A drop in compression pressure as well as an increase in lube oil consumption and excessive blowby.

Lack of power, increase in fuel consumption, drop in lube oil pressure, hard starting and abnormal sound are also engine troubles. These troubles, however, are not always the result of low compression pressure and give no valid reason for overhauling the engine.

The engine develops troubles of widely different varieties when its compression pressure drops. Following are the list of typical troubles caused by this compression pressure fault.

1. Lack of power
2. Increase in fuel consumption
3. Increase in lube oil consumption
4. Excessive blowby through breather due to worn cylinders, pistons, etc.
5. Excessive blowby due to poor seating of worn inlet and exhaust valves
6. Hard starting
7. Abnormal sound

In most cases, these troubles occur concurrently. Some of them are directly caused by low compression pressure, but others are not. Among the troubles listed above, 1, 2, and 6 could be caused by low compression pressure.

The most valid reason for overhauling the engine is (4). To determine when to overhaul the engine, it is reasonable to take this trouble into consideration in conjunction with the other troubles.

Engine Set-Up and Testing

After overhaul, the engine must be tested before it is installed in the truck. If a suitable test stand is not available, the following procedures can be used after the engine is installed in the truck.

1. Fill the crankcase with the proper quantity and grade of engine oil.

Notice: DO NOT use cooling system seal tabs (or similar compounds) unless otherwise instructed. The use of cooling system seal tabs (or similar compounds) may restrict coolant flow through the passages of the cooling system or the engine components. Restricted coolant flow may cause engine overheating and/or damage to the cooling system or the engine components/assembly.

2. Fill the cooling system with the proper quantity and grade of coolant.
3. With the ignition OFF or disconnected, crank the engine several times. Listen for any unusual noises or evidence that any of the parts are binding.
4. Start the engine and listen for unusual noises.
5. Check the truck oil pressure gauge or light and confirm that the engine has acceptable oil pressure. If necessary, install an oil pressure gauge and measure the engine oil pressure.
6. Operate the engine at about 1,000 RPM until the engine has reached normal operating temperature.
7. Listen for improperly adjusted or sticking valves, sticking valve lifters or other unusual noises.
8. Inspect for oil and/or coolant leaks while the engine is operating.
9. Verify that the distributor is properly positioned.
10. Perform a final inspection for the proper engine oil and coolant levels.