

ENGINE

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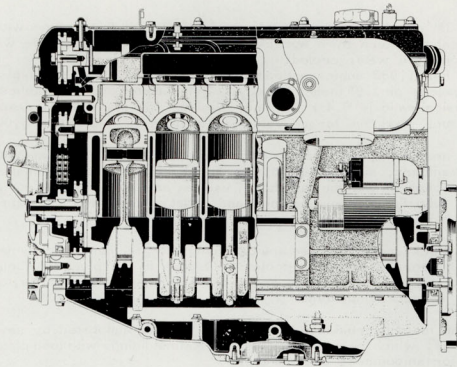


Fig.3-1 Cross Sectional Side View A1262

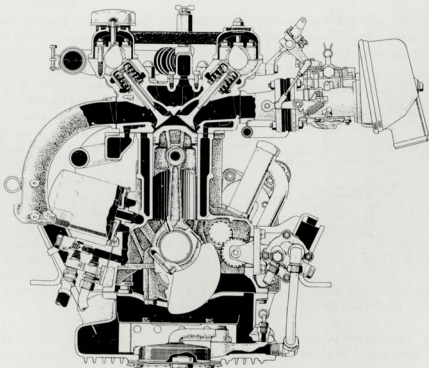


Fig.3-2 Cross Sectional Front View A1263

DESCRIPTION

This model 3M engine is a four cycle, six cylinder in-line engine with double overhead camshaft driven by a sprocket chain, overhead valve type with force feed lubrication, and water cooled.

This engine has 1,988 cubic centimeters or 121.4 cubic inches displacement, with 75 millimeters or 2.95 inches bore, and 75 millimeters or 2.95 inches stroke. The compression ratio is 8.4 to 1, and develops 150 maximum horsepower at 7,000 rpm, and maximum torque value is 18 m-kg (130 ft-lb) at 5,000 rpm.

The cylinder head being made of an aluminum alloy, and with sem-hemisphere combustion chambers, allow efficient heat distribution, and forms a major portion of the valve mechanism with the camshafts, valves, and other related components. Also together with the independent inlet and outlet ports provide smooth performances during high speed operations.

The cylinder block and crankcase are cast integrally, forming a rigidly reinforced unit, and are integrally cast with coolant passages in the block for cooling. The block forms a major portion of the engine with the crankshaft, pistons, oil pump, and the other related components.

The crankshaft is counterbalanced completely, and is supported by seven main journal bearings, which are of steel backed Kelmet linings with lead plated bearing surfaces for smoothness and durability.

The crankshaft end play is controlled by No.4 main journal with thrust washers which are made separately from the main journal bearings.

To improve the balance, a crankshaft damper is installed at the front of the crankshaft resulting less vibrations, and engine disagreeable sounds during high speed operation.

The pistons are of special light alloy with eccentric finished slightly larger at the right angle to piston pin. Two compression rings, and one oil ring are used on each piston. The piston pin is secured with hole snap rings at both ends of the piston pin.

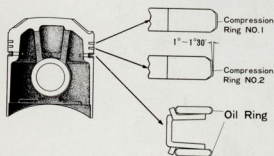


Fig.3-3 Piston & Piston Rings G0074

The connecting rods are "I" beam section forged steel with bronze piston pin bushings at the small ends, and steel backed Kelmet bearing inserts are used for the large ends.

Two camshafts are provided on the cylinder head, and also are independently for the inlet, and exhaust valves. The camshafts are of cast iron with cam lobe surfaces are induction hardened, and the camshaft is supported with seven Babbitt bearings.

pump drive shaft gear through the chain No.1, and the camshaft timing gears are driven by the pump drive shaft gear through the chain No.2.

The valves are operated with the cam lobes directly through the valve lifters, and the lifters, are installed off from the center of the cams to serve the lubrication of the lifters, and to permit the uneven wear of the lifters. The valve lifters are of cylindrical form and run in guides which shrunk fit into the cyl-

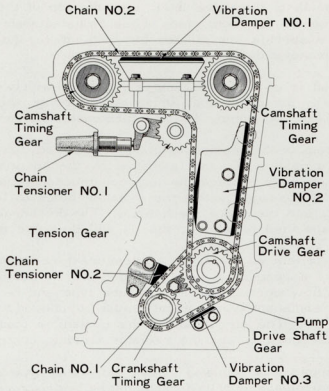


Fig.3-4 Gears & Chains Mechanism

Y5197

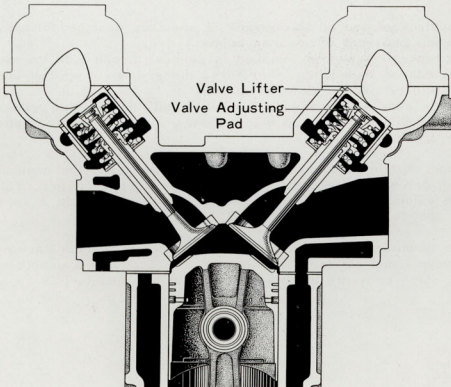


Fig.3-5 Valve Mechanism

Y5053

3-4 ENGINE - Description

inder head. A steel pad for adjustment of the valve clearance is sandwiched between the underneath of the valve lifter, and the top of the valve stem. The intake and exhaust valves are both made of heat resistance steel. The large valve heads and dual valve springs are utilized for both intake and exhaust valves to provide high performances during high speed operation.

The pump drive shaft is of cast iron, and is supported with two Kelmet bearings. The shaft is driven by the crankshaft timing gear through the chain No.1, and it drives the distributor, oil pump, and the tachometer driven gear.

The lubricating system of this engine is an all forced-feed, full-flow filtering type. The oil pump is of a gear type, and is driven by the oil pump drive shaft. The oil filter element is an easy replaceable unit construction type. The discharged oil travels into the oil passages within the cylinder block to lubricate the engine internal components, and the valve mechanism. The discharged oil pressure becomes higher than specified pressure, the oil will flow into the oil cooler.

The cooling system of this engine is of a pressure forced circulation type, and the water pump is of a centrifugal type provided with a six blade impeller. The radiator is a cross flow corrugated fin and tube type and is pressurized type. Long-life coolant (Permanent type coolant) must be utilized. The cooling fan is an electro-motion type. The circulation of the coolant is controlled by the wax pellet element type thermostat, and the radiator thermic control switch.

This engine is equipped with triple SOLEX side-draft type carburetors to insure efficient high performance of the carburetors under various operations. A manual mixture control is provided which operates on all three carburetors. The fuel pump is an electric fuel pump type, and is operated independently of the engine operation.

The distributor equipped on this engine is specially designed for high speed operation, utilizing two sets of breaker points.

The dual breaker sets are installed in parallel circuit with the cam which is provided with three cam lobes, therefore, the engine can operate at much higher speeds and still produce a uniform sparks.

This engine is also equipped with an ignition coil built-in with a primary resistor, and the coil excels in building up high secondary voltage to give sufficient sparks during high speed operations.

The charging system is composed of the alternator, and the regulator, and the alternator is driven by the crankshaft pulley through the "V" belt. This alternator provided an efficient output also at lower engine speeds, and a very high output at cruising speed.

The starter is incorporated with the magnetic switch, and the starter clutch. The magnetic switch, and starter clutch enable to accomplish a smooth meshing, and the starter clutch prevents the over-running of the armature.

TROUBLE SHOOTING

Symptoms & Probable CausesRemedies

Low Power or Loss of Power

1. Low compression

- a. Improper valve clearance
- b. Compression leak from valve seat
- c. Sticky valve stem
- d. Weak or defective valve spring
- e. Cylinder head gasket leaks
- f. Piston ring sticking or defective
- g. Worn piston ring or cylinder
- h. Worn or scored cylinder or piston
- i. Incorrect valve timing
- j. Ring gaps in line

Adjust valve clearance
Lap valve/s or seat/s

Replace valve or valve stem guide pushing

Replace valve spring

Replace cylinder head gasket

Replace piston ring

Overhaul engine

Overhaul engine

Adjust valve timing

Correct gap position

2. Incorrect ignition system

- a. Incorrect ignition timing
- b. Defective spark plug/s
- c. Defective distributor breaker point/s
- d. Incorrect octane selector setting

Adjust ignition timing

Clean, adjust or replace spark plug/s
Dress or replace breaker point/s also check condenser

Adjust octane selector

3. Insufficient fuel

- a. Clogged carburetor fuel passage
- b. Clogged fuel pipe
- c. Dirty fuel tank
- d. Air in fuel system
- e. Defective fuel pump
- f. Clogged fuel filter
- g. Fuel line leaks

Disassemble, and clean carburetor

Clean fuel pipe

Clean fuel tank

Check connection, and tighten

Repair or replace fuel pump

Replace filter element

Check connection, and repair

4. Insufficient air intake

- a. Restricted air cleaner
- b. Insufficient carburetor throttle valve opening

Clean or replace element

Repair and adjust throttle valve opening

5. Overheating

- a. Insufficient coolant
- b. Loose "V" belt
- c. Worn or defective "V" belt
- d. Faulty thermostat or wrong thermostat
- e. Worn or damaged water pump

Replenish coolant

Adjust "V" belt tension

Replace "V" belt

Replace thermostat

Replace water pump

Symptoms & Probable Causes

- f. Clogged or leaky radiator
- g. Incorrect ignition timing
- h. Incorrect distributor advance
- i. Cooling system passages clogged
- j. Defective fan motor, control switch or control relay
- k. Low oil level or incorrect viscosity
- l. Radiator fins clogged or obstructed

Remedies

- Flush, repair or replace radiator
- Adjust ignition timing
- Repair distributor
- Repair or replace
- Repair or replace
- Replenish or replace with proper viscosity
- Clean radiator fins

Excessive Oil Consumption

1. Oil leak

- a. Loose oil pan drain plug
- b. Loose oil pan attaching screws
- c. Defective oil pan gasket
- d. Loose timing chain cover or defective gasket
- e. Defective oil seal/s
- f. Loose oil filter or defective "O" ring
- g. Loose oil cooler flexible hose connection/s
- h. Defective cylinder head cover gasket
- i. Oil leak from oil cooler

- Tighten drain plug
- Tighten screws
- Replace gasket
- Tighten bolts or replace gasket

- Replace oil seal/s
- Tighten or replace oil filter
- Check and tighten connection/s

Replace gasket

Repair or replace oil cooler

2. Excessive oil consumption

- a. Broken or worn piston ring/s
- b. Ring gaps in line
- c. Sticky piston ring grooves
- d. Carbon deposit in oil return holes in the oil rings
- e. Excessive piston and cylinder wear
- f. Defective valve stem oil seal/s
- g. Worn valve stem or valve stem guide bushing

- Replace piston ring/s
- Correct gap position
- Replace rings
- Replace piston rings

Replace pistons, or cylinder block

- Replace oil seal/s
- Replace valve or valve stem guide bushing

Hard Starting

1. Slow Starting

- a. Improper grade oil
- b. Discharged battery
- c. Defective battery
- d. Loose or defective battery terminal
- e. Defective starter

- Replace with proper grade oil
- Charge battery
- Replace battery
- Clean, tighten or replace battery

Repair or replace starter

Symptoms & Probable CausesRemedies

2. Ignition system

- a. Burnt distributor breaker points
- b. Incorrect point gap
- c. Incorrect spark plug gap
- d. Loose connection or defective high tension lead/s
- e. Defective ignition coil
- f. Incorrect connection of primary wire/s
- g. Defective condenser
- h. Incorrect ignition timing

- Replace breaker points
- Adjust point gap
- Adjust gap
- Tighten or replace high tension lead/s
- Replace ignition coil
- Check, and correct wire/s
- Replace
- Adjust ignition timing

3. Engine

- a. Burnt valve/s
- b. Loose intake manifold retaining nut or defective gasket/s
- c. Excessively worn pistons, piston rings and cylinders
- d. Defective cylinder head gasket
- e. Incorrect valve timing
- f. Incorrect valve clearance

- Grind, retouch or replace valve/s
- Tighten nuts or replace gasket/s
- Replace pistons, piston rings and bore cylinders
- Replace gasket
- Adjust valve timing
- Adjust valve clearance

4. Fuel system

- a. Defective starter disc mechanism
- b. Incorrect engine idle speed setting
- c. Dirty or clogged carburetor
- d. Loose carburetor mounting nuts

- Repair and adjust
- Adjust engine idle setting
- Disassemble and clean
- Tighten nuts

Popping, Spitting and Detonation

1. Ignition system

- a. Ignition system wires loose
- b. Defective spark plug/s
- c. Incorrect ignition timing
- d. Incorrect heat range spark plugs

- Check connection/s, and tighten
- Clean adjust or replace
- Adjust ignition timing
- Replace spark plugs

2. Air-fuel mixture

- a. Lean mixture
- b. Dirty carburetor
- c. Clogged fuel pipe or fuel filter
- d. Intake manifold gasket leak
- e. Water in fuel lines or carburetor

- Clean and adjust carburetor
- Clean carburetor
- Clean pipe, and replace filter element
- Tighten nuts or replace gasket
- Clean fuel line, and replace fuel

Symptoms & Probable CausesRemedies

3. Valve

- | | |
|------------------------------|------------------------|
| a. Incorrect valve clearance | Adjust valve clearance |
| b. Sticky valve/s | Replace valve/s |
| c. Weak valve spring/s | Replace spring/s |
| d. Incorrect valve timing | Adjust valve timing |

4. Cylinder head

- | | |
|---|---------------------|
| a. Excessive carbon deposit in combustion chamber | Remove carbon |
| b. Defective cylinder head gasket | Replace head gasket |
| c. Clogged water passages in cylinder head | Clean water passage |

Rough Engine Idle

1. Fuel system

- | | |
|---|-------------------|
| a. Incorrect carburetor idle adjustment | Adjust carburetor |
| b. Water in fuel | Replace fuel |

2. Engine

- | | |
|---|---|
| a. Intake manifold gasket or insulator leak | Tighten nut . . . replace gasket or insulator |
| b. Incorrect valve clearance | Adjust valve clearance |
| c. Incorrect valve seating | Grind valve/s or seat/s |
| d. Excessive clearance between valve stem/s, and stem guide bushing/s | Replace valve/s and bushing/s |
| e. Defective cylinder head gasket | Replace head gasket |

Engine Misses at Acceleration

1. Fuel system

- | | |
|---|------------------------|
| a. Clogged carburetor accelerating system | Disassemble, and clean |
| b. Lean mixture | Adjust carburetor |

2. Ignition system

- | | |
|--|-----------------------------|
| a. Defective spark plug/s | Replace spark plug/s |
| b. Defective high tension lead/s | Replace high tension lead/s |
| c. Incorrect distributor breaker point gap | Adjust point gap |
| d. Defective ignition coil | Replace ignition coil |
| e. Incorrect ignition timing | Adjust ignition timing |

Symptoms & Probable CausesRemedies

3. Engine

- | | |
|--|--|
| a. Burnt or incorrect valve clearance adjustment | Replace valve, or adjust valve clearance |
| b. Compression leak | Overhaul engine |
| c. Defective cylinder head gasket | Replace head gasket |

Noisy Engine

One of the difficult of all trouble shooting operation is to locate the source of the noise in the engine. Every rotating or reciprocating part is a potential source of noise. Certain noises possess characteristics which can be detected. These characteristics vary, and experience is the best guide in most cases.

1. Crankshaft bearing

- | | |
|--------------------------------|---|
| a. Worn bearings | Replace bearings |
| b. Worn crankshaft journals | Replace crankshaft |
| c. Melted crankshaft bearing/s | Replace bearing/s, and check lubricating system |

2. Connecting rods, and bearings

- | | |
|------------------------------------|---|
| a. Worn bearings | Replace bearings |
| b. Worn crankpin journals | Replace crankshaft |
| c. Bent connecting rod | Straighten or replace connecting rod |
| d. Melted connecting rod bearing/s | Replace bearing/s, and check lubricating system |

3. Piston, piston ring, and piston pin

- | | |
|------------------------------|-------------------------|
| a. Worn cylinder bore/s | Replace cylinder block |
| b. Worn piston or piston pin | Replace piston with pin |
| c. Sticky piston | Replace piston with pin |
| d. Broken piston ring/s | Replace piston rings |

4. Other components

- | | |
|-----------------------------------|-----------------------------------|
| a. Incorrect valve timing | Adjust valve timing |
| b. Worn crankshaft thrust washers | Replace thrust washers |
| c. Worn timing gear/s | Replace timing gear/s |
| d. Excessive valve clearance | Correct valve clearance |
| e. Insufficient engine oil | Replenish engine oil |
| f. Worn timing chain | Replace timing chain |
| g. Defective chain tensioner | Repair or replace chain tensioner |

Removal

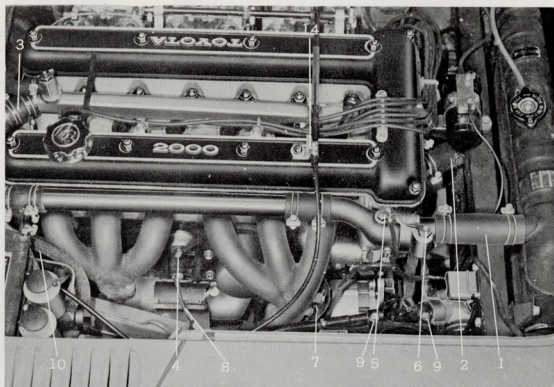


Fig. 3-6 Engine Removal No. 1

V1235

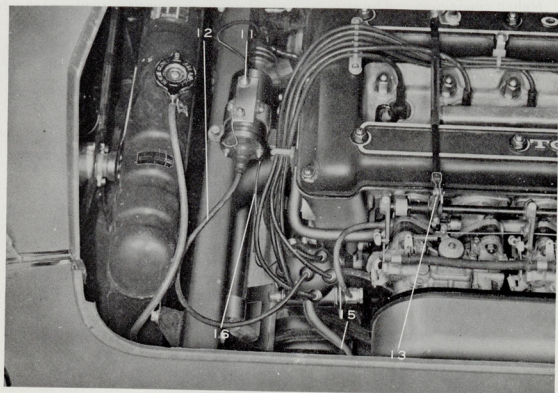


Fig. 3-7 Engine Removal No. 2

V1231

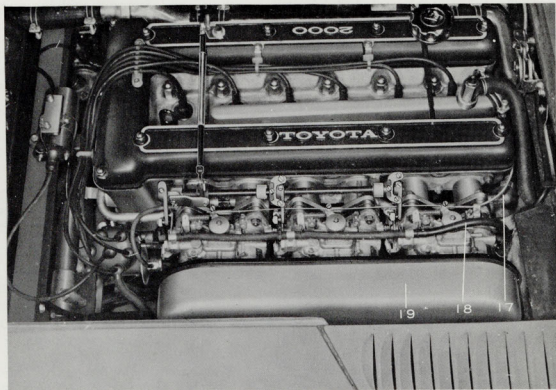


Fig.3-8 Engine Removal No.3

V 1257

1. Disconnect the engine compartment inspection light wire, and remove the engine hood hinge mounting bolts. Remove the engine hood.
2. Disconnect the battery to starter cable, and the battery to ground cable from the battery terminals. To disconnect the cables, refer to removal in BATTERY section.
3. Drain the engine coolant, and if the Long-life (Permanent type) coolant is used, do not discard. Disconnect the radiator upper hose (1), and lower hose (2) from the radiator.
4. Disconnect the water hoses of the car heater (3) from the water hose joint, and the water pipe under the intake manifold.
5. Disconnect the oil pressure sender gauge wire (4), water temperature sender gauge wire (5), radiator
- thermic control switch wire (6), and the alternator wires (7).
6. Disconnect the ground cable (8) from the cylinder block.
7. Unscrew the steering shaft universal joint securing bolts (9), and disconnect the universal joint from the steering pinion.
8. Disconnect the brake booster vacuum hose (10) from the vacuum pipe.
9. Disconnect the primary wires (11) and the high tension wire (12) from the ignition coil.
10. Disconnect the accelerator flexible wire from the accelerator link shaft arm (13), and clamp (14) on the cylinder head cover.
11. Pull out the tube (15) of the distributor from the tube clips.

3-12 ENGINE - Removal

12. Disconnect the tachometer drive cable (16) from the tachometer shaft sleeve on the cylinder block.
13. Disconnect the choke wire (17) from the starter disc of each carburetor.
Disconnect the fuel hose (18) from the carburetor No.3.
14. Disconnect the air cleaner hose from the intake air connector No.1 (19), and unscrew the two retaining bolts, then remove the intake air connector No.1 (19).
15. Remove the gear shift lever knob (20), and remove the console panel (21).
16. Remove the gear shift lever (22).
17. Remove the seat assembly (RH), then remove the access hole cover RH (23).

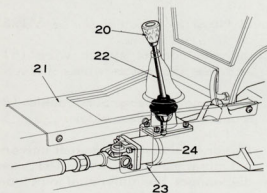


Fig.3-9 Engine Removal X6149
No.4

18. Remove the bolts (24), and disconnect the propeller shaft from the transmission universal joint flange.
19. Remove the access hole cover LH, and disconnect the back-up light switch wire, and the speedometer drive cable from the transmission.
20. Raise the front of the car using a jack under the front cross mem-

ber, and support with the suitable stands.

To raise the rear of the car using a jack, and attachment, locate the center lower member under the differential carrier case, and support with the suitable stands.

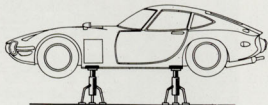


Fig.3-10 Complete Car G0311
Supporting Points

To raise complete car, use the suitable stands, and support at the points illustrated in figure 3-10.

21. Remove the front wheels with the hub nut wrench, and mallet furnished in the tool set.
22. Remove the radiator lower shroud.
23. Drain the engine lubricant, and disconnect the oil cooler flexible hose No.1, and No.2 from the connectors on the engine.
24. Disconnect the stabilizer links from the frame, and withdraw downward.
25. Disconnect the radiator thermic control relay wires, and remove the upper cross-member.
26. Remove the radiator.
27. Remove the four bolts mounting the steering rack housing support to the frame.
28. Disconnect the starter wires from the starter magnetic switch ter-

minal, and disconnect the wire from the oil temperature sender gauge.

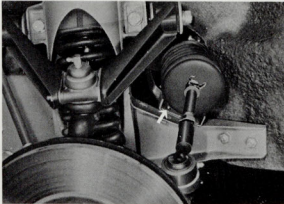


Fig. 3-11 Steering Rack V1237
Housing Support
Removal

29. Remove the cross-member No. 2 under the oil pan rear.
30. Disconnect the tension spring from the clutch release fork, and withdraw the clutch release cylinder from the clutch housing.
31. Place a jack under the transmission, and remove the engine rear mounting bracket.
32. Remove the exhaust pipe support bracket No. 1 clamp (1), and disconnect the exhaust front pipes No. 1 (2), and No. 2 (3) from the exhaust manifold. Loosen the clamp bolts (4), then remove the exhaust front pipes (2), and (3).

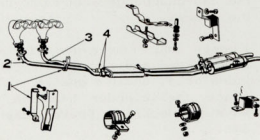


Fig. 3-12 Exhaust Front Y2324
Pipe Removal

33. Remove the bolts securing the engine front mountings to the engine front mounting brackets.
34. Install the lifting hooks to the engine hangers. Raise the engine slightly, and carefully move towards the front together with the transmission with a suitable hoist. Take care not to damage the other components.

Disassembly

1. Remove the starter assembly.
2. Remove the flywheel housing under cover and dust seal. Remove the transmission with clutch housing.
3. Mark the clutch cover and the flywheel, so that the parts can be installed in the same original position. Remove the clutch cover assembly, and the clutch disc.
4. Remove the flywheel, and the rear end plate. The following operations should be performed on the engine work stand.
5. Install the engine onto the work stand, and remove the oil level gauge.
6. Remove the exhaust manifold No. 1, and No. 2 with the gasket.
7. Remove the oil pressure sender gauge, and the oil regulator.
8. Remove the oil filter with the Oil Filter Band Wrench 09228-41010.
9. Remove the alternator adjusting bar bolt, and disengage the "V" belt, then remove the alternator with the bracket.
10. Disconnect the water hose, and the by-pass hose, then remove the water pump.

11. Loosen the distributor clamp bolts, and lift the distributor out of the cylinder block.
Pull up the distributor driven gear sleeve, and the driven gear.
12. Disconnect the accelerator connecting rods from the accelerator link rod arms.
Remove the air horns, and the intake air connector No.2.
Remove the carburetors together with the carburetor vibration insulators, intake manifolds, and the gaskets.
13. Remove the water pipe, and the ventilation tube.
14. Remove the engine mounting insulators together with the brackets.
15. Loosen the union nuts, and disconnect the oil pump inlet, and outlet pipes from the oil pan and the oil pump.
Remove the oil pump assembly from the cylinder block.
16. Loosen the hose clamps, and remove the water outlet housing connector No.1 (1), No.2 (2), No.3 (3), and the hoses.

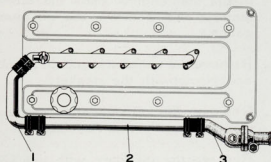


Fig.3-13 Water Outlet Housing Connectors & Hoses Y2325

17. Remove the accelerator link shaft assembly from the cylinder head.
18. Remove the cylinder head cover.

gasket, and the semi-circular plugs.

Whenever the cylinder head cover is removed, always cover the timing chain cover with a clean shop towel to prevent dropping bolt, washer or the straight pin into the timing chain cover.

19. Lock the camshaft securely with the Valve Timing Adjust Wrench 09225-43010, and loosen the camshaft timing gear securing bolts.

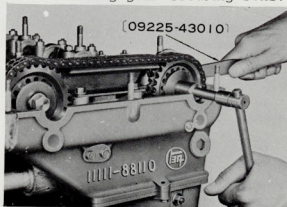


Fig.3-14 Removing Camshaft Timing Gear V1241 Securing Bolt

20. Remove the chain tensioner No.1, and remove the camshaft timing gears.

Caution:

Do not rotate the crankshaft while the camshaft timing gear/s is removed.

If the crankshaft is rotated, the piston head will hit against the valve, and will damage both parts. Do not forget the straight pin/s in the camshaft flange when removing the gear/s.

21. Loosen and remove the cylinder head nuts, and remove the cylinder head, and the gasket.
Place the cylinder head on a wooden block/s to prevent damage.
Loosen and remove the cylinder head nuts in the order illustrated in figure 3-15 to prevent warpage.

Do not loosen and remove the cylinder head nuts at one time. Perform the removal in twice or three procedures.

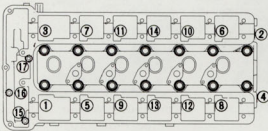


Fig. 3-15 Cylinder Head Y5191 Bolts Removal

22. Remove the crankshaft damper retaining bolt, then remove the crankshaft damper using the Crankshaft Damper Puller 09213-43010.
23. Remove the oil pipe, oil pan and the gasket.
24. Remove the timing chain cover with chain vibration damper No. 2, No. 3 and the gaskets.
25. Remove the chain No. 2 and the crankshaft oil slinger.
26. Remove the chain tensioner No. 2.
27. Loosen and remove the pump drive shaft gear retaining nut, then remove the distributor drive gear (1), and the camshaft drive gear (2).
28. Remove the pump drive shaft gear (3), and the crankshaft timing gear (4) together with the chain No. 1 (5) at the same time.
29. Remove the pump drive shaft thrust plate, and pull out the pump drive shaft.
30. Remove the connecting rod cap, and push the connecting rod and

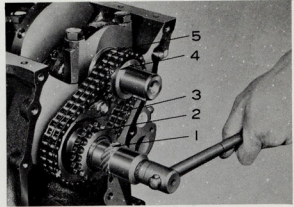


Fig. 3-16 Gears & Chain V1242 Removal

piston assembly towards the top of the cylinder block with a handle of the hammer.

Avoid damaging the crankpin journal or the cylinder wall when removing the piston, and the connecting rod.

Replace the respective connecting rod caps to the connecting rods after removal.

Make sure that all connecting rods and pistons are marked so that these can be installed in their original locations.

31. Remove the crankshaft rear oil seal retainer, and the gasket.
32. Remove the crankshaft bearing caps, and the thrust washers, then remove the crankshaft. Take care not to change the combination of the crankshaft bearing caps, and the bearings.
33. Remove the piston rings from each piston using a piston ring expander. The removed piston rings should be laid in accordance with the cylinder number.
34. Remove the hole snap rings, and heat the piston with the connecting rod assembly in a piston heater to 50 ~ 60°C (122 ~ 140°F), then remove the piston pin from the piston, and the connecting rod. Do not mix the mated parts with

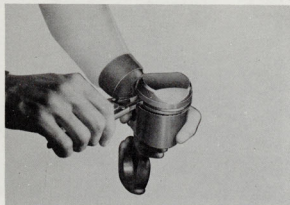


Fig.3-17 Removing Piston Ring V1245

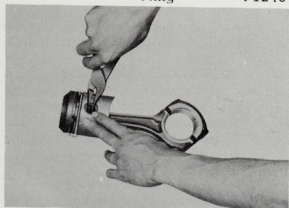


Fig.3-18 Removing Hole Snap Ring W9079

the others.

35. Cylinder head disassembly.

The cylinder head being made of an aluminum alloy, and finished surfaces of the cylinder head must be protected from damages.

Do not rotate the camshaft for the intake and exhaust sides as the valve will strike each other, and will cause damage.

Remove the chain vibration damper No.1.

Remove the water outlet housing and the water inlet housing using a Hex Head Wrench (hollow screw wrench).

Pull out the tension gear arm shaft, and remove the tension gear assembly.

Loosen and remove the camshaft bearing cap retaining nuts in the order illustrated in figure 3-20 to

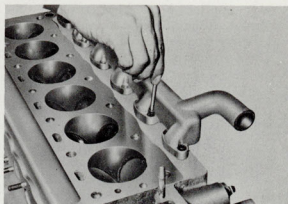


Fig.3-19 Removing Water Inlet Housing V1246

prevent the camshaft/s from bending, then remove the camshaft or camshafts.

Do not loosen and remove the camshaft bearing cap retaining nuts at one time. Perform the removal in twice or three procedures.

After removing the camshaft/s, replace the bearing caps, and tighten the retaining nuts finger tight.

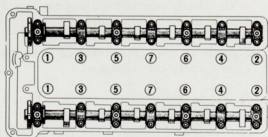


Fig.3-20 Camshaft Bearing Caps Removal Y5192

Pull out the valve lifters, and the valve adjusting pads using a hand valve lapper.

Do not mix the mated parts with the others.

Compress the valve springs with the Valve Spring Compressor 09202-43010, then remove the valve spring retainer locks, and release the valve springs.

Remove the valve spring retainer, valve springs, valve, valve stem

oil seal, and the spring seat.

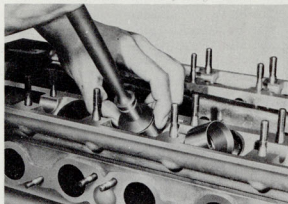


Fig.3-21 Removing Valve V1247 Lifters

Valves, valve lifters, pads, and the springs should be placed in a rack in their proper sequence so these can be installed in the original positions.

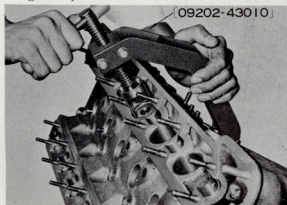


Fig.3-22 Removing Valve V1248

Inspection & Repair

Wash the disassembled parts thoroughly before inspection, and repair to remove the dirt, oil carbon, and water scale.

Do not mix or change the original mated parts of the valves, valve lifters, valve adjusting pads, bearings or the bearing caps.

Cylinder Head

1. Remove the carbon deposits from the combustion chambers. Be careful not to damage the cylinder head gasket surface.

2. Check the cylinder head for cracks, and the gasket surface for burrs and nicks.

Replace the head if cracked.

3. Check the flatness of the cylinder head gasket surface.

Correct or replace if the distortion exceeds 0.05 mm (0.002").

4. Check the distortion of the intake manifold-gasket surface.

Correct or replace if the distortion exceeds 0.08 mm (0.003").

Valve Stem Guide Bushing

1. Check the clearance between the valve stem, and the respective valve stem guide bushing.

The specified clearance should be 0.025 ~ 0.055 mm or 0.001" to 0.002" for the intake, and 0.045 to 0.075 mm (0.002 ~ 0.003") for the exhaust.

The valve stem diameter is 7.960 to 7.975 mm (0.313 ~ 0.314") for the intake, and 7.940 ~ 7.955 mm (0.312 ~ 0.313") for the exhaust.

The clearance limits are 0.07 mm (0.003") for the intake, and 0.09 mm (0.004") for the exhaust.

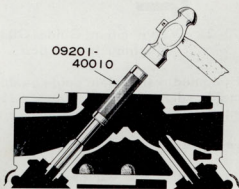


Fig.3-23 Valve Stem Guide Bushing Removal G0312

2. To remove the valve stem guide bushing, remove the carbon deposits completely from the combustion chamber, then remove the valve stem guide bushing towards

the valve lifter using the Valve Stem Guide Remover & Replacer 09201-40010.

3. Install the snap ring onto the valve stem guide bushing, and install the new valve stem guide bushing from the valve lifter side with the Valve Guide Bushing Replacer 09201-41010 until the snap ring contacts the cylinder head.

Caution:

The cylinder head should be heated to 80 ~ 100°C (176 ~ 212°F) for removal, and also for installation of the valve stem guide bushing.

4. After installing the valve stem guide bushing, then ream all the replaced valve stem guide bushings until proper clearance is obtained.

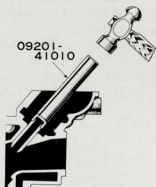


Fig.3-24 Valve Stem Guide G0313 Bushing Installation

Specified valve stem guide bushing inside diameter is 8.00 ~ 8.015 mm (0.315 ~ 0.316").

Valve Seat

The seating of the valves is essential in the performance of the engine, and the reconditioning of the seats is very important.

1. Check the valve seat for proper seating with the valve.
If necessary, the seat must be reconditioned with a valve seat cutter.

If the valve stem guide bushing is not to the specified clearance, remove and replace the valve stem guide bushing or valve before reconditioning the valve seats.

2. The valve seat angle is 45° for both intake, and exhaust valves. If the valve seat cutter is used, three different cutters of 20°, 45° and 65° are required. Use a 20° angle cutter to remove the stock from the top of the seat, and use a 65° angle cutter to remove stock from the bottom of the seat.
3. After cutting the valve seat, the valve should contact the seat exactly at the center, and proper width should be 1.5 ~ 1.7 mm or 0.059 ~ 0.067" for the intake and 1.7 ~ 1.9 mm (0.067 ~ 0.075") for the exhaust.

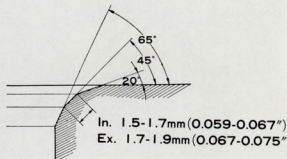


Fig.3-25 Valve Seat Angle G0314

Lap the valve lightly with a lapping compound to match the seat. Remove the compound thoroughly from the valve, and the seat after lapping.

Valve

1. Remove all deposits from the valve stem with a wire brush or a buffing wheel.
2. Check the valve face, and the edge of the valve head for pits, grooves, scores, and other defects.
3. Check the valve stem for bend,

and for grooves or scores at the end of the stem.

4. Check the valve head for sign of burning or erosion, warpage, and cracks.

Discard any valves that are severely damaged.

5. If refacing is necessary, grind the valve with a valve refacing machine to obtain a smooth, and correct angle.

Grind the valve to 45° removing only sufficient stock to correct the run-out and to remove the pits or grooves.

The valve head edge width limit is 2 mm (0.079") for both intake and exhaust valves.

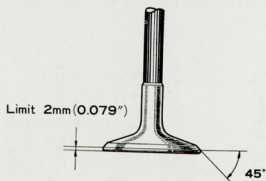


Fig.3-26 Valve Head Edge G0315

6. Remove the grooves, and scores from the end of the valve stem, then chamfer as necessary.

The overall length is 117 mm or 4.606" for the intake, and 115.2 mm (4.535") for the exhaust.

7. Lap the valves slightly with a lapping compound for proper contact. Remove the compound thoroughly from the valve, and valve seat after lapping.

Valve Spring

1. Check the valve spring free length. The free length is 41.8 mm or 1.646" for the outer, and 41.0 mm or 1.614" for the inner.

2. Check the spring for proper pressure at the specified spring length with a spring tester.

If the pressure of any spring approaches the wear limit, replace the spring.

Outer valve spring:

Installed length - 37.0 mm (1.457")

Installed pressure - 20.1 kg (44.22 lb)

Installed pressure limit

19.0 kg (41.8 lb)

Inner valve spring:

Installed length - 35.0 mm (1.378")

Installed pressure - 9.7 kg (21.34 lb)

Installed pressure limit

9.0 kg (19.8 lb)

3. Check the valve spring squareness with a steel square, and a surface plate.

The limit is 1.5 mm (0.059") for the outer, and 1.4 mm (0.055") for the inner.

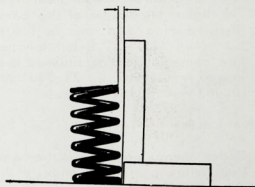


Fig.3-27 Valve Spring X3111 Squareness

Camshaft

1. Check the camshaft bearing journals, and the cam lobe surfaces for pits, scores, and abnormal wear.

If the intake cam height is less than 42.5 mm (1.673"), and the exhaust cam height is less than 42.6 mm (1.677"), replace the camshaft.

2. Check the camshaft for bend.

If the bend exceeds 0.05 mm or 0.002" correct or replace the camshaft.

3. Check the camshaft thrust clearance between the camshaft flange and the camshaft bearing cap No.1. The clearance should be 0.05 to 0.20 mm (0.002 ~ 0.008"), and if the clearance exceeds 0.3 mm (0.012"), replace the camshaft bearings.

Camshaft Bearing

1. Check the camshaft bearing for proper contact, worn thin, partially melted or heavily scored. If necessary, replace the bearings.
2. Check the oil clearance with a Plastigage.
The oil clearance should be 0.020 to 0.062 mm (0.001 ~ 0.002"), and the limit is 0.08 mm (0.003"). If necessary, replace the bearings.
The tightening torque of the camshaft bearing cap nuts is 1.8 to 2.4 m·kg (13 ~ 17 ft·lb) torque. The camshaft journal finished diameter is 24.967 ~ 24.980 mm (0.983 ~ 0.984").

Valve Lifter

1. Check the valve lifters at the camshaft lobes contacting ends. If the valve lifter end shows excessive wear, replace the lifter.
2. Inspect the oil clearance between the valve lifter, and the cylinder head bores.
If the clearance exceeds 0.1 mm (0.004"), replace the valve lifter or the cylinder head.
The valve lifter outer diameter is 37.920 ~ 37.940 mm (1.4927 to 1.4937").

Cylinder Block

1. Check the cylinder block for cracks

and the gasket surface for burrs and nicks.

Replace the cylinder block if cracked.

2. Check the flatness of the cylinder block gasket surface.
If the warpage exceeds 0.05 mm (0.002"), replace the cylinder block.

3. Check the cylinder bore for out-of-round or taper wear with a bore gauge.

Measure the bore of each cylinder at the top, middle, and bottom placing the gauge at right angle, and parallel to the center line of the cylinder block.

The limit of the taper wear is 0.20 mm (0.008").

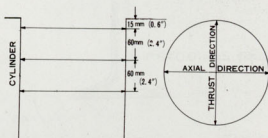


Fig.3-28 Measuring Points X0313 of Cylinder Bore

4. Check the piston to cylinder bore clearance.

To check, always measure the piston skirt at right angle to the piston pin boss with a micrometer. The piston pin should be removed before measuring, and the temperature should be about 20°C or 68°F when measuring.

The piston to cylinder bore clearance should be 0.06 ~ 0.08 mm (0.002 ~ 0.003").

Cylinder bore dimension:

75.00 ~ 75.03 mm (2.953 ~ 2.954")

Piston dimension:

74.93 ~ 74.96 mm (2.950 ~ 2.951")

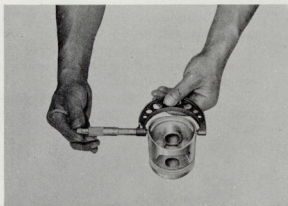


Fig.3-29 Measuring Piston W9091 Diameter

Piston, Piston Pin & Piston Ring

1. Check the piston ring grooves for wear, burrs or nicks, and if necessary, replace as a set.
2. Check the piston for wear, scores and damage. If necessary, replace the piston.
3. Check the piston pin fitness by pressing in the pin with the thumb at $50 \sim 80^{\circ}\text{C}$ ($122 \sim 176^{\circ}\text{F}$). If the fitness is loose, replace both the piston and the pin.
4. Check the piston rings for wear, and other damages.
If the piston requires replacement, the rings should be replaced at the same time.
Always install the rings with the marks facing upward.
5. Check the piston ring grooves to the piston rings clearance.
Clean the piston ring grooves on the piston thoroughly before checking the clearance.
The clearance should be 0.025 to 0.065 mm ($0.001 \sim 0.003$ ") for both compression rings No.1, and No.2.
If necessary, replace the piston or the piston rings as a set.
6. Check the piston ring end gap. Install each ring into the cylinder

bore, and check the end gap with a feeler gauge.

The piston ring end gap should be $0.2 \sim 0.4$ mm ($0.008 \sim 0.016$ ") for both compression rings No.1, and No.2, and oil ring should be $0.2 \sim 1.2$ mm ($0.008 \sim 0.047$ "). If necessary, replace the piston rings as a set.

Connecting Rod

1. Check the connecting rod for bend and twist using a connecting rod aligner.
If correction is impossible, replace the connecting rod.
The allowance of bend or twist per 100 mm (3.94 ") is 0.15 mm or 0.006 " .

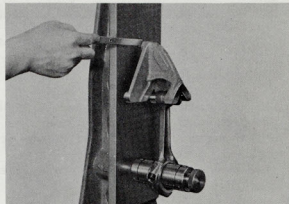


Fig.3-30 Connecting Rod W9102 Alignment

2. Install the connecting rod onto the crankshaft, and measure the thrust clearance.
The thrust clearance should be $0.110 \sim 0.246$ mm ($0.004 \sim 0.010$ ") and the limit is 0.3 mm (0.012 "). Also check the connecting rod for defect on the thrust surface of the connecting rod both side.
If defective, replace the connecting rod.
3. Check the connecting rod bushing for wear, and damage. If worn or defective, replace the bushing with the Connecting Rod Bushing Remover & Replacer 09222-30010 to obtain proper fitness of the pis-

ton pin, and the bushing by honing the bushing.

The fitness should be determined by pushing in the pin with engine oil applied onto the pin with the thumb by applying sufficient strength. The clearance limit is 0.015 mm (0.0006").

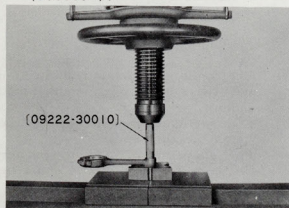


Fig. 3-31 Removing Connecting Rod Bushing W9104

Connecting Rod Bearing

The connecting rod bearings are of the precision type insert bearings, and these bearings should never be scraped, ground or filed.

Also never insert any shim or lap the bearing cap.

1. Check the bearing for proper contact, worn thin, partially melted or heavily scored. If necessary, replace the bearings.

2. Check the oil clearance with a Plastigage.

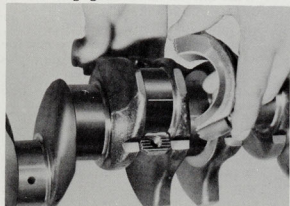


Fig. 3-32 Installing Plastigage W9107

The clearance should be 0.02 to 0.06 mm (0.0008 ~ 0.0023"), and the limit is 0.08 mm (0.0031"). If necessary, replace the bearing/s or the crankshaft.

The tightening torque of the connecting rod bearing cap bolts is 4.2 ~ 4.8 m-kg (30 ~ 35 ft-lb) torque.

Crankshaft

1. Check the crankshaft journals, and crankpin journals for wear, and scores. Also check the oil seal contact surfaces. Check the oil passage holes for clogging.
2. Check the crankshaft for bend. If the bend exceeds 0.03 mm or 0.0012", replace the crankshaft.

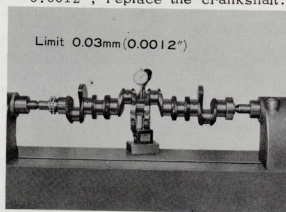


Fig. 3-33 Measuring Crankshaft Bend W9113

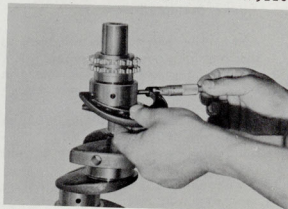


Fig. 3-34 Measuring Crankshaft Journal W9114

3. Check the roundness or taper of the crankshaft journals, and the crankpin journals, and if it exceeds 0.01 mm (0.0004"), correct the crankshaft journals, and or the crankpin journals.

The crankshaft journal finished diameter is 59.99 ~ 60.01 mm (2.362 ~ 2.363"), and the crankpin journal finished diameter is 51.984 ~ 52.000 mm (2.046 to 2.047").

4. Check the crankshaft thrust clearance.

The crankshaft thrust clearance is maintained by the crankshaft thrust washers at the center.

To check, check the crankshaft thrust clearance by moving the crankshaft to the extreme front or rear position, and measure with a feeler gauge.

The thrust clearance should be 0.05 ~ 0.25 mm (0.002 ~ 0.010") and the limit is 0.3 mm (0.012"). If the thrust clearance exceeds this limit, replace the crankshaft thrust washers.

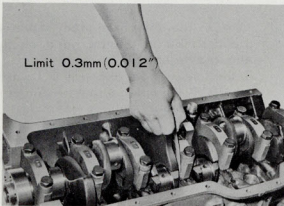


Fig.3-35 Measuring Crankshaft Thrust Clearance W9115

Crankshaft Bearing

The crankshaft bearings are also the same precision type bearing inserts, therefore, the same procedures of inspection, and oil clearance check should be performed as the connecting rod bearings.

These bearings should never be

scraped, ground or filed. Also never insert any shim or lap the bearing cap to obtain the proper bearing oil clearance.

1. Check the bearing for poor contact worn thin, partially melted or heavily scored.
If necessary, replace the bearings.

2. Check the oil clearance with a Plastigage.

The oil clearance should be 0.02 to 0.042 mm (0.0008 ~ 0.0016"), and the limit is 0.06 mm (0.0024") and if necessary, replace the bearings.

The tightening torque of the crankshaft bearing cap bolts is 9.9 to 10.9 m·kg (72 ~ 79 ft·lb) torque.

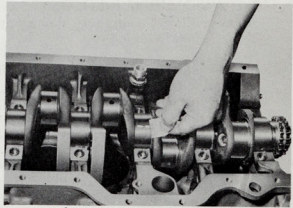


Fig.3-36 Measuring Crankshaft Oil Clearance W9112

Pump Drive Shaft

1. Check the pump drive shaft for bend.
If the bend exceeds 0.01 mm or 0.0004"), replace the shaft.

2. Check the pump drive shaft end play which should be 0.06 ~ 0.13 mm (0.002 ~ 0.005").
If the end play exceeds 0.3 mm (0.012"), replace the pump drive shaft thrust plate.

3. Check the tachometer drive gear, and the oil pump drive gear for excessive wear, and scores.
If necessary, replace the pump drive shaft.

4. Inspect the pump drive shaft journals for pits, scores, and abnormal wear.

The run-out or taper should be less than 0.01 mm (0.0004"), and if necessary, replace the pump drive shaft.

The pump drive shaft journal finished diameter:

No.1 (front journal)
40.959 ~ 40.975 mm
(1.612 ~ 1.613")

No.2 (rear journal)
32.959 ~ 32.975 mm
(1.297 ~ 1.298")

Pump Drive Shaft Bearing

1. Inspect the pump drive shaft bearings for wear, scores, poor contact, and partially melted. If necessary, replace the pump drive shaft bearings.
2. Check the oil pump drive shaft journal oil clearance. The clearance should be 0.025 to 0.066 mm (0.001 ~ 0.002"), and the limit is 0.08 mm (0.003"). If necessary, replace the bearings. If the pump drive shaft bearing requires replacement, use the Pump Drive Shaft Bearing Replacer 09233-41010.

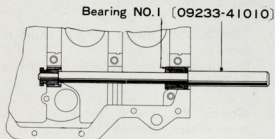


Fig.3-37 Front Bearing G0316
No.1 Removal

The oil pump drive shaft bearing finished inside diameter:

No.1 (front bearing)
41.000 ~ 41.025 mm
(1.614 ~ 1.615")

No.2 (rear bearing)
33.000 ~ 33.025 mm
(1.299 ~ 1.300")

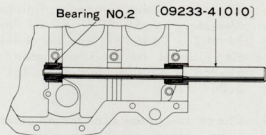


Fig.3-38 Rear Bearing G0317
No.2 Removal

Distributor Driven Gear Sleeve and Bushing

1. Check the bushing and sleeve for run-out, and scores. If necessary, replace the bushing.
2. Check the distributor driven gear for excessive wear, and scores. If necessary, replace the gear.
3. Check the oil clearance between the distributor driven gear shaft, and the bushing. If the clearance exceeds 0.08 mm (0.003"), replace the bushing or the distributor driven gear.
4. Check the oil clearance between the distributor driven gear sleeve, and the distributor driven gear shaft. If the clearance exceeds 0.08 mm (0.003"), replace the gear sleeve or the driven gear.

Tachometer Driven Gear, Sleeve, and Bushing

1. Check the tachometer driven gear for excessive wear, and scores. If necessary, replace the driven gear.
2. Check the oil clearance between the tachometer driven gear shaft

and the bushing and sleeve.
If the clearance exceeds 0.08 mm (0.003"), replace the driven gear, bushing or the sleeve.

Chains No.1 & No.2

Inspect the chain for broken links. If the chain shows signs of stretching or wear, replace with new chain/s. For inspection, and adjustment, refer to Valve Timing Adjustment, in Engine Assembly.
Loose chain will cause retarded valve timing.

Crankshaft Timing Gear, Camshaft Timing Gears & Pump Drive Shaft Gear.

Inspect the gears for cracks, and worn or damaged teeth.
If necessary, remove the crankshaft timing gear from the crankshaft using the Universal Puller 09950-20010.

Chain Vibration Dampers No.1, No.2 & No.3.

Check the rubbers of the dampers No.1, No.2, and No.3 for wear and cracks.

Chain Tensioners & Tension Gear

Remove the hole snap ring, and disassemble the chain tensioner.

1. Inspect the chain tensioner body, plunger, and the compression spring for wear and other defects. If necessary, replace the chain tensioner assembly.
2. Check the compression spring length, and spring pressure with a spring tester, and replace if the installed pressure is less than specified.

Chain tensioner No.1

Free length - 117.4 mm (4.622")
Installed length - 62.9 mm (2.476")
Installed pressure - 5.0 kg (11 lb)

Installed pressure limit:
4.5 kg (9.9 lb)

Chain tensioner No.2

Free length - 59 mm (2.323")
Installed length - 27.5 mm (1.080")
Installed pressure - 0.86 kg (30.3 oz)
Installed pressure limit - 0.77 kg (27.2 oz)

3. Check the oil clearance between the body, and the plunger. If the clearance exceeds this limit, replace the chain tensioner assembly.

Chain tensioner No.1

Chain tensioner body inner diameter:
15.000 ~ 15.027 mm (0.591 ~ 0.592")
Plunger diameter:
14.950 ~ 14.968 mm (0.588 ~ 0.589")
Oil clearance limit: 0.1 mm (0.004")

Chain tensioner No.2

Chain tensioner body inner diameter:
14.510 ~ 14.534 mm (0.571 ~ 0.572")
Plunger diameter:
14.479 ~ 14.494 mm (0.570 ~ 0.571")
Oil clearance limit: 0.07 mm (0.003")

4. Check the tension gear for cracks and worn or damaged teeth.
5. Inspect the gear bushing for wear and check the oil clearance between the shaft and bushing. If necessary, replace the bushing or tension arm.
To replace the bushing, use the Connecting Rod Bushing Remover & Replacer 09222-30010.
The specified clearance is 0.020 to 0.054 mm (0.0008 ~ 0.0021"), and the limit is 0.1 mm (0.004").
6. Check the tension gear thrust clearance with a feeler gauge. If necessary, replace the claw washer.

The clearance should be 0.05 to 0.65 mm (0.002 ~ 0.256"), and the limit is 1.0 mm (0.039").

7. Check the oil clearance between the tension arm, and the straight pin.

If necessary, replace the straight pin or tension arm.

The clearance should be 0.022 to 0.058 mm (0.001 ~ 0.002"), and the limit is 0.08 mm (0.003").

Flywheel

1. Check the clutch disc contacting surface for cracks, scores, and other defects.

Correct or replace the flywheel as necessary.

2. Install the flywheel aligning the dowel on the crankshaft, and tighten the bolts.

Position a dial gauge against the flywheel surface, and check the run-out.

The run-out should not exceed 0.2 mm (0.008").

If it exceeds, check the contact surface of the flywheel, and the crankshaft or replace the flywheel.

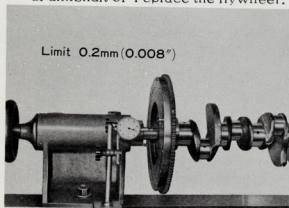


Fig.3-39 Measuring Flywheel Run-out W9126

3. Check the flywheel ring gear for chipped teeth or excessive wear. If necessary, replace the ring gear.

To remove the flywheel ring gear, heat the ring gear by rotating the

flywheel on a suitable stand to about 160 ~ 200°C (320 ~ 395°F), and tap slightly, and remove the ring gear from the flywheel.

To install, heat the ring gear to about 200°C (395°F), and install the ring gear onto the flywheel as quickly as possible.

The ring gear should be installed while still hot.

Oil Pan

1. Check the oil pan for cracks, and the gasket surface for burrs and nicks.

Replace the oil pan if cracked.

2. Check the threads that connect the elbows.

If necessary, replace the oil pan or elbows.

To install the elbow onto the oil pan, coat a liquid sealer onto the threads of the elbow, and tighten it securely.

Crankshaft Oil Seal

It is recommended that the oil seals should be replaced when the engine is overhauled.

1. To install the new front oil seal, use the Crankshaft Front Oil Seal Replacer 09223-50010.

2. Install the new rear oil seal using the Crankshaft Rear Oil Seal Replacer 09223-41010.

Intake Manifold & Carburetor Vibration Insulator

1. Inspect the intake manifold for corrosion, cracks, or other damages. If necessary, replace the intake manifold.

2. Check the distortion of the intake manifold flanges.

If distortion exceeds 0.08 mm or 0.003", replace the intake manifold.

3. Inspect the carburetor vibration insulator for cracks or other damages.
If necessary, replace the part.

Exhaust Manifold

1. Inspect the exhaust manifold for corrosion, cracks or other damages.
2. Check the distortion of the exhaust manifold.
If the distortion exceeds 0.4 mm (0.016"), grind the surfaces with a surface grinder.

Input Shaft Front Bearing

1. Inspect the bearing for scores, roughness, abnormal noises or damage.
If the bearing requires the removal, use the Input Shaft Front Bearing Puller 09303-35010.

Assembly

Thoroughly clean the disassembled components before assembly, especially the oil passages, bearings, bearing bores, and the cylinder walls. Apply engine oil onto the cylinder walls, pistons, bearings, camshafts, crankshaft, and the gears before the assembly.

It is recommended that all gaskets, and the oil seals are to be replaced upon assembly.

To prevent the oil or water leak, the use of a sealer is also essential. Each clearance previously checked, and adjusted must be rechecked upon assembly.

When installing bolts into the aluminum parts, threaded portions, apply a few drops of engine oil onto the bolt threads. If the aluminum parts threads are stripped, correct then using "Heli-sert" (coil insert).

Service torque specifications should be adhered whenever tightening the bolts or nuts specified with torque.

1. Valve assembly

Install the valve stem oil seals onto the valve stem guide bushings. To soften the oil seals, heat the oil seals in engine oil, heated to about 60~100 C (140~212 F). Next, insert the valve (2) into the valve stem guide bushing, and the valves should be inserted smoothly into the oil seals.

Check the valves reciprocate smoothly.

Replace the oil seal, if it does not stay on the valve stem guide bushing.

Install the washer (1), and the valve spring inner and outer, onto the valve stem guide bushing.

Install the valve spring retainer (4), and compress the valve springs with the Valve Spring Compressor 09202-43010, then install the valve spring retainer locks (6).

Install the same pad (3) which was removed during disassembly from the end of the valve stem, then install the valve lifter (5) into the cylinder head bore.

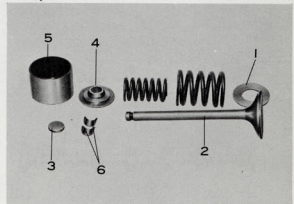


Fig.3-40 Valve Assembly V1249 Components

2. Camshaft assembly.

Install the lower halves of the camshaft bearings onto the cylinder head.

Apply engine oil onto the bearings, and the camshaft journals, then install one of the camshafts.

Install the upper halves of the bearings onto the bearing caps.

As the bearings are provided with sequence numbers on the side surface, the cap must be installed in the sequence upon assembly. When assembling, the sequence number on the camshaft bearing cap should be faced towards the outside as shown in figure 3-41.

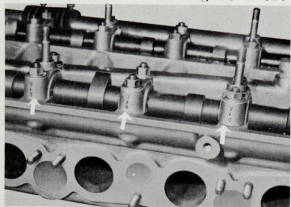


Fig.3-41 Camshaft Bearing V1250
Cap Sequence Number

Tighten the nuts a little at a time with a torque wrench in the sequence illustrated in figure 4-42. The specified torque is 1.8 ~ 2.4 m·kg (13 ~ 17 ft·lb) torque.

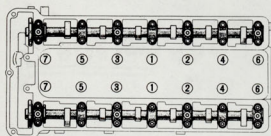


Fig.3-42 Bearing Cap Nuts Y5195
Tightening Sequence

- Adjust the valve clearance. Rotate the camshaft with the Valve Timing Adjust Wrench 09225-43010 and measure the clearance between the camshaft, and the valve lifter. Measure and take note of clearances needed to achieve the pre-

scribed clearance.

The valve clearance should be 0.35 mm (0.0138") for the intake, and 0.45 mm (0.0177") for the exhaust.

If necessary, adjust the valve clearance with the valve adjusting pad.

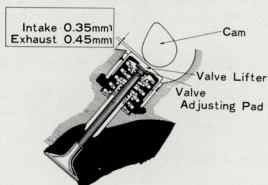


Fig.3-43 Valve Clearance G0318

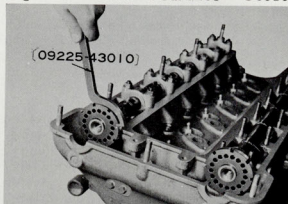


Fig.3-44 Rotating Camshaft V1252

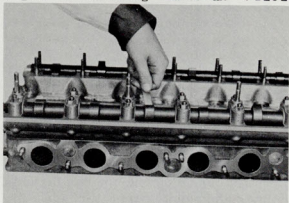


Fig.3-45 Measuring Valve V1251
Clearance

To adjust, remove the camshaft, and the valve lifter, and then insert the corrected valve adjusting pad

onto the valve stem end.

Recheck the valve clearance, and readjust until the specified clearance is obtained.

The valve adjusting pad should not be used two on the same valve for adjustment.

The valve adjusting pads are available in the following 37 different thicknesses in increments of 0.025 mm (0.001").

1.000, 1.025, 1.050, 1.075 to 1.900 mm.
(0.0394"), (0.0404"), (0.0413"), (0.0423") to (0.0748").

Caution:

If the intake or exhaust side camshaft is rotated, the intake valve/s and the exhaust valve/s will strike each other, therefore, the other camshaft should be removed when adjusting the valve clearance either the intake or exhaust side.

4. Assemble the tension gear onto the tension arm, then install the tension gear assembly onto the cylinder head.

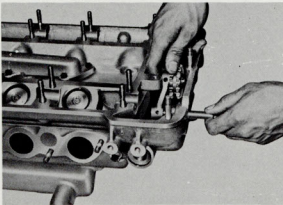


Fig.3-46 Installing Tension V1253 Gear

5. Install the chain vibration damper No.1 onto the cylinder head.
6. Install the water outlet housing, and the water inlet housing onto the cylinder head.

Tighten the bolts with a Hex. Head Wrench (Hollow Screw Wrench) to 50 ~ 70 cm-kg (43 ~ 61 in-lb) torque.

7. Piston assembly.

The pistons, and the connecting rods are marked with TOYOTA marks indicating the front.

To install the piston pin into the piston pin bores, heat the piston with a piston heater to 50 ~ 60°C (122 ~ 140°F) to facilitate the installation.

Assemble the piston, and the connecting rod with the piston pin mating the marks.

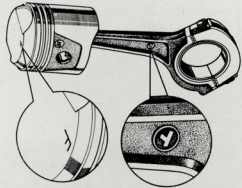


Fig.3-47 Correct Piston & Y2342 Connecting Rod Position

Install the hole snap rings into the piston.

Assemble the piston rings onto the piston with a piston ring expander. The piston rings are provided with marks as illustrated in figure 3-48, and these marks must be faced upward upon installation.

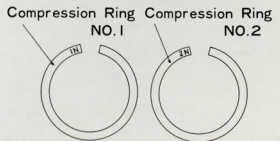


Fig.3-48 Piston Ring X6157 Marks

8. Assemble the crankshaft bearings,

thrust washers, and the crankshaft onto the cylinder block.

The thrust washer oil grooves must face towards the crankshaft thrust surface sides.

9. Install the crankshaft bearing caps onto the cylinder block adhering the marks, and numbers in each bearing cap.

Next, tighten the bearing cap bolts alternately to 9.9 ~ 10.9 m·kg or 71 ~ 78 ft·lb torque as illustrated sequence in figure 3.49.

Always check if the crankshaft rotates smoothly.

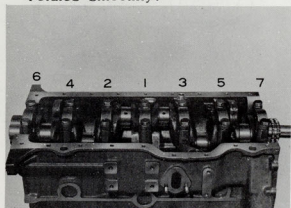


Fig.3-49 Bearing Cap Bolts Tightening Sequence W9135

10. Make sure that the piston ring gaps are properly spaced around the circumference of the piston.

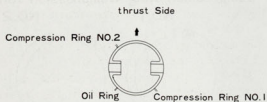


Fig.3-50 Spacing Piston Ring Gaps G0839

11. Install the piston, and connecting rod assembly into the cylinder

block using a piston ring compressor with the "F" mark on the piston head towards the front of the engine.

Install the connecting rod bearing caps, and tighten the cap bolts to 4.2 ~ 4.8 m·kg (30 ~ 35 ft·lb) torque.

12. Assemble the pump drive shaft into the cylinder block, and tighten the pump drive shaft thrust plate retaining bolts.

13. Rotate the crankshaft until No.1 piston is positioned at T.D.C. The crankshaft timing gear is provided with an "O" mark (1).

When the No.1 piston is positioned at T.D.C., this "O" mark will be at the lower position.

Positioning this "O" mark at the lower position, align the TOYOTA mark (2) on the crankshaft timing gear, and the mark (3) on the pump drive shaft gear as illustrated in the figure 3-51.

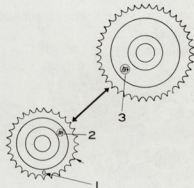


Fig.3-51 Aligning TOYOTA Marks G0319

14. Place the keys onto the shafts, then install the pump drive shaft gear, and the crankshaft timing gear together with the chain No.1 at a time.

Next, slide the camshaft drive gear and the distributor drive gear. Install the lock washer, and tighten the gear securing nut to 5 ~ 6 m·kg (36 ~ 43 ft·lb) torque, and tap the lock washer against the nut.

15. Install the chain tensioner No.2 onto the cylinder block
16. Position the chain vibration damper No.2, and the chain vibration-damper No.3 onto the timing chain cover, and tighten the mounting nuts finger tighten.
17. Install the crankshaft oil slinger onto the crankshaft.
18. Apply a multipurpose grease onto the crankshaft oil seal contact surface.
Install the chain No.2, then fit the timing chain cover with the gasket. Tighten the 8 mm securing bolts to 1.5 ~ 2.1 m-k_g (11 ~ 15 ft-lb) torque, and the 10 mm bolts to 3.0 ~ 4.0 m-k_g (22 ~ 29 ft-lb) torque.
Pull the chain No.2 lightly, and tighten the chain vibration damper No.2 with a cord.
19. Adjust the clearance between the chain No.1, and the chain vibration damper No.3 to about 0.5 mm (0.02"), and tighten the vibration damper No.3 mounting nuts securely.

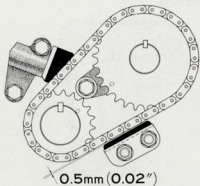


Fig.3-52 Chain Vibration G0320 Damper Adjustment

20. Install the crankshaft damper onto the crankshaft.
Position the washer, and tighten the damper retaining bolt to 6 to 7 m-k_g (43 ~ 50 ft-lb) torque

while aligning the crankshaft damper "V" groove at T.D.C., and the timing pointer on the timing chain cover.

21. Rotate the camshafts slightly with the Valve Timing Adjust Wrench 09225-43010, and align the check slit on the camshaft flange with the Valve Timing Adjust Gauge 09248-43010 as illustrated in figure 3-55.

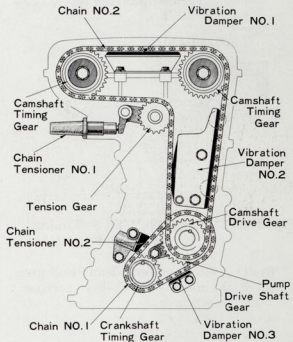


Fig.3-53 Chains, Gears & Y5197 Vibration Damper Construction

22. Position a new cylinder head gasket onto the cylinder block.
Apply liquid sealer onto the cylinder block, and the cylinder head if available.
23. Position the washers, and tighten the cylinder head nuts a little at a time with a torque wrench in the sequence illustrated in figure 3-56. Finally tighten the three 8 mm bolt nuts to 1.5 ~ 2.2 m-k_g (11 ~ 16



Fig.3-54 Valve Timing Marks Alignment V1254

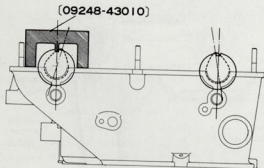


Fig.3-55 Camshaft Valve Timing Alignment Y5196

ft-lb), the fourteen 12 mm bolt nuts to 8.0 m-k_g (58 ft-lb) torque.

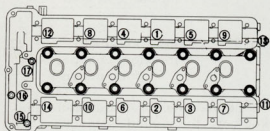


Fig.3-56 Cylinder Head Nuts Tightening Sequence Y5198

24. Recheck the camshaft valve timing with the Valve Timing Adjust Gauge 09248-43010, and fit the chain No.2 onto the camshaft timing

gears, then install the camshaft timing gears onto the camshafts at the same time.

25. Fill the engine oil into the chain tensioner No.1 then install the chain tensioner No.1 into the cylinder head. Tighten it to 3.0 to 4.0 m-k_g (22 ~ 29 ft-lb) torque. Check the operation of the chain tension No.1.

It is important to tension the chain No.2 before attempting to check or set the valve timing.

Turn the engine each way slightly and recheck the chain tension. When the tension is correct, there should be a slight flexibility below the camshaft timing gear, that is the chain must not be dead tight.

26. Unscrew the straight screw plugs on the timing chain cover, and the cylinder head, then adjust the clearance between the chain No.2, and the chain vibration damper No.2 to about 0.5 mm (0.02").

Tighten the nuts mounting the chain vibration damper No.2 onto the timing chain cover securely. After adjustment, apply a liquid sealer onto the threads of the straight screw plugs, and tighten securely.

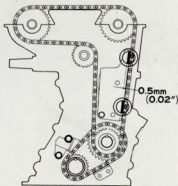


Fig.3-57 Chain Vibration Damper Adjustment Y5199

27. Recheck the No.1 piston at T.D. C. by aligning the timing pointer on the timing chain cover with the "V" groove on the crankshaft

damper. To align, first turn the crankshaft counter-clockwise to about 30° , and then turn it clockwise slightly.

28. Recheck the camshafts valve timing with the Valve Timing Adjust Gauge 09248-43010.

The camshaft timing gears are provided with sixteen holes, and the camshaft flanges are provided with seventeen holes for valve timing adjustment.

Find out the hole in the camshaft timing gear, which will align with the hole in the camshaft flange, then insert the straight pin into the holes.

When the holes do not align, rotate the camshaft slightly to within $1^\circ 20'$ with the Valve Timing Adjust Wrench 09225-43010, and then insert the straight pin into the holes in the camshaft timing gear, and the camshaft flange.

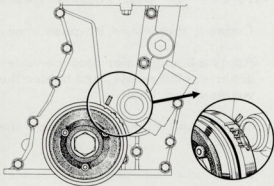


Fig.3-58 Crankshaft Timing Mark Adjustment Y5188

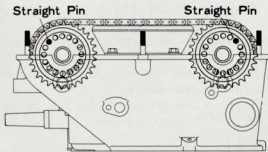


Fig.3-59 Camshaft Timing Y5200 Gears & Straight Pins

29. Position the washers onto the camshaft timing gears, and tighten the bolts securing the gears to the camshaft to 3.5 ~ 4.5 m-kg or 25 ~ 33 ft-lb torque.
30. Rotate the crankshaft two turns clockwise, and recheck the valve timing. If necessary, correct the valve timing again.
31. Position the semi-circular plugs on the cylinder head, and install the cylinder head cover, and the gasket.
32. Install the ventilation tube, and the gasket.
33. Install the engine mounting front brackets together with the engine mounting insulators. Tighten the bolts securely.
34. Install the water outlet housing connection No.1 (1), No.2 (2), and No.3 (3), connect the water hoses, and tighten the clamps.

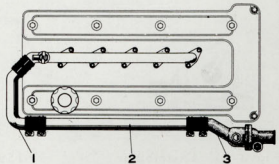


Fig.3-60 Water Outlet Housing Connection Y2352 & Hoses

35. Position the intake manifold gaskets, and install the intake manifolds together with the carburetors, and the water pipe. Tighten the nuts to 1.0 ~ 1.5 m-kg (7 ~ 11 ft-lb) torque.
36. Connect the fuel hoses on each carburetor.

37. Install the accelerator link shaft assembly onto the cylinder head, and connect the accelerator connecting rods to the accelerator link rod arms on the carburetor.

38. Insert the distributor driven gear, and the distributor driven gear sleeve with the gasket. Position the distributor in the distributor driven gear sleeve with the rotor at the No.1 firing position.

Rotate the distributor until the breaker points are just starting to open.

Install the retaining clamp, and tighten the bolts.

The distributor driven gear is provided with a male protrusion, and the distributor shaft is provided with a female slot, and these are off-setted.

For detail installation, and adjustment, refer to DISTRIBUTOR in ENGINE ELECTRICAL SYSTEM.

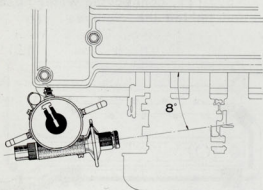


Fig.3-61 Distributor Installation X6159

39. Connect the vacuum line to the fitting on the vacuum advancer.

40. Install the "O" ring onto the tachometer shaft sleeve, then insert the tachometer driven gear together with the tachometer shaft sleeve into the cylinder block.

Install the sleeve lock plate, and tighten the bolt.

41. Install the water pump assembly, and connect the water hoses, and the hose heat protector.

42. Install the alternator with the bracket.

43. Engage the "V" belt, and adjust the tension. The specified tension is 8 ~ 10 mm (0.3 ~ 0.4") when depressed at midway of the belt with 10 kg (22 lb) pressure.

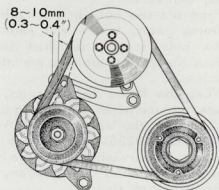


Fig.3-62 "V" Belt Tension X6160

44. Connect the water by-pass hose.

45. Apply a liquid sealer onto the water drain cock threads, and tighten the water drain cock.

46. Install the oil regulator, and the gasket.

47. Install the oil pressure sender gauge.

48. Install the oil filter assembly, tighten firmly with the hand. Never use the Oil Cleaner Band Wrench 09228-41010 to tighten.

49. Install the oil level gauge.

50. Position the gasket, and install the exhaust manifolds. Tighten the nuts to 1.2 ~ 1.6 m-kG (9 ~ 13 ft-lb) torque.

51. Apply a multipurpose grease onto the crankshaft rear oil seal contact surface.

Install the oil seal retainer with the oil seal, and gasket.

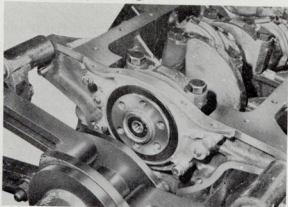


Fig. 3-63 Oil Seal Retainer W9150 Installation

52. Coat the oil pan gasket with a sealer, and install the oil pan onto the cylinder block. Tighten the screws to 40 ~ 70 cm-kg (35 ~ 61 in-lb) torque.
53. Install the oil pump assembly, and connect the oil pump inlet and outlet pipes onto the oil pump, and the oil pan. Next, connect the oil pipe to the oil pan and the oil pressure regulator.
54. Remove the engine from the work stand.
55. If the input shaft front bearing is removed, install the bearing with the Input Shaft Front Bearing Replacer 09304-30012.

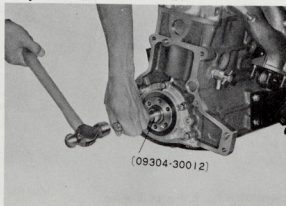


Fig. 3-64 Installing Input Shaft Front Bearing W9151

55. Install the rear end plate.
57. Install the flywheel, and the bolts with the lock plates, then tighten the bolts to 7.2 ~ 7.8 m-kg or 52 ~ 56 ft-lb torque. Lock the bolts with the lock plates.
58. Assemble the clutch cover, and the clutch disc with the Clutch Guide Tool 09301-36010, then insert the end of the Tool into the input shaft front bearing. Tighten the clutch cover to the flywheel retaining bolts to 0.8 ~ 1.3 m-kg (6 ~ 9 ft-lb) torque.

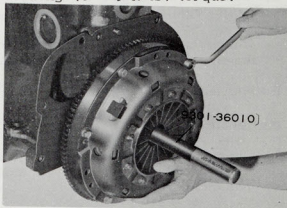


Fig. 3-65 Installing Clutch Cover & Clutch Disc W9152

59. Assemble the transmission with the clutch housing onto the rear end plate.
60. Install the starter onto the rear end plate. Install the flywheel housing under cover, and the dust seal.

Installation

Follow the removal procedures in the reverse order.

1. Refill the engine with coolant, and lubricant. The Long-life engine coolant (permanent-type) used in filling the cooling system in the factory is a high quality solution. The cooling system is made of an aluminum alloy, therefore, always

use a reliable brand long-life engine coolant (permanent-type) to protect the cooling system of this engine.

Oil pan capacity: 6.0 liters (6.34 US qts., 5.28 Imp. qts)

Coolant capacity: 14 liters (14.80 US qts., 12.32 Imp. qts)

2. Check and adjust the clutch release fork free-play. The free-play should be 2 ~ 3 mm (0.08 ~ 0.12").
3. Tune-up the engine by referring to ENGINE TUNE-UP section.
4. Check and if necessary, adjust the engine hood for proper closing.

EXHAUST PIPE & MUFFLER

Removal

1. Disconnect the exhaust front pipes No.1 and No.2 from the exhaust manifolds.

2. Remove the frame cross member No.2.
3. Raise the transmission at the transmission oil pan with a jack placing a piece of wood between the jack and the oil pan.
4. Remove the engine rear mounting member.
5. Loosen the clamps at the front end of the muffler. Remove the muffler supports No.1 (1) and No.2 (2), and then remove the muffler assembly from the exhaust center pipes No.1 (3) and No.2 (4) as shown in figure 3-66.
6. Remove the clamps for exhaust pipe support bracket No.1 (5) and bracket (6), and then remove the exhaust center pipe sub-assembly with exhaust front pipe.

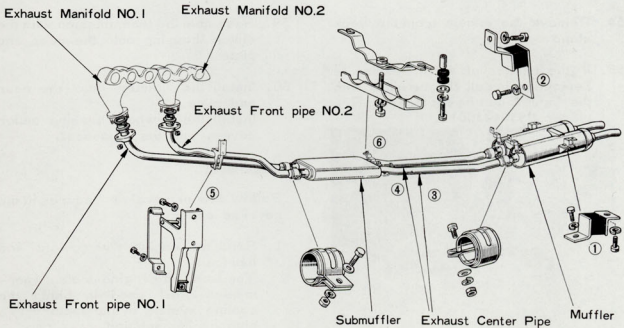


Fig.3-66 Exhaust System

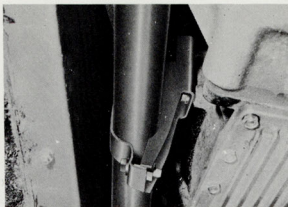


Fig.3-67 Removing Support V1264
Bracket No.1

Inspection

Check each part for cracks or damage. If necessary, replace the part/s.

Installation

To install, follow the removal procedures in the reverse order.

NOTE :

1. When installing the front and center exhaust pipes, care should be taken to have these parts in proper relation with each other.
2. The exhaust pipe should never contact the frame.
3. After starting the engine, check for gas leaks. If defective, apply a sealer into the pipe connections.

* * * * *