SAFETY SERVICING AND REPAIRING

(1) Before working on the engine :
- Stop the engine, and remove the key.
- Allow the engine to cool before proceeding.
- Place the engine on a firm and level surface.
- Disconnect the battery's ground cable.
- Clean the work area and engine.

(2) Do not work on the engine while under the influence of alcohol, medication, or other substances or while fatigued.

(3) Do not wear a necktie, scarf, necklace, loose or bulky clothing when you work near machine tools or moving parts.

(4) Wear a suitable hearing protective device such as earmuffs or earplugs to protect against objectionable or uncomfortable loud noises.

(5) Use tools appropriate to the work. Makeshift tools, parts, and procedures will not make good repairs.

(6) When servicing is performed together by two or more persons, take care to perform all work safely.

(7) If the engine must be running to do some work, make sure the area is well ventilated. Never run the engine in a closed area. The exhaust gas contains poisonous carbon monoxide.

(8) Do not touch the rotating or hot parts while the engine is running.

(9) Fuel is extremely flammable and explosive under certain conditions. Do not smoke or allow flames or sparks in your working area.

(10) To avoid sparks from an accidental short circuit, always disconnect the battery's ground cable first and connect it last.

(11) Sulfuric acid in battery electrolyte is poisonous. It is strong enough to burn skin, clothing and cause blindness if splashed into eyes. Keep electrolyte away from eyes, hands and clothing. If you spill electrolyte on yourself, flush with water, and get medical attention immediately.

(12) Battery gas can explode. Keep sparks and open flame away from the top of battery, especially when charging the battery.

(13) Never remove the radiator cap while the engine is running, or immediately after stopping. Otherwise, hot water will spout out from radiator. Wait for more than ten minutes to cool the radiator, before removing the cap.

(14) Escaping fuel fluid under pressure can penetrate the skin causing serious injury. Relieve pressure before disconnecting fuel lines. Tighten all connections before applying pressure.

(15) Do not start the engine by shorting across starter terminals.

(16) Unauthorized modifications to the engine may impair the function and / or safety and affect engine life.

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SPECIFICATIONS

Model			D1403-B (E)	D1703-B (E)
Number of Cylinders			3	
Type			Vertical, water-cooled, 4-cycle diesel engine	
Bore x Stroke		mm (in.)	80 x 92.4 (3.15 x 3.64)	87 x 92.4 (3.43 x 3.64)
Total Displacement		cm^3 (cu. in.)	1393 (85.01)	1647 (100.55)
Engine	SAE Net Cont.	kW/rpm (HP/rpm)	18.6/2800 (25.0/2800)	22.4/2800 (30.0/2800)
	SAE Net Intermittent	kW/rpm (HP/rpm)	21.6/2800 (29.0/2800)	25.7/2800 (34.5/2800)
	SAE Gross Intermittent	kW/rpm (HP/rpm)	23.1/2800 (31.0/2800)	27.6/2800 (37.0/2800)
	DIN6271-NA	kW/rpm (PS/rpm)	18.4/2800 (25.0/2800)	22.1/2800 (30.0/2800)
	DIN6271-NB	kW/rpm (PS/rpm)	20.6/2800 (28.0/2800)	24.6/2800 (33.5/2800)
	DIN70020	kW/rpm (PS/rpm)	22.1/2800 (30.0/2800)	26.5/2800 (36.0/2800)
Maximum Bare Speed		rpm	3000	
Minimum Idling Speed		rpm	700 to 750	
Combustion Chamber			Spherical Type	
Fuel Injection Pump			Bosch Type Mini Pump (PFR 3M)	
Governor			Centrifugal Ball Mechanical Governor	
Direction of Rotation			Counter-clockwise (Viewed from flywheel side)	
Injection Nozzle			BOSCH Throttle-Type	
Injection Timing			0.314 rad. (18°) Before T.D.C	
Firing Order			1-2-3	
Injection Pressure			13.73 MPa (140 kgf/cm^2, 1991 psi)	
Compression Ratio			23 : 1	
Lubricating System			Forced Lubrication by trochoid Pump	
Oil Pressure Indicating			Electrical Type Switch	
Lubricating Filter			Full Flow Paper Filter (Cartridge Type)	
Cooling System			Pressurized radiation, forced Circulation with Water Pump	
Starting System			Electric Starting with Starter	
			12 V 1.2 kw	
Starting Support Device			By Glow Plug in Combustion Chamber	
Battery			12V 70 to 80 AH	
Dynamo for Charing			12V, 360W	
Fuel			Diesel Fuel No.2-D (ASTM D975)	
Lubricating Oil			Better than CD class (API)	
* Lubricating Oil Capacity	Oil pan depth 90 mm (3.54 in.)		5.6 ℓ (1.48 US gals, 1.23 Imp gals)	
	Oil pan depth 124 mm (4.88 in.)		7.0 ℓ (1.85 US gals, 1.54 Imp gals)	
Weight (Dry)		kg (lbs)	148 (326)	

*90 mm (3.54 in.) Oil pan depth is optional

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[4] TROUBLESHOOTING

Symptom	Probable Cause	Solution	Reference Page
Engine does not start	• No fuel	Replenish fuel	
	• Air in the fuel system	Vent air	
	• Water in the fuel system	Change fuel and repair or replace fuel system	
	• Fuel pipe clogged	Clean	
	• Fuel filter clogged	Clean or change	S-41
	• Excessively high viscosity of fuel or engine oil at low temperature	Use the specified fuel or engine oil	S-39
	• Fuel with low cetane number	Use the specified fuel	
	• Fuel leak due to loose injection pipe retaining nut	Tighten nut	
	• Incorrect injection timing	Adjust	S-105
	• Fuel cam shaft worn	Replace	
	• Injection nozzle clogged	Clean	
	• Injection pump malfunctioning	Repair or replace	
	• Seizure of crankshaft, camshaft, piston, cylinder liner or bearing	Repair or replace	
	• Compression leak from cylinder	Replace head gasket, tighten cylinder head bolt, glow plug and nozzle holder	S-53
	• Improper valve timing	Correct or replace timing gear	
	• Piston ring and liner worn	Replace	S-87, 19
	• Excessive valve clearance	Adjust	S-43
Starter does not run	• Battery discharged	Charge	
	• Starter malfunctioning	Repair or replace	
	• Key switch malfunctioning	Repair or replace	
	• Wiring disconnected	Connect	
Engine revolution is not smooth	• Fuel filter clogged or dirty	Clean or change	S-41
	• Air cleaner clogged	Clean or change	S-41
	• Fuel leak due to loose injection pipe retaining nut	Tighten nut	
	• Injection pump malfunctioning	Repair or replace	
	• Incorrect nozzle opening pressure	Adjust	S-107
	• Injection nozzle stuck or clogged	Repair or replace	
	• Fuel over flow pipe clogged	Clean	
	• Governor malfunctioning	Repair	
Either white or blue exhaust gas is observed	• Excessive engine oil	Reduce to the specified level	
	• Piston ring and liner worn or stuck	Repair or replace	S-87, 19
	• Incorrect injection timing	Adjust	S-105
	• Deficient compression	Adjust top clearance	S-53
Either black or dark gray exhaust gas is observed	• Overload	Lessen the load	
	• Low grade fuel used	Use the specified fuel	
	• Fuel filter clogged	Clean or change	
	• Air cleaner clogged	Clean or change	
	• Deficient nozzle injection	Repair or replace the nozzle	
Deficient output	• Incorrect injection timing	Adjust	S-105
	• Engine's moving parts seem to be seizing	Repair or replace	
	• Uneven fuel injection	Repair or replace the injection pump	
	• Deficient nozzle injection	Repair or replace the nozzle	S-107
	• Compression leak	Replace head gasket, tighten cylinder head bolt, glow plug and nozzle holder	

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[6] MAINTENANCE CHECK LIST

To maintain long-lasting and safe engine performance, make it a rule to carry out regular inspections by following the table below.

Item		Service Interval										
		Every 50 hrs	Every 75 hrs	Every 100 hrs	Every 150 hrs	Every 200 hrs	Every 300 hrs	Every 400 hrs	Every 500 hrs	Every 800 hrs	Every one year	Every two years
Checking fuel pipes and clamps		○										
* Changing engine oil	(1) Oil pan depth (90 mm)		○									
	(2) Oil pan depth (124 mm)			○								
	(3) Oil pan depth (90 mm)				○							
	(4) Oil pan depth (124 mm)					○						
Cleaning air filter element				○								
Cleaning fuel filter element				○								
Checking fan belt tension and damage				○								
Checking water pipes and clamps						○						
* Changing oil filter cartridge	(5) Oil pan depth (90 mm)				○							
	(6) Oil pan depth (124 mm)					○						
	(7) Oil pan depth (90 mm)						○					
	(8) Oil pan depth (124 mm)							○				
Changing fuel filter cartridge								○				
Cleaning radiator interior									○			
Changing radiator cleaner and coolant												○
Changing air filter element											○	
Checking valve clearance										○		
Changing water pipes and clamps												○
Changing fuel pipes and clamps												○

(1), (2) For generators (3000 / 3600 rpm)
(3), (4) For generators (1800 / 1500 rpm) and general construction / industrial machinery and farm equipment
(5), (6) For generators (3000 / 3600 rpm) and general construction / industrial machinery and farm equipment
(7), (8) For generators (1800 / 1500 rpm)

* Change engine oil and oil cartridge after the first 50 hours of operation.

CAUTION

- **When changing or inspecting, be sure to level and stop the engine.**

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[3] TIGHTENING TORQUES

Screws, bolts and nuts must be tightened to the specified torque using a torque wrench, Several screws, bolts and nuts such as those used on the cylinder head must be tightened in proper sequence and at the proper torque.

(1) Tightening torques for special use screws, bolts and nuts

■ **NOTE**

- **For "*" marked screws, bolts and nuts on the table, apply engine oil to their threads and seats before tightening.**
- **After well cleaning its thread and bearing surface, fit a new head bolt (rust-preventive oil applied) without applying engine oil to it.**
- **When reusing the head bolt, apply engine oil to its thread and bearing surface before fitting it. After installing the engine, let it run for 30 minutes, and retighten the head bolt. (Before retightening it, loosen it by 30 to 90°.)**

Item	Size x Pitch	N·m	kgf·m	ft-lbs
Head cover cap nut	M8 x 1.25	6.9 to 8.8	0.7 to 0.9	5.1 to 6.5
* Head bolt	M11 x 1.25	93.1 to 98.0	9.5 to 10.0	68.7 to 72.3
* Bearing case bolt 1	M9 x 1.25	46.1 to 50.9	4.7 to 5.2	34.0 to 37.6
* Bearing case bolt 2	M10 x 1.25	68.6 to 73.5	7.0 to 7.5	50.6 to 54.2
* Flywheel bolt	M12 x 1.25	98.0 to 107.8	10.0 to 11.0	72.3 to 79.5
* Connecting rod bolt				
(Non-flange bolt)	M8 x 1.0	36.3 to 41.2	3.7 to 4.2	26.6 to 30.4
(flange bolt)	M8 x 1.0	44.1 to 49.0	4.5 to 5.0	32.5 to 36.2
* Rocker arm bracket nut	M8 x 1.25	22.5 to 27.5	2.4 to 2.8	17.4 to 20.3
* Idle gear shaft bolt	M8 x 1.25	22.5 to 27.5	2.4 to 2.8	17.4 to 20.3
* Crankshaft end nut	M30 x 1.5	137.3 to 156.9	14.0 to 16.0	101.2 to 115.7
Crankshaft end bolt (F2803-B(E))	M16 x 1.5	313.8 to 333.4	32.0 to 34.0	231.4 to 245.9
Glow plug	M10 x 1.25	19.6 to 24.5	2.0 to 2.5	14.5 to 18.1
Nozzle holder assembly	M20 x 1.5	49.0 to 68.6	5.0 to 7.0	36.2 to 50.6
Oil switch taper screw	PT 1/8	14.7 to 19.6	1.5 to 2.0	10.8 to 14.5
Injection pipe retaining nut	M12 x 1.5	24.5 to 34.3	2.5 to 3.5	18.1 to 25.3

(2) Tightening torques for general use screws, bolts and nuts

When the tightening torques are not specified, tighten the screws, bolts and nuts according to the table below.

Grade / Nominal Diameter / Unit	Standard Screw and Bolt (4) SG00F004			Special Screw and Bolt (7)		
	N·m	kgf·m	ft-lbs	N·m	kgf·m	ft-lbs
M 6	7.9 to 9.3	0.80 to 0.95	5.8 to 6.9	9.8 to 11.3	1.00 to 1.15	7.23 to 8.32
M 8	17.7 to 20.6	1.8 to 2.1	13.0 to 15.2	23.5 to 27.5	2.4 to 2.8	17.4 to 20.3
M10	39.2 to 45.1	4.0 to 4.6	28.9 to 33.3	48.1 to 55.9	4.9 to 5.7	35.4 to 41.2
M12	62.8 to 72.6	6.4 to 7.4	46.3 to 53.5	77.5 to 90.2	7.9 to 9.2	57.1 to 66.5

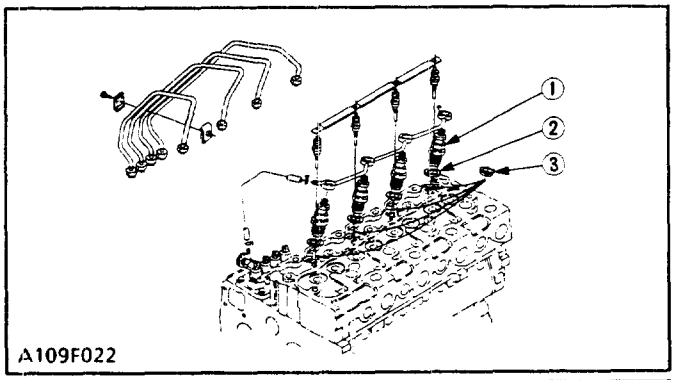
Screw and bolt material grades are shown by numbers punched on the screw and bolt heads. Prior to tightening, be sure to check out the numbers as shown below.

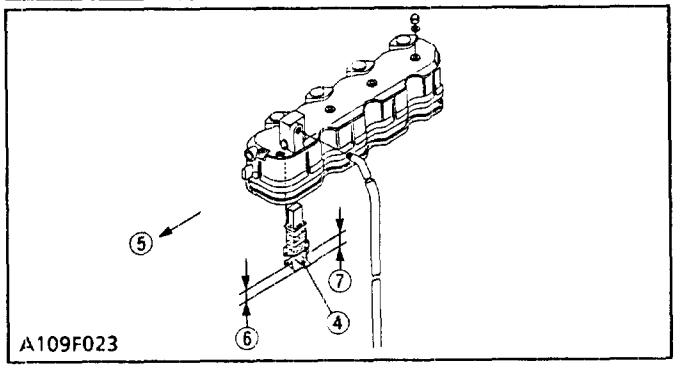
Punched Number	Screw and Bolt Material Grade
None or **4**	Standard Screw and Bolt SS41, S20C
7	Special Screw and Bolt S43C, S48C (Refined)

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[3] CYLINDER HEAD AND VALVES





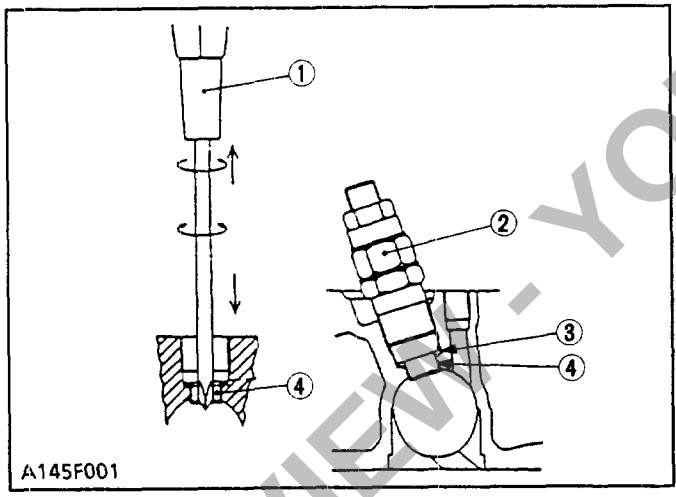
Cylinder Head Cover and Nozzle Holder

1. Remove the injection pipes and overflow pipes.
2. Remove the glow plugs.
3. Remove the nozzle holder and copper gaskets.
4. Remove the heat seal.
5. Remove the head cover.

(When reassembling)

- Check to see that the cylinder head cover gasket is not defective.
- Be sure to place the heat seal (3) and breather oil shield (4) (See Fig).

(1) Nozzle Holder
(2) Copper Gasket
(3) Heat Seal
(4) Breather Oil Shield
(5) Gear Case Side
(6) Short Plate
(7) Long Plate



Nozzle Heat Seal Service Removal Procedure

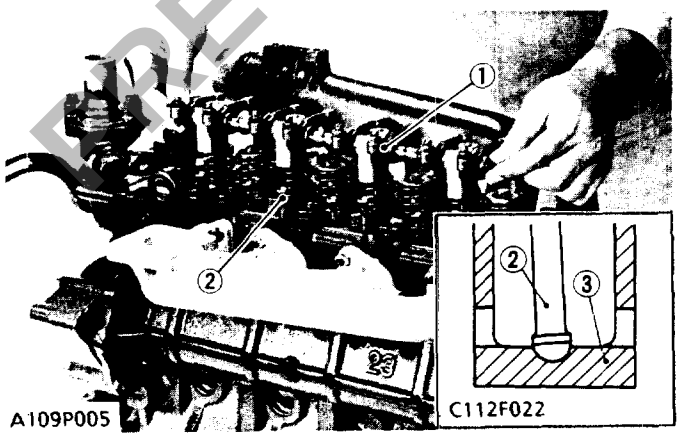
■ IMPORTANT

- **Use a plus (phillips head) screw driver that has a Dia. which is bigger than the heat seal hole (Approx. 6 mm) 1/4 in..**

1. Drive screw driver lightly into the heat seal hole.
2. Turn screw driver three or four times each way.
3. While turning the screw driver, slowly pull the heat seal out together with the injection nozzle gasket.

   If the heat seal drops, repeat the above procedure. Heat seal and injection nozzle gasket must be changed when the injection nozzle is removed for cleaning or for service.

(1) Plus Screw Driver
(2) Injection Nozzle
(3) Injection Nozzle Packin
(4) Heat Seal



Rocker Arm, Push Rod and In./Ex. Manifold

1. Remove the rocker arm as a unit.
2. Remove the push rods.
3. Remove the In./Ex. manifold.

(When reassembling)

- When putting the push rods onto the tappets, check to see if their ends are properly engaged with the grooves.

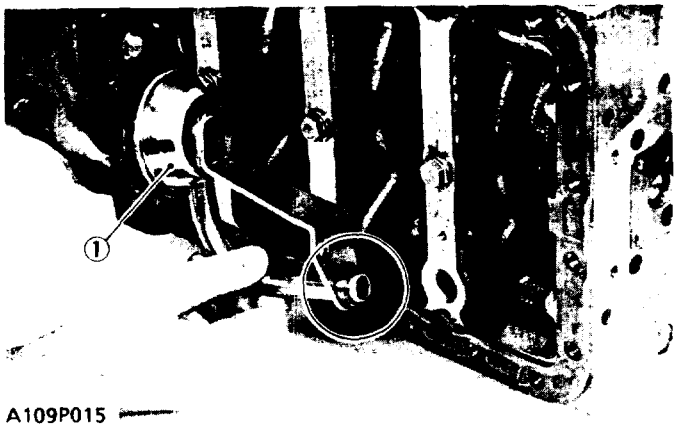
■ IMPORTANT

- **After reassembling the rocker arm, be sure to adjust the valve clearance.**

(1) Rocker Arm
(2) Push Rod
(3) Tappet

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[5] PISTON AND CONNECTING ROD



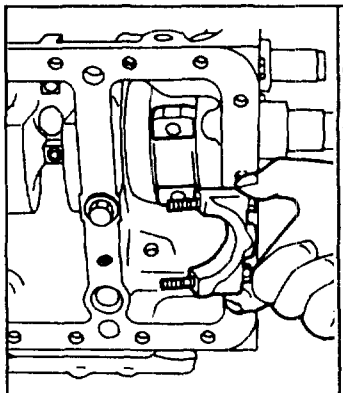
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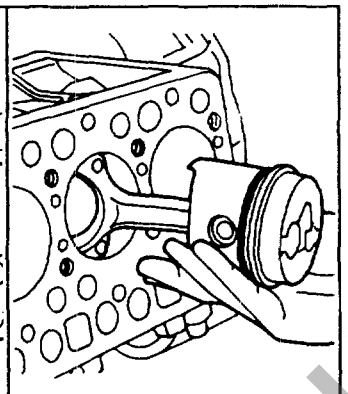
Oil Pan and Oil Strainer

1. Remove the oil pan and strainer (1).

(When reassembling)
- After cleaning the oil strainer, install it.
- Install the oil strainer (1), being careful not to damage the O-ring.
- Apply a liquid gasket (Three Bond 1215 or equivalent) to both sides of the oil pan gasket.
- To avoid uneven tightening, tighten mounting bolts in diagonal order from the center.

(1) Oil Strainer

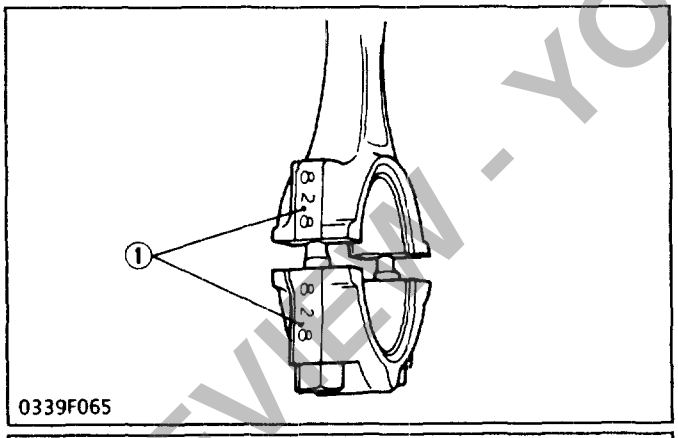

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Piston

1. Turn the flywheel, and bring the piston to the bottom dead center.
2. Remove the connecting rod bolt and take off the connecting rod cap.
3. Turn the flywheel, and bring the piston to the top dead center.
4. Pull out the piston upward by lightly tapping it from the bottom of the crankcase with the grip of a hammer.

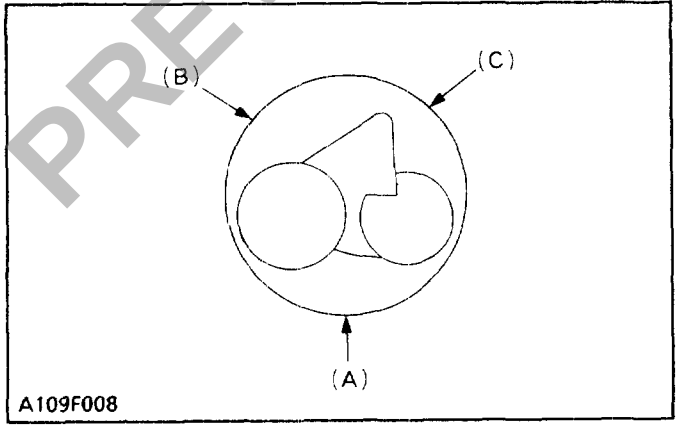
(When reassembling)
- Apply engine oil to the piston, piston ring and cylinder bore.
- When inserting the piston into the cylinder, face the number (1) on the connecting rod to the injection pump.
- Align the number (1) on the connecting rod and connecting rod cap.
- Apply engine oil to the crank pin bearings and bolts.



0339F065

Tightening torque	Connecting rod bolt	Non-Flange bolt	36.3 to 41.2 N·m 3.7 to 4.2 kgf·m 26.6 to 30.4 ft-lbs
		Flange bolt	44.1 to 49.0 N·m 4.5 to 5.0 kgf·m 32.5 to 36.2 ft-lbs

■ IMPORTANT
- **Do not change the combination of cylinder and piston. Make sure of the position of each piston by marking.**
- **The oil ring's edge is hard-chromium plated; and when inserting the piston into the cylinder, make certain the piston ring compressor is tight so that the oil ring is not caught by the cylinder, peeling off the plating.**
- **Place the piston rings so that there are gaps every 120° (2.09 rad.) with no gap facing the piston pin in the cylinder. (See Fig.)**



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(1) Align the mark

(A) Top Ring Gap
(B) Second Ring Gap
(C) Oil Ring Gap

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2 LUBRICATING SYSTEM

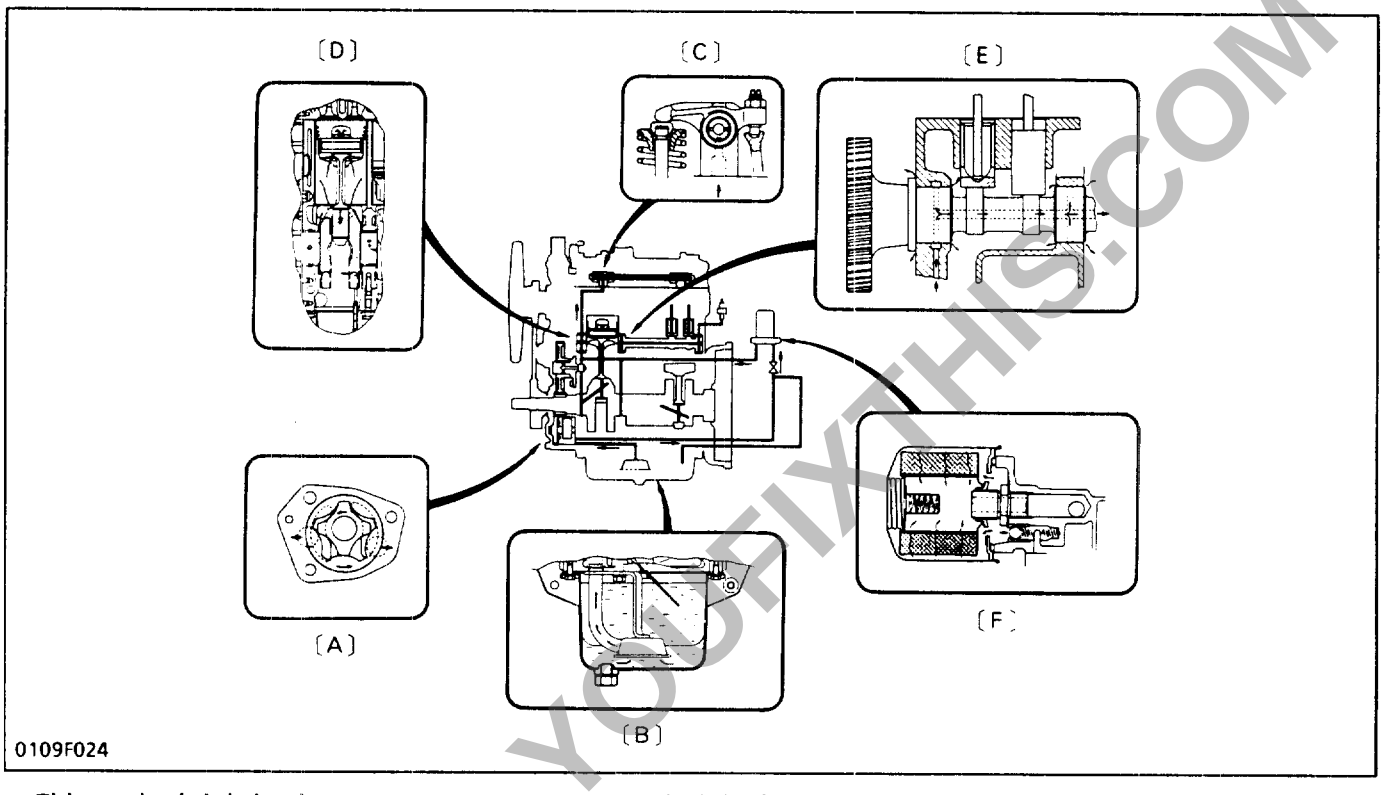
2 SYSTEME DE LUBRIFICATION

2 SCHMIERUNGS-SYSTEM

[1] GENERAL

[1] GENERALITES

[1] ALLGEMEINES



This engine's lubricating system consists of oil strainer, oil pump, relief valve, oil filter cartridge and oil switch. The oil pump sucks lubricating oil from the oil pan through the oil strainer and the oil flows down to the filter cartridge, where it is further filtered. Then the oil is forced to crankshaft, connecting rods, idle gear, camshaft and rocker arm shaft to lubricate each part. Some part of oil, splashed by the crankshaft or leaking and dropping from gaps of each part, lubricates these parts: pistons, cylinders, small ends of connecting rods, tappets, pushrods, inlet and exhaust valves and timing gears.

[A] Oil Pump
[B] Oil Strainer
[C] Rocker Arm and Rocker Arm Shaft
[D] Piston
[E] Camshaft
[F] Oil Filter Cartridge and Relief Valve

Le système de lubrification du moteur se compose d'une crépine, d'une pompe à huile, d'une soupape de décharge, d'un filtre à huile à cartouche et d'un manocontact de pression d'huile. La pompe à huile aspire l'huile du carter par l'intermédiaire de la crépine et la force au travers de la cartouche filtre, qui en assure une filtration plus parfaite. Ensuite, l'huile est forcée vers le vilebrequin, les bielles, le pignon de renvoi, l'arbre à cames et l'axe de culbuteurs, afin de lubrifier toutes ces pièces.

L'huile éclaboussée par le vilebrequin ou dégouttant des orifices des différentes pièces lubrifie les pièces suivantes: pistons, cylindres, pied de bielle et bielle, poussoirs, tiges de poussoirs, soupapes d'admission et d'échappement et pignons de distribution.

[A] Pompe à huile
[B] Crépine
[C] Culbuteur et axe de culbuteur
[D] Piston
[E] Arbre à cames
[F] Cartouche de filtre à huile et soupape de décharge

Dieses Motorschmierungssystem umfaßt den Ölfilter, die Ölpumpe, das Überdruckventil, die Ölfilterpatrone und den Ölschalter. Die Ölpumpe saugt das Schmierungsöl aus der Ölwanne durch den Ölfilter an. Das Öl fließt sodann in die Filterpatrone, wo es weiter gefiltert wird. Anschließend wird das Öl zur Kurbelwelle sowie zu den Pleuelstangen, dem Leerlaufgetriebe, der Nockenwelle und der Kipphebelachse gepreßt und sorgt für dir Schmierung eines jeden dieser Teile. Ein Teil des Öls, der von der Kurbelwelle abgeschleudert wird oder an den Zwischenräumen der Teile austritt und heruntertropft, übernimmt die Schmierung dieser Teile: Kolben, Zylinder, Pleuelstangenkopf, Stößel, Stößelstangen, Ein- und Auslaßventile und Steuerungen.

[A] Ölpumpe
[B] Ölfilter
[C] Kipphebel und Kipphebelachse
[D] Kolben
[E] Nockenwelle
[F] Ölfilterpatrone und Überdruckventil

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