WSM

WORKSHOP MANUAL
DIESEL ENGINE
MANUAL D'ATELIER
MOTEUR DIESEL
WERKSTATTANLEITUNG
DIESELMOTOR

70mm STROKE SERIES
MOTEUR DE 70mm DE COURSE
SERIENMOTOR MIT 70mm HUB

Kubota

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Cummins Power Generation

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SPECIFICATIONS

Model		Z500-B	Z600-B	ZH600-B	D650-B	D750-B
Number of Cylinders		2			3	
Type		Vertical, water-cooled, 4-cycle diesel engine				
Bore x Stroke mm (in.)		68 x 70 (2.68 x 2.76)	72 x 70 (2.83 x 2.76)		64 x 70 (2.52 x 2.76)	68 x 70 (2.68 x 2.76)
Total Displacement cm^3 (cu. in.)		508 (31.00)	570 (34 78)		675 (41.2)	762 (46.5)
Brake Horsepower	SAE Net Cont. kW/rpm (HP/rpm)	6.3/3000 (8.5/3000)	8.2/3200 (11/3200)	8.6/3600 (11.5/3600)	8.6/3000 (11.5/3000)	9.7/3000 (13.0/3000)
	SAE Net Intermittent kW/rpm (HP/rpm)	7.46/3000 (10.0/3000)	9.3/3200 (12.5/3200)	10.4/3600 (14.0/3600)	9.7/3000 (13.0/3000)	11.2/3000 (15.0/3000)
	SAE Gross Intermittent kW/rpm (HP/rpm)	8.2/3000 (11.0/3000)	10.4/3200 (13.8/3200)	11 5/3600 (15.5/3600)	11 2/3000 (14.3/3000)	12.7/3000 (16.5/3000)
	DIN6271-NA kW/rpm (PS/rpm)	6.25/3000 (8.5/3000)	8.1/3200 (11.0/3200)	8.5/3600 (11.5/3600)	8.5/3000 (11.5/3000)	9.6/3000 (13.0/3000)
	DIN6271-NB kW/rpm (PS/rpm)	7.0/3000 (9.5/3000)	8.8/3200 (12.0/3200)	9.9/3600 (13.5/3600)	9.2/3000 (12.5/3000)	10.7/3000 (14.5/3000)
	DIN70020 kW/rpm (PS/rpm)	7 7/3000 (10.5/3000)	9 6/3200 (13.0/3200)	10 7/3600 (14.5/3600)	10.3/3000 (14.0/3000)	11 8/3000 (16.0/3000)
Maximum Bare Speed rpm		3200	3500	3780	3200	
Minimum Idling Speed rpm		800				
Maximum torque N-m/rpm		28.0/1800	32 9/2000	33 2/2000	36.5/1800	42.2/1800
kgf-m/rpm		2.86/1800	3.36/2000	3.39/2000	3.72/1800	4.30/1800
ft-lbs/rpm		20.72/1800	24.29/2000	24.52/2000	26.94/1800	31.08/1800
Combustion Chamber		Spherical Type				
Fuel Injection Pump		Bosch K Type Mini Pump				
Governor		Centrifugal Ball Mechanical Governor				
Direction of Rotation		Counter-clockwise (viewed from flywheel side)				
Injection Nozzle		Bosch Throttle Type				
Injection Timing		25° (0.44 rad.) before T.D.C.				
Firing Order		1 – 2			1 – 2 – 3	
Injection Pressure		140 kgf/cm^2 (13.73 MPa, 1991 psi)				
Compression Ratio		22:1				
Lubricating System		Forced Lubrication by Pump				
Oil Pressure Indicating		Electrical Type Switch				
Lubricating Filter		Full Flow Paper Filter (Cartridge Type)				
Cooling System		Pressurized Radiator, Forced Circulation with Water Pump (Not included in the basic engine)				
Starting System V, kW		Electric Starting with Starter (12, 0.8)			Electric Starting with Starter (12, 0.8)	
Starting Support Device		By Glow Plug in Combustion Chamber				
Battery		12V, 45AH, equivalent			12V, 65AH, equivalent	
Dynamo for Charging		12 V, 150 W				
Fuel		Diesel Fuel No.2–D (ASTM D975)				
Lubricating Oil		MIL-L-46152, MIL-L-2104C, quality better than CC class (API)				
Lubricating Oil Capacity ℓ		2.55 (2.70 U.S. qts., 2.24 Imp. qts.)			4.6 (4.86 U.S. qts , 4 05 Imp qts)	
Weight (Dry) kg (lbs)		69.7 (153.7)	70.5 (155.5)		82.6 (182.1)	82.1 (181.0)
Application		General Power Source				

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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	S-37
	• 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-113
	• 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-55
	• Improper valve timing	Correct or replace timing gear	
	• Piston ring and liner worn	Replace	S-103
	• 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-37
	• 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-115
	• 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-91
	• Incorrect injection timing	Adjust	S-113
	• Deficient compression	Adjust top clearance	S-55.
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 output	• Incorrect injection timing	Adjust	S-113
	• 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-55
	• 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 100 hrs	Every 150 hrs	Every 200 hrs	Every 400 hrs	Every 800 hrs	Every 1000 hrs	Every three months	Every one year	Every two years
Checking fuel pipes and clamps	O									
Changing engine oil *		O								
Cleaning air filter element		O								
Cleaning fuel filter		O								
Checking fan belt tension and damage		O								
Checking water pipes and clamps			O							
Changing oil filter cartridge *				O						
Changing fuel filter element					O					
Cleaning radiator interior					O					
Changing radiator cleaner and coolant								O		
Changing air filter element									O	
Checking valve clearance						O				
Checking nozzle injection pressure							O			
Changing water pipes and clamps										O
Changing fuel pipes and clamps										O

* Change engine oil and oil filter 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 tighten 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.**

Item	Size x Pitch	N·m	kgf·m	ft-lbs
* Head cover cap nuts	M7 x 1.0	6.9 to 8.8	0.7 to 0.9	5.1 to 6.5
* Head screws and nuts (Z500-B only)	M8 x 1.25	39.2 to 44.1	4.0 to 4.5	28.9 to 32.5
(Others)	M9 x 1.25	64.7 to 69.6	6.6 to 7.1	47.7 to 51.4
* Bearing case screws 1				
(Flange bolts)	M7 x 1.0	26.5 to 30.4	2.7 to 3.1	19.5 to 22.4
(Non-flange bolt)	M7 x 1.0	19.6 to 23.5	2.0 to 2.4	14.5 to 17.4
* Bearing case screws 2	M8 x 1.25	29.4 to 34.3	3.0 to 3.5	21.7 to 25.3
* Flywheel screws				
(Flange bolts)	M10 x 1.25	58.8 to 63.7	6.0 to 6.5	43.4 to 47.0
(Non-flange bolts)	M10 x 1.25	53.9 to 58.8	5.5 to 6.0	39.8 to 43.4
* Connecting rod screws	M7 x 0.75	26.5 to 30.4	2.7 to 3.1	19.5 to 22.4
* Rocker arm bracket nuts	M7 x 1.0	16.7 to 20.6	1.7 to 2.1	12.3 to 5.2
* Idle gear shaft screws	M6 x 1.0	9.8 to 11.3	1.00 to 1.15	7.2 to 8.3
Glow plugs	M10 x 1.25	19.6 to 24.5	2.0 to 2.5	14.5 to 18.1
Drain plug	M12 x 1.25	39.2 to 49.0	4.0 to 5.0	28.9 to 36.2
Nozzle holder assembly	M24 x 2.0	29.4 to 49.0	3.0 to 5.0	21.7 to 36.2
Oil switch taper screw	PT 1/8	14.7 to 19.6	1.5 to 2.0	10.8 to 14.5
Fuel limit lock nut	M12 x 1.0	27.5 to 34.3	2.8 to 3.5	20.3 to 25.3
Fuel limit cap nut	M12 x 1.0	24.5 to 29.4	2.5 to 3.0	18.1 to 21.7
Injection pipe retaining nuts	M12 x 1.5	14.7 to 24.5	1.5 to 2.5	10.8 to 8.1
Nozzle holder and nozzle retaining nut		58.8 to 78.5	6.0 to 8.0	43.4 to 57.9
Nozzle holder mounting screw	M24 x 2.0	39.2 to 49.0	4.0 to 5.0	28.9 to 36.2
* Crankshaft nut	M20 x 1.5	137.3 to 156.9	14.0 to 16.0	101.3 to 115.7

(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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[4] GEAR CASE



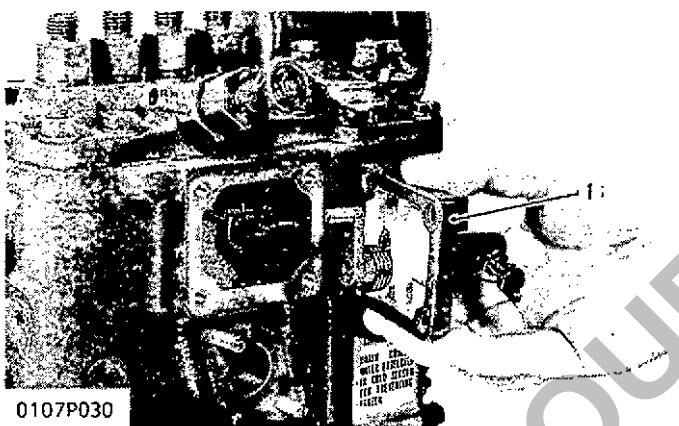
Fuel Feed Pump

1. Loosen the pipe clamp and remove the fuel pipe from the injection pump side.
2. Remove the fuel feed pump mounting nuts.
3. Remove the fuel feed pump (1).

(When reassembling)

- Apply a liquid gasket (Three Bond 1215 or equivalent) to the both sides of fuel feed pump gasket.

(1) Fuel Feed Pump



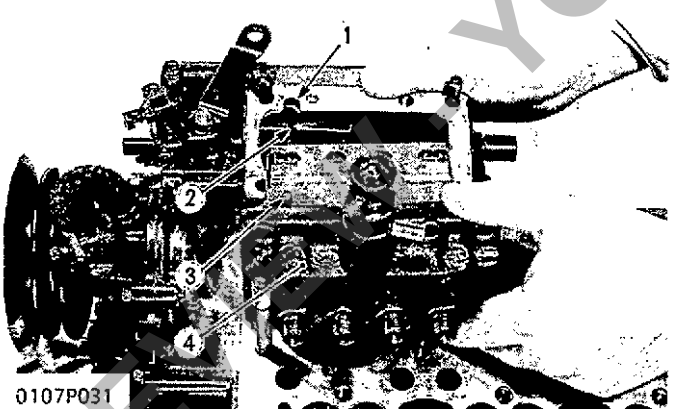
Injection Pump Cover

1. Remove the injection pump cover (1).

(When reassembling)

- Apply a liquid gasket (Three Bond 1215 or equivalent) to the both sides of injection pump cover gasket.

(1) Injection Pump Cover

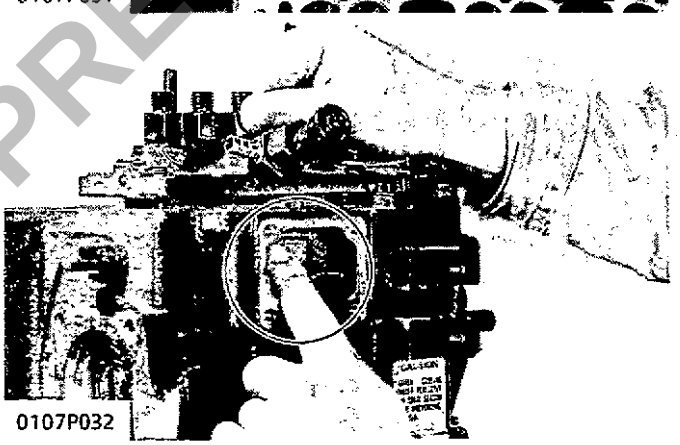


Injection Pump

1. Remove the injection pump mounting screws and nuts.
2. Align the control rack pin (3) with the notch (1) on the crankcase, and remove the injection pump (4).
3. Remove the injection pump shims.
4. In principle, the injection pump should not be disassembled.

(When reassembling)

- When installing the injection pump, insert the control rack pin (3) firmly into the groove (2) of the fork lever 1.
- Addition or reduction of one shim delays or advances the injection timing by 1.5° (0.026 rad).



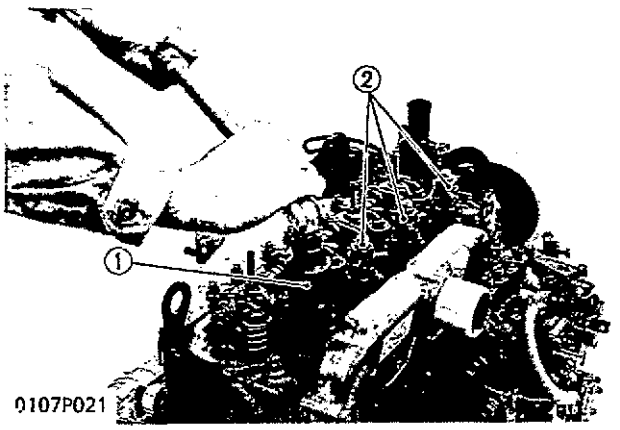
■ IMPORTANT

- Insert the same number of shims as used before between crank case and pump, and then check the injection timing.
- Apply a thin coat of liquid gasket (Three Bond 1215 or equivalent) to the shims.

(1) Notch
(2) Groove
(3) Control Rack Pin
(4) Injection Pump

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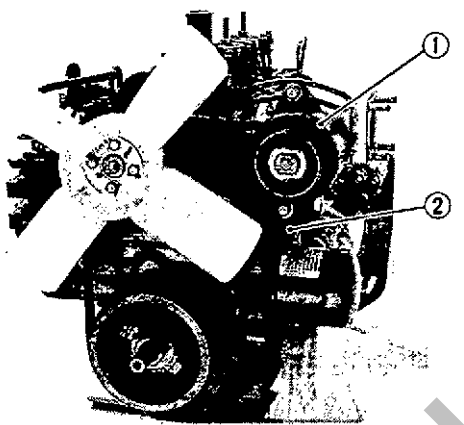


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Nozzle Holder Assembly

1. Remove the fuel overflow pipes.
2. Loosen the lock nuts, and remove the nozzle holder assemblies with a nozzle holder socket wrench 27 (1).
3. Remove the copper gaskets on the seats.

(1) Nozzle Holder Socket Wrench
(2) Nozzle Holder Assembly



0076P013

Alternator and Fan Belt

1. Remove the alternator (1).
2. Remove the fan belt (2).

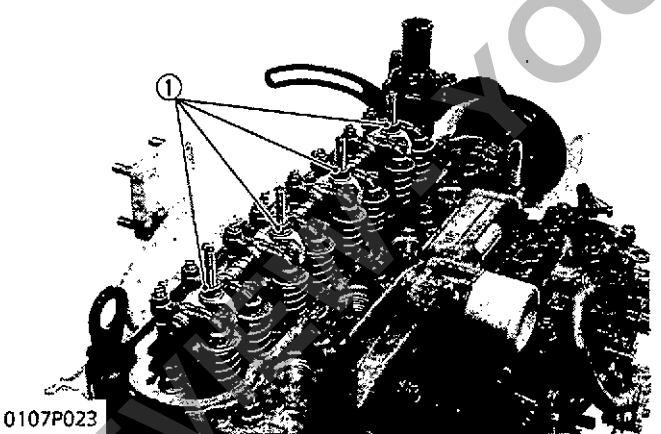
(When reassembling)

- Check to see that there are no cracks on the belt surface.

■ IMPORTANT

- **After reassembling the fan belt, be sure to adjust the fan belt tension.**

(1) Alternator
(2) Fan Belt



0107P023

Rocker Arm

1. Remove the rocker arm bracket mounting nuts (1).
2. Remove the rocker arm as a unit.

■ IMPORTANT

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

(1) Rocker Arm Bracket Mounting Nuts



0107P024

Push Rod

1. Remove the push rods.

(When reassembling)

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

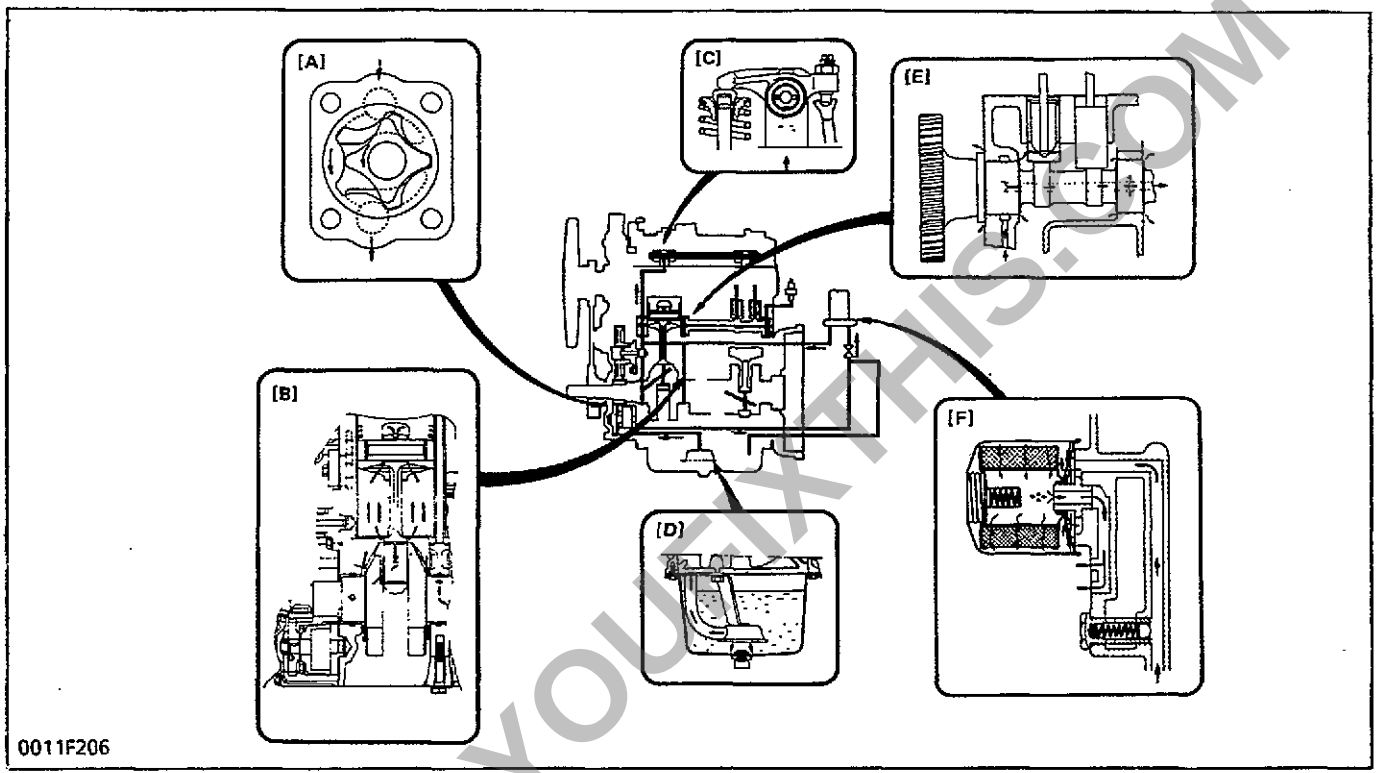
(1) Push Rod

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2 LUBRICATING SYSTEM

[1] GENERAL



This engine lubricating 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] Piston
[C] Rocker Arm and Rocker Arm Shaft
[D] Oil Strainer
[E] Camshaft
[F] Oil Filter Cartridge and Relief Valve

2 SYSTEME DE LUBRIFICATION

[1] GENERALITES

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

2 SCHMIERUNGS-SYSTEM

[1] ALLGEMEINES

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

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Valve Timing

Item		Factory Specification	Allowable Limit
Intake valve	Open	20° (0.35 rad.) before T.D.C.	–
	Close	45° (0.79 rad.) after B.D.C.	–
Exhaust valve	Open	50° (0.87 rad.) before B.D.C.	–
	Close	15° (0.26 rad.) after T.D.C.	–

Valve Spring

Free length	35.1 to 35.6 mm 1.382 to 1.401 in.	34.8 mm 1.370 in.
Setting load / setting length	7.5 kgf/31.0 mm 73.5 N/31.0 mm, 16.5 lbs/1.22 in.	6.4 kgf/31.0 mm 62.8 N/31.0 mm, 14.1 lbs/1.22 in.
Tilt	–	1.3 mm 0.051 in.

Rocker Arm

Clearance between rocker arm shaft and bearing	0.016 to 0.068 mm 0.0006 to 0.0027 in.	0.12 mm 0.0047 in.
Rocker arm shaft O.D.	10.973 to 10.984 mm 0.4320 to 0.4324 in.	–
Rocker arm bearing I.D.	11.000 to 11.041 mm 0.4331 to 0.4347 in.	–

Tappet

Clearance between tappet and guide	0.020 to 0.062 mm 0.0008 to 0.0024 in.	0.1 mm 0.0039 in.
Tappet O.D.	19.959 to 19.980 mm 0.7858 to 0.7866 in.	–
Tappet guide I.D.	20.000 to 20.021 mm 0.7874 to 0.7882 in.	–

Camshaft

Camshaft side clearance	0.07 to 0.22 mm 0.0028 to 0.0087 in.	0.3 mm 0.0118 in.
Camshaft alignment	–	0.01 mm 0.0004 in.
Cam height (IN., EX.)	26.88 mm 1.0583 in.	26.83 mm 1.0563 in.
Oil clearance of camshaft	0.050 to 0.091 mm 0.0020 to 0.0036 in.	0.15 mm 0.0059 in.
Camshaft journal O.D.	32.934 to 32.950 mm 1.2966 to 1.2972 in.	
Camshaft bearing I.D.	33.000 to 33.025 mm 1.2992 to 1.3002 in.	

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FÜR DEN LESER

Dieses Handbuch soll dem Wartungspersonanl Informationen über die Funktion, den Betrieb und die Wartung der KUBOTA-Dieselmotoren Serienmotormit 70 mm Hub liefern. Es ist in zwei Teile, "Funktion" und "Ausbau und Wartung" aufgegliedert.

■ **Mechanismus**

Für jeden Motorabschnitt werden Informationen bezüglich Konstruktion und Funktion gegeben. Dieser Teil sollte sorgfältig gelesen werden, bevor mit der Störungssuche, dem Ausbau und der Wartung begonnen wird.

■ **Ausbau und Wartung**

Der Abschnitt "allgemeines" beinhaltet allgemeine Vorkehrungen, Störungssuchen und Listen von Wartungsdaten sowie von regelmäßig zu überprüfenden Teilen. Für jeden Motorabschnitt ist ein Kapitel "Prüfung und Einstellung", "Aus- und Einbau" und "Wartung" vorgesehen, welches über Verfahrensweisen, Vorkehrungen, Werkdaten und zulässige Grenzwerte Aufschluß gibt.

Allen in diesem Hanbuch enthaltenen Informationen, Abbildungen und technischen Merkmalen liegen die letzten, zum Zeitpunkt der Veröffentlichung verfügbaren Informationen zugrunde. Eine Änderung aller Informationen zu jeder Zeit und ohne Ankündigung bleibt vorbehalten.

Da in diesem Handbuch mehrere Modelle beschrieben werden, wurden die jeweilig verwendeten abbildungen oder Bilder nicht für ein einzelnes Modell präzisiert.

Apr. '88

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[6] LISTE DES VERIFICATION D'ENTRETIEN

Pour conserver longtemps la fiabilité et la sécurité du moteur, procéder aux inspections periodiques cuivantes.

Elément	Périodes d'entretien									
	Toutes les 50 hrs	Toutes les 100 hrs	Toutes les 150 hrs	Toutes les 200 hrs	Toutes les 400 hrs	Toutes les 800 hrs	Toutes les 1000 hrs	Tous les les 3 mois	Une fois par an	Une fois tous les 2 ans
Vérification des conduits d'alimentqation et des étriers	o									
Changer de l'huile moteur *		o								
Nettoyage de l'élément de filtre à air		o								
Nettoyage du filtre à carburant		o								
Vérification de la tension de la courroie de ventilateur et de son état		o								
Vérification des conduits d'eau et des étriers			o							
Renouvellement de la cartouche du filtre à huile *				o						
Renouvellement de l'élément de filtre à carburant					o					
Nettoyage de l'intérieur du radiateur					o					
Renouvellement du filtre de radiateur et du liquide de refroidissement								o		
Renouvellement de l'élément de filtre à air									o	
Vérification du jeu des soupapes						o				
Vérification de la pression d'injection							o			
Renouvellement des conduits d'eau et de étriers										o
Renouvellement des conduits d'alimentation et des étriers										o

* Changer l'huile moteur et la cartouche du filtre à huile après les premières 50 heures de service.

ATTENTION

- Pour toute opération de remplacement ou de vérification, veiller à ce que le moteur soit placé de niveau et mis à l'arrêt.

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