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TO THE READER

This Workshop Manual has been prepared to provide servicing personnel with information on the mechanism, service and maintenance of KUBOTA Diesel Engines 70 mm STROKE SERIES. It is divided into two parts, "Mechanism" and "Disassembling and Servicing".

■ **Mechanism**

Information on construction and functions are included for each engine section. This part should be understood before proceeding with trouble-shooting, disassembling and servicing.

■ **Disassembling and Servicing**

Under the heading "General" come general precautions, troubleshooting, lists of servicing specifications and periodic inspection items. For each engine section, there are "Checking and Adjustment", "Disassembling and Assembling", and "Servicing" which cover procedures, precautions, factory specification and allowable limits.

All information, illustrations and specifications contained in this manual are based on the latest production information available at the time of publication. The right is reserved to make changes in all information at any time without notice.

Due to covering many models of this manual, illustration or picture being used have not been specified as one model.

Apr. '88

INTRODUCTION

Ce manuel d'atelier a été préparé pour permettre au personnel d'entretien de disposer d'informations sur les mécanismes, les entretiens et la maintenance des moteurs Kubota Diesel moteur de série à 70 mm de course. Il est divisé en deux sections: "Mécanismes" et "Démontage et entretien".

■ **Mécanisme**

Des informations sur la construction et les fonctions sont données pour chaque partie du moteur. Cette partie du manuel doit être comprise avant que l'oncommence les opérations de recherche des anomalies, de démontage et d'entretien.

■ **Démontage et entretien**

Sous le titre "Généralités" on trouvera des précautions générales, les procédures de recherche des anomalies et les listes de caractéristiques d'entretien et items de vérification périodique. Pour chaque partie du moteur, on trouvera les titres "Vérification et réglage", "Démontage et remontage" et "Entretien" où sont reprises les précautions, les caractéristiques d'usine et les limite de service.

Toutes lees informations, illustrations et spécifications contenues dans ce manuel sont basées sur les dernières informations de production disponibles au moment de la publication. Nous nous réservons le droit de modifier tout élément de ces infomations, à tout moment et sans préavis.

Ce manuel couvrant de nombreux modèles, les illustrations ou photos utilisées sont données à titre indicatif.

Avr. '88

CONTENTS

M. MECHANISM

S. DISASSEMBLING AND SERVICING

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/cm2 (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				

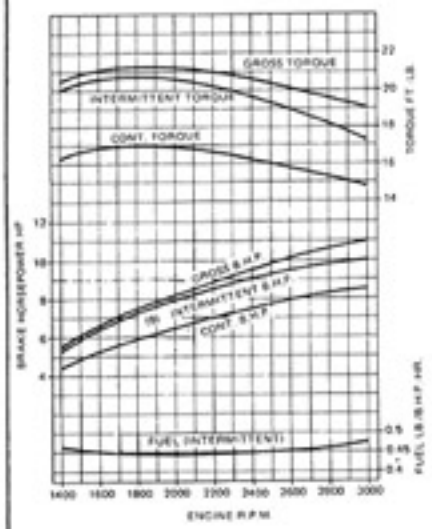
D850-B	DH850-B	D950-B	V1100-B	VH1100-B	V1200-B
3			4		
Vertical, water-cooled, 4-cycle diesel engine					
72 x 70 (2.83 x 2.76)		75 x 70 (2.95 x 2.76)	72 x 70 (2.83 x 2.76)		75 x 70 (2.95 x 2.76)
855 (52.2)		927 (56.6)	1140 (69.56)		1237 (75.49)
11.6/3000 (15.5/3000)	13.1/3600 (17.5/3600)	12.7/3000 (17.0/3000)	15.29/3000 (20.5/3000)	17.15/3600 (23/3600)	16.79/3000 (22.5/3000)
13.4/3000 (18.0/3000)	15.7/3600 **(21.0/3600)**	14.5/3000 (19.5/3000)	17.90/3000 (24.0/3000)	20.89/3600 (28.0/3600)	19.40/3000 (26.0/3000)
14.9/3000 (19.8/3000)	17.2/3600 (23.0/3600)	16.0/3000 (21.5/3000)	19.77/3000 (26.5/3000)	22.98/3600 (30.8/3600)	21.26/3000 (28.5/3000)
11.4/3000 (15.5/3000)	12.9/3600 (17.5/3600)	12.5/3000 (17.0/3000)	15.08/3000 (20.5/3000)	16.92/3600 (23.0/3600)	16.55/3000 (22.5/3000)
12.5/3000 (17.0/3000)	14.7/3600 (20.0/3600)	13.6/3000 (18.5/3000)	16.55/3000 (22.5/3000)	19.86/3600 (27.0/3600)	18.02/3000 (24.5/3000)
14.0/3000 (19.0/3000)	16.2/3600 (22.0/3600)	15.1/3000 (20.5/3000)	18.39/3000 (25.0/3000)	21.70/3600 (29.5/3600)	19.86/3000 (27.0/3000)
3200	3780	3200	3200	3780	3200
800					
50.6/1800 5.16/1800 37.30/1800	49.9/2400 5.09/2400 36.78/2400	55.6/1800 5.67/1800 41.00/1800	68.45/1800 6.98/1800 50.45/1800	66.49/2400 6.78/2400 49.04/2400	74.04/1800 7.55/1800 54.65/1800
Spherical Type					
Bosch K Type Mini Pump					
Centrifugal Ball Mechanical Governor					
Counter-clockwise (viewed from flywheel side)					
Bosch Throttle Type					
25° (0.44 rad.) before T.D.C.					
1 – 2 – 3			1 – 3 – 4 – 2		
140 kgf/cm² (13.73 MPa, 1991 psi)					
22:1					
Forced Lubrication by Pump					
Electrical Type Switch					
Full Flow Paper Filter (Cartridge Type)					
Pressurized Radiator, Forced Circulation with Water Pump (Not included in the basic engine)					
Electric Starting with Starter (12, 0.8)			Electric Starting with Starter (12, 1.0)		
By Glow Plug in Combustion Chamber					
12 V, 65 AH, equivalent			12 V, 80 AH, equivalent		
12V, 150W					
Diesel Fuel No.2-D (ASTM D975)					
MIL-L-46152, MIL-L-2104C, quality better than CC class (API)					
4.6 (4.86 U.S. qts., 4.05 Imp. qts.)	3.7 (3.91 U.S.qts., 3.26 Imp.qts.)	4.6 (4.86 U.S.qts., 4.05 Imp. qts.)	5.7 (6.0 U.S. qts.,5.02 Imp. qts.)		
82.6 (182.1)		83.1 (183.2)	103.3 (227.8)		104 (229.3)
General Power Source					

PERFORMANCE CURVES

COURBES DE PERFORMANCE

LEISTUNGSKURVEN

Z500-B (SAE)



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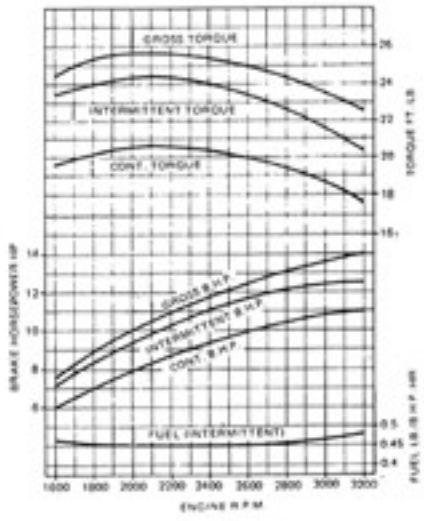

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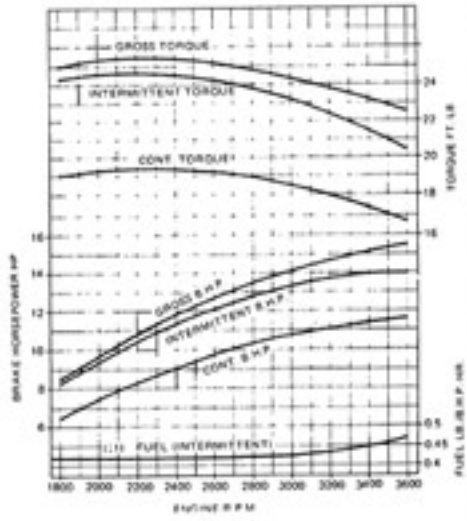

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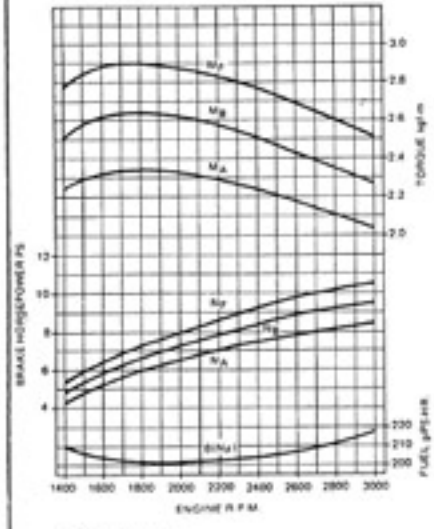

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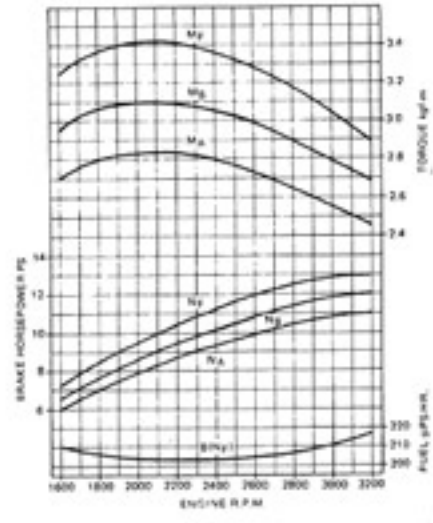

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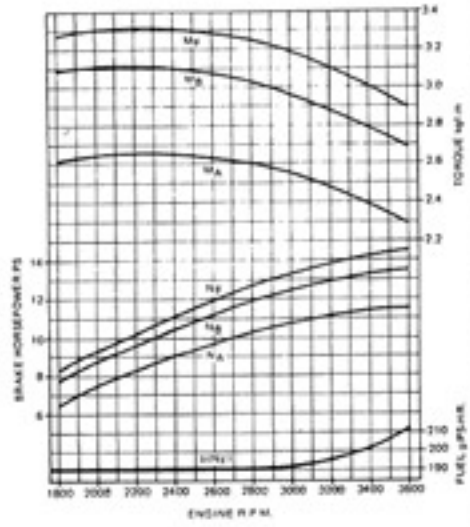

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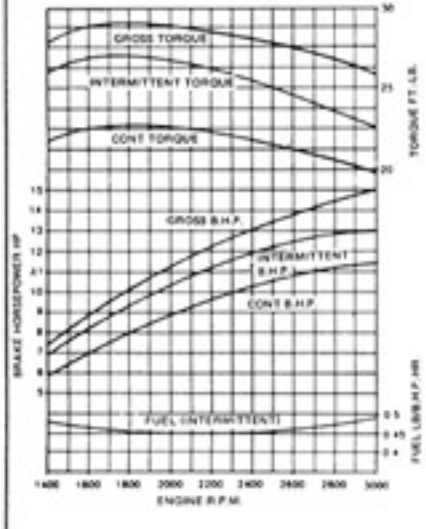

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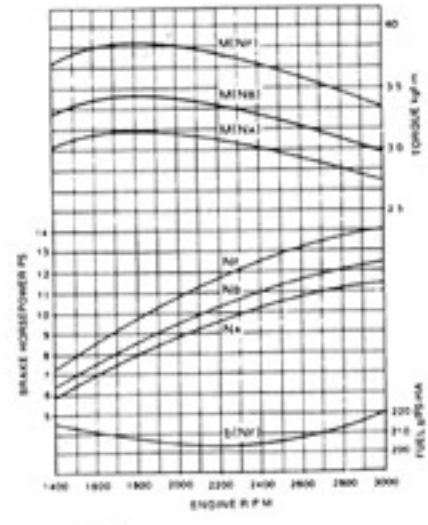

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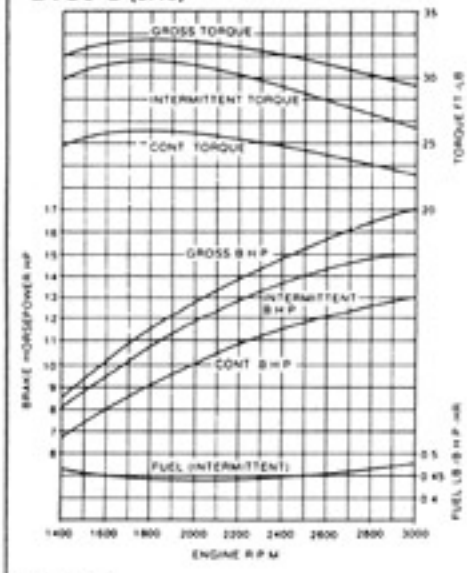

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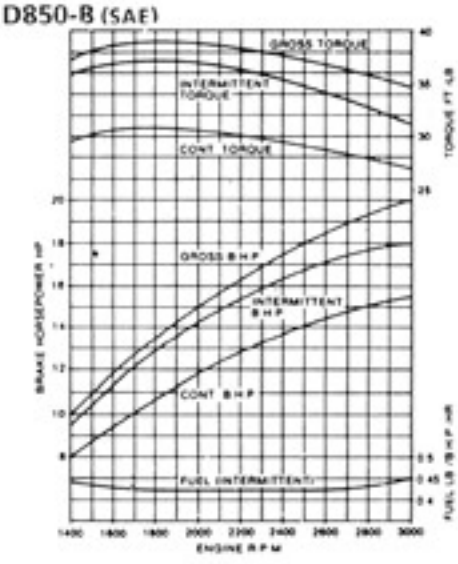

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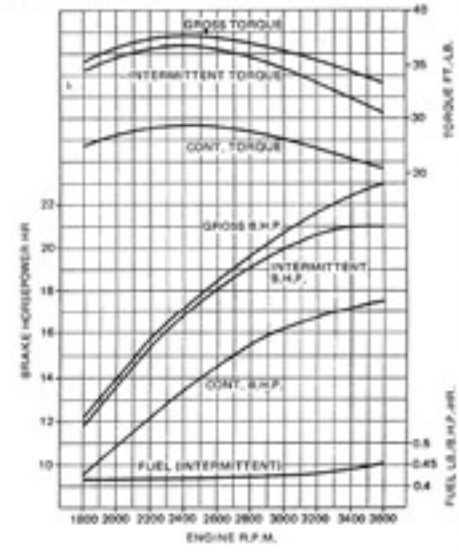

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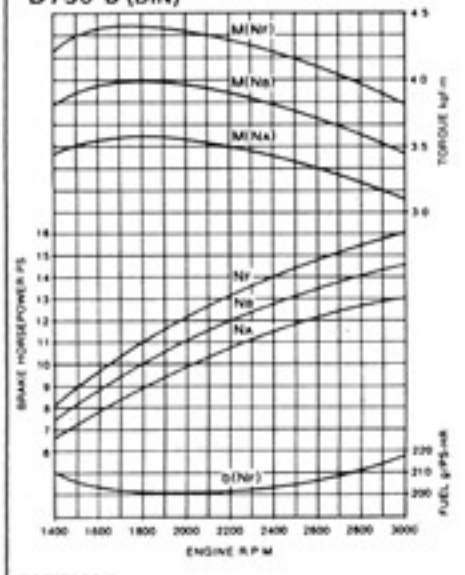

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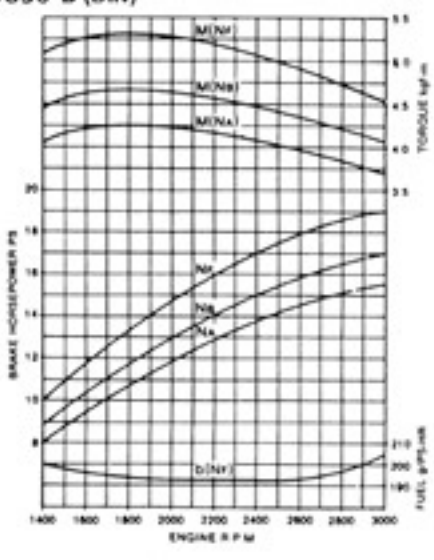

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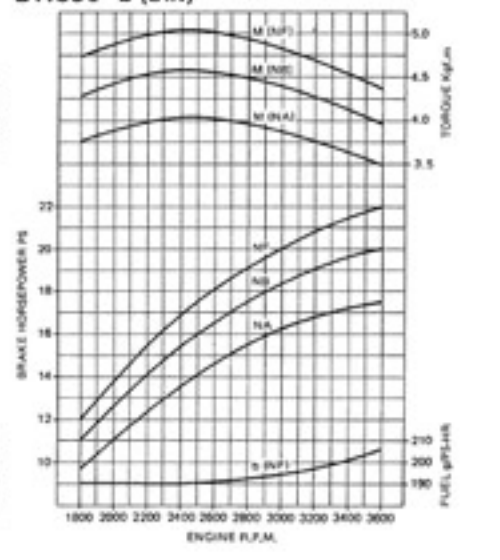

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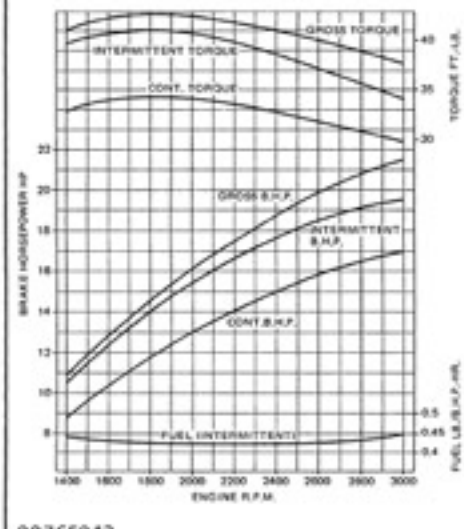

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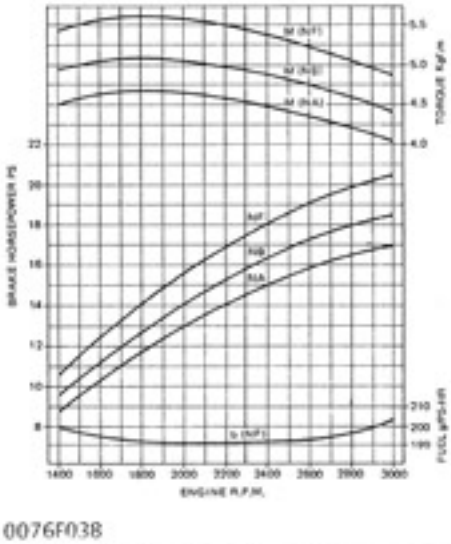

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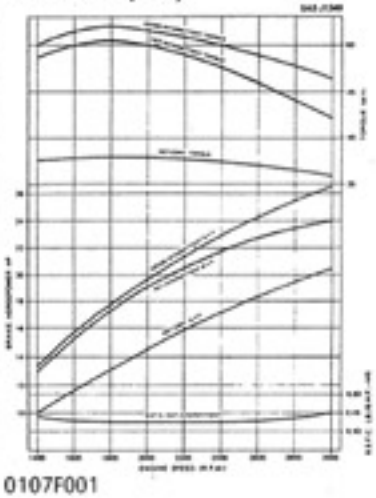

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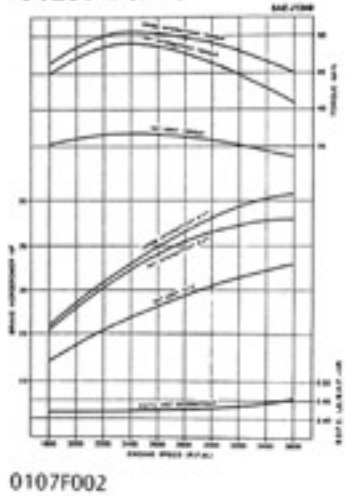

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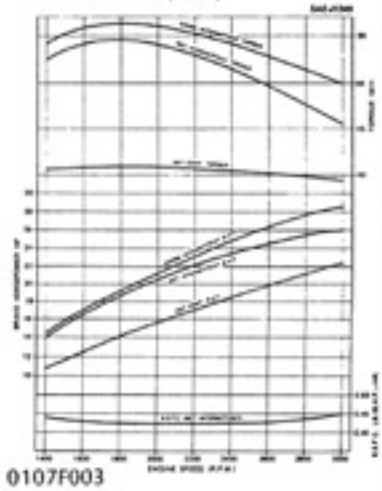

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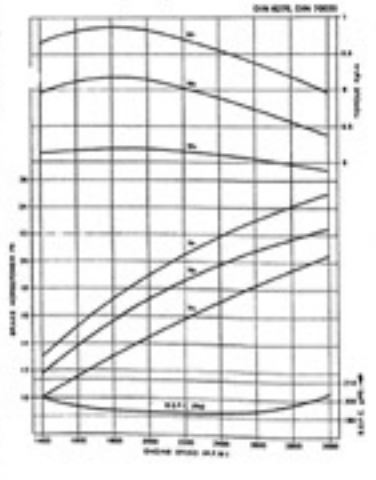

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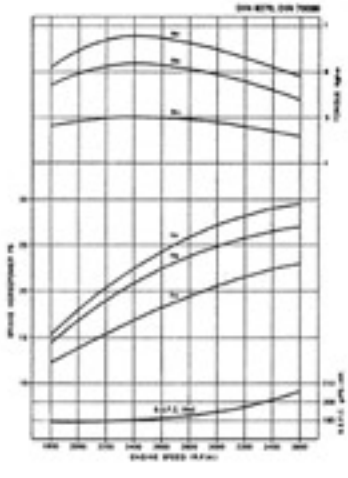

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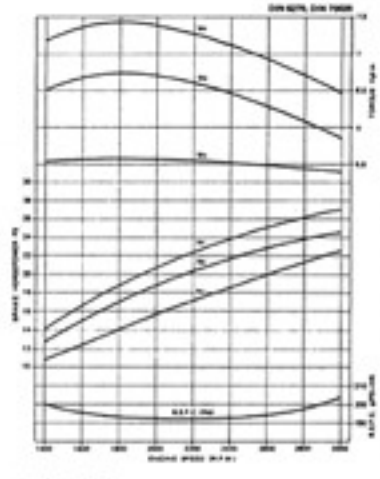


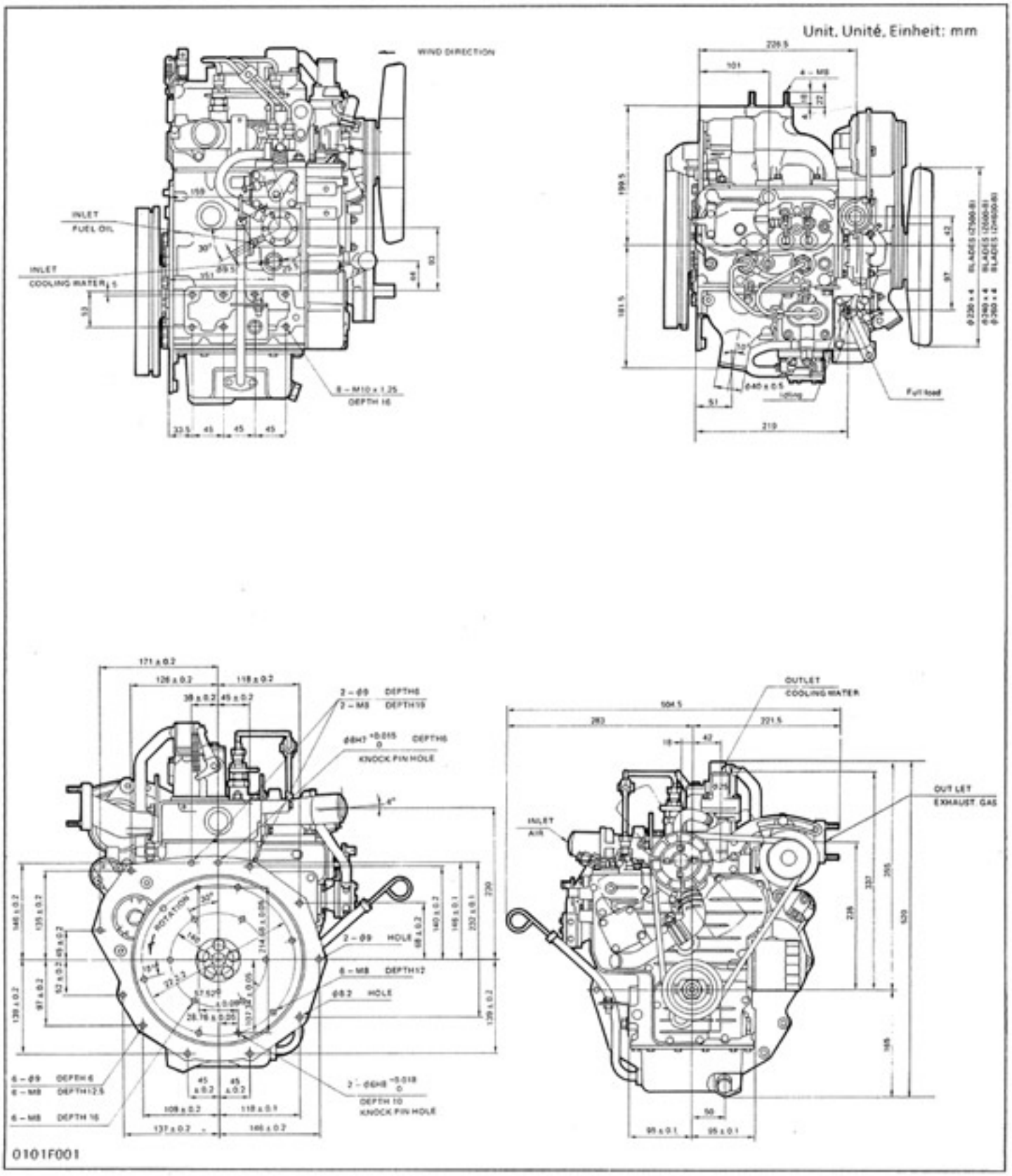
0107F006

■ **NOTE**
- Each performance curves, obtained in accordance with DIN 6271.
- Each performance curves, obtained in accordance with SAE J1349.

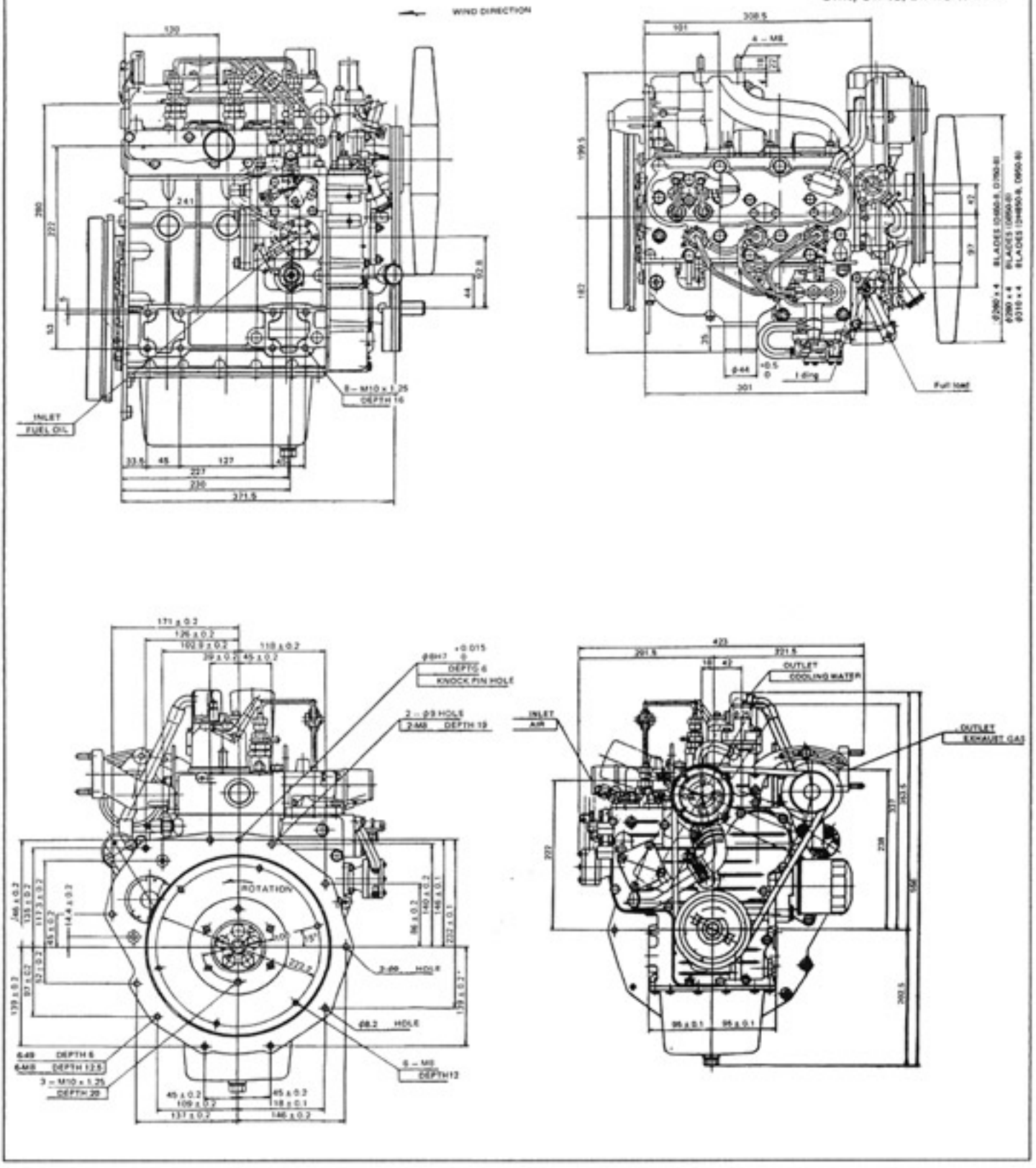
■ **NOTA**
- Les courbes de performance présentées ici ont été établies en conformité avec DIN 6271.
- Les courbes de performance présentées ici ont été établies en conformité avec SAE J1349.

■ **ANMERKUNG**
- Jede Leistungskurve aufgestellt in Übereinstimmung nach DIN 6271.
- Jede Leistungskurve aufgestellt in Übereinstimmung nach SAE J1349.

DIMENSIONS
DIMENSIONS
ABMESSUNGEN



Unit, Unité, Einheit: mm



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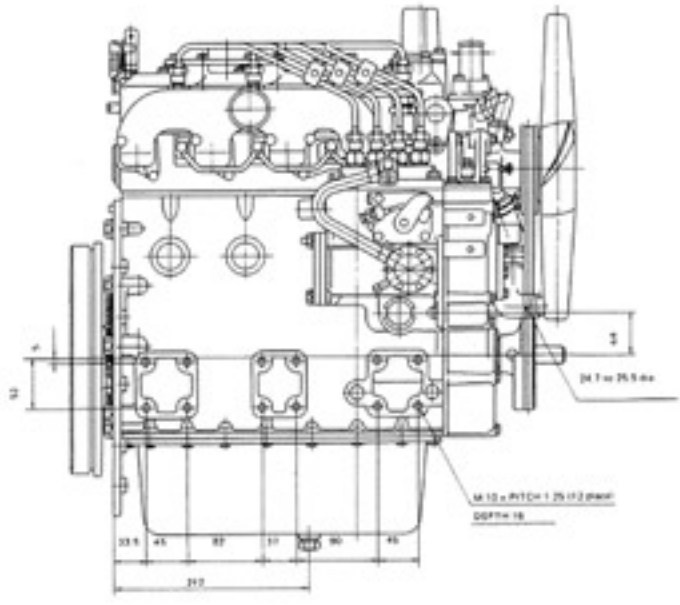
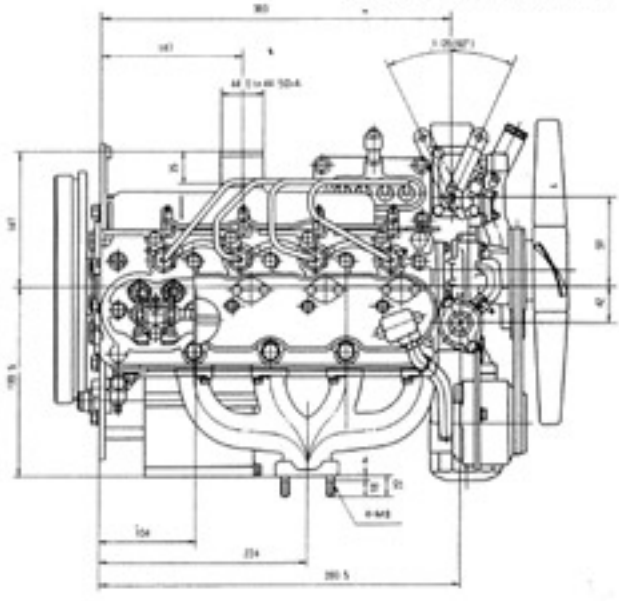
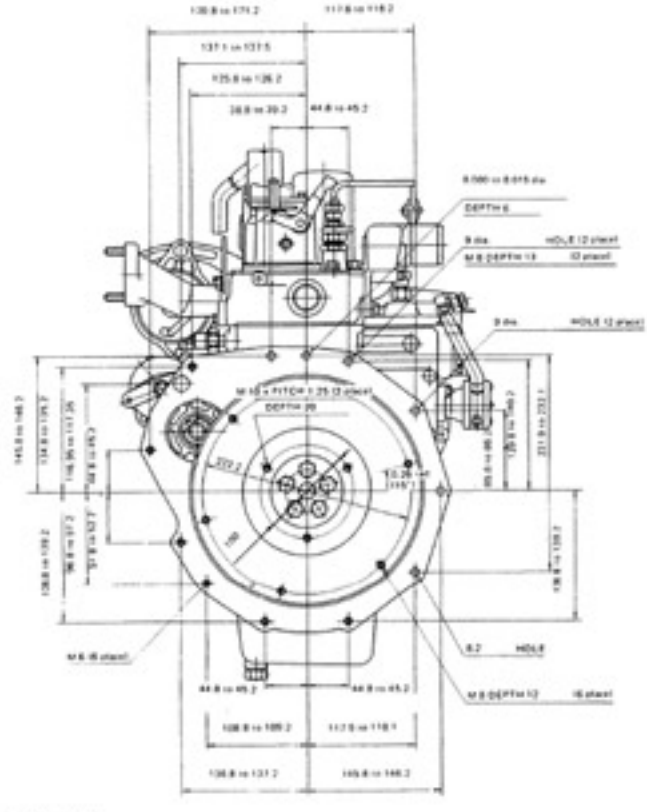
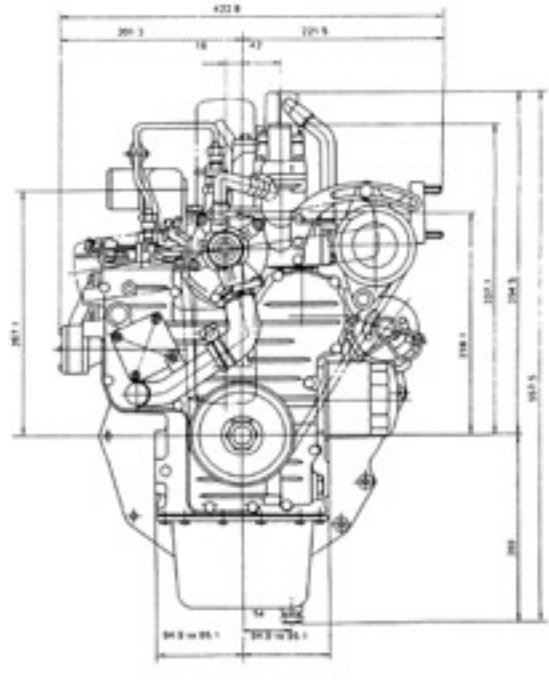




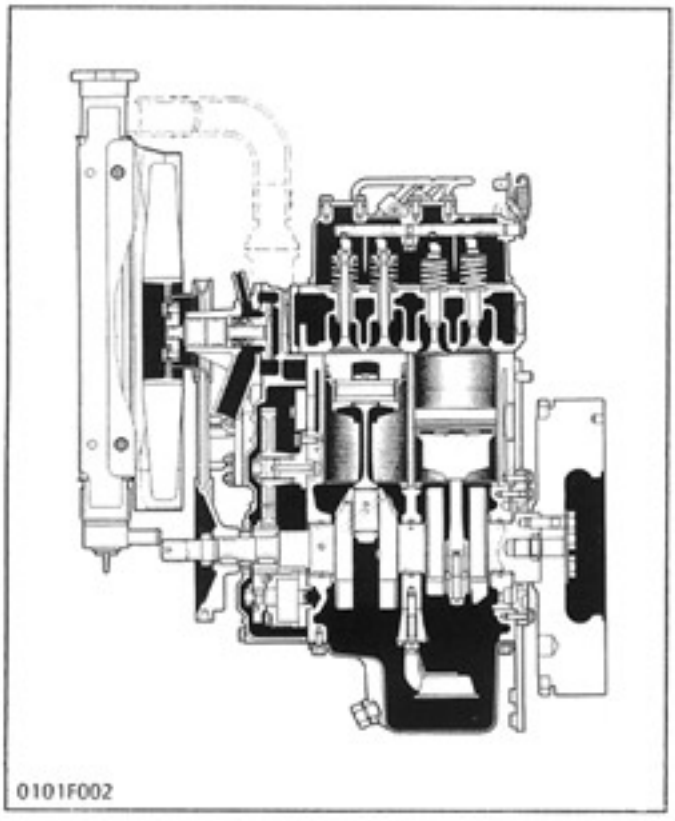




0107F007

M. MECHANISM MECANISME MECHANISMUS

F FEATURE
F GENERALITES
F ALLGEMEINES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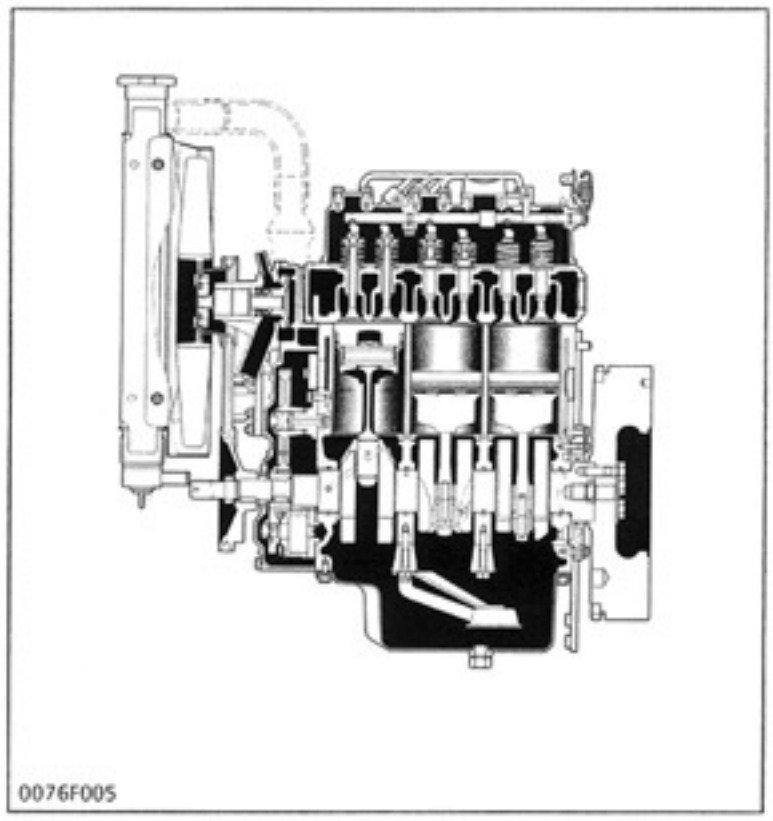
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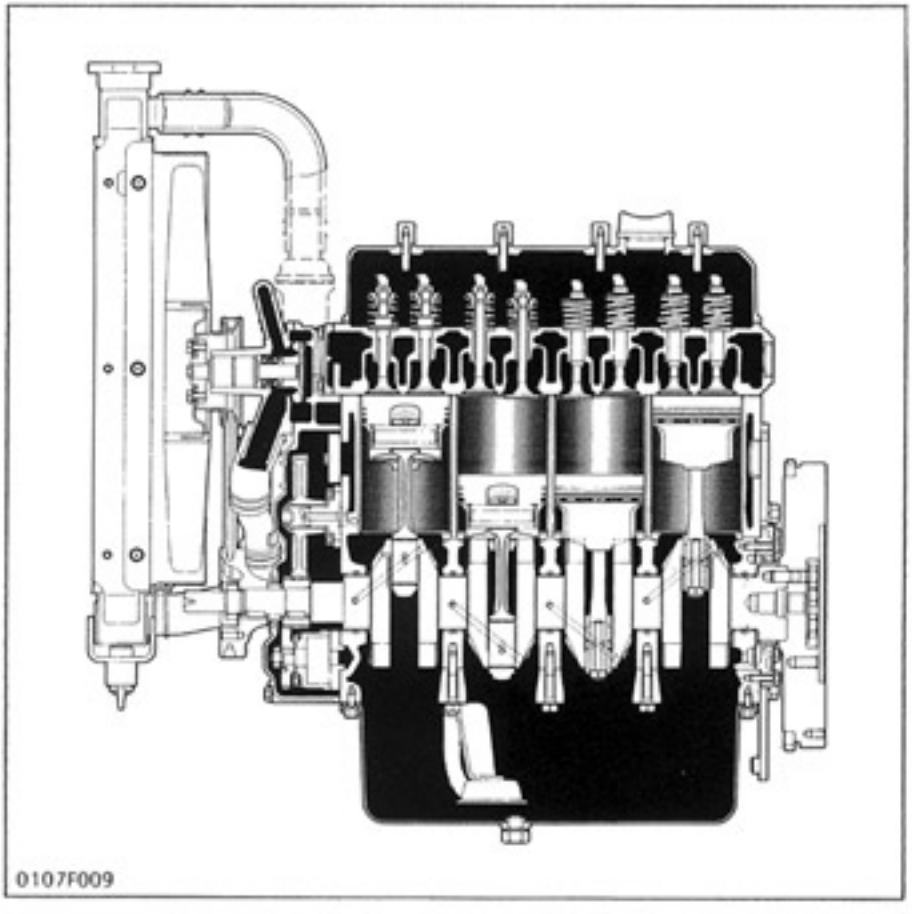
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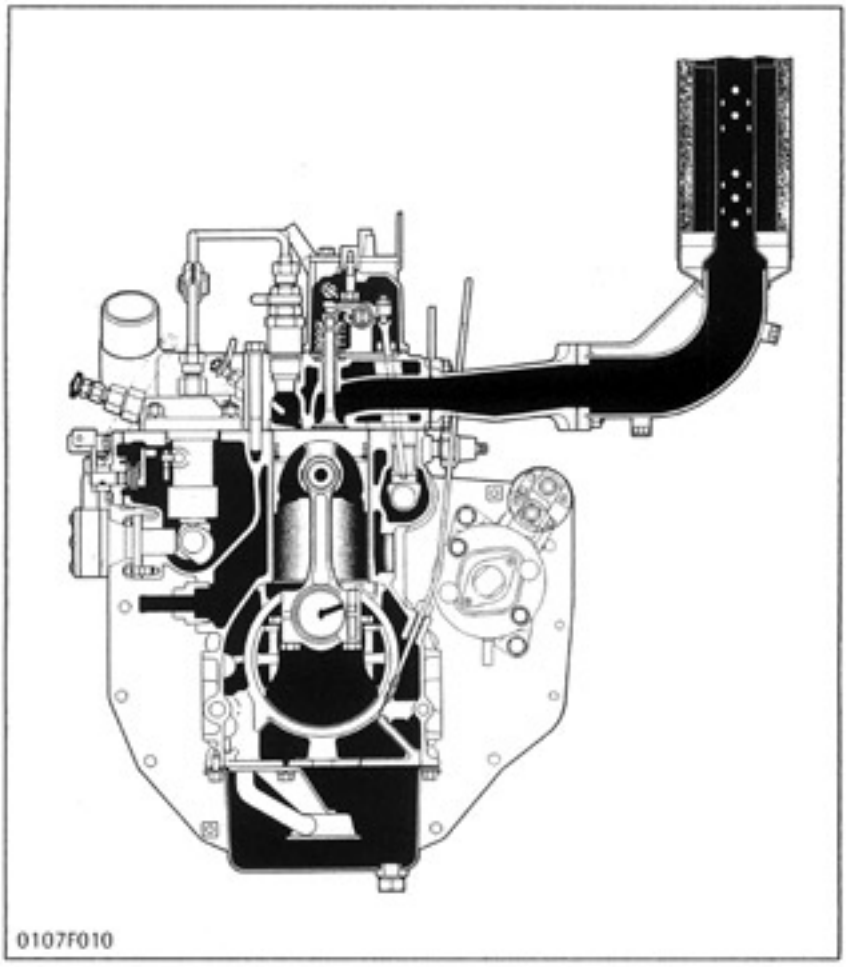


0107F010

The 70 mm STROKE SERIES ENGINE are vertical, water-cooled, 4-cycle diesel engines.

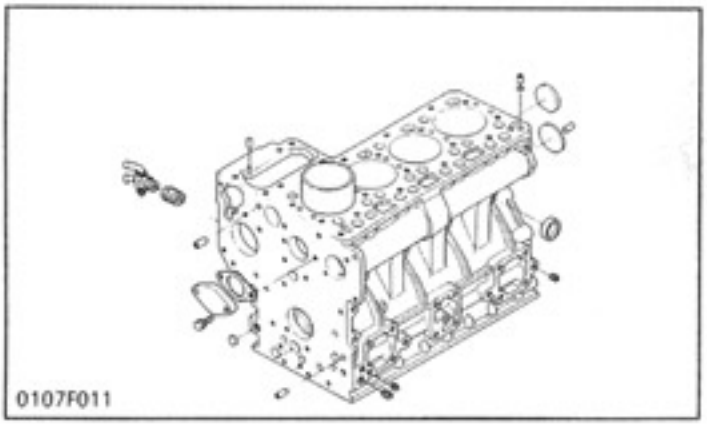
They are incorporated KUBOTA's foremost technologies. With KUBOTA's spherical combustion chamber, well-known Bosch K type injection pump and the well-balanced designs, they give greater power, low fuel consumption, little vibration and quiet operation.

Les moteurs moteur de série à 70 mm de course sont des moteurs diesel à 4 temps, à cylindres verticaux et refroidissement par eau. Ils incorporent les technologies les plus avancées KUBOTA. Les chambres de combustion sphérique de KUBOTA, les pompes d'injecjtion K de Bosch type bien connues, et une conception bien équilibrée donnent à ces moteurs une puissance accrue, une consommation très basse, un faible niveau de vibrations et un fonctionnement silencieux.

Bei den Motoren Serienmotor mit 70 mm Hub handelt es sich um vertikale, wassergekühlte, Viertakt-Dieselmotoren. Sie sind nach der neuesten Technologie KUBOTAS ausgelegt. Mit der kugelförmigen Verbrennungskammer von KUBOTA, der bekannten Einspritzpumpe Typ K von Bosch und der durchdachten, ausgewogenen Konstruktion bieten sie höhere Leistung, geringen Kraftstoffvrebrauch sowie vibrationsarmen und ruhigen Lauf.

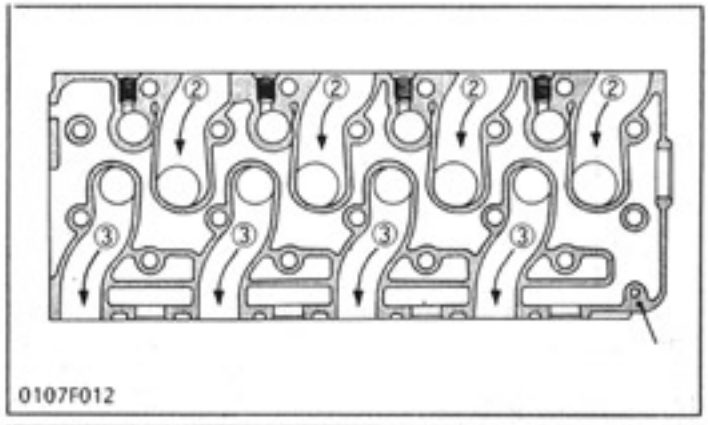
1 ENGINE BODY

[1] CYLINDER BLOCK

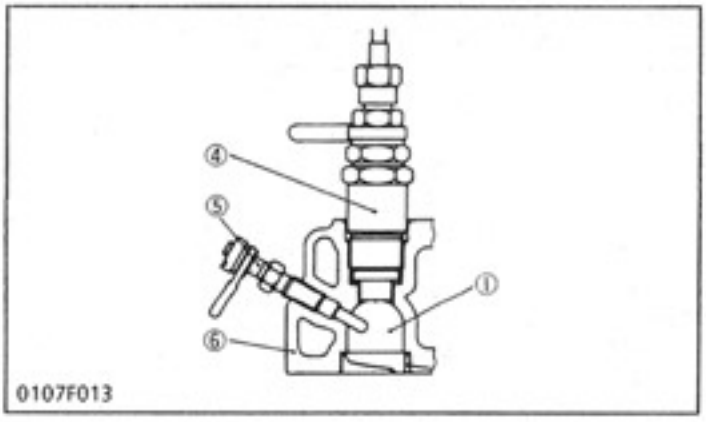

0107F011

The engine has a high durability tunnel-type cylinder in which the crank bearing component is a constructed body. Furthermore, dry-type cylinder liners, being pressure-fitted into cylinders, allow effective cooling, less distortion, and greater wear-resistance. The noise level is reduced to a minimum because each cylinder has its own chamber.

[2] CYLINDER HEAD



0107F012



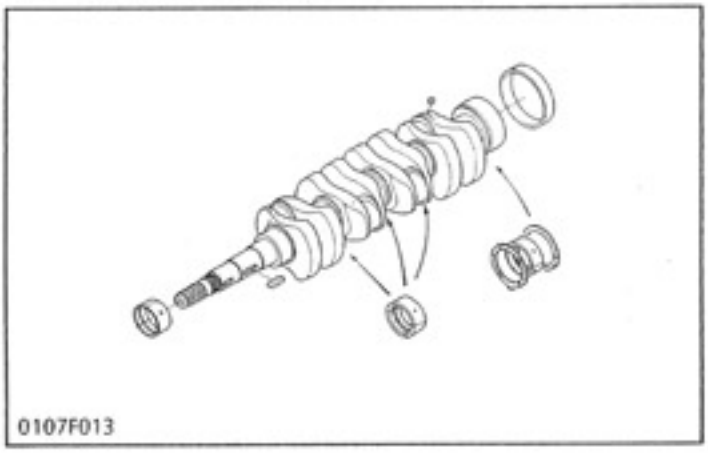
0107F013

The cross-flow type intake/exhaust ports in this engine have their openings at both sides of the cylinder head. Because overlaps of intake/exhaust ports are smaller than in ports of other types which have openings on one side, the suction air can be protected from being heated and expanded by heated exhaust air. The cool, high density suction air has high volume efficiency and raises the power of the engine. Furthermore, distortion of the cylinder head by heated exhaust gas is reduced because intake ports are arranged alternately. The combustion chamber is of KUBOTA's exclusive spherical combustion chamber type. Suction air is whirled to be mixed effectively with fuel, prompting combustion and reducing fuel consumption.

In the combustion chamber are installed throttle type injection nozzle and rapid heating sheathed type glow plug. This glow plug assures easier than ever engine starts even at −15°C (5°F).

(1) Combustion Chamber
(2) Intake Port
(3) Exhaust Port
(4) Nozzle Assembly
(5) Glow Plug
(6) Cylinder Head

[3] CRANKSHAFT


0107F013

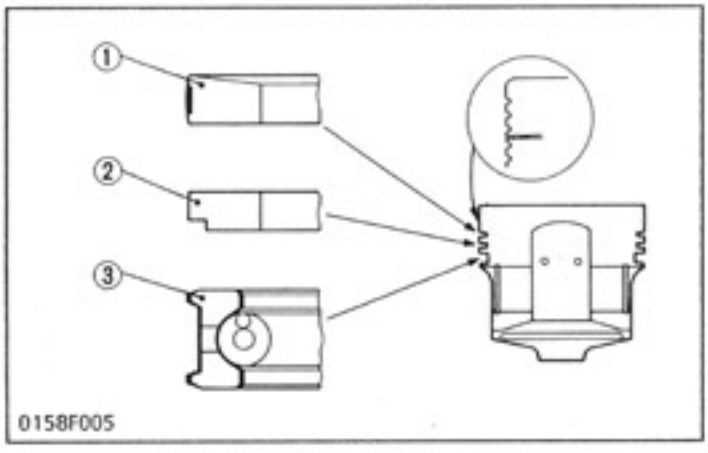
The crankshaft with the connecting rod converts the reciprocating motion of the piston into the rotating motion.

The crankshaft is made of tough special alloy steel, and the journals, pins and oil seal sliding portions are induction hardened to increase the hardness for higher wear resistance.

The front journal is supported by a solid type bearing, the intermediate journal by a split type, and the rear journal by a split type with thrust bearings.

The crankshaft is provided with an oil gallery, through which engine oil is fed to the crank pin portion, and lubricate it.

[4] PISTON AND PISTON RINGS



0158F005

The piston has a slightly oval shape when cold (in consideration of thermal expansion) and a flat head.

Three rings are installed in grooves in the piston.

The top ring (1) is a keystone type, which can stand against heavy loads, and the barrel face on the ring fits well to the cylinder wall.

The second ring (2) is an undercut type, which effectively prevents the oil from being carried up.

The oil ring (3) has chamfered contact faces and an expander ring, which increase the pressure of the oil ring against the cylinder wall.

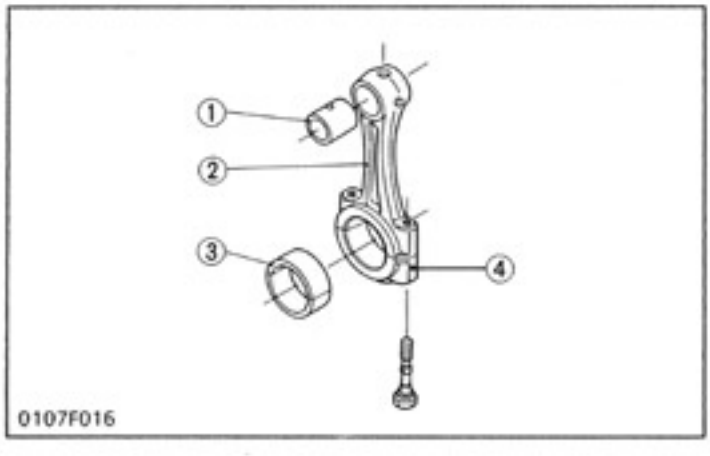
Several grooves are cut on the topland to help heat dissipate and to prevent scuffing.

■ **IMPORTANT (V1200-B only)**

- **Note that the piston 2's in the No.2 and No.3 cylinders have different profile from the piston in the No.1 and No.4 cylinders. The piston 2 is marked "2" on the head. Be sure to install them each original cylinders.**

(1) Top Ring
(2) Second Ring
(3) Oil Ring

[5] CONNECTING ROD

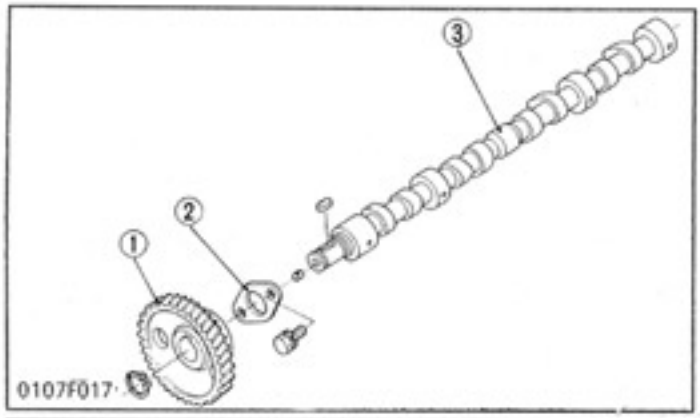


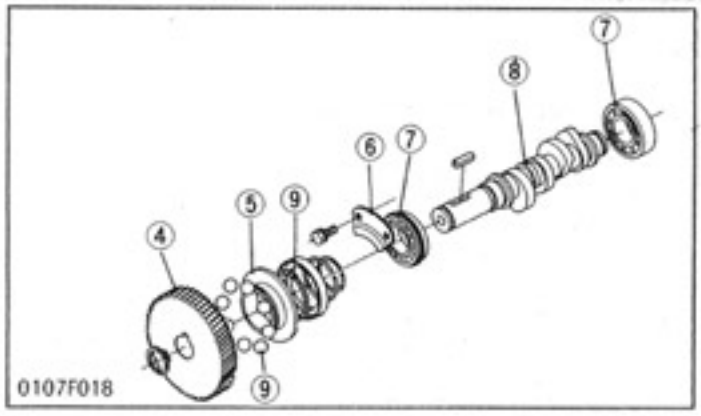
0107F016

Connecting rod (2) is used to connect the piston with the crankshaft. The big end of the connecting rod has a crank pin bearing (3) (split type) and the small end has a small end bushing (1) (solid type).

(1) Small End Bushing
(2) Connecting Rod
(3) Crank pin Bearing
(4) Connecting Rod Cap

[6] CAMSHAFT

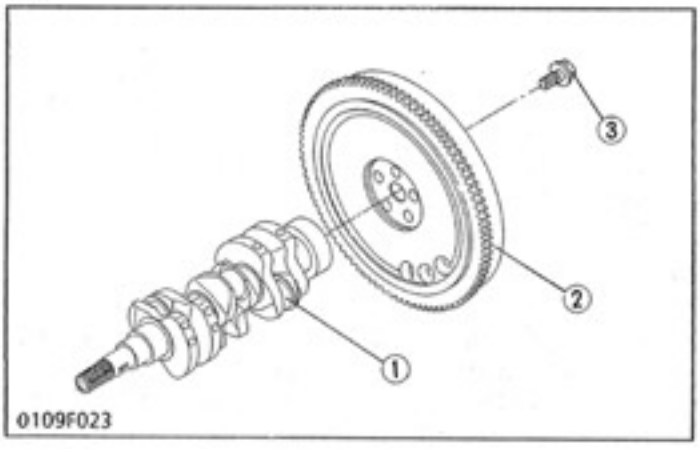




The camshaft (3) is made of special cast iron and the journal and cam sections are chilled to resist wear. The journal sections are force-lubricated. The fuel camshaft (8) controls the reciprocating movement of the injection pump, and is equipped with a ball to control the governor. The fuel camshaft is made of carbon steel and the cam sections are quenched and tempered to provide greater wear resistance.

(1) Cam Gear
(2) Camshaft Stopper
(3) Camshaft
(4) Injection Pump Gear
(5) Governor Sleeve
(6) Fuel Camshaft Stopper
(7) Ball Bearing
(8) Fuel Camshaft
(9) Steel Ball

[7] FLYWHEEL



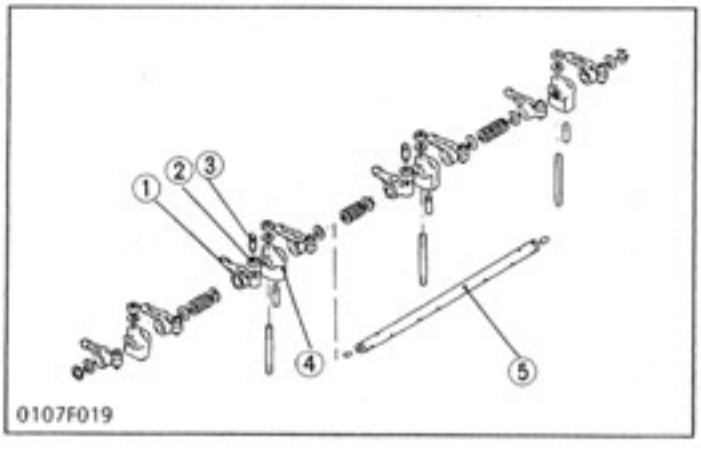
The flywheel stores the rotating force in the combustion stroke as inertial energy, reduces crankshaft rotating speed fluctuation and maintains the smooth rotating conditions.

The flywheel periphery is inscribed with the marks showing fuel injection timing mark **FI** and top dead center mark **TC**.

The flywheel has gear teeth around its outer rim, which mesh with the drive pinion of the starter.

(1) Crankshaft
(2) Flywheel
(3) Flywheel Screw

[8] ROCKER ARM



The rocker arm assembly includes the rocker arms (1), rocker arm brackets (4) and rocker arm shaft (5) and converts the reciprocating movement of the push rods to an open/close movement of the inlet and exhaust valves.

Lubricating oil is pressurized through the bracket to the rocker arm shaft, which serves as a fulcrum so that the rocker arm bearing and the entire system are lubricated sufficiently.

(1) Rocker Arm
(2) Lock Nut
(3) Adjusting Screw
(4) Rocker Arm Bracket
(5) Rocker Arm Shaft

2 LUBRICATING SYSTEM

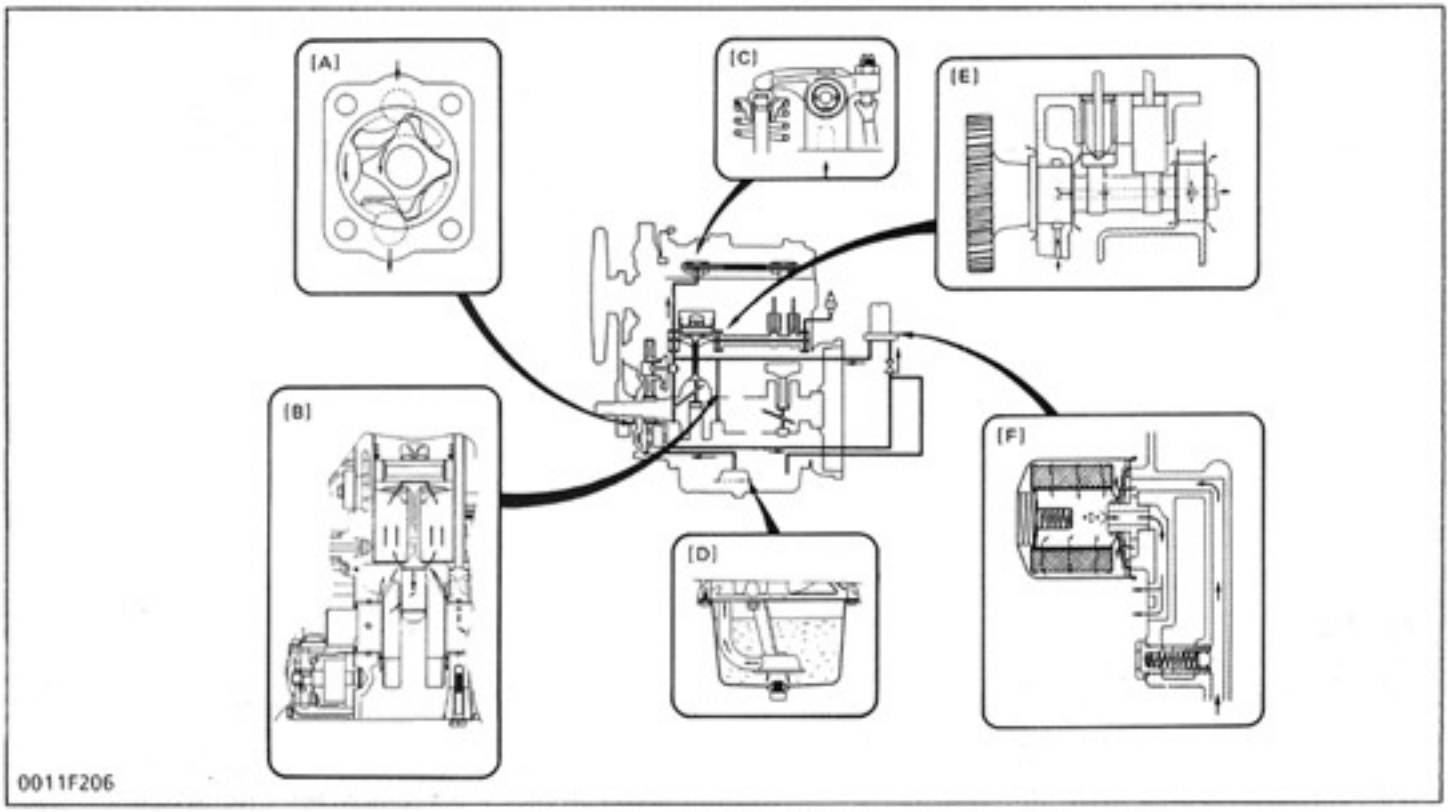
2 SYSTEME DE LUBRIFICATION

2 SCHMIERUNGS-SYSTEM

[1] GENERAL

[1] GENERALITES

[1] ALLGEMEINES



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 ...ar, camshaft and rocker arm ...haft 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

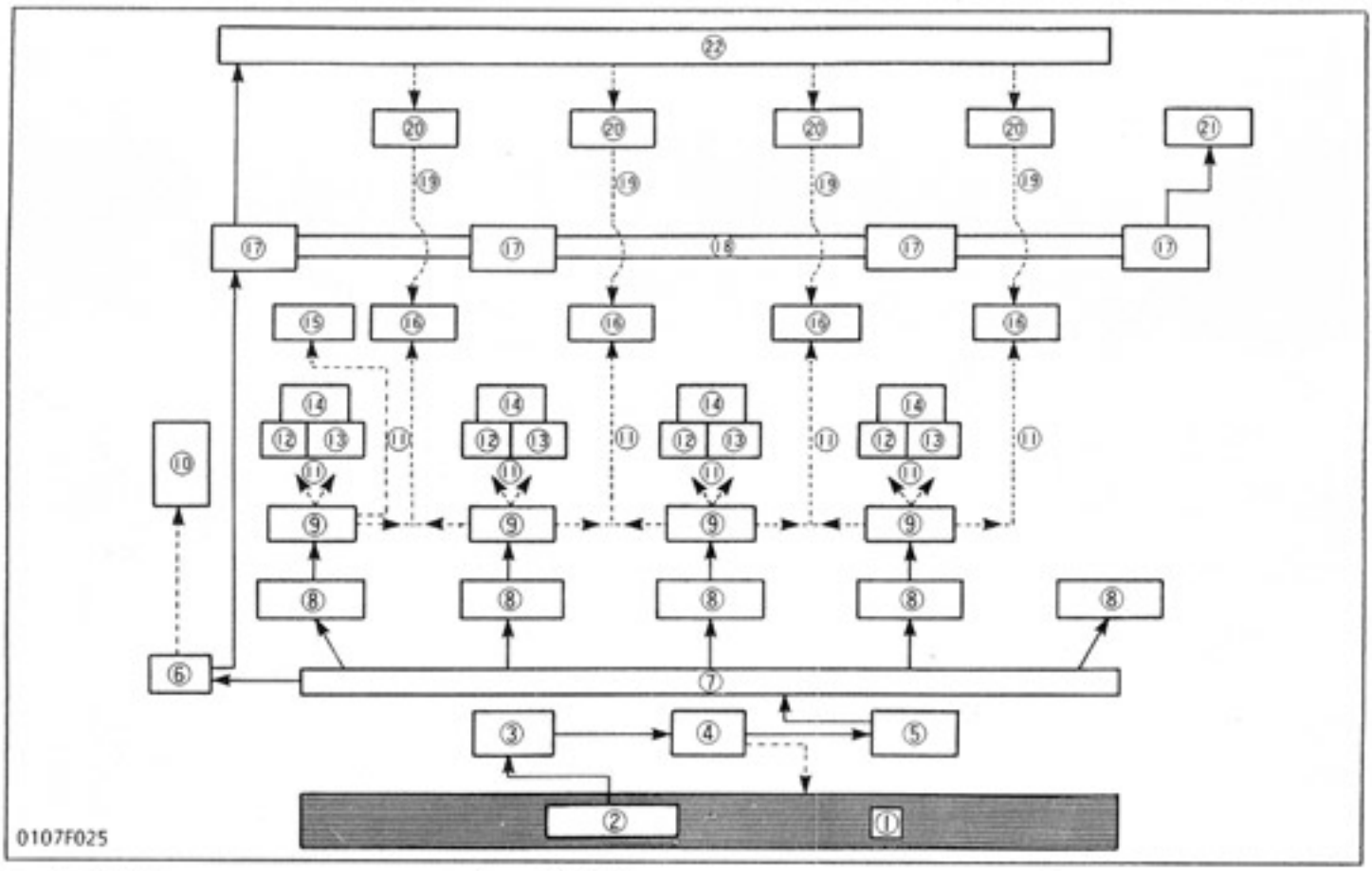
Le système de lubrification du moteur se compose d'une crépine, d'une pompe à huile, d'une soupape de décharge, d'un filtre à huile à cartouche et d'un manocontact de pression d'huile. La pompe à huile aspire l'huile du carter par l'intermédiaire de la crépine et la force au travers de la cartouche filtre, 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

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



Engine Oil Flow

(1) Oil Pan
(2) Oil Strainer
(3) Oil Pump
(4) Relief Valve
(5) Oil Filter Cartridge
(6) Idle Gear
(7) Main Oil Gallery
(8) Main Bearing
(9) Big End
(10) Timing Gear
(11) Splash
(12) Bore
(13) Small End
(14) Piston
(15) Fuel Camshaft
(16) Tappets
(17) Camshaft Bearing
(18) Camshaft
(19) Drain
(20) Rocker Arm
(21) Oil Switch
(22) Rocker Arm Shaft

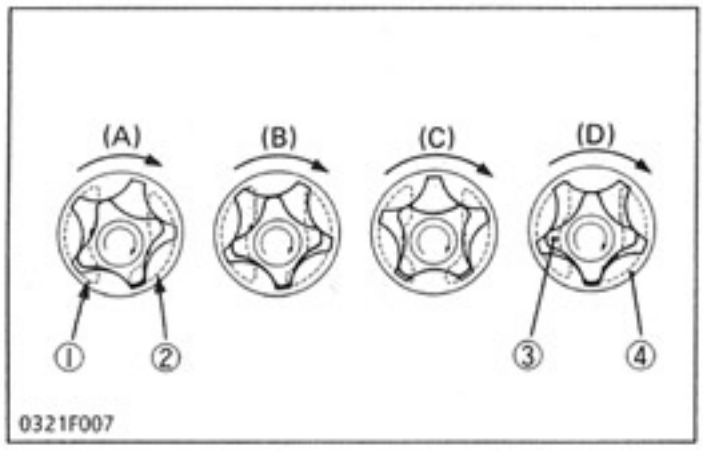
Circuit d'huile

(1) Carter d'huile
(2) Crépine
(3) Pompe à huile
(4) Soupape de décharge
(5) Cartouche de filtre à huile
(6) Pignon de renvoi
(7) Rampe de distribution d'huile
(8) Palier principal
(9) Tête de bielle
(10) Pignon de distribution
(11) Eclaboussement
(12) Alésage
(13) Pied de bielle
(14) Piston
(15) Arbre à cames d'alimentation
(16) Poussoirs
(17) Paliers d'arbre à cames
(18) Arbre à cames
(19) Retour
(20) Culbuteur
(21) Manocontact de pression d'huile
(22) Arbre de culbuteur

Motorölstrom

(1) Ölwanne
(2) Ölfilter
(3) Ölpumpe
(4) Überdruckventil
(5) Ölfilterpatrone
(6) Leerlaufgetriebe
(7) Hauptölkanal
(8) Hauptlager
(9) Pleuelstangenfuß
(10) Steuerung
(11) Ölspritzer
(12) Bohrung
(13) Pleuelstangenkopf
(14) Kolben
(15) Kraftstoff-Nockenwelle
(16) Stößel
(17) Nockenwellenlager
(18) Nockenwelle
(19) Ablauf
(20) Kipphebel
(21) Ölschalter
(22) Kipphebelachse

[2] OIL PUMP



0321F007

The oil pump in this engine is a trochoid pump.

Inside the pump body, the 4 lobe inner rotor (3) is eccentrically engaged with the 5 lobe outer rotor (4). The inner rotor is driven by the crankshaft via gears, which in turn rotate the outer rotor.

When the inner rotor rotates, the outer rotor also rotates in the same direction.

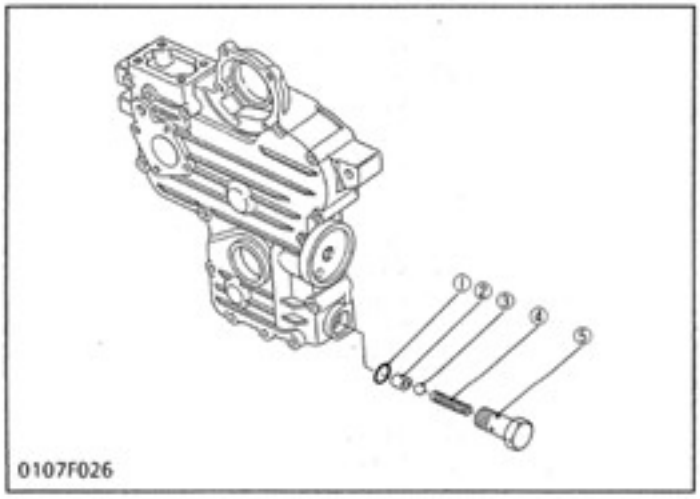
The two rotors have differences in lobe number and center, which generates space between lobes as shown in the figure.

At position (A), there is little space between lobes in the inlet port. As the rotor rotates towards position (B), the space between the lobes becomes larger, creating a negative pressure which sucks in oil.

Outside the inlet port, as shown in position (C), the space between the lobes becomes gradually smaller, and oil pressure increases. At position (D), oil is discharged from the outlet port.

(1) Inlet
(2) Outlet
(3) Inner Rotor
(4) Outer Rotor

[3] RELIEF VALVE



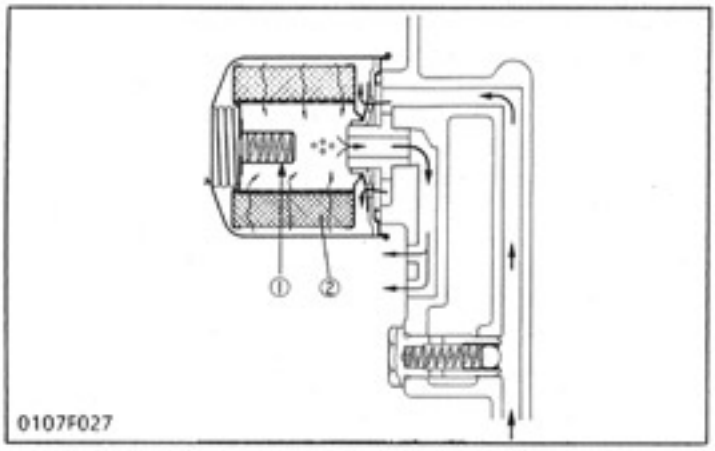
0107F026

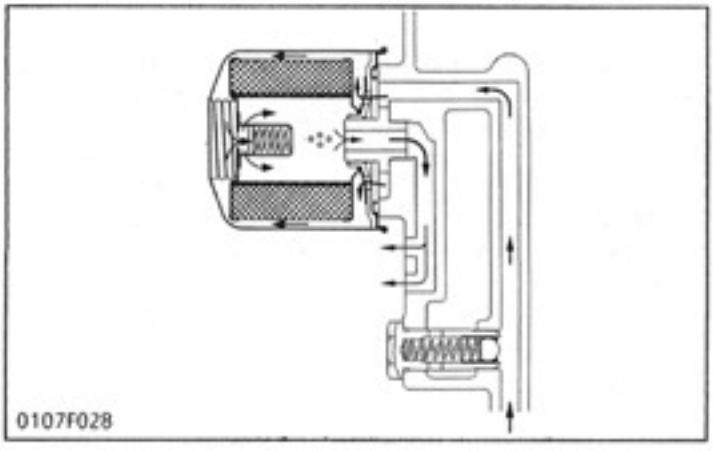
The relief valve prevents damage to the lubricating system due to high oil pressure. This relief valve is a ball type direct acting relief valve, and is best suited for low pressures.

When oil pressure exceeds the upper limit, the ball (3) is pushed back by the pressure oil and the oil escapes.

(1) O-ring
(2) Valve Seat
(3) Steel Ball
(4) Spring
(5) Relief Valve Body

[4] OIL FILTER CARTRIDGE



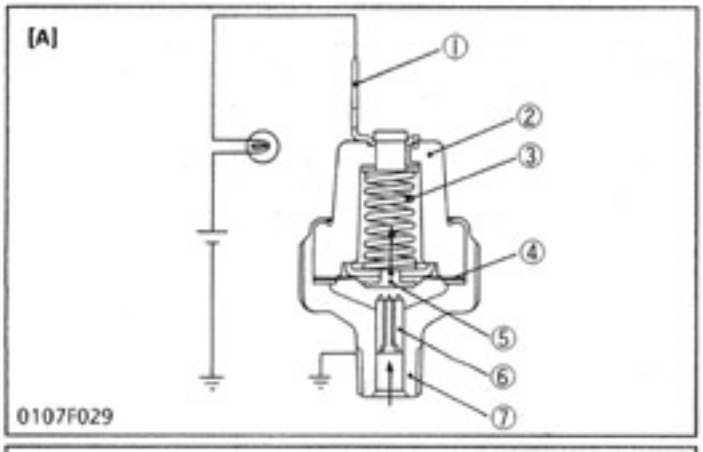


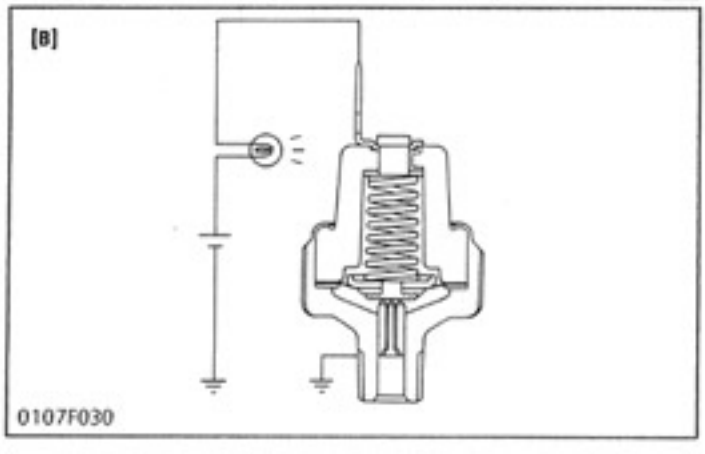
Impurities in engine oil can cause to wear and seize components as well as impairing the physical and chemical properties of the oil itself. Impurities contained in force-fed engine oil are absorbed on the filter paper for removal as they pass through the filter element (2).

When the filter element is clogged and the oil pressure in inlet line builds up by 98 kPa (1.0 kgf/cm^2, 14 psi) more than the outlet line, the bypass valve (1) opens and the oil flows from inlet to outlet bypassing the filter element.

(1) Bypass Valve
(2) Filter Element

[5] OIL PRESSURE SWITCH





The oil pressure switch is mounted on the cylinder-block, to warn the operator that the lubricating oil pressure is poor.

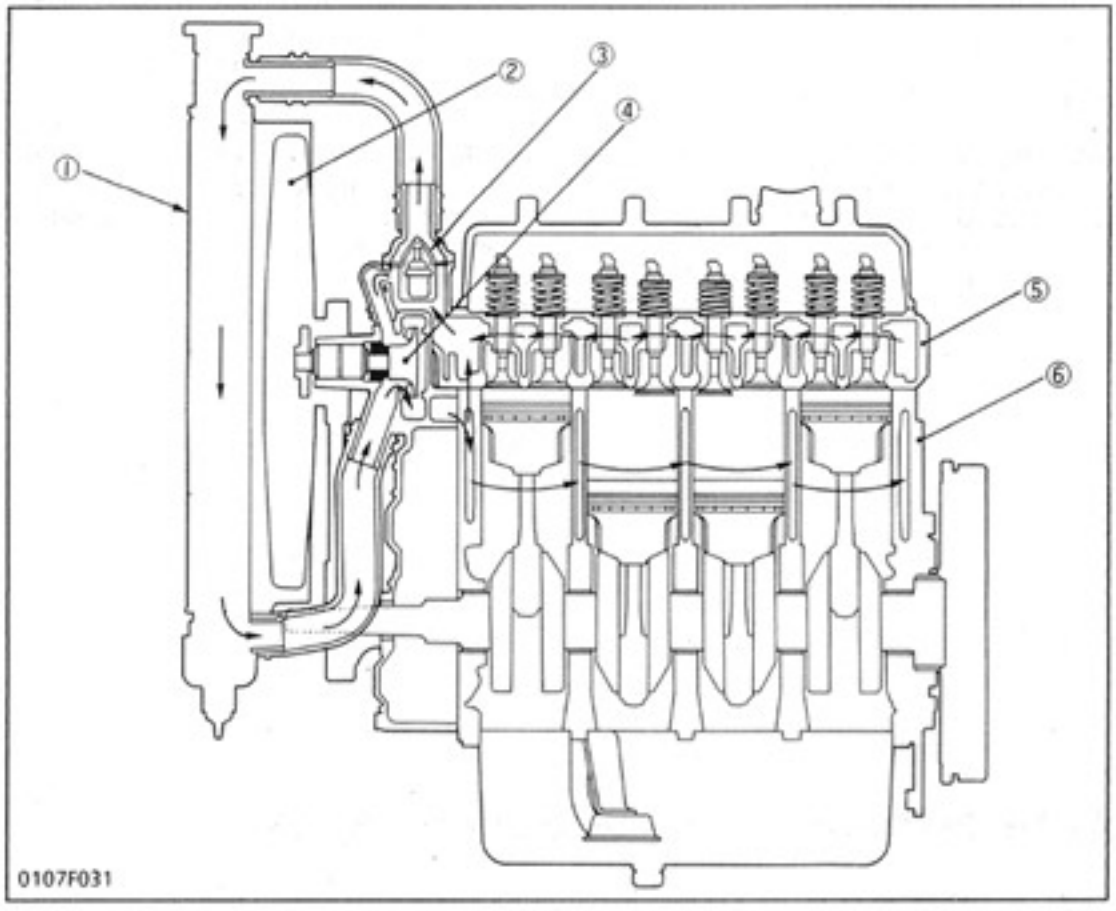
If the oil pressure falls below 49kPa (0.5 kgf/cm^2, 7 psi), the oil warning lamp will light up, warning the operator. In this case, stop the engine immediately and check the cause of pressure drop.

[A] At Proper Oil Pressure
[B] At Oil Pressures of 49 kPa (0.5 kgf/cm^2, 7 psi) or Less

(1) Terminal
(2) Insulator
(3) Spring
(4) Diaphragm
(5) Contact Rivet
(6) Contact
(7) Oil Switch Body

3 COOLING SYSTEM

[1] GENERAL



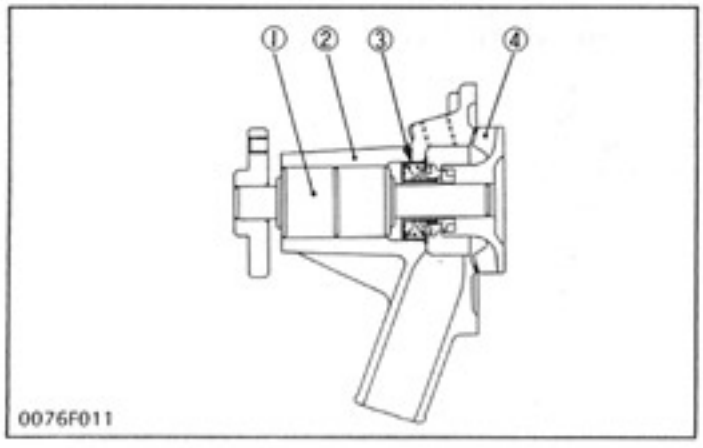
(1) Radiator
(2) Suction Fan
(3) Thermostat
(4) Water Pump
(5) Cylinder Head
(6) Cylinder Block

The cooling system consists of a radiator (1) (not included in the basic engine), centrifugal water pump (4), suction fan (2) and thermostat (3).

The water is cooled through the radiator core, and the fan set behind the radiator pulls cooling air through the core to improve cooling.

The water pump sucks the cooled water, forces it into the cylinder block and draws out the hot water. Then the cooling is repeated. Furthermore, to control temperature of water, a thermostat is provided in the system. When the thermostat opens, the water moves directly to radiator, but when it closes, the water moves toward the water pump through the bypass between thermostat and water pump. The opening temperature of thermostat is approx. 82°C (180°F).

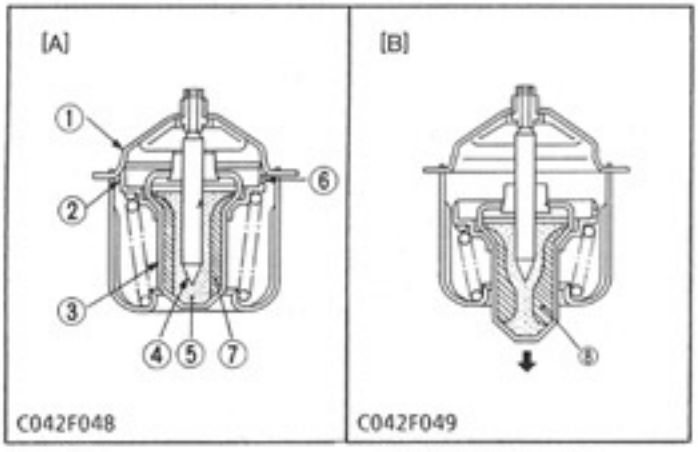
[2] WATER PUMP



The water pump is driven by the crankshaft via a V-belt. Water cooled in the radiator is sucked into the water pump from its lower portion and is sent from the center of the water pump impeller (4) radially outward into the water jacket in the crankcase.

(1) Bearing Unit
(2) Water Pump Body
(3) Mechanical Seal
(4) Water Pump Impeller

[3] THERMOSTAT



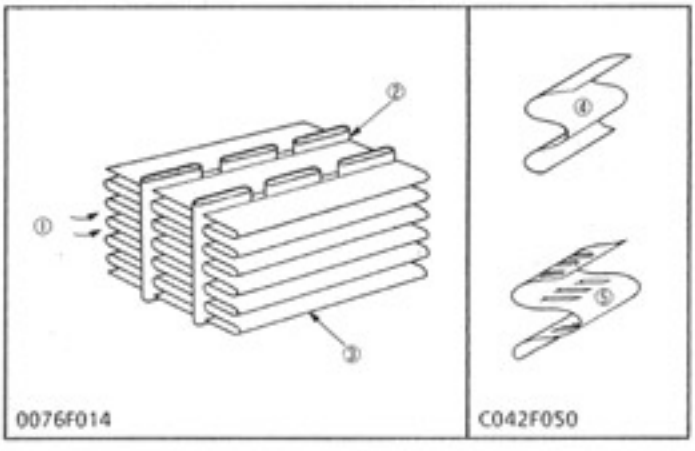
(1) Seat
(2) Valve
(3) Pellet
(4) Spindle
(5) Synthetic Rubber
(6) Leak Hole
(7) Wax (solid)
(8) Wax (liquid)

The thermostat maintains the cooling water at correct temperature. KUBOTA's engine uses a wax pellet type thermostat. Wax is enclosed in the pellet. The wax is solid at low temperatures, but turns liquid at high temperatures, expands and opens the valve.

(A) At low temperatures (lower than 82°C (180°F)).
As the thermostat is closed, cooling water circulates in the engine through the water return pipe without running to the radiator. Air in the water jacket escapes to the radiator side through leak hole (6) of the thermostat.

(B) At high temperatures (higher than 82°C (180°F)).
When the temperature of cooling water exceeds 82°C (180°F), wax in the pellet turns liquid and expands. Because the spindle (4) is fixed, the pellet (3) is lowered, the valve (2) is separated from the seat (1), and then cooling water is sent to the radiator.

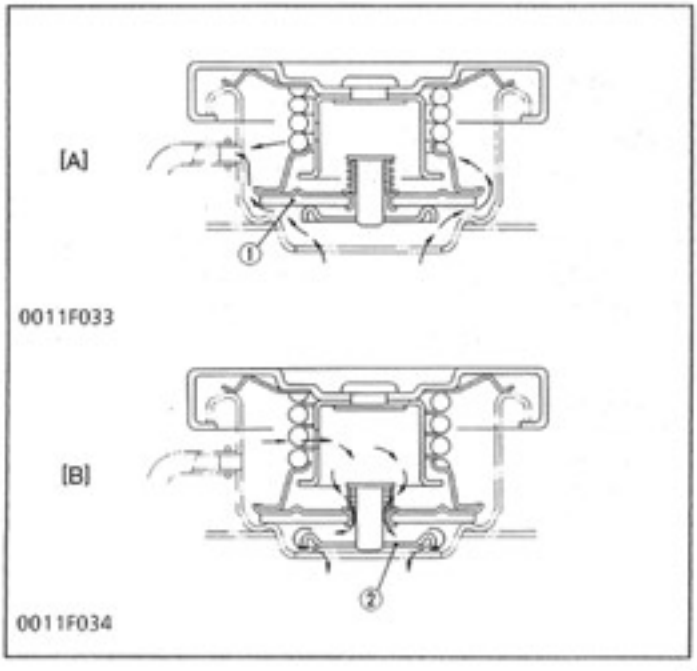
[4] RADIATOR (not included in the basic engine)



The radiator core consists of water carrying tubes and fins (3) at a right angle to the tubes (2). Heat of hot water in the tubes is radiated from the tube walls and fins. KUBOTA's engine uses corrugated fin type core which has a light weight and high heat transfer rate. Clogging is minimized by the louverless corrugated fins.

(1) Cooling Air
(2) Tube
(3) Fin
(4) Louverless Corrugated Fin
(5) Louvered Corrugated Fin

[5] RADIATOR CAP



The radiator cap is for sustaining the internal pressure of the cooling system at the specified level 88 kPa (0.9 kgf/cm^2, 13 psi) when the engine is in operation. The cap consists of a pressure valve (1) a vacuum valve (2), valve springs, gasket, etc.

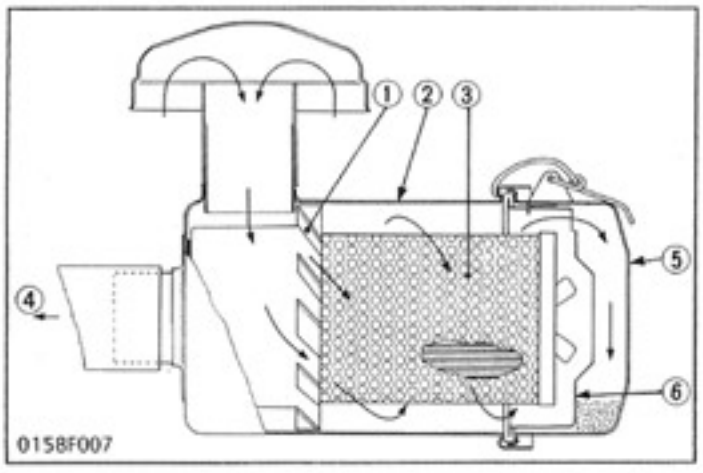
Cooling water is pressurized by thermal expansion of steam, and as its boiling temperature rises, generation of air bubbles will be suppressed. (Air bubbles in cooling water lowers the cooling effect.)

[A] When radiator internal pressure is high
[B] When radiator internal pressure is negative

(1) Pressure Valve
(2) Vacuum Valve

4 INTAKE/EXHAUST SYSTEM

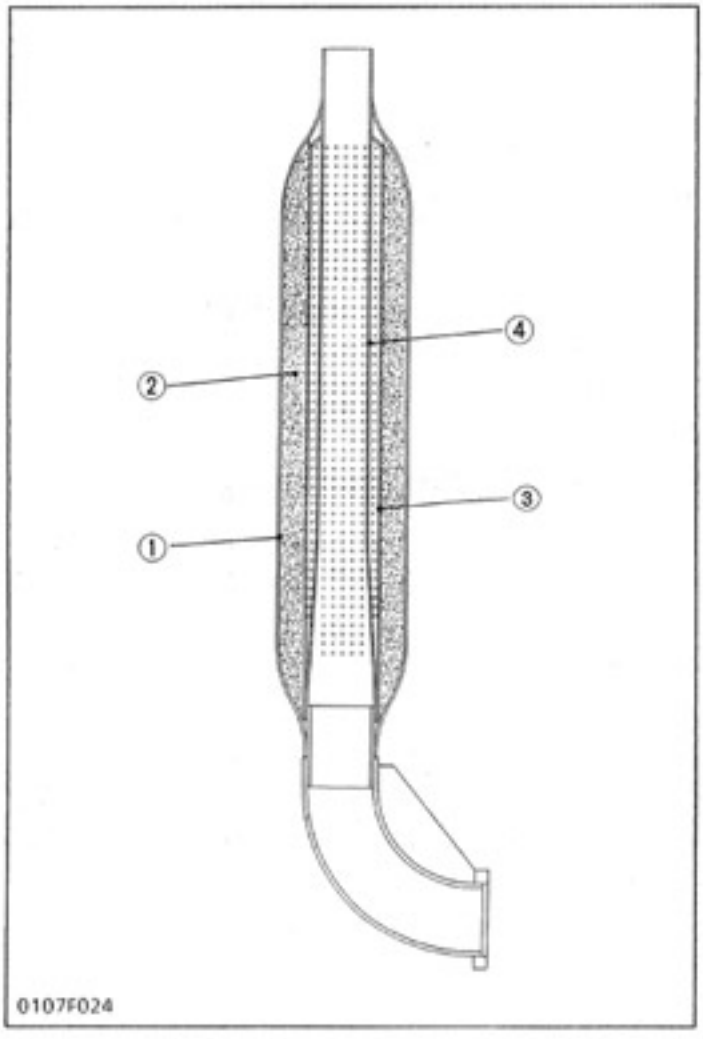
[1] AIR CLEANER (not included in the basic engine)



The air cleaner is a dry-cyclone type for easy maintenance. Sucked air is caused to flow in a whirling way with fin (1). As a result, heavier dust particles circulate around the circumference and enter the holes in the baffle cover (6) and accumulate in the dust cup (5). Minute dust, while circulating in the air flow, is absorbed by the element (3) and thus prevented from entering the engine.

(1) Fin
(2) Air Cleaner Body
(3) Air Filter Element
(4) To Cylinder
(5) Dust Cup
(6) Baffle Cover

[2] MUFFLER (not included in the basic engine)



High temperature and high pressure exhaust gas is intermittently discharged by fuel combustion generating pressure waves inside the exhaust pipe which will result in noise.

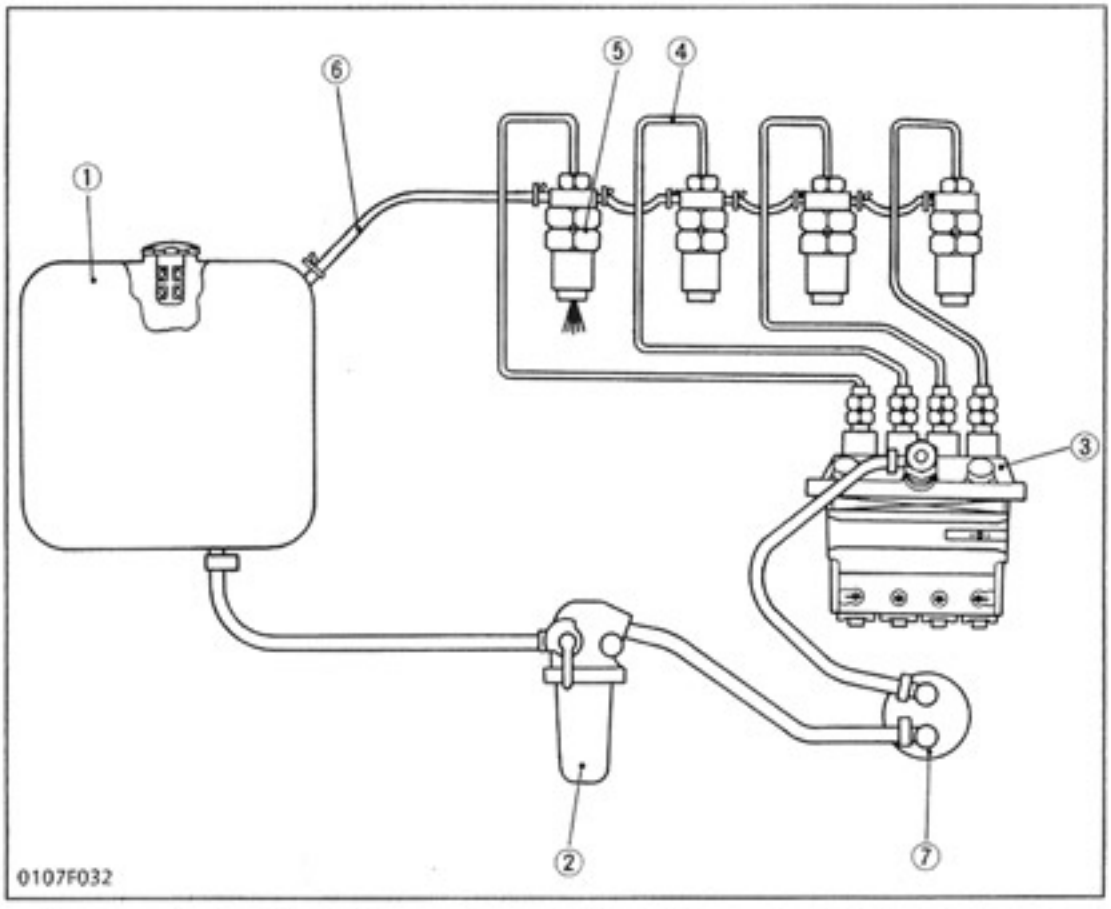
The muffler is used to reduce this noise.

This muffler consists of a perforated inner tube (4) and outer tube (3), glass wool (2), main body (1), etc. The glass wool placed between the outer tube and main body, absorbs the exhaust noise of higher frequency.

(1) Main Body
(2) Glass Wool
(3) Outer Tube
(4) Inner Tube

5 FUEL SYSTEM

[1] GENERAL



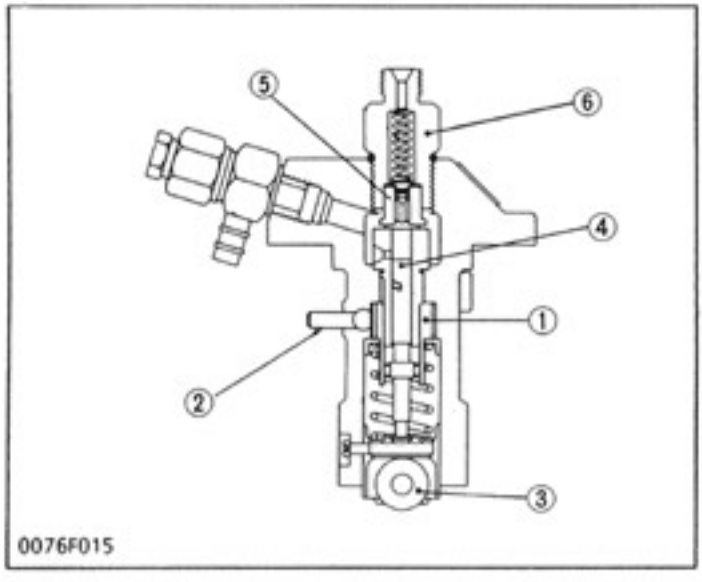
(1) Fuel Tank
(2) Fuel Filter
(3) Injection Pump
(4) Injection Pipe
(5) Injection Nozzle
(6) Fuel Overflow Pipe
(7) Fuel Lift Pump

Fuel from the fuel tank (1) passes through the fuel filter (2), and then enters the injection pump (3) after impurities such as dirt, water, etc. are removed.

The fuel pressurized by the injection pump to the opening pressure (13.73 to 14.71 MPa, 140 to 150 kgf/cm^2, 1991 to 2062 psi), of the injection nozzle (5) is injected into the combustion chamber.

Part of the fuel fed to the injection nozzle (5) lubricates the moving parts of the plunger inside the nozzle, then returns to the fuel tank through the fuel overflow pipe (6) from the upper part of the nozzle holder.

[2] INJECTION PUMP

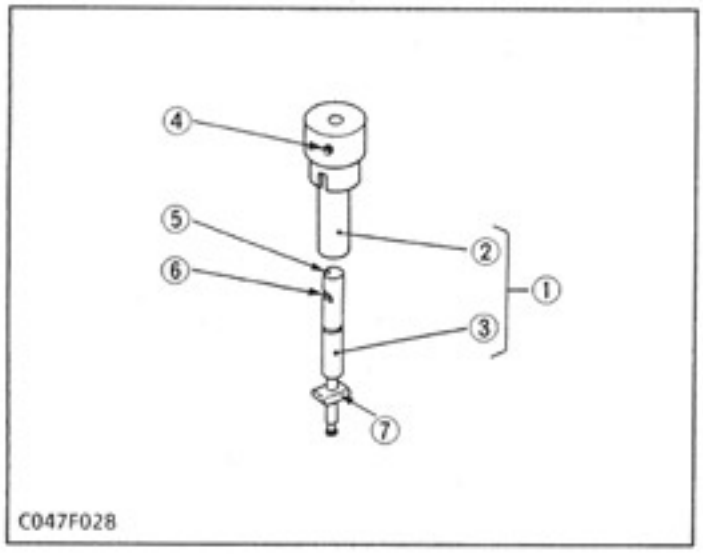


A Bosch K type mini pump is used for the injection pump. It is small, lightweight and easy to handle.

The plunger (4) with a right-hand lead reciprocates via the tappet roller (3) by means of the camshaft fuel cam, causing the fuel to be delivered into the injection nozzle.

(1) Control Sleeve
(2) Control Rack
(3) Tappet Roller
(4) Plunger
(5) Delivery Valve
(6) Delivery Valve Holder

(1) Pump Element



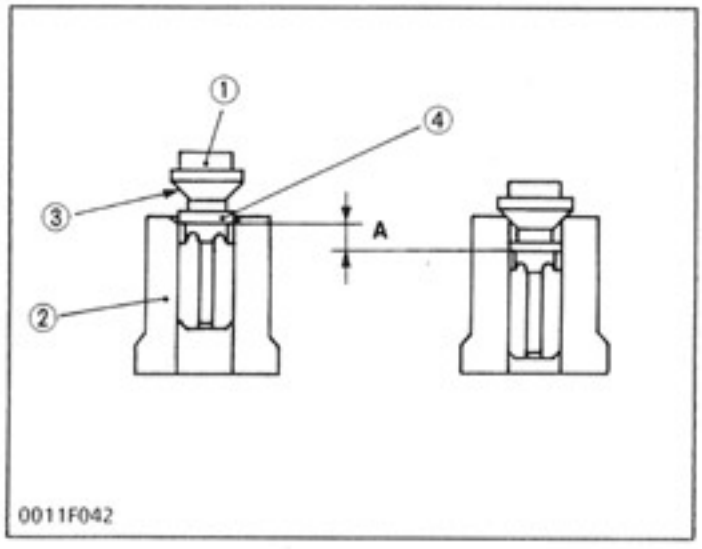
The pump element (1) is consist of the plunger (3) and cylinder (2).

The sliding surfaces are super-precision machined to maintain injection pressure at engine low speeds. Since the driving face (7) fits in the control sleeve, the plunger (3) is rotated by the movement of the control rack to increase or decrease of fuel delivery.

As described above, the plunger (3) is machined to have the slot (5) and the control groove (6).

(1) Pump Element
(2) Cylinder
(3) Plunger
(4) Feed Hole
(5) Slot
(6) Control Groove
(7) Driving Face

) Delivery Valve



The delivery valve consists of the delivery valve (1) and delivery valve seat (2).

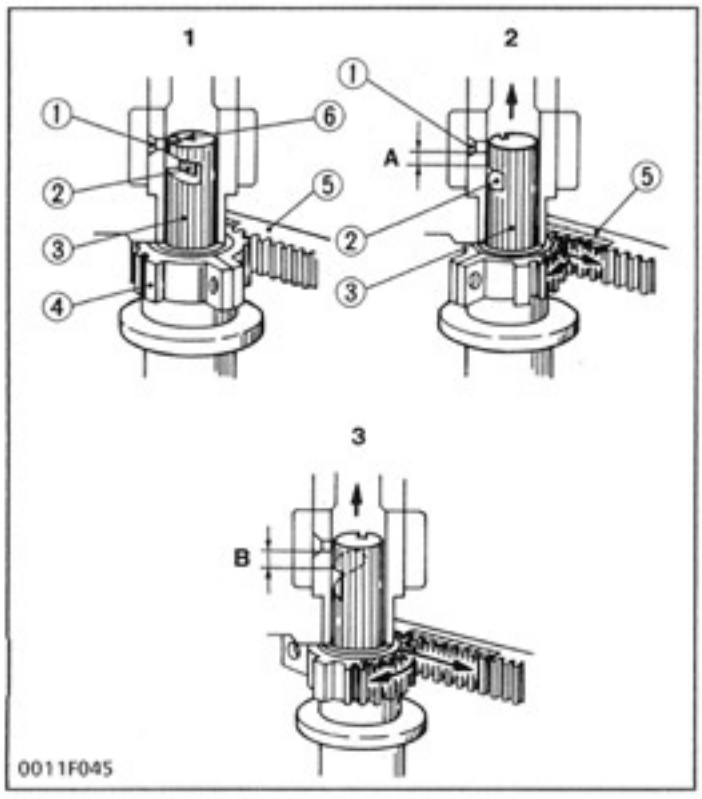
The delivery valve performs the following functions.

1. **Reverse flow preventing function**
   If the fuel flow reverse from the injection nozzle side when the plunger lowers, the time lag between the next delivery start and the nozzle injection start increases. To avoid this, the delivery chamber to injection pipe interruption by delivery valve (1) prevents this reverse flow, thus keeping fuel always filled in the nozzle and pipe.

2. **Suck-back function**
   After completing the fuel delivery, the delivery valve lowers, and the relief plunger (4) end contacts the delivery valve seat (2). The valve further lowers until its seat surface (3) seats firmly the delivery valve seat. During this time, the amount of fuel corresponding to (A) is sucked back from inside the injection pipe, the pressure inside the pipe is reduced, thus leading to an improved injection shut off and preventing after leakage dribbling.

(1) Delivery Valve
(2) Delivery Valve Seat
(3) Seat Surface
(4) Relief Plunger

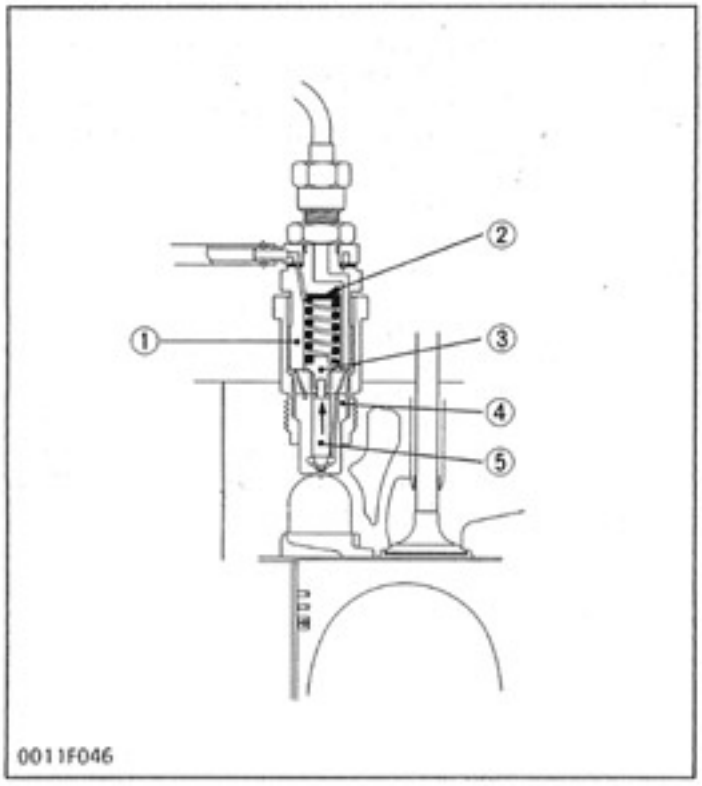
(3) Injection Control



1. **No fuel delivery ····· Engine stop**
   When the control rack (5) is set at the engine stop position, the plunger does not force fuel and no fuel is delivered since the feed hole (1) aligns with the slot (6) in the plunger (3).
2. **Partial fuel delivery**
   When the plunger (3) is rotated by the control rack (5) in the direction of arrow, the fuel is delivered to the injection nozzle.
   The amount of fuel corresponds to the effective stroke (A) from closing the feed hole (1) by the plunger head to contact of the control groove (2) with the feed hole.
3. **Maximum fuel delivery**
   When the control rack is moved to the extreme end in the direction of the arrow, the effective stroke (B) of the plunger is at its maximum, thus the maximum fuel delivery occurs.

(1) Feed Hole
(2) Control Groove
(3) Plunger
(4) Control Sleeve
(5) Control Rack
(6) Slot

[3] INJECTION NOZZLE



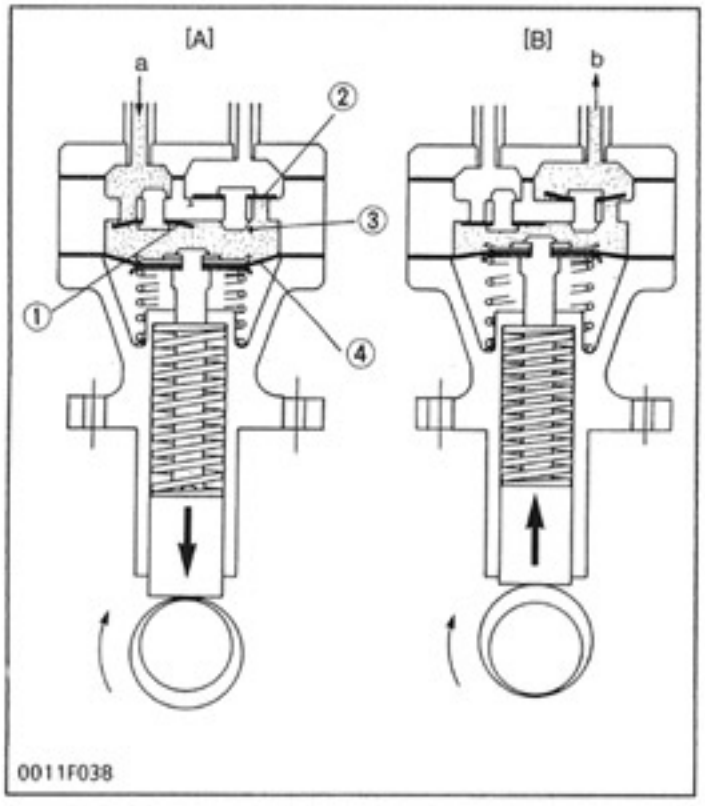
This nozzle is throttle-type. The needle valve (5) is pushed against the nozzle body (4) by the nozzle spring via the push rod (3). Fuel pressurized by the injection pump pushes the needle valve up and then is injected into the sub-combustion chamber.

Excessive flow passes from nozzle holder center through the eye joint and the fuel overflow pipe to the fuel tank.

The injection pressure is 13.73 to 14.71 MPa (140 to 150 kgf/cm^2, 1991 to 2133 psi), and is adjusted with adjusting washers (2).

(1) Nozzle Holder Body
(2) Adjusting Washer
(3) Push Rod
(4) Nozzle Body
(5) Needle Valve

[4] FUEL LIFT PUMP



Filtered fuel is fed to the injection pump by the fuel lift pump. The fuel lift pump operates as shown in the figure. Power is applied to the tappet by an eccentric movement on the fuel camshaft. As the fuel camshaft rotates, the eccentric movement causes the tappet to move up and down. The tappet is linked to a flexible diaphragm (4) via the pull rod.

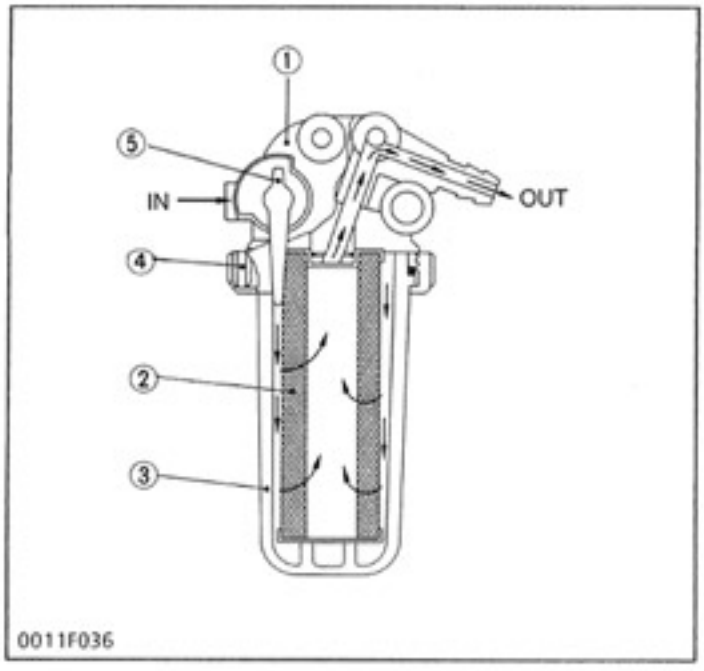
When the diaphragm is pulled down, a low vacuum or low pressure area is created above the diaphragm. This causes atmospheric pressure in the fuel tank to force fuel into the fuel lift pump. The inlet valve (1) opens to admit fuel into the chamber (3)

When the diaphragm is pushed up, pressure is created in the area above the diaphragm. This pressure closes the inlet valve and opens the outlet valve (2), forcing fuel from the pump through the fuel pipe to the injection pump.

[A] Inlet Stroke
[B] Discharge Stroke
(a) From Fuel Filter
(b) To Injection Pump

(1) Inlet Valve
(2) Outlet Valve
(3) Chamber
(4) Diaphragm

[5] FUEL FILTER (not included in the basic model)



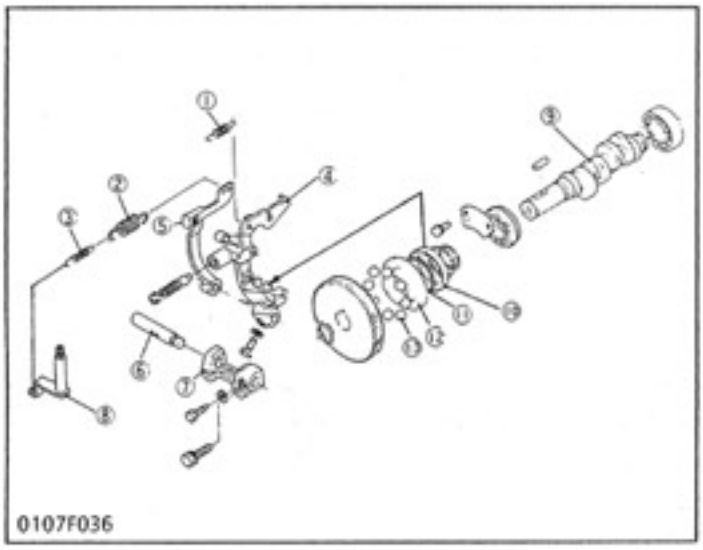
Each moving part of the injection pump and nozzle is extremely precision machined, and clearances of their sliding parts are extremely small. Fuel itself serves as lubricating oil. For this reason, it is extremely important to completely remove water and dirt contained in fuel.

This fuel filter, which uses very fine filter paper, serves to separate and filter dirt in fuel and water accumulated in the tank.

Air vent plug is fitted to the cock body. Before starting or after disassembling and reassembling, loosen this plug and bleed the air in the fuel system.

(1) Cock Body
(2) Filter Element
(3) Filter Cup
(4) Retaining Ring
(5) Fuel Cock

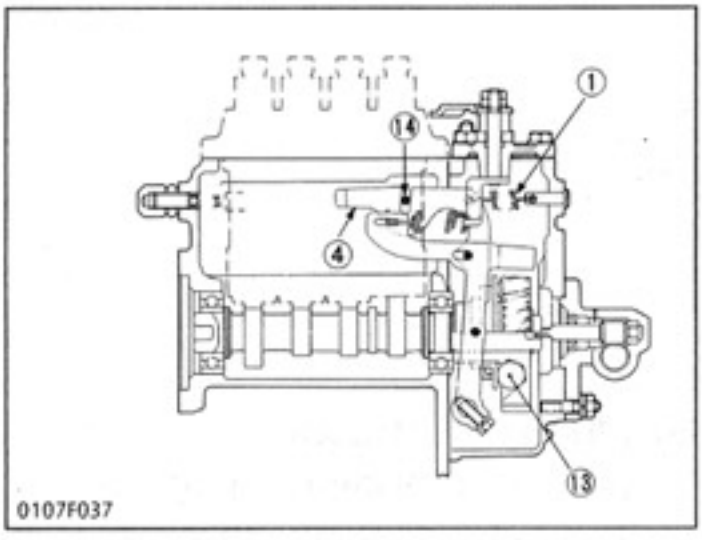
[6] GOVERNOR


0107F036

The governor serves to keep engine speed constant by automatically adjusting the amount of fuel supplied to the engine according to changes in the load. This engine employs an all-speed governor which controls the centrifugal force of the steel ball (13) weight, produced by rotation of the fuel camshaft (9), and the tension of the governor spring 1 (2) and 2 (3) are balanced.

(1) Start Spring
(2) Governor Spring 1
(3) Governor Spring 2
(4) Fork Lever 1
(5) Fork Lever 2
(6) Fork Lever Shaft
(7) Fork Lever Holder
(8) Governor Lever
(9) Fuel Camshaft
(10) Governor Ball Case
(11) Steel Ball
(12) Governor Sleeve
(13) Steel Ball

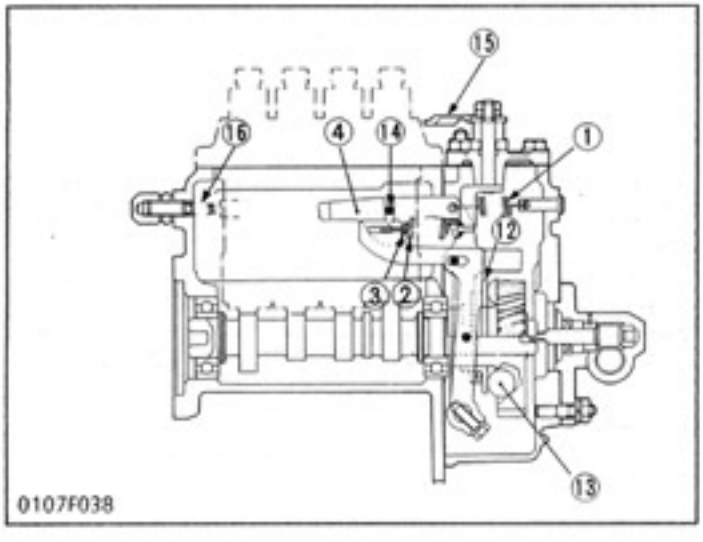
■ At start


0107F037

Since the steel balls (13) have no centrifugal force, a fork lever 1 (4) is pulled to the right by the starter spring (1). Accordingly, the control rack (14) moves to the maximum injection position to assure easy starting.

(14) Control Rack

■ At idling

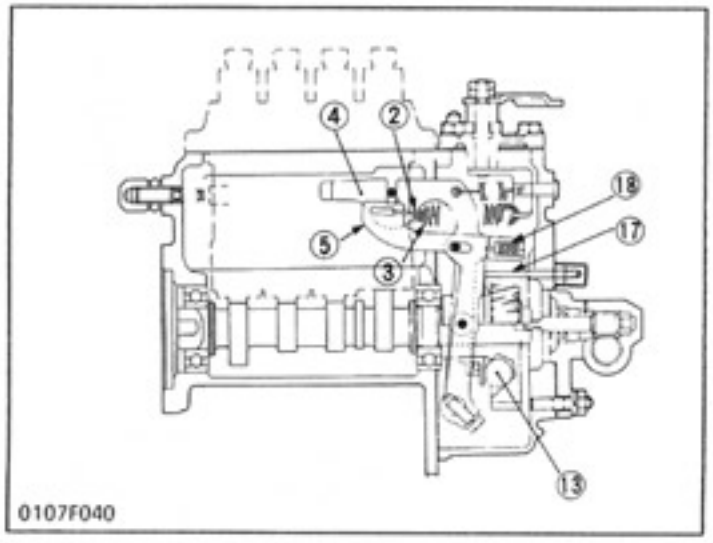

0107F038

When the speed control lever (15) is set at the idling position after the engine starts, the governor spring 1 (2) does not work at all and the governor spring 2 (3) does only act slightly. The governor sleeve (12) is pushed leftward by a centrifugal force of steel balls (13).

Therefore, the fork lever 1 (4) and control rack (14) are moved to the left by the governor sleeve and then the idling limit spring (16) is compressed by the control rack. As a result, the control rack is kept at a position where a centrifugal force of steel balls and forces start spring (1), governor spring 2 and idling limit spring are balanced, providing stable idling.

(15) Speed Control Lever
(16) Idling Limit Spring

■ At high speed running with overload



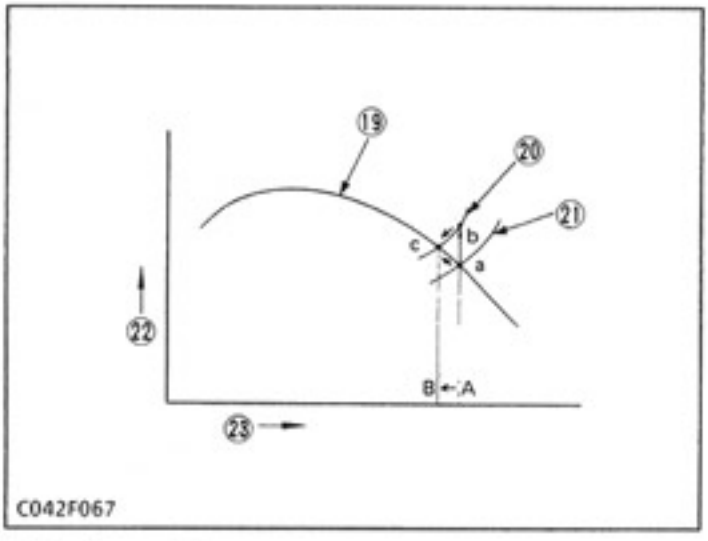
0107F040

When an overload is applied to the engine running at a high speed, the centrifugal force of steel balls (13) becomes small as the engine speed is dropped, and fork lever 2 (5) is pulled to the right by the governor springs 1 (2) and 2 (3), increasing fuel injection. Though, fork lever 2 becomes ineffective in increasing fuel injection when it is stopped by the adjusting bolt (17).

After that, when the force of torque spring (18) becomes greater than the centrifugal force of the steel ball, fork lever 1 (4) moves rightward to increase fuel injection, causing the engine to run continuously at a high torque.

(17) Adjusting Bolt
(18) Torque Spring

■ When load is increased



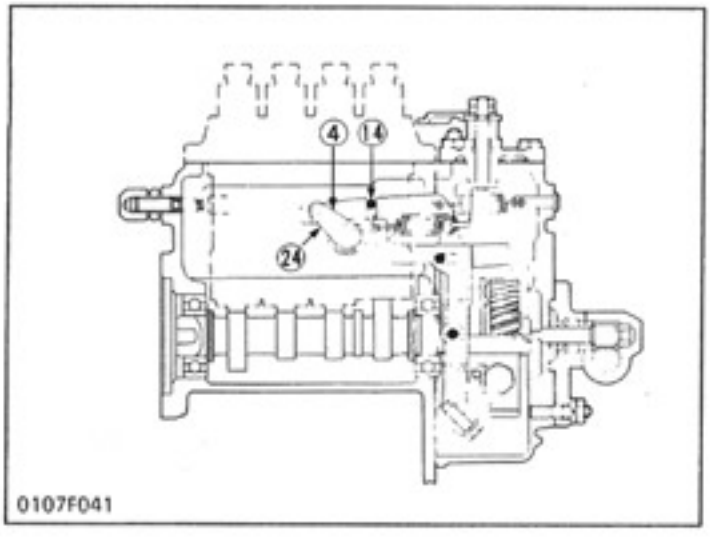
C042F067

The engine speed is controlled when the tension of governor springs 1 (2) and 2 (3), which are pulled by the speed control lever (15), and the centrifugal force of steel balls (13) are balanced.

When the engine speed is dropped (A→B) with load increased (a→b), the centrifugal force of steel balls becomes smaller than the tension of governor springs 1 and 2. As a result, the control rack (14) is moved to the right and amount of fuel injected is increased to produce an engine torque required for the load.

(19) Engine Torque Curve
(20) Large Load Torque Curve
(21) Small Load Torque Curve
(22) Torque
(23) Engine Speed

■ To stop engine



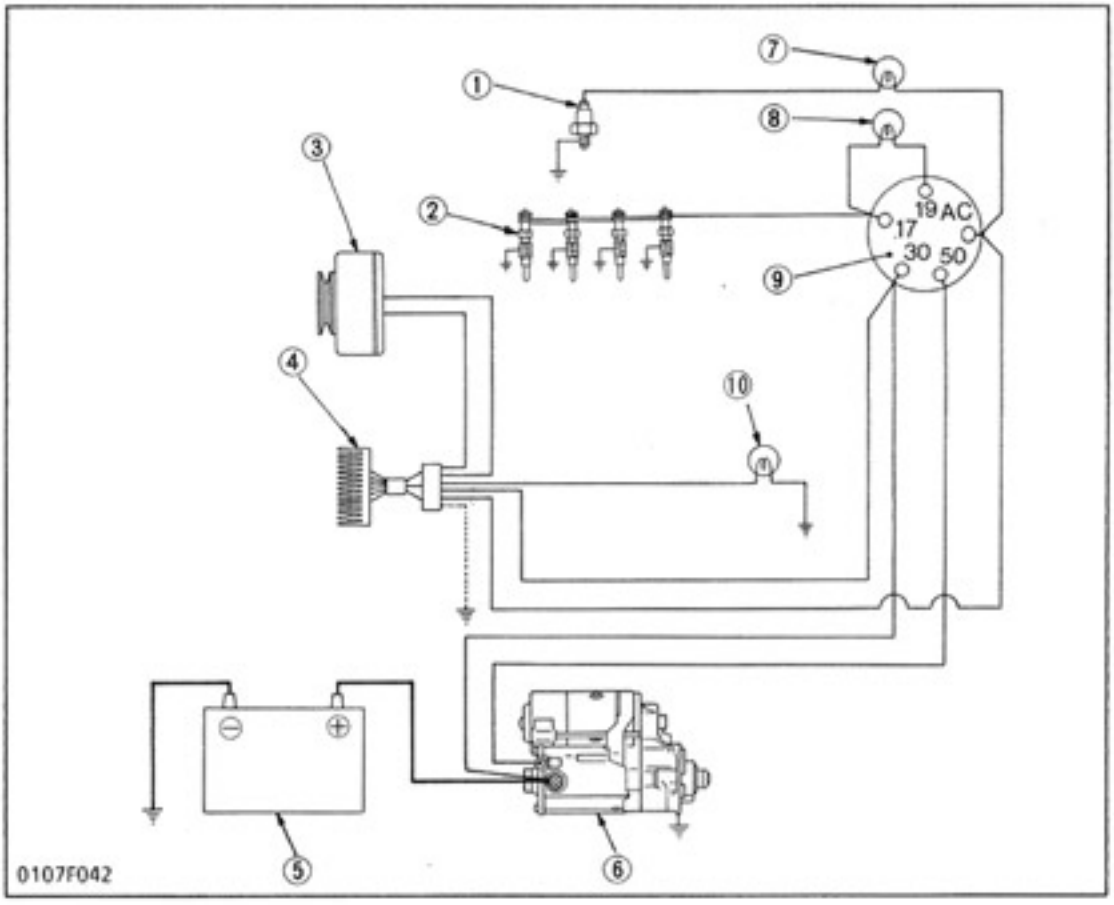
0107F041

When the stop lever (24) is moved to STOP position, fork lever 1 (4) is moved leftward and the control rack (14) is moved to the non-injection position, stopping the engine.

(24) Stop Lever

6 ELECTRICAL SYSTEM

[1] GENERAL



(1) Oil Switch
(2) Glow Plug
(3) Alternator
(4) Regulator
(5) Battery
(6) Starter
(7) Oil Lamp
(8) Glow Plug Indicator
(9) Key Switch
(10) Charge Lamp

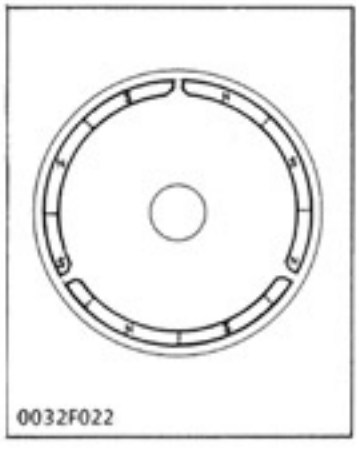
*(5), (7), (8), (9) and (10) are not included in the basic engine.

The electrical system of the engine consists of a starting system (including a starter, glow plugs, etc.), a charging system (including a alternator, regulator, etc.), a battery and an oil switch.

[2] CHARGING SYSTEM

(1) Alternator


0302P005


0032F022

This alternator is an 8 pole rotating magnet type generator. It is simple in construction, consisting of a stator and rotor.

The rotor is made up of eight permanent magnet pole pieces assembled on a shaft and rotates on the center of the stator around which eight electromagnetic coils are provided. This alternator produces higher voltage in slow speed rotation, and charges electric current to the battery during engine idling.

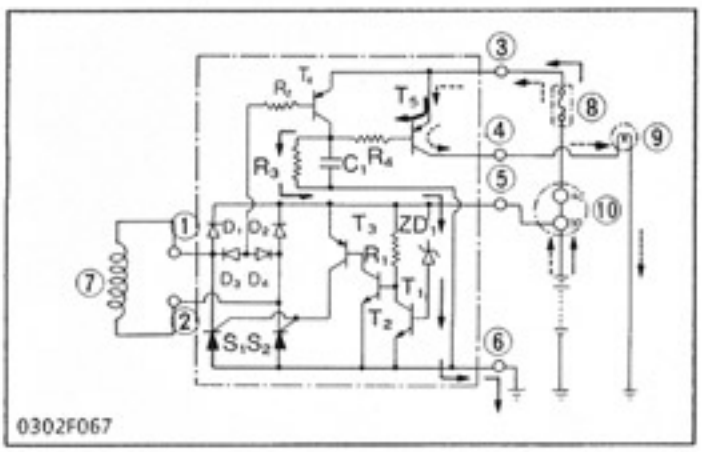
Rotation direction	Clockwise (as seen from pulley side)
Speed in normal use	1600 to 5600 rpm
Charging performance	Over 14A at 5200 rpm
Charge starting speed	Over 1800 rpm

(2) Regulator

0302P006

A regulator has two functions:
1. When the battery voltage is low, it turns the SCR on to form a charging circuit to the battery.
2. During charging, it turns the charging lamp off.

■ When the key switch is turned "ON"

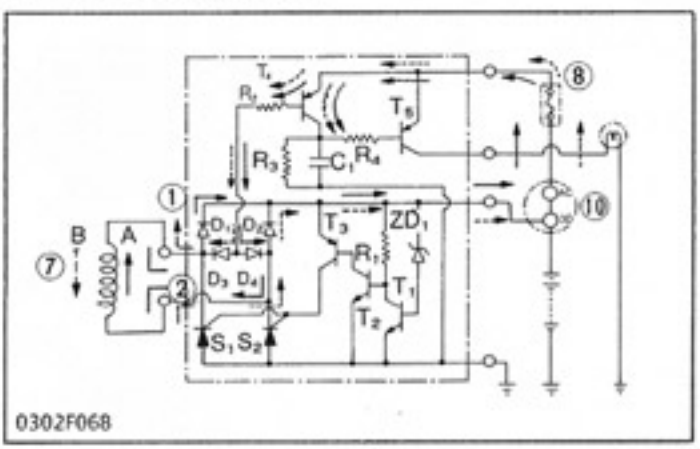


0302F067

When the key switch is turned on, current (⟶) flows from the base of transistor T5 to resistor R4, resistor R3 and to ground, turning transistor T5 on. Then, the current (⇢) flows to the charge lamp to light.

(1) Light Blue (To alternator)
(2) Light Blue (To alternator)
(3) Yellow (To key switch AC terminal)
(4) Green (To charge lamp)
(5) Red (To key switch terminal No.30)
(6) Black (To ground)
(7) Alternator
(8) Fuse
(9) Charge Lamp
(10) Key Switch

■ When the engine starts



0302F068

When the engine starts and a generated voltage in the alternator causes a current in ↑ (A) direction, the current flows as follows:
Diode D1 ⟶ Key Switch ⟶ Transistor T4 ⟶ Resistor R2 ⟶ Diode D4 ⟶ Alternator.

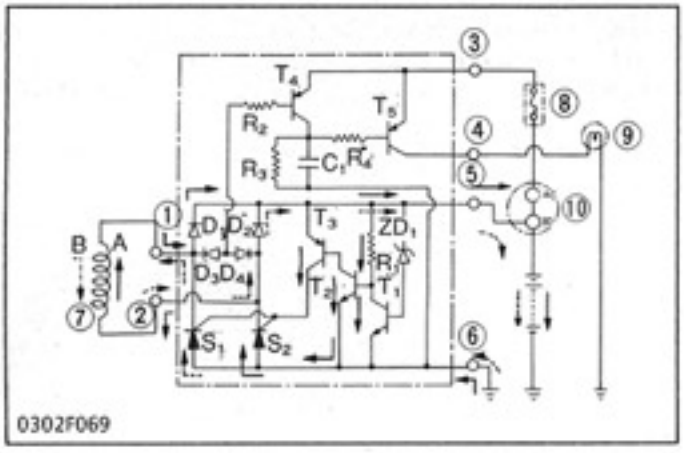
With a current in ↓ (B) direction, a current flows as follows:
Diode D2 ⇢ Key Switch ⇢ Transistor T4 ⇢ Resistor R2 ⇢ Diode D3 ⇢ Alternator.

In both cases, the current flows to the base of transistor T4 to turn T4 on.

When transistor T4 is turned on, potential difference between the emitter and base of transistor T5 becomes zero, turning T5 off. The charge lamp then goes off.

A capacitor C1 is provided to stabilize voltage across resistor R3. Without this capacitor, transistor T4 repeats on and off at low voltage in the alternator, and the charge lamp lights dimly. This capacitor eliminates the ripples to prevent unstable operation.

■ During charging



When the battery voltage is below the specified value (14.5 ± 0.5 V) of zener diode ZD1, a current does not flow to zener diode ZD1. Base current of transistor T1 does not flow, and transistor T1 is off. Current flows from resistor R1 to the base of transistor T2 to turn it on.

When transistor T2 is on, transistor T3 is forward based and turns on, allowing a gate current of SCR's S1 and S2 to turn them on.

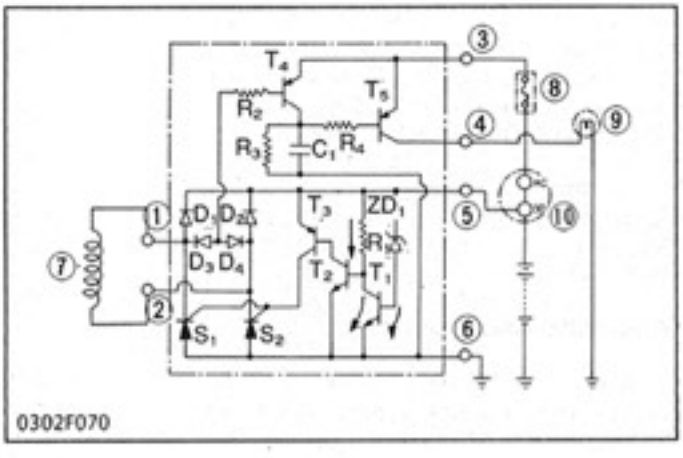
Therefore, when a generated voltage in alternator causes a current in ↑ (A) direction, the changing current flows as follows:

Diode D1 → Key Switch (Terminal No.30) → Battery → Ground → SCR S2 → Alternator.

With a current in ↓ (B) direction, the charging current flows as follows:

Diode D2 → Key Switch (Terminal No.30) → Battery → Ground → SCR S1 → Alternator.

Prevention of overcharging



When the battery voltage rises over the specified value of zener diode ZD1, a current flows to the base of transistor T1 through ZD1, turning transistor T1 on. This causes a potential difference between the base and emitter of transistor T2 to become zero, turning off transistor T2 simultaneously.

Therefore, the current is no longer supplied to the gates of SCR's S1 and S2, turning off SCRs and the charging circuit is cut off.