SHOP MANUAL

KOMATSU

108 SERIES

DIESEL ENGINE

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SAFETY
SAFETY NOTICE

IMPORTANT SAFETY NOTICE

Proper service and repair is extremely important for safe machine operation. The service and repair techniques recommended by Komatsu and described in this manual are both effective and safe. Some of these techniques require the use of tools specially designed by Komatsu for the specific purpose.

To prevent injury to workers, the symbol ⚠ is used to mark safety precautions in this manual. The cautions accompanying these symbols should always be followed carefully. If any dangerous situation arises or may possibly arise, first consider safety, and take the necessary actions to deal with the situation.

GENERAL PRECAUTIONS

Mistakes in operation are extremely dangerous. Read the Operation and Maintenance Manual carefully BEFORE operating the machine.

1. Before carrying out any greasing or repairs, read all the precautions given on the decals which are fixed to the machine.
2. When carrying out any operation, always wear safety shoes and helmet. Do not wear loose work clothes, or clothes with buttons missing.
   - Always wear safety glasses when hitting parts with a hammer.
   - Always wear safety glasses when grinding parts with a grinder, etc.
3. If welding repairs are needed, always have a trained, experienced welder carry out the work. When carrying out welding work, always wear welding gloves, apron, hand shield, cap and other clothes suited for welding work.
4. When carrying out any operation with two or more workers, always agree on the operating procedure before starting. Always inform your fellow workers before starting any step of the operation. Before starting work, hang UNDER REPAIR signs on the controls in the operator's compartment.
5. Keep all tools in good condition and learn the correct way to use them.
6. Decide a place in the repair workshop to keep tools and removed parts. Always keep the tools and parts in their correct places. Always keep the work area clean and make sure that there is no dirt or oil on the floor. Smoke only in the areas provided for smoking. Never smoke while working.

PREPARATIONS FOR WORK

7. Before adding oil or making any repairs, park the machine on hard, level ground, and block the wheels or tracks to prevent the machine from moving.
8. Before starting work, lower blade, ripper, bucket or any other work equipment to the ground. If this is not possible, insert the safety pin or use blocks to prevent the work equipment from falling. In addition, be sure to lock all the control levers and hang warning signs on them.
9. When disassembling or assembling, support the machine with blocks, jacks or stands before starting work.
10. Remove all mud and oil from the steps or other places used to get on and off the machine. Always use the handrails, ladders or steps when getting on or off the machine. Never jump on or off the machine. If it is impossible to use the handrails, ladders or steps, use a stand to provide safe footing.

PRECAUTIONS DURING WORK

11. When removing the oil filler cap, drain plug or hydraulic pressure measuring plugs, loosen them slowly to prevent the oil from spurting out.
    Before disconnecting or removing components of the oil, water or air circuits, first remove the pressure completely from the circuit.
12. The water and oil in the circuits are hot when the engine is stopped, so be careful not to get burned.
    Wait for the oil and water to cool before carrying out any work on the oil or water circuits.
13. Before starting work, remove the leads from the battery. Always remove the lead from the negative (–) terminal first.
14. When raising heavy components, use a hoist or crane.
    Check that the wire rope, chains and hooks are free from damage.
    Always use lifting equipment which has ample capacity.
    Install the lifting equipment at the correct places. Use a hoist or crane and operate slowly to prevent the component from hitting any other part. Do not work with any part still raised by the hoist or crane.
15. When removing covers which are under internal pressure or under pressure from a spring, always leave two bolts in position on opposite sides. Slowly release the pressure, then slowly loosen the bolts to remove.
16. When removing components, be careful not to break or damage the wiring. Damaged wiring may cause electrical fires.
17. When removing piping, stop the fuel or oil from spilling out. If any fuel or oil drips onto the floor, wipe it up immediately. Fuel or oil on the floor can cause you to slip, or can even start fires.
18. As a general rule, do not use gasoline to wash parts. In particular, use only the minimum of gasoline when washing electrical parts.
19. Be sure to assemble all parts again in their original places.
    Replace any damaged parts with new parts.
    - When installing hoses and wires, be sure that they will not be damaged by contact with other parts when the machine is being operated.
20. When installing high pressure hoses, make sure that they are not twisted. Damaged tubes are dangerous, so be extremely careful when installing tubes for high pressure circuits. Also, check that connecting parts are correctly installed.
21. When assembling or installing parts, always use the specified tightening torques. When installing protective parts such as guards, or parts which vibrate violently or rotate at high speed, be particularly careful to check that they are installed correctly.
22. When aligning two holes, never insert your fingers or hand. Be careful not to get your fingers caught in a hole.
23. When measuring hydraulic pressure, check that the measuring tool is correctly assembled before taking any measurements.
24. Take care when removing or installing the tracks of track-type machines.
    When removing the track, the track separates suddenly, so never let anyone stand at either end of the track.

FOREWORD

GENERAL

This shop manual has been prepared as an aid to improve the quality of repairs by giving the serviceman an accurate understanding of the product and by showing him the correct way to perform repairs and make judgements. Make sure you understand the contents of this manual and use it to full effect at every opportunity.

This shop manual mainly contains the necessary technical information for operations performed in a service workshop. For ease of understanding, the manual is divided into the following chapters; these chapters are further divided into the each main group of components.

STRUCTURE AND FUNCTION

This section explains the structure and function of each component. It serves not only to give an understanding of the structure, but also serves as reference material for troubleshooting.

TESTING AND ADJUSTING

This section explains checks to be made before and after performing repairs, as well as adjustments to be made at completion of the checks and repairs.
Troubleshooting charts correlating "Problems" to "Causes" are also included in this section.

DISASSEMBLY AND ASSEMBLY

This section explains the order to be followed when removing, installing, disassembling or assembling each component, as well as precautions to be taken for these operations.

MAINTENANCE STANDARD

This section gives the judgement standards when inspecting disassembled parts.

NOTICE

The specifications contained in this shop manual are subject to change at any time and without any advance notice. Use the specifications given in the book with the latest date.

HOW TO READ THE SHOP MANUAL

VOLUMES

Shop manuals are issued as a guide to carrying out repairs. They are divided as follows:

Chassis volume: Issued for every machine model
Engine volume: Issued for each engine series
Electrical volume:
Attachments volume: } Each issued as one volume to cover all models

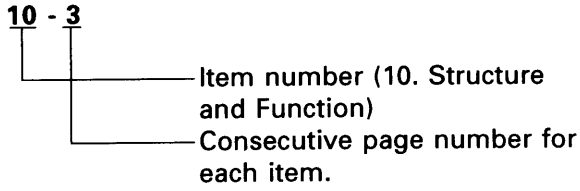
These various volumes are designed to avoid duplicating the same information. Therefore, to deal with all repairs for any model , it is necessary that chassis, engine, electrical and attachment volumes be available.

DISTRIBUTION AND UPDATING

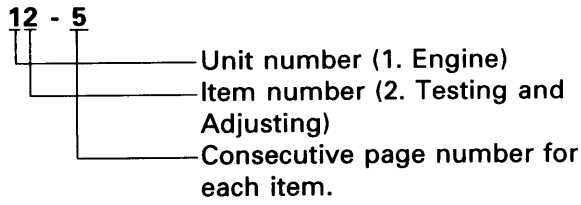
Any additions, amendments or other changes will be sent to KOMATSU distributors. Get the most up-to-date information before you start any work.

FILING METHOD

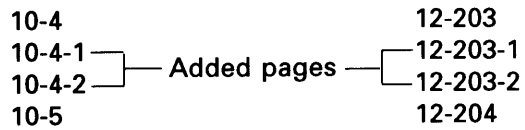
1. See the page number on the bottom of the page. File the pages in correct order.
2. Following examples show how to read the page number.
   Example 1 (Chassis volume):



   Example 2 (Engine volume):



3. Additional pages: Additional pages are indicated by a hyphen (-) and number after the page number. File as in the example.
   Example:



REVISED EDITION MARK

When a manual is revised, an edition mark (①②③....) is recorded on the bottom of the pages.

REVISIONS

Revised pages are shown in the LIST OF REVISED PAGES next to the CONTENTS page.

SYMBOLS

So that the shop manual can be of ample practical use, important safety and quality portions are marked with the following symbols.

Symbol	Item	Remarks
⚠	Safety	Special safety precautions are necessary when performing the work.
★	Caution	Special technical precautions or other precautions for preserving standards are necessary when performing the work.
kg	Weight	Weight of parts of systems. Caution necessary when selecting hoisting wire, or when working posture is important, etc.
kgm	Tightening torque	Places that require special attention for the tightening torque during assembly.
	Coat	Places to be coated with adhesives and lubricants, etc.
	Oil, water	Places where oil, water or fuel must be added, and the capacity.
	Drain	Places where oil or water must be drained, and quantity to be drained.

HOISTING INSTRUCTIONS

HOISTING

Heavy parts (25 kg or more) must be lifted with a hoist, etc. In the **DISASSEMBLY AND ASSEMBLY** section, every part weighing 25 kg or more is indicated clearly with the symbol kg

- If a part cannot be smoothly removed from the machine by hoisting, the following checks should be made:
  1) Check for removal of all bolts fastening the part to the relative parts.
  2) Check for existence of another part causing interference with the part to be removed.

WIRE ROPES

1) Use adequate ropes depending on the weight of parts to be hoisted, referring to the table below:

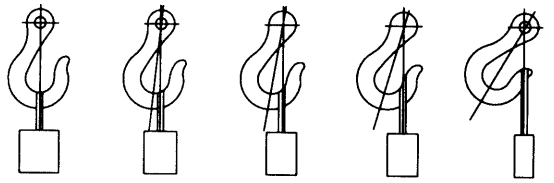
Wire ropes
(Standard "Z" or "S" twist ropes without galvanizing)

Rope diameter	Allowable load	
mm	kN	tons
10	9.8	1.0
11.2	13.7	1.4
12.5	15.7	1.6
14	21.6	2.2
16	27.5	2.8
18	35.3	3.6
20	43.1	4.4
22.4	54.9	5.6
30	98.1	10.0
40	176.5	18.0
50	274.6	28.0
60	392.2	40.0

★ The allowable load value is estimated to be one-sixth or one-seventh of the breaking strength of the rope used.

2) Sling wire ropes from the middle portion of the hook.

Slinging near the edge of the hook may cause the rope to slip off the hook during hoisting, and a serious accident can result. Hooks have maximum strength at the middle portion.



100% 88% 79% 71% 41%

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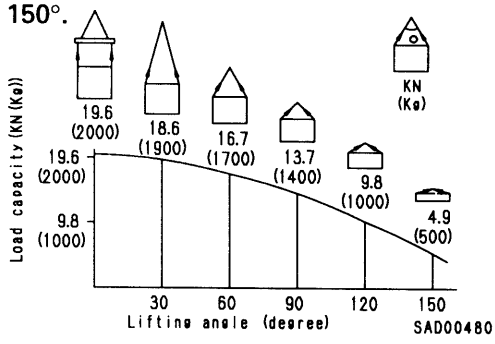
3) Do not sling a heavy load with one rope alone, but sling with two or more ropes symmetrically wound onto the load.
   ⚠ Slinging with one rope may cause turning of the load during hoisting, untwisting of the rope, or slipping of the rope from its original winding position on the load, which can result in a dangerous accident.

4) Do not sling a heavy load with ropes forming a wide hanging angle from the hook. When hoisting a load with two or more ropes, the force subjected to each rope will increase with the hanging angles. The table below shows the variation of allowable load kN {kg} when hoisting is made with two ropes, each of which is allowed to sling up to 9.8 kN {1000 kg} vertically, at various hanging angles.
   When two ropes sling a load vertically, up to 19.6 kN {2000 kg} of total weight can be suspended. This weight becomes 9.8 kN {1000 kg} when two ropes make a 120° hanging angle. On the other hand, two ropes are subjected to an excessive force as large as 39.2 kN {4000 kg} if they sling a 19.6 kN {2000 kg} load at a lifting angle of 150°.



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COATING MATERIALS

★ The recommended coating materials such as adhesives, gasket sealants and greases used for disassembly and assembly are listed below.
★ For coating materials not listed below, use the equivalent of products shown in this list.

Category	Komatsu code	Part No.	Q'ty	Container	Main applications, features
Adhesives	LT-1A	790-129-9030	150 g	Tube	• Used to prevent rubber gaskets, rubber cushions, and cock plug from coming out.
	LT-1B	790-129-9050	20 g (2 pes.)	Polyethylene container	• Used in places requiring an immediately effective, strong adhesive. Used for plastics (except polyethylene, polyprophylene, tetrafluoroethlene and vinyl chloride), rubber, metal and non-metal.
	LT-2	09940-00030	50 g	Polyethylene container	• Features: Resistance to heat and chemicals • Used for anti-loosening and sealant purpose for bolts and plugs.
	LT-3	790-129-9060 (Set of adhesive and hardening agent)	Adhesive: 1 kg Hardening agent: 500 g	Can	• Used as adhesive or sealant for metal, glass and plastic.
	LT-4	790-129-9040	250 g	Polyethylene container	• Used as sealant for machined holes.
	Holtz MH 705	790-126-9120	75 g	Tube	• Used as heat-resisting sealant for repairing engine.
	Three bond 1735	790-129-9140	50 g	Polyethylene container	• Quick hardening type adhesive • Cure time: within 5 sec. to 3 min. • Used mainly for adhesion of metals, rubbers, plastics and woods.
	Aron-alpha 201	790-129-9130	2 g	Polyethylene container	• Quick hardening type adhesive • Quick cure type (max. strength after 30 minutes) • Used mainly for adhesion of rubbers, plastics and metals.
	Loctite 648-50	79A-129-9110	50 cc	Polyethylene container	• Features: Resistance to heat, chemicals • Used at joint portions subject to high temperatures.
Gasket sealant	LG-1	790-129-9010	200 g	Tube	• Used as adhesive or sealant for gaskets and packing of power train case, etc.
	LG-3	790-129-9070	1 kg	Can	• Features: Resistance to heat • Used as sealant for flange surfaces and bolts at high temperature locations, used to prevent seizure. • Used as sealant for heat resistance gasket for high temperature locations such as engine precombustion chamber, exhaust pipe, etc.

Category	Komatsu code	Part No.	Q'ty	Container	Main applications, features
Gasket sealant	LG-4	790–129–9020	200 g	Tube	• Features: Resistance to water, oil • Used as sealant for flange surface, thread. • Also possible to use as sealant for flanges with large clearance. • Used as sealant for mating surfaces of final drive case, transmission case.
	LG-5	790–129–9080	1 kg	Polyethylene container	• Used as sealant for various threads, pipe joints, flanges. • Used as sealant for tapered plugs, elbows, nipples of hydraulic piping.
	LG-6	09940–00011	250 g	Tube	• Features: Silicon based, resistance to heat, cold • Used as sealant for flange surface, tread. • Used as sealant for oil pan, final drive case, etc.
	LG-7	09920-00150	150 g	Tube	• Features: Silicon based, quick hardening type • Used as sealant for flywheel housing, intake manifold, oil an, thermostat housing, etc.
	Three bond 1211	790–129–9090	100 g	Tube	• Used as heat-resisting sealant for repairing engine.
Molybdenum disulphide lubricant	LM-G	09940-00051	60 g	Can	• Used as lubricant for sliding portion (to prevent from squeaking).
	LM-P	09940-00040	200 g	Tube	• Used to prevent seizure or scuffling of the thread when press fitting or shrink fitting. • Used as lubricant for linkage, bearings, etc.
Grease	G2-LI	SYG2-400LI SYG2-350LI SYG2-400LI-A SYG2-160LI SYGA-160CNLI	Various	Various	• General purpose type
	G2-CA	SYG2-400CA SYG2-350CA SYG2-400CA-A SYG2-160CA SYGA-160CNCA	Various	Various	• Used for normal temperature, light load bearing at places in contact with water or steam.
	Molybdenum disulphide lubricant	SYG2-400M	400 g (10 per case)	Belows type	• Used for places with heavy load

STANDARD TIGHTENING TORQUE

STANDARD TIGHTENING TORQUE TABLE (WHEN USING TORQUE WRENCH)

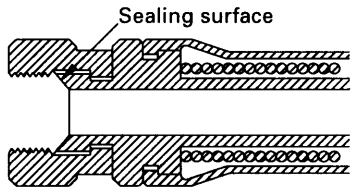
★ In the case of metric nuts and bolts for which there is no special instruction, tighten to the torque given in the table below.

Thread diameter of bolt	Width across flats	 CDL00372	
mm	mm	Nm	kgm
6	10	13.2 ± 1.4	1.35 ± 0.15
8	13	31 ± 3	3.2 ± 0.3
10	17	66 ± 7	6.7 ± 0.7
12	19	113 ± 10	11.5 ± 1
14	22	177 ± 19	18 ± 2
16	24	279 ± 30	28.5 ± 3
18	27	382 ± 39	39 ± 4
20	30	549 ± 59	56 ± 6
22	32	745 ± 83	76 ± 8.5
24	36	927 ± 103	94.5 ± 10.5
27	41	1320 ± 140	135 ± 15
30	46	1720 ± 190	175 ± 20
33	50	2210 ± 240	225 ± 25
36	55	2750 ± 290	280 ± 30
39	60	3290 ± 340	335 ± 35

Thread diameter of bolt	Width across flats	 CDL00373	
mm	mm	Nm	kgm
6	10	7.85 ± 1.95	0.8 ± 0.2
8	13	18.6 ± 4.9	1.9 ± 0.5
10	14	40.2 ± 5.9	4.1 ± 0.6
12	27	82.35 ± 7.85	8.4 ± 0.8

TABLE OF TIGHTENING TORQUES FOR FLARED NUTS

★ In the case of flared nuts for which there is no special instruction, tighten to the torque given in the table below.



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Thread diameter	Width across flat	Tightening torque	
mm	mm	Nm	kgm
14	19	24.5 ± 4.9	2.5 ± 0.5
18	24	49 ± 19.6	5 ± 2
22	27	78.5 ± 19.6	8 ± 2
24	32	137.3 ± 29.4	14 ± 3
30	36	176.5 ± 29.4	18 ± 3
33	41	196.1 ± 49	20 ± 5
36	46	245.2 ± 49	25 ± 5
42	55	294.2 ± 49	30 ± 5

TABLE OF TIGHTENING TORQUES FOR SPLIT FLANGE BOLTS

★ In the case of split flange bolts for which there is no special instruction, tighten to the torque given in the table below.

Thread diameter	Width across flat	Tightening torque	
mm	mm	Nm	kgm
10	14	65.7 ± 6.8	6.7 ± 0.7
12	17	112 ± 9.8	11.5 ± 1
16	22	279 ± 29	28.5 ± 3

TABLE OF TIGHTENING TORQUES FOR O-RING BOSS PIPING JOINTS

★ Unless there are special instructions, tighten the O-ring boss piping joints to the torque below.

Nominal No.	Thread diameter	Width across flat	Tightening torque	
	mm	mm	Nm	kgm
02	14	Varies depending on type of connector.	34.3 ± 4.9	3.5 ± 0.5
03, 04	20		93.1 ± 9.8	9.5 ± 1
05, 06	24		142.1 ± 19.6	14.5 ± 2
10, 12	33		421.4 ± 58.8	43 ± 6
14	42		877.1 ± 132.3	89.5 ± 13.5

TABLE OF TIGHTENING TORQUES FOR O-RING BOSS PLUGS

★ Unless there are special instructions, tighten the O-ring boss plugs to the torque below.

Nominal No.	Thread diameter	Width across flat	Tightening torque	
	mm	mm	Nm	kgm
08	8	14	7.35 ± 1.47	0.75 ± 0.15
10	10	17	11.27 ± 1.47	1.15 ± 0.15
12	12	19	17.64 ± 1.96	1.8 ± 0.2
14	14	22	22.54 ± 1.96	2.3 ± 0.2
16	16	24	29.4 ± 4.9	3 ± 0.5
18	18	27	39.2 ± 4.9	4 ± 0.5
20	20	30	49 ± 4.9	5 ± 0.5
24	24	32	68.6 ± 9.8	7 ± 1
30	30	32	107.8 ± 14.7	11 ± 1.5
33	33	—	127.4 ± 19.6	13 ± 2
36	36	36	151.9 ± 24.5	15.5 ± 2.5
42	42	—	210.7 ± 29.4	21.5 ± 3
52	52	—	323.4 ± 44.1	33 ± 4.5

TIGHTENING TORQUE FOR 102 ENGINE SERIIES (BOLT AND NUTS)

Use these torques for bolts and nuts (unit: mm) of Cummins Engine.

Thread diameter	Tightening torque	
mm	Nm	kgm
6	10 ± 2	1.02 ± 0.20
8	24 ± 4	2.45 ± 0.41
10	43 ± 6	4.38 ± 0.61
12	77 ± 12	7.85 ± 1.22

TIGHTENING TORQUE FOR 102 ENGINE SERIIES (EYE JOINTS)

Use these torques for eye joints (unit: mm) of Cummins Engine.

Thread diameter	Tightening torque	
mm	Nm	kgm
6	8 ± 2	0.81 ± 0.20
8	10 ± 2	1.02 ± 0.20
10	12 ± 2	1.22 ± 0.20
12	24 ± 4	2.45 ± 0.41
14	36 ± 5	3.67 ± 0.51

TIGHTENING TORQUE FOR 102 ENGINE SERIIES (TAPERED SCREWS)

Use these torques for tapered screws (unit: inch) of Cummins Engine.

Thread diameter	Tightening torque	
inch	Nm	kgm
1 / 16	3 ± 1	0.31 ± 0.10
1 / 8	8 ± 2	0.81 ± 0.20
1 / 4	12 ± 2	1.22 ± 0.20
3 / 8	15 ± 2	1.53 ± 0.41
1 / 2	24 ± 4	2.45 ± 0.41
3 / 4	36 ± 5	3.67 ± 0.51
1	60 ± 9	6.12 ± 0.92

ELECTRIC WIRE CODE

In the wiring diagrams, various colors and symbols are employed to indicate the thickness of wires. This wire code table will help you understand WIRING DIAGRAMS.
Example: 5WB indicates a cable having a nominal number 5 and white coating with black stripe.

CLASSIFICATION BY THICKNESS

Nominal number	Copper wire			Cable O.D. (mm)	Current rating (A)	Applicable circuit
	Number of strands	Dia. of strands (mm)	Cross section (mm^2)			
0.85	11	0.32	0.88	2.4	12	Starting, lighting, signal etc.
2	26	0.32	2.09	3.1	20	Lighting, signal etc.
5	65	0.32	5.23	4.6	37	Charging and signal
15	84	0.45	13.36	7.0	59	Starting (Glow plug)
40	85	0.80	42.73	11.4	135	Starting
60	127	0.80	63.84	13.6	178	Starting
100	217	0.80	109.1	17.6	230	Starting

CLASSIFICATION BY COLOR AND CODE

Priority	Circuits / Classification		Charging	Ground	Starting	Lighting	Instrument	Signal	Other
1	Primary	Code	W	B	B	R	Y	G	L
		Color	White	Black	Black	Red	Yellow	Green	Blue
2	Auxiliary	Code	WR	—	BW	RW	YR	GW	LW
		Color	White & Red	—	Black & White	Red & White	Yellow & Red	Green & White	Blue & White
3		Code	WB	—	BY	RB	YB	GR	LR
		Color	White & Black	—	Black & Yellow	Red & Black	Yellow & Black	Green & Red	Blue & Red
4		Code	WL	—	BR	RY	YG	GY	LY
		Color	White & Blue	—	Black & Red	Red & Yellow	Yellow & Green	Green & Yellow	Blue & Yellow
5		Code	WG	—	—	RG	YL	GB	LB
		Color	White & Green	—	—	Red & Green	Yellow & Blue	Green & Black	Blue & Black
6		Code	—	—	—	RL	YW	GL	—
		Color	—	—	—	Red & Blue	Yellow & White	Green & Blue	—

CONVERSION TABLE

METHOD OF USING THE CONVERSION TABLE

The Conversion Table in this section is provided to enable simple conversion of figures. For details of the method of using the Conversion Table, see the example given below.

EXAMPLE

- Method of using the Conversion Table to convert from millimeters to inches

1. Convert 55 mm into inches.
   (1) Locate the number 50 in the vertical column at the left side, take this as Ⓐ, then draw a horizontal line from Ⓐ.
   (2) Locate the number 5 in the row across the top, take this as Ⓑ, then draw a perpendicular line down from Ⓑ.
   (3) Take the point where the two lines cross as Ⓒ. This point Ⓒ gives the value when converting from millimeters to inches. Therefore, 55 mm = 2.165 inches.

2. Convert 550 mm into inches.
   (1) The number 550 does not appear in the table, so divide by 10 (move the decimal point one place to the left) to convert it to 55 mm.
   (2) Carry out the same procedure as above to convert 55 mm to 2.165 inches.
   (3) The original value (550 mm) was divided by 10, so multiply 2.165 inches by 10 (move the decimal point one place to the right) to return to the original value. This gives 550 mm = 21.65 inches.

Millimeters to inches

1 mm = 0.03937 in

	0	1	2	3	4	5 (Ⓑ)	6	7	8	9
0	0	0.039	0.079	0.118	0.157	0.197	0.236	0.276	0.315	0.354
10	0.394	0.433	0.472	0.512	0.551	0.591	0.630	0.669	0.709	0.748
20	0.787	0.827	0.866	0.906	0.945	0.984	1.024	1.063	1.102	1.142
30	1.181	1.220	1.260	1.299	1.339	1.378	1.417	1.457	1.496	1.536
40	1.575	1.614	1.654	1.693	1.732	1.772	1.811	1.850	1.890	1.929
50 (Ⓐ)	1.969	2.008	2.047	2.087	2.126	2.165 (Ⓒ)	2.205	2.244	2.283	2.323
60	2.362	2.402	2.441	2.480	2.520	2.559	2.598	2.638	2.677	2.717
70	2.756	2.795	2.835	2.874	2.913	2.953	2.992	3.032	3.071	3.110
80	3.150	3.189	3.228	3.268	3.307	3.346	3.386	3.425	3.465	3.504
90	3.543	3.583	3.622	3.661	3.701	3.740	3.780	3.819	3.858	3.898

Millimeters to Inches

1 mm = 0.03937 in

	0	1	2	3	4	5	6	7	8	9
0	0	0.039	0.079	0.118	0.157	0.197	0.236	0.276	0.315	0.354
10	0.394	0.433	0.472	0.512	0.551	0.591	0.630	0.669	0.709	0.748
20	0.787	0.827	0.866	0.906	0.945	0.984	1.024	1.063	1.102	1.142
30	1.181	1.220	1.260	1.299	1.339	1.378	1.417	1.457	1.496	1.536
40	1.575	1.614	1.654	1.693	1.732	1.772	1.811	1.850	1.890	1.929
50	1.969	2.008	2.047	2.087	2.126	2.165	2.205	2.244	2.283	2.323
60	2.362	2.402	2.441	2.480	2.520	2.559	2.598	2.638	2.677	2.717
70	2.756	2.795	2.835	2.874	2.913	2.953	2.992	3.032	3.071	3.110
80	3.150	3.189	3.228	3.268	3.307	3.346	3.386	3.425	3.465	3.504
90	3.543	3.583	3.622	3.661	3.701	3.740	3.780	3.819	3.858	3.898

Kilogram to Pound

1 kg = 2.2046 lb

	0	1	2	3	4	5	6	7	8	9
0	0	2.20	4.41	6.61	8.82	11.02	13.23	15.43	17.64	19.84
10	22.05	24.25	26.46	28.66	30.86	33.07	35.27	37.48	39.68	41.89
20	44.09	46.30	48.50	50.71	51.91	55.12	57.32	59.53	61.73	63.93
30	66.14	68.34	70.55	72.75	74.96	77.16	79.37	81.57	83.78	85.98
40	88.18	90.39	92.59	94.80	97.00	99.21	101.41	103.62	105.82	108.03
50	110.23	112.44	114.64	116.85	119.05	121.25	123.46	125.66	127.87	130.07
60	132.28	134.48	136.69	138.89	141.10	143.30	145.51	147.71	149.91	152.12
70	154.32	156.53	158.73	160.94	163.14	165.35	167.55	169.76	171.96	174.17
80	176.37	178.57	180.78	182.98	185.19	187.39	189.60	191.80	194.01	196.21
90	198.42	200.62	202.83	205.03	207.24	209.44	211.64	213.85	216.05	218.26

Liter to U.S. Gallon

1ℓ = 0.2642 U.S. Gal

	0	1	2	3	4	5	6	7	8	9
0	0	0.264	0.528	0.793	1.057	1.321	1.585	1.849	2.113	2.378
10	2.642	2.906	3.170	3.434	3.698	3.963	4.227	4.491	4.755	5.019
20	5.283	5.548	5.812	6.076	6.340	6.604	6.869	7.133	7.397	7.661
30	7.925	8.189	8.454	8.718	8.982	9.246	9.510	9.774	10.039	10.303
40	10.567	10.831	11.095	11.359	11.624	11.888	12.152	12.416	12.680	12.944
50	13.209	13.473	13.737	14.001	14.265	14.529	14.795	15.058	15.322	15.586
60	15.850	16.115	16.379	16.643	16.907	17.171	17.435	17.700	17.964	18.228
70	18.492	18.756	19.020	19.285	19.549	19.813	20.077	20.341	20.605	20.870
80	21.134	21.398	21.662	21.926	22.190	22.455	22.719	22.983	23.247	23.511
90	23.775	24.040	24.304	24.568	24.832	25.096	25.361	25.625	25.889	26.153

Liter to U.K. Gallon

1ℓ = 0.21997 U.K. Gal

	0	1	2	3	4	5	6	7	8	9
0	0	0.220	0.440	0.660	0.880	1.100	1.320	1.540	1.760	1.980
10	2.200	2.420	2.640	2.860	3.080	3.300	3.520	3.740	3.950	4.179
20	4.399	4.619	4.839	5.059	5.279	5.499	5.719	5.939	6.159	6.379
30	6.599	6.819	7.039	7.259	7.479	7.969	7.919	8.139	8.359	8.579
40	8.799	9.019	9.239	9.459	9.679	9.899	10.119	10.339	10.559	10.778
50	10.998	11.281	11.438	11.658	11.878	12.098	12.318	12.528	12.758	12.978
60	13.198	13.418	13.638	13.858	14.078	14.298	14.518	14.738	14.958	15.178
70	15.398	15.618	15.838	16.058	16.278	16.498	16.718	16.938	17.158	17.378
80	17.598	17.818	18.037	18.257	18.477	18.697	18.917	19.137	19.357	19.577
90	19.797	20.017	20.237	20.457	20.677	20.897	21.117	21.337	21.557	21.777

kgm to ft. lb

1 kgm = 7.233 ft. lb

	0	1	2	3	4	5	6	7	8	9
0	0	7.2	14.5	21.7	28.9	36.2	43.4	50.6	57.9	65.1
10	72.3	79.6	86.8	94.0	101.3	108.5	115.7	123.0	130.2	137.4
20	144.7	151.9	159.1	166.4	173.6	180.8	188.1	195.3	202.5	209.8
30	217.0	224.2	231.5	238.7	245.9	253.2	260.4	267.6	274.9	282.1
40	289.3	296.6	303.8	311.0	318.3	325.5	332.7	340.0	347.2	354.4
50	361.7	368.9	376.1	383.4	390.6	397.8	405.1	412.3	419.5	426.8
60	434.0	441.2	448.5	455.7	462.9	470.2	477.4	484.6	491.8	499.1
70	506.3	513.5	520.8	528.0	535.2	542.5	549.7	556.9	564.2	571.4
80	578.6	585.9	593.1	600.3	607.6	614.8	622.0	629.3	636.5	643.7
90	651.0	658.2	665.4	672.7	679.9	687.1	694.4	701.6	708.8	716.1
100	723.3	730.5	737.8	745.0	752.2	759.5	766.7	773.9	781.2	788.4
110	795.6	802.9	810.1	817.3	824.6	831.8	839.0	846.3	853.5	860.7
120	868.0	875.2	882.4	889.7	896.9	904.1	911.4	918.6	925.8	933.1
130	940.3	947.5	954.8	962.0	969.2	976.5	983.7	990.9	998.2	1005.4
140	1012.6	1019.9	1027.1	1034.3	1041.5	1048.8	1056.0	1063.2	1070.5	1077.7
150	1084.9	1092.2	1099.4	1106.6	1113.9	1121.1	1128.3	1135.6	1142.8	1150.0
160	1157.3	1164.5	1171.7	1179.0	1186.2	1193.4	1200.7	1207.9	1215.1	1222.4
170	1129.6	1236.8	1244.1	1251.3	1258.5	1265.8	1273.0	1280.1	1287.5	1294.7
180	1301.9	1309.2	1316.4	1323.6	1330.9	1338.1	1345.3	1352.6	1359.8	1367.0
190	1374.3	1381.5	1388.7	1396.0	1403.2	1410.4	1417.7	1424.9	1432.1	1439.4

kg/cm² to lb/in²

1kg/cm² = 14.2233 lb/in²

	0	1	2	3	4	5	6	7	8	9
0	0	14.2	28.4	42.7	56.9	71.1	85.3	99.6	113.8	128.0
10	142.2	156.5	170.7	184.9	199.1	213.4	227.6	241.8	256.0	270.2
20	284.5	298.7	312.9	327.1	341.4	355.6	369.8	384.0	398.3	412.5
30	426.7	440.9	455.1	469.4	483.6	497.8	512.0	526.3	540.5	554.7
40	568.9	583.2	597.4	611.6	625.8	640.1	654.3	668.5	682.7	696.9
50	711.2	725.4	739.6	753.8	768.1	782.3	796.5	810.7	825.0	839.2
60	853.4	867.6	881.8	896.1	910.3	924.5	938.7	953.0	967.2	981.4
70	995.6	1010	1024	1038	1053	1067	1081	1095	1109	1124
80	1138	1152	1166	1181	1195	1209	1223	1237	1252	1266
90	1280	1294	1309	1323	1337	1351	1365	1380	1394	1408
100	1422	1437	1451	1465	1479	1493	1508	1522	1536	1550
110	1565	1579	1593	1607	1621	1636	1650	1664	1678	1693
120	1707	1721	1735	1749	1764	1778	1792	1806	1821	1835
130	1849	1863	1877	1892	1906	1920	1934	1949	1963	1977
140	1991	2005	2020	2034	2048	2062	2077	2091	2105	2119
150	2134	2148	2162	2176	2190	2205	2219	2233	2247	2262
160	2276	2290	2304	2318	2333	2347	2361	2375	2389	2404
170	2418	2432	2446	2460	2475	2489	2503	2518	2532	2546
180	2560	2574	2589	2603	2617	2631	2646	2660	2674	2688
190	2702	2717	2731	2745	2759	2773	2788	2802	2816	2830
200	2845	2859	2873	2887	2901	2916	2930	2944	2958	2973
210	2987	3001	3015	3030	3044	3058	3072	3086	3101	3115
220	3129	3143	3158	3172	3186	3200	3214	3229	3243	3257
230	3271	3286	3300	3314	3328	3343	3357	3371	3385	3399
240	3414	3428	3442	3456	3470	3485	3499	3513	3527	3542

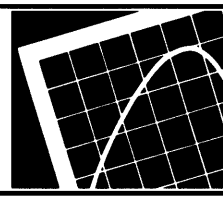
Temperature

Fahrenheit-Centigrade Conversion ; a simple way to convert a Fahrenheit temperature reading into a Centigrade temperature reading or vice versa is to enter the accompanying table in the center or boldface column of figures.
These figures refer to the temperature in either Fahrenheit or Centigrade degrees.
If it is desired to convert from Fahrenheit to Centigrade degrees, consider the center column as a table of Fahrenheit temperatures and read the corresponding Centigrade temperature in the column at the left.
If it is desired to convert from Centigrade to Fahrenheit degrees, consider the center column as a table of Centigrade values, and read the corresponding Fahrenheit temperature on the right.

1°C = 33.8°F

°C		°F	°C		°F	°C		°F	°C		°F
-40.4	**-40**	-40.0	-11.7	**11**	51.8	7.8	**46**	114.8	27.2	**81**	117.8
-37.2	**-35**	-31.0	-11.1	**12**	53.6	8.3	**47**	116.6	27.8	**82**	179.6
-34.4	**-30**	-22.0	-10.6	**13**	55.4	8.9	**48**	118.4	28.3	**83**	181.4
-31.7	**-25**	-13.0	-10.0	**14**	57.2	9.4	**49**	120.2	28.9	**84**	183.2
-28.9	**-20**	-4.0	-9.4	**15**	59.0	10.0	**50**	122.0	29.4	**85**	185.0
-28.3	**-19**	-2.2	-8.9	**16**	60.8	10.6	**51**	123.8	30.0	**86**	186.8
-27.8	**-18**	-0.4	-8.3	**17**	62.6	11.1	**52**	125.6	30.6	**87**	188.6
-27.2	**-17**	1.4	-7.8	**18**	64.4	11.7	**53**	127.4	31.1	**88**	190.4
-26.7	**-16**	3.2	-7.2	**19**	66.2	12.2	**54**	129.2	31.7	**89**	192.2
-26.1	**-15**	5.0	-6.7	**20**	68.0	12.8	**55**	131.0	32.2	**90**	194.0
-25.6	**-14**	6.8	-6.1	**21**	69.8	13.3	**56**	132.8	32.8	**91**	195.8
-25.0	**-13**	8.6	-5.6	**22**	71.6	13.9	**57**	134.6	33.3	**92**	197.6
-24.4	**-12**	10.4	-5.0	**23**	73.4	14.4	**58**	136.4	33.9	**93**	199.4
-23.9	**-11**	12.2	-4.4	**24**	75.2	15.0	**59**	138.2	34.4	**94**	201.2
-23.3	**-10**	14.0	-3.9	**25**	77.0	15.6	**60**	140.0	35.0	**95**	203.0
-22.8	**-9**	15.8	-3.3	**26**	78.8	16.1	**61**	141.8	35.6	**96**	204.8
-22.2	**-8**	17.6	-2.8	**27**	80.6	16.7	**62**	143.6	36.1	**97**	206.6
-21.7	**-7**	19.4	-2.2	**28**	82.4	17.2	**63**	145.4	36.7	**98**	208.4
-21.1	**-6**	21.2	-1.7	**29**	84.2	17.8	**64**	147.2	37.2	**99**	210.2
-20.6	**-5**	23.0	-1.1	**30**	86.0	18.3	**65**	149.0	37.8	**100**	212.0
-20.0	**-4**	24.8	-0.6	**31**	87.8	18.9	**66**	150.8	40.6	**105**	221.0
-19.4	**-3**	26.6	0	**32**	89.6	19.4	**67**	152.6	43.3	**110**	230.0
-18.9	**-2**	28.4	0.6	**33**	91.4	20.0	**68**	154.4	46.1	**115**	239.0
-18.3	**-1**	30.2	1.1	**34**	93.2	20.6	**69**	156.2	48.9	**120**	248.0
-17.8	**0**	32.0	1.7	**35**	95.0	21.1	**70**	158.0	51.7	**125**	257.0
-17.2	**1**	33.8	2.2	**36**	96.8	21.7	**71**	159.8	54.4	**130**	266.0
-16.7	**2**	35.6	2.8	**37**	98.6	22.2	**72**	161.6	57.2	**135**	275.0
-16.1	**3**	37.4	3.3	**38**	100.4	22.8	**73**	163.4	60.0	**140**	284.0
-15.6	**4**	39.2	3.9	**39**	102.2	23.3	**74**	165.2	62.7	**145**	293.0
-15.0	**5**	41.0	4.4	**40**	104.0	23.9	**75**	167.0	65.6	**150**	302.0
-14.4	**6**	42.8	5.0	**41**	105.8	24.4	**76**	168.8	68.3	**155**	311.0
-13.9	**7**	44.6	5.6	**42**	107.6	25.0	**77**	170.6	71.1	**160**	320.0
-13.3	**8**	46.4	6.1	**43**	109.4	25.6	**78**	172.4	73.9	**165**	329.0
-12.8	**9**	48.2	6.7	**44**	111.2	26.1	**79**	174.2	76.7	**170**	338.0
-12.2	**10**	50.0	7.2	**45**	113.0	26.7	**80**	176.0	79.4	**175**	347.0

ENGINE
01 GENERAL



Specifications 01-002
Engine performance curve 01-006
Weight table 01-014

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SPECIFICATIONS

Engine model			S6D108-1		
Applicable machine			D57S-1	WA320-3	WA380-3
Number of cylinder – Bore x Stroke		mm	6 – 108 x 130		
Total piston displacement		ℓ {cc}	7.15 {7,150}		
Firing order		–	1 – 5 – 3 – 6 – 2 – 4		
Dimensions	Overall length	mm	1,273	1,312	1,312
	Overall width	mm	700 (excluding fan)	846	824
	Overall height (excluding exhaust pipe)	mm	1,493 (excluding fan)	1,420	1,420
	Overall height (including exhaust pipe)	mm	–	–	–
Performance	Flywheel horsepower	kW/rpm {HP/rpm}	99.3/1,900 {133/1,900} (Net)	121/2,380 {163/2,380} (Net)	140/2,200 {187/2,200} (Net)
	Maximum torque	Nm/rpm {kgm/rpm}	618/1,400 {63.0/1,400} (Net)	647/1,600 {66.0/1,600} (Net)	804/1,500 {82.0/1,500} (Net)
	High idling speed	rpm	2,050 – 2,150	2,560 – 2,610	2,450 – 2,550
	Low idling speed	rpm	800 – 850	780 – 830	800 – 850
	Minimum fuel consumption ratio	g/kW•h {g/HP•h}	218 {163}	212 {158}	212 {158}
Dry weight		kg	820	730	730
Fuel injection pump			BOSCH PES-AD type		
Governor			BOSCH RSV centrifugal, all speed type		
Lubricating oil amount (refill capacity)		ℓ	26 (22)	31 (28)	31 (28)
Coolant amount		ℓ	58 (engine only: 13)	33 (engine only: 13)	53 (engine only: 13)
Alternator			24 V, 13 A *1: 24 V, 35 A	24 V, 50 A	24 V, 50 A
Starting motor			24 V, 7.5 kW	24 V, 7.5 kW	24 V, 7.5 kW
Battery			12 V 150 Ah x 2 *1: 12 V 200 Ah x 2	12 V 140 Ah x 2	12 V 150 Ah x 2
Turbocharger			GARRET TO4E type	SCHWITZER S2B type	SCHWITZER S2B type
Air compressor			–	–	–
Others			–	–	–

*1: cold terrain spec.

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		S6D108-1		
Generator EG150BS-5 Generator for OEM				
		6 – 108 – 130		
		7.15 {7,150}		
		1 – 5 – 3 – 6 – 2 – 4		
1,407 800 1,181 –				
Rated flywheel horsepower 113 {151}/1,500 (50 Hz) 134 {180}/1,800 (60 Hz) Maximum flywheel horsepower 128 {171}/1,500 (50 Hz) 152 {204}/1,800 (60 Hz) (Net) – max. 1,575 (50 Hz) max. 1,890 (60 Hz) 700 – 800 211 {158}				
790				
		BOSCH PES-AD type		
		BOSCH RSV centrifugal, all speed type		
25 (23.5)				
58 (engine only: 13)				
24 V, 25 A 24 V, 7.5 kW 12 V 120 Ah x 2				
GARRET TO4E type – –				

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Engine model			SA6D108-1		
Applicable machine			PC300-5 PC300HD-5 PC360LC-5	WA420-3	Sugar cane harvester AUSTOFT in AUSTRALIA (Engine No. 10001 - 10926)
Number of cylinder - Bore x Stroke		mm	6 - 108 x 130		
Total piston displacement		ℓ {cc}	7.15 {7,150}		
Firing order		-	1 - 5 - 3 - 6 - 2 - 4		
Dimensions	Overall length	mm	1,523	1,346	1,216
	Overall width	mm	921	839	786
	Overall height (excluding exhaust pipe)	mm	1,127	1,423	1,070
	Overall height (including exhaust pipe)	mm	-	-	-
Performance	Flywheel horsepower	kW/rpm {HP/rpm}	154/1,950 {207/2,950} (Net)	162/2,200 {217/2,200} (Net)	179/2,400 {240/2,400} (Gross)
	Maximum torque	Nm/rpm {kgm/rpm}	814/1,500 {83.0/1,500} (Net)	847/1,500 {86.4/1,500} (Net)	785/1,600 {80.0/1,600} (Gross)
	High idling speed	rpm	2,115 - 2,235	2,425 - 2,525	2,560 - 2,640
	Low idling speed	rpm	700 - 750	700 - 750	950 - 1,050
	Minimum fuel consumption ratio	g/kW•h {g/HP•h}	197 {147}	204 {152}	206 {151}
Dry weight		kg	700	790	610
Fuel injection pump			DENSO NB (EP-9) type		
Governor			DENSO RSV centrifugal, all speed type		
Lubricating oil amount (refill capacity)		ℓ	28 (25)	31 (28)	28 (25)
Coolant amount		ℓ	30	53 (engine only: 14)	(engine only: 13)
Alternator			24 V, 25 A	24 V, 25 A	24 V, 50 A
Starting motor			24 V, 7.5 kW	24 V, 7.5 kW	24 V, 7.5 kW
Battery			12 V 150 Ah x 2	12 V 150 Ah x 2	12 V 120 Ah x 2
Turbocharger			GARRET TO4E type	GARRET TO4E type (with waist gate valve)	GARRET TO4E type
Air compressor			-	-	-
Others			Aftercooler	Aftercooler	Aftercooler

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SA6D108-1				
Sugar cane harvester AUSTOFT in AUSTRALIA (Engine No. 10927 and up)	Generator EG185B-L-1 (for ALGERIA)	Generator DENYO DCA180	SA6D108-M-1	
6 – 108 – 130				
7.15 {7,150}				
1 – 5 – 3 – 6 – 2 – 4				
1,216	1,507	1,507	1,173.8	
786	828	827	640	
1,070	1,267	1,210	944.6	
–	–	–	–	
180/2,500 {241/2,500} (Gross)	Long time rated flywheel horsepower 136/1,500 {182/1,500} (Net)	Rated flywheel horsepower 136 {182}/1,500 (50 Hz) 162 {217}/1,800 (60 Hz) (Net)	Maximum flywheel horsepower 309/2,700 {420/2,700} (Gross)	
824/1,600 {84.0/1,600} (Gross)	Normal flywheel horsepower 150/1,500 {201/1,500} (Net)	Maximum flywheel horsepower 150 {201}/1,500 (50 Hz) 178 {239}/1,800 (60 Hz) (Net)	–	
2,700 – 2,750	max. 1,575	max. 1,560 (Rated, 50 Hz) max. 1,870 (Rated, 60 Hz)	2,920 – 3,020	
950 – 1,050	700 – 800	750	700 – 750	
206 {151}	215 {160}	210 {155} (50 Hz) 212 {158} (60 Hz)	– (Supplied by A.D.E.)	
610	835	835	777	
DENSO NB (EP-9) type				
DENSO RSV centrifugal, all speed type				
28 (25)	25 (23)	24 (22)	22	
(engine only: 13)	28 (engine only: 13)	53 (engine only: 14)	–	
24 V, 50 A	24 V, 13 A	24 V, 13 A	Supplied by A.D.E.	
24 V, 7.5 kW	24 V, 7.5 kW	24 V, 7.5 kW		
12 V 120 Ah x 2	12 V 120 Ah x 2	12 V 120 Ah x 2		
GARRET TO4E type	GARRET TO4E type	GARRET TO4E type	–	
–	–	–	–	
Aftercooler	Aftercooler	Aftercooler	Aftercooler	

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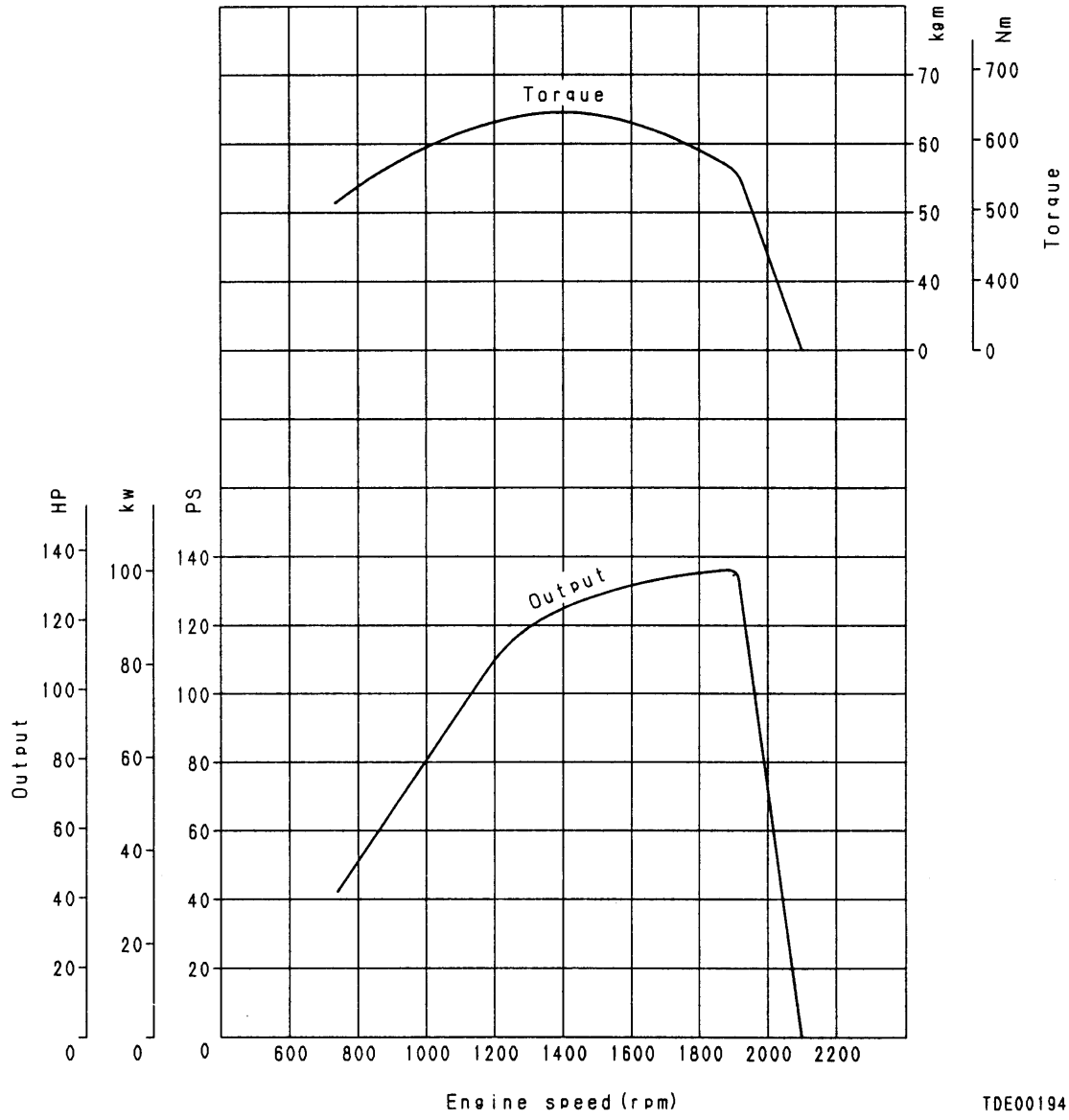
ENGINE PERFORMANCE CURVE

S6D108-1 (D57S-1B)

Flywheel horsepower : 99 kW (133 HP)/1,900 rpm
Max. torque : 618 Nm (63 kgm)/1,400 rpm



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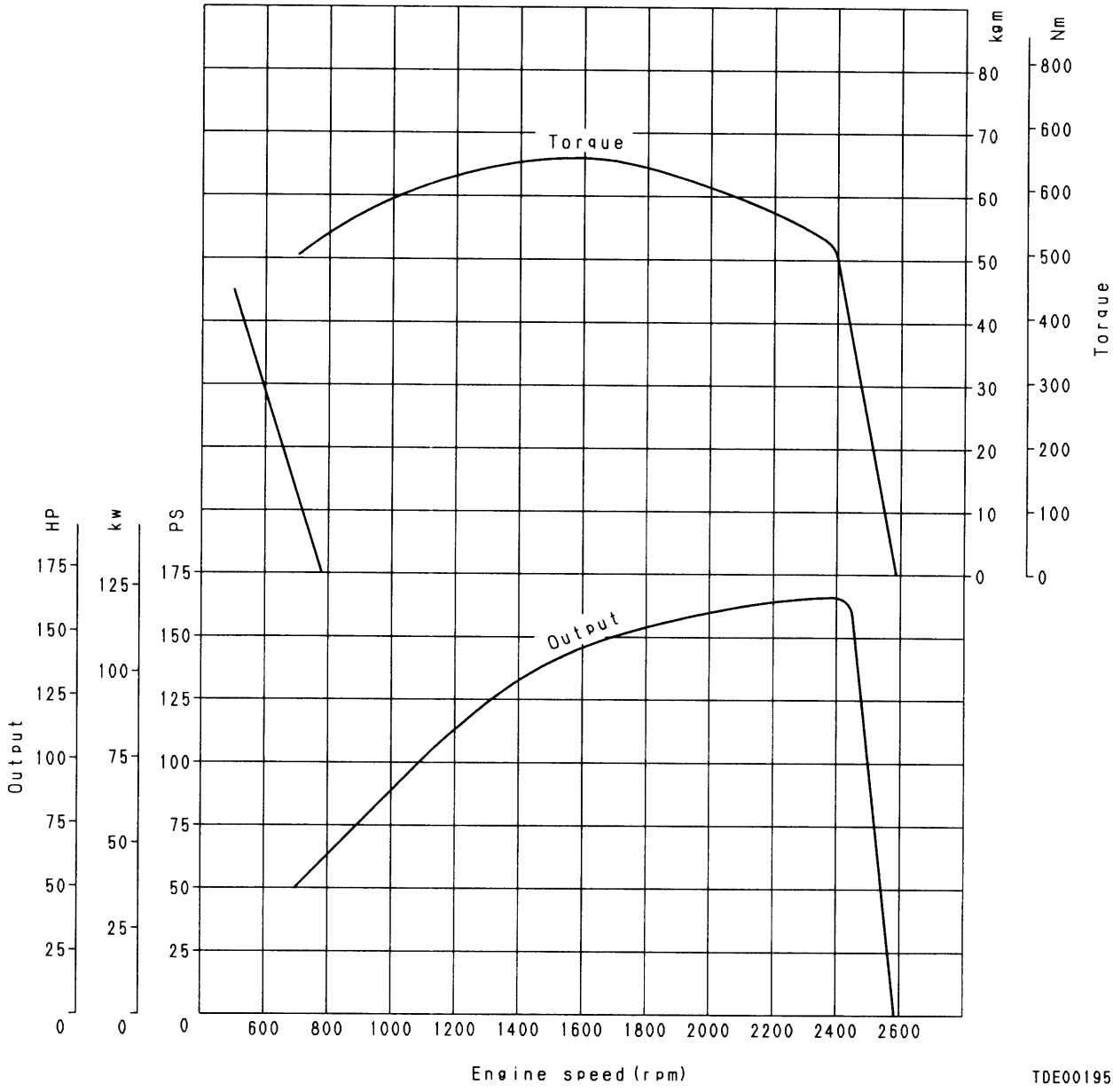
S6D108-1 (WA320-3)

Flywheel horsepower : 122 kW (163 HP)/2,380 rpm
Max. torque : 647 Nm (66 kgm)/1,600 rpm



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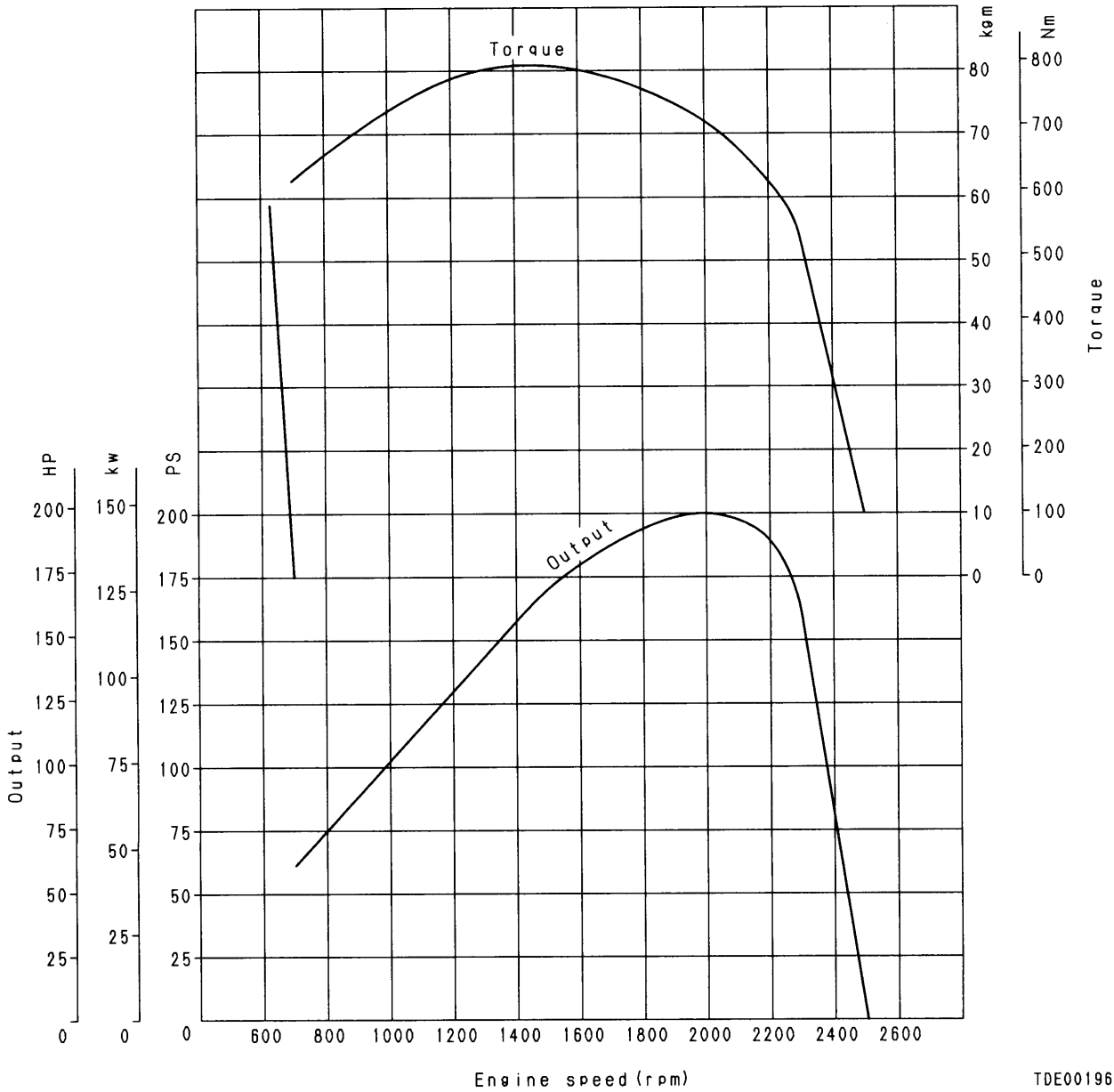
S6D108-1 (WA380-3)

Flywheel horsepower : 140 kW (187 HP)/2,200 rpm
Max. torque : 840 Nm (82 kgm)/1,500 rpm



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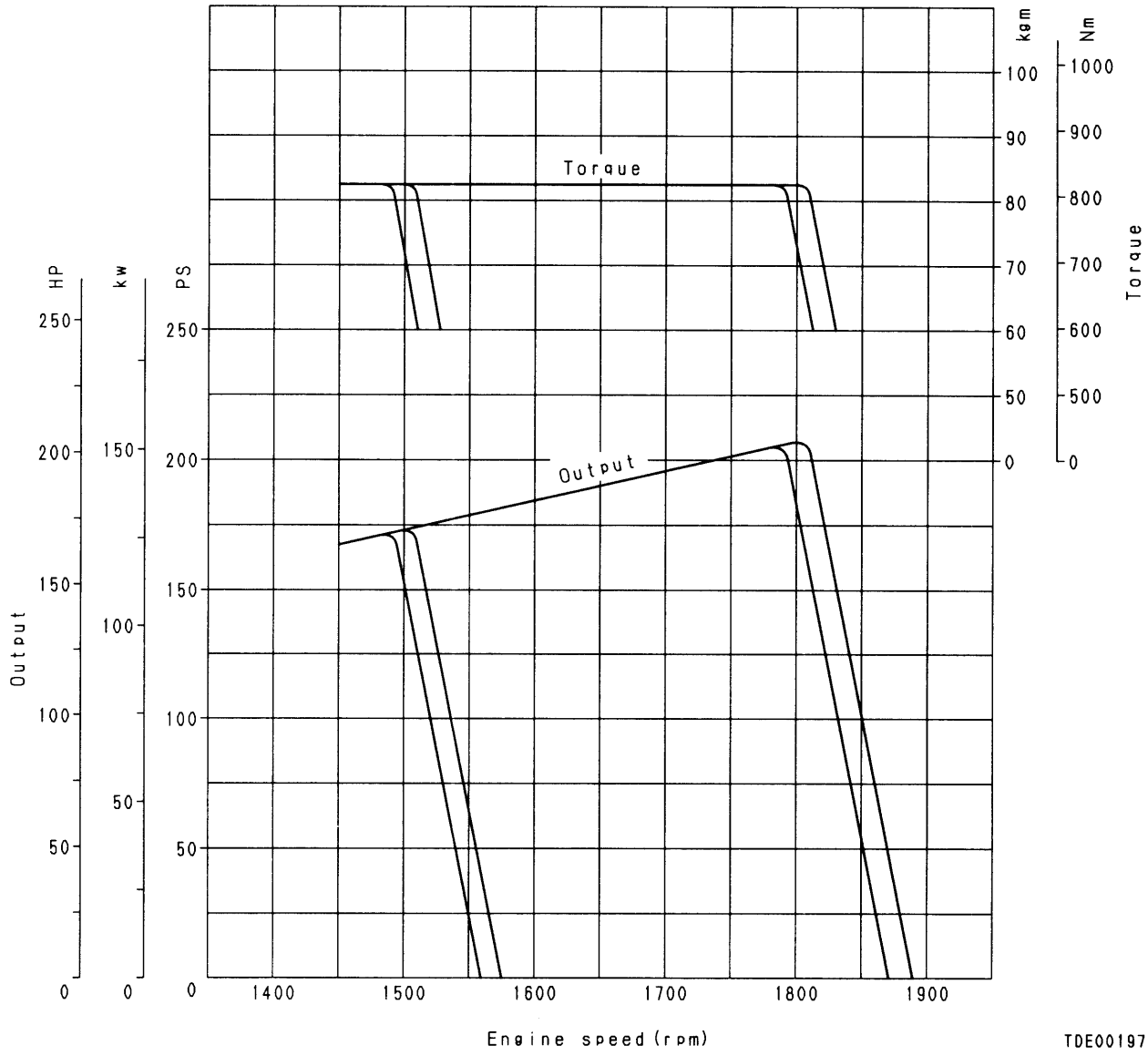
S6D108-1 (EG150BS-5)

	Emergency	Normal
Flywheel horsepower :	152 kW (204 HP)/1,800 rpm (60 Hz)	134 kW (180 HP)/1,800 rpm (60 Hz)
	128 kW (171 HP)/1,500 rpm (50 Hz)	113 kW (151 HP)/1,500 rpm (50 Hz)



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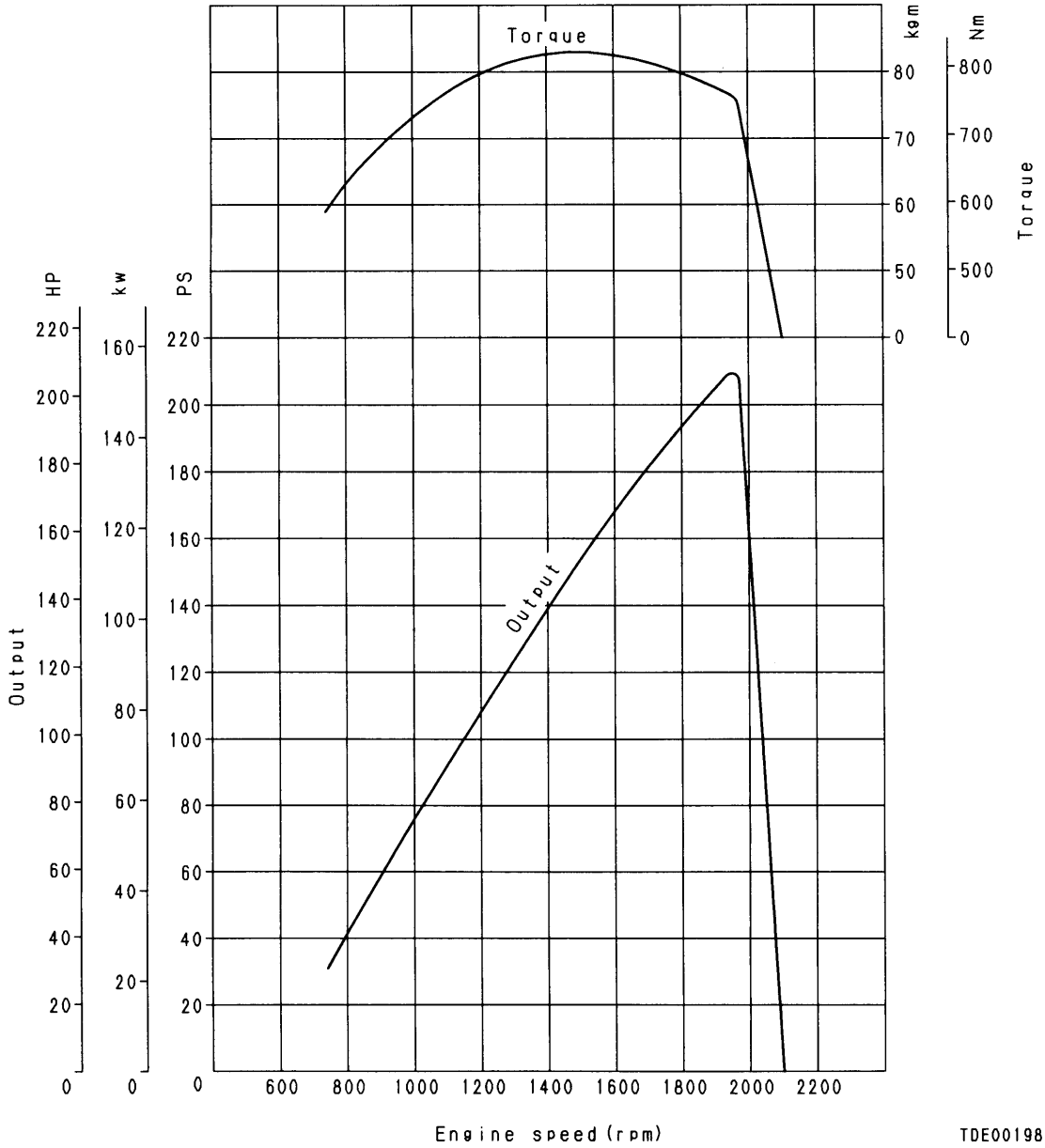
SA6D108-1 (PC300-5)

Flywheel horsepower : 154 kW (207 HP)/1,950 rpm

Max. torque : 814 Nm (83 kgm)/1,500 rpm



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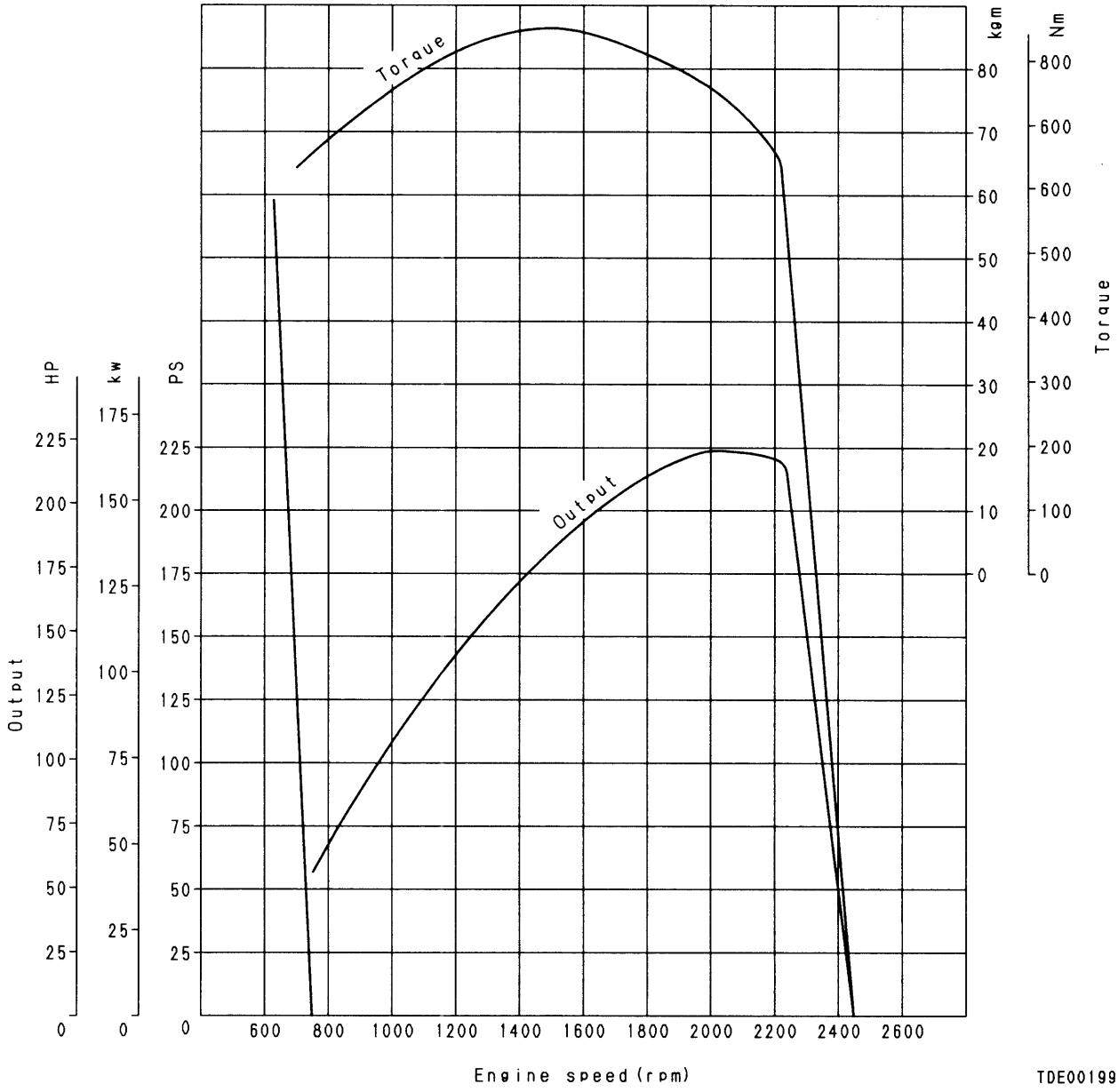
SA6D108-1 (WA420-3)

Flywheel horsepower : 162 kW (217 HP)/2,200 rpm
Max. torque : 847 Nm (86.4 kgm)/1,500 rpm



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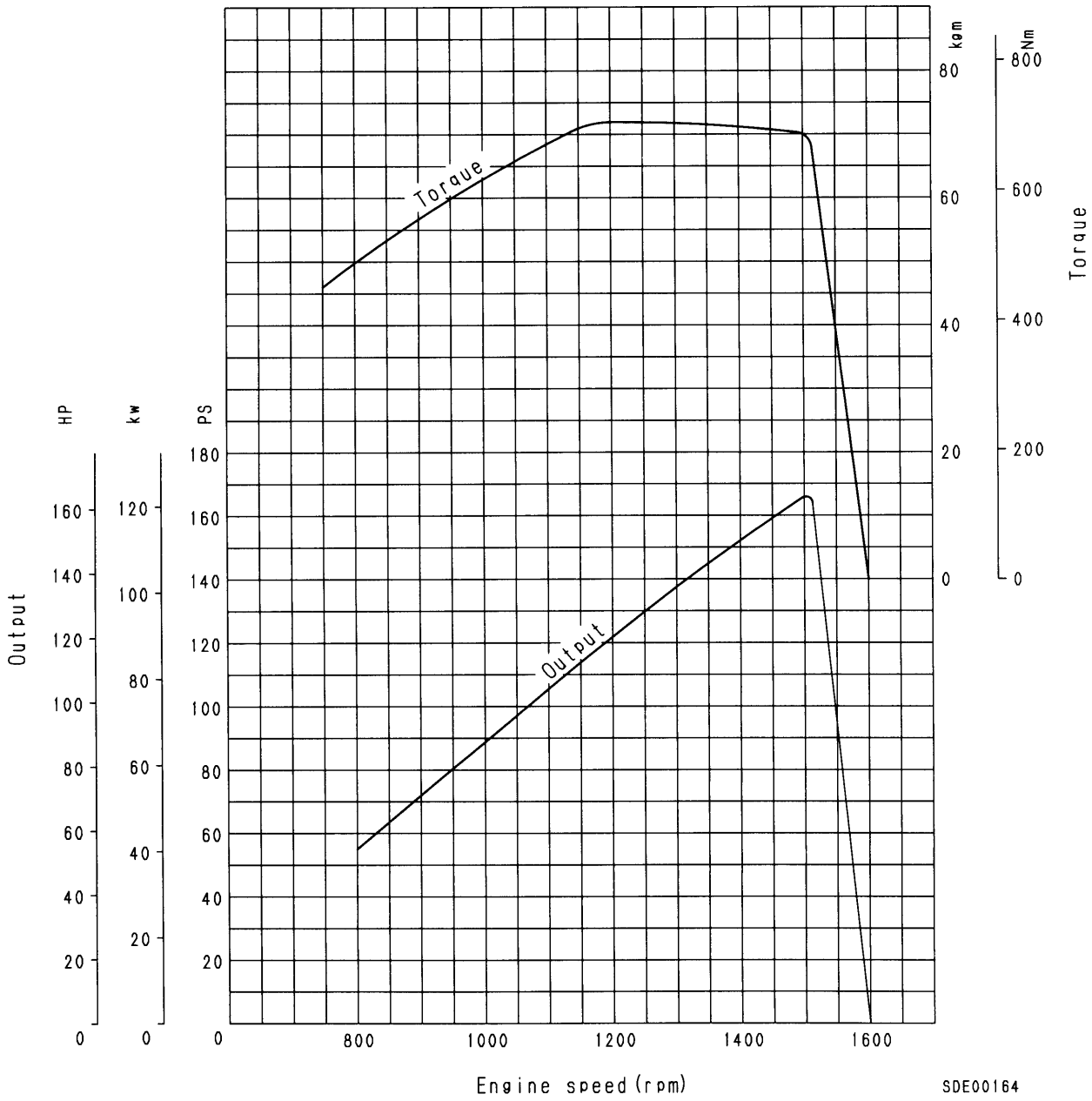
SA6D108-1 (For Egypt EIM: Power unit)

Flywheel horsepower : 119 kW (160 HP)/1,500 rpm

Max. torque : 706 Nm (72 kgm)/1,200 rpm



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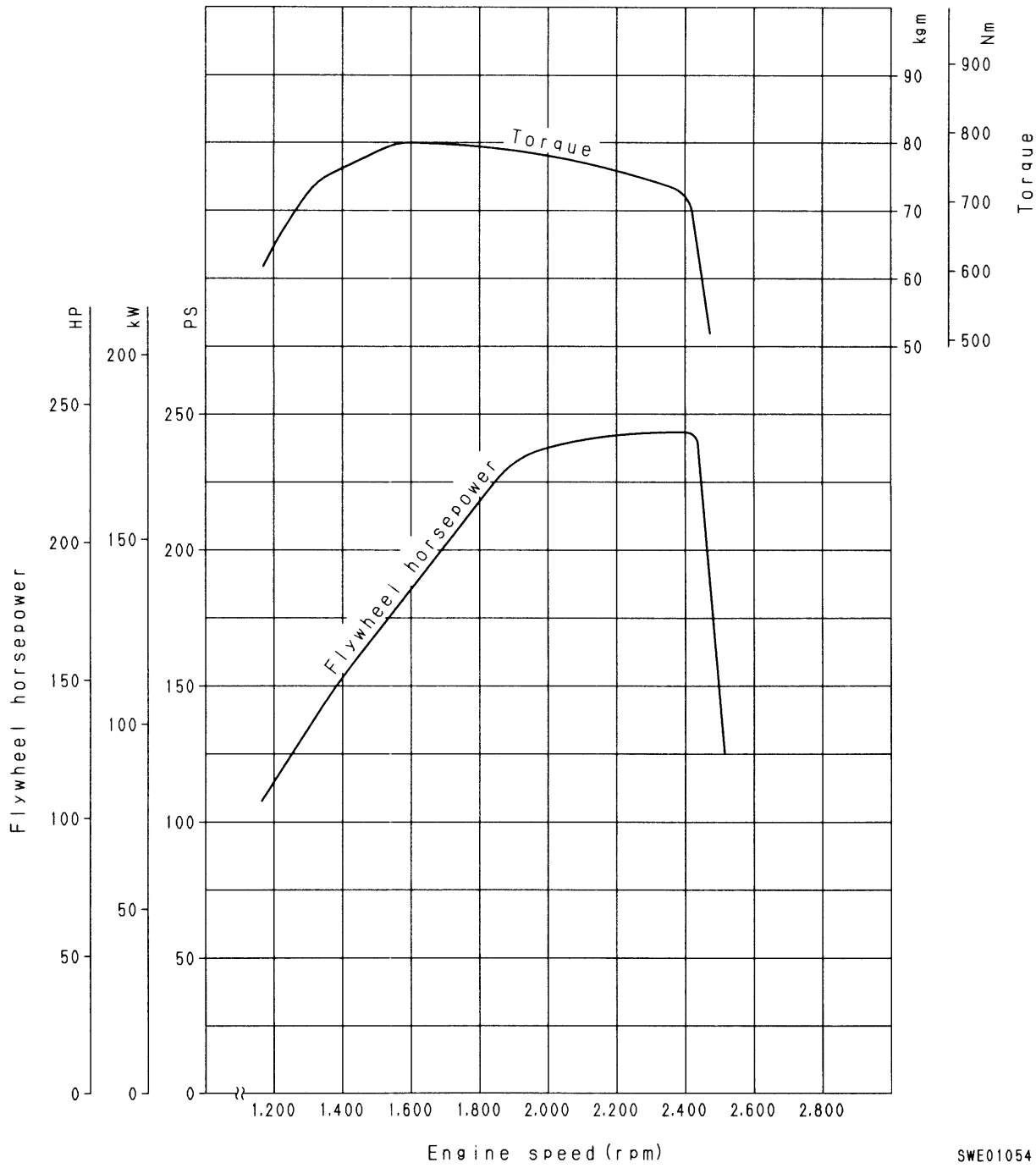
SA6D108-1 [Sugar cane harvester AUSTOFT in AUSTRALIA (Engine No. 10001 – 10296)]

Flywheel horsepower : 179 kW {240 HP}/2,400 rpm

Maximum. torque : 785 Nm {80.0 kgm}/1,600 rpm



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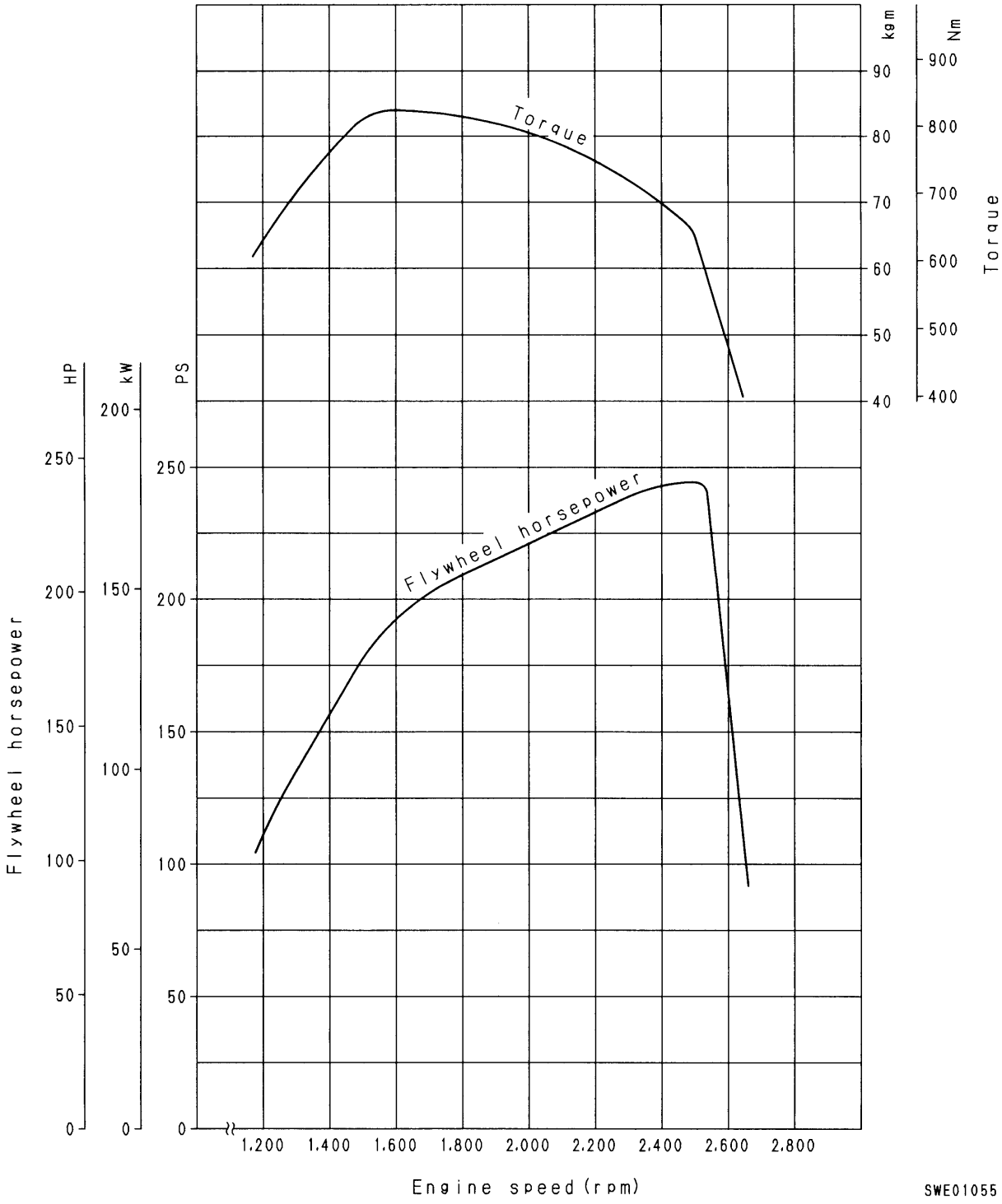
SA6D108-1 [Sugar cane harvester AUSTOFT in AUSTRALIA (Engine No. 10297 and up)]

Flywheel horsepower : 180 kW {241 HP}/2,400 rpm

Maximum. torque : 824 Nm {84.0 kgm}/1,600 rpm



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WEIGHT TABLE

⚠ This weight table is a guide for use when transporting or handling components.

Unit: kg

No.	Item	Components	S6D108-1	
1	Turbocharger	GARRET TO4E type	9.9	
		SCHWITZER S2B type	7.0	
2	Aftercooler assembly		–	
	Intake manifold		14.2	
3	Cylinder head assembly	Cylinder head, valve, rocker arm	63.0	
4	Cylinder block assembly	Cylinder block, bearing cap, valve spring	187	
5	Crankshaft assembly	Crankshaft, crankshaft gear	75.3	
6	Camshaft assembly	Camshaft, camshaft gear, thrust bearing	8.0	
7	Timing gear case assembly		19.5	
8	Oil pan		11.0	
9	Piston and connecting rod assembly	Piston, piston ring, piston pin, connecting rod	27.0	
10	Flywheel assembly		D57S-1	62.5
			WA320-3, WA380-3	32.3
			EG150BS-5	113.0
11	Flywheel housing		D57S-1	59.5
			WA320-3, WA380-3	33.1
			EG150BS-5	46.5
12	Fuel injection pump		D57S-1, EG150BS-5	16.0
			WA320-3, WA380-3	15.0
13	Water pump		D57S-1	10.4
			WA320-3, WA380-3	24.0
14	Alternator		24 V, 13 A	8.5
			24 V, 25 A	8.5
			24 V, 50 A	10.0
15	Starting motor		14.5	

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Unit: kg

SA6D108-1	
9.0	
10.0 (with waist gate valve)	
–	
23.8	
–	
63.0	
187	
75.3	
8.0	
19.5	
11.0	
27.0	
PC300-5	31.3
WA420-3	29.8
Sugar cane harvester AUSTOFT in AUSTRALIA	27.0
PC300-5	46.5
WA420-3	59.5
Sugar cane harvester AUSTOFT in AUSTRALIA	29.5
PC300-5	16.0
WA420-3	16.5
PC300-5	10.4
WA420-3	16.5
24 V, 13 A	8.5
24 V, 25 A	8.5
24 V, 50 A	10.0
14.5	

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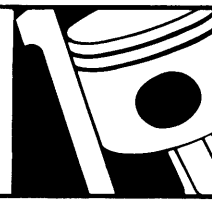
ENGINE
11 STRUCTURE AND FUNCTION



GENERAL STRUCTURE 11-002

INTAKE AND EXHAUST SYSTEM
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- Turbocharger 11-007

ENGINE BODY
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LUBRICATION SYSTEM
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- Oil pressure switch 11-052
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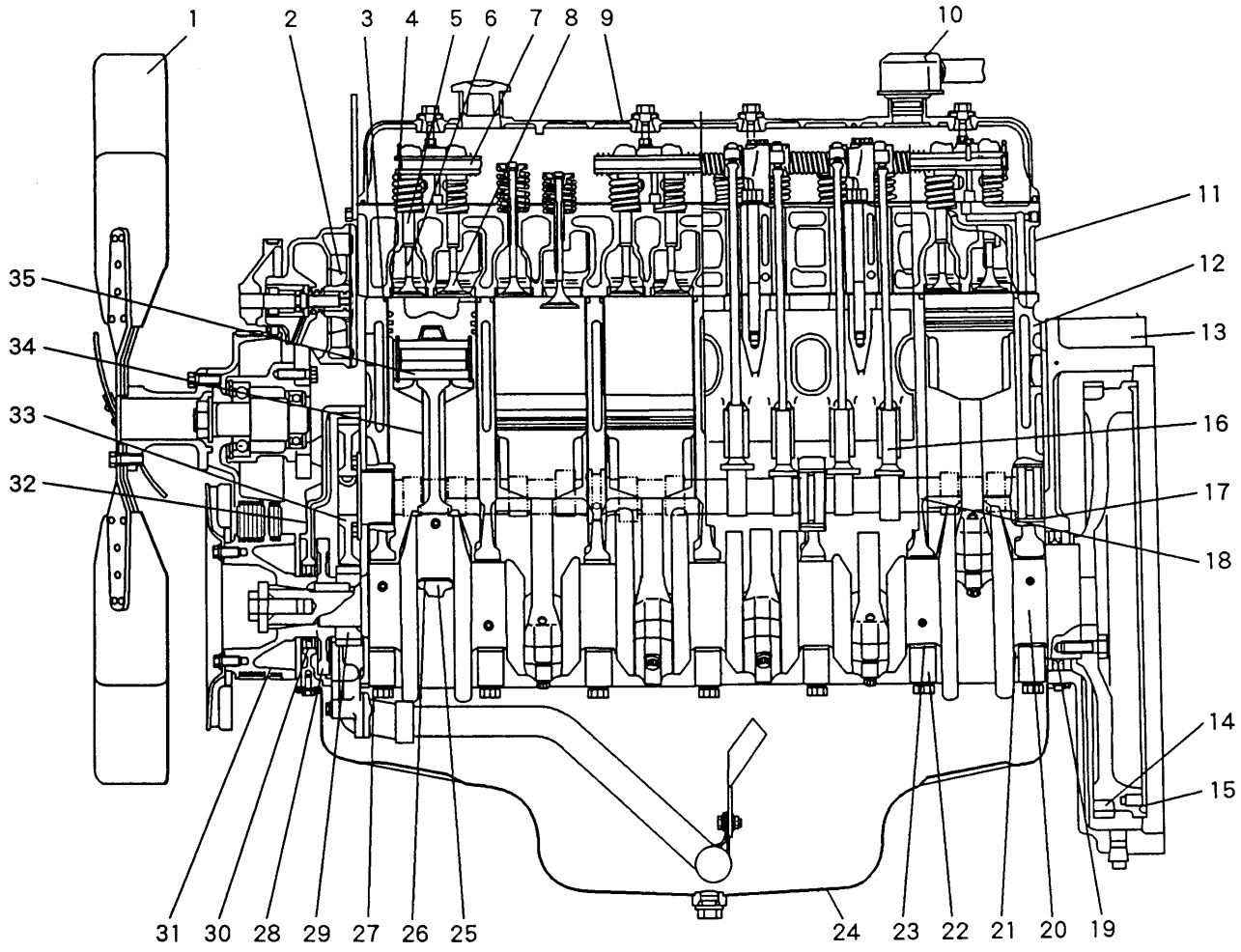
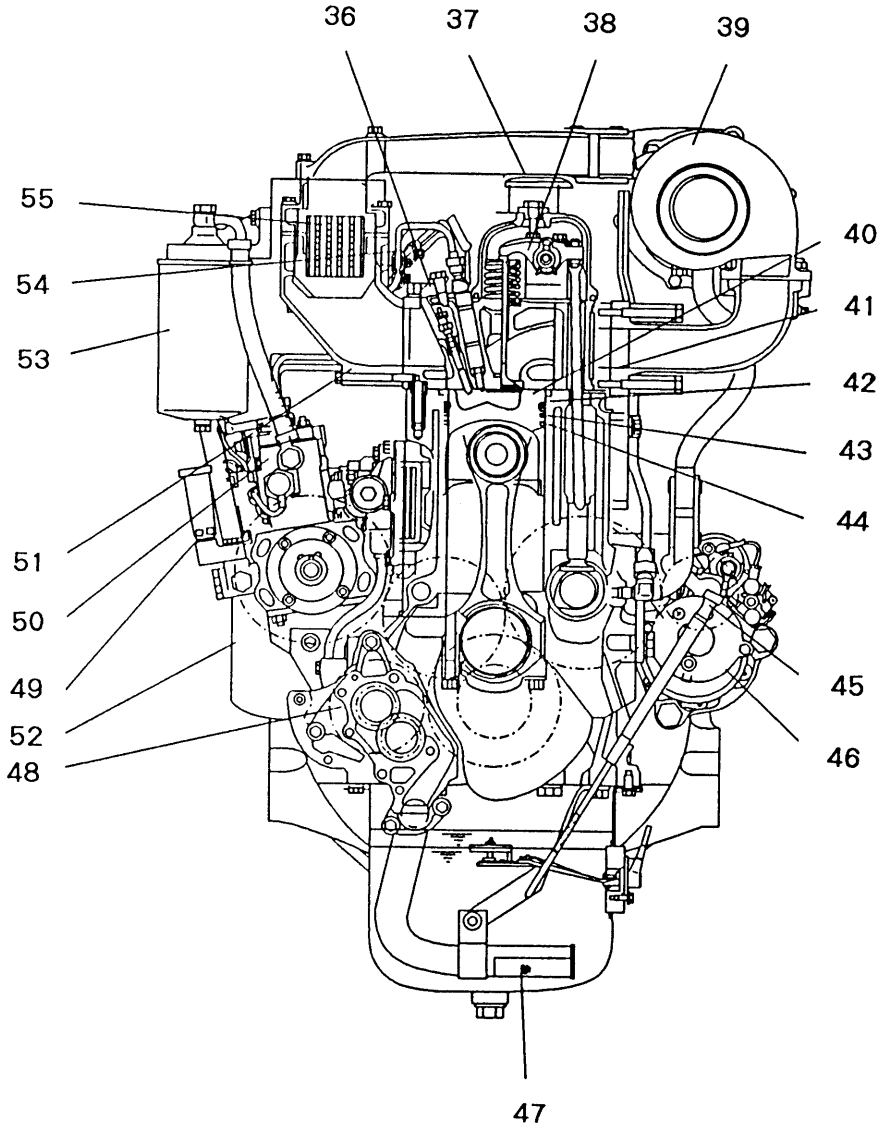
GENERAL STRUCTURE

Note : This figure is of SA6D108−1



1. Fan
2. Water pump
3. Cylinder liner
4. Valve seat insert
5. Valve guide
6. Valve (exhaust)
7. Rocker arm shaft
8. Valve (intake)
9. Cylinder head cover
10. Breather
11. Cylinder head
12. Cylinder block
13. Flywheel housing
14. Ring gear
15. Flywheel
16. Tappet
17. Cam bushing
18. Camshaft
19. Rear seal
20. Crankshaft
21. Thrust bearing
22. Main bearing cap
23. Main bearing
24. Oil pan
25. Connecting rod cap
26. Connecting rod bearing
27. Front plate
28. Crankshaft gear
29. Oil pump drive gear
30. Front seal



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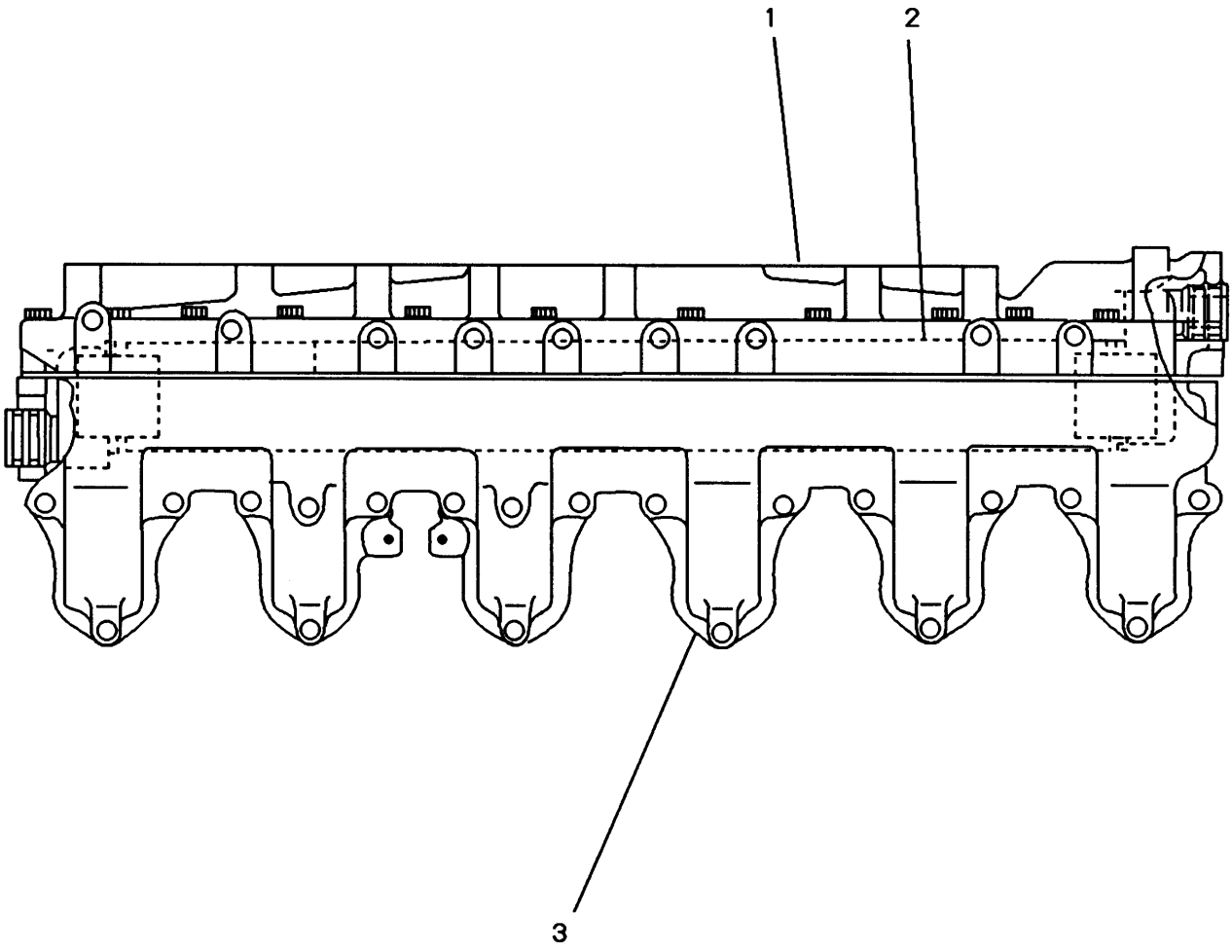
31. Crankshaft pulley	41. Exhaust manifold	51. Intake manifold
32. Front cover	42. Top ring	52. Oil filter
33. Cam gear	43. Second ring	53. Fuel filter
34. Connecting rod	44. Oil ring	54. Fuel injection pipe
35. Piston pin	45. Oil level gauge	55. After-cooler
36. Nozzle holder	46. Starting motor	
37. Oil filler	47. Oil strainer	
38. Rocker arm	48. Oil pump	
39. Turbocharger	49. Feed pump	
40. Piston	50. Fuel injection pump	

INTAKE AND EXHAUST SYSTEM

AFTER-COOLER (SA6D108-1)



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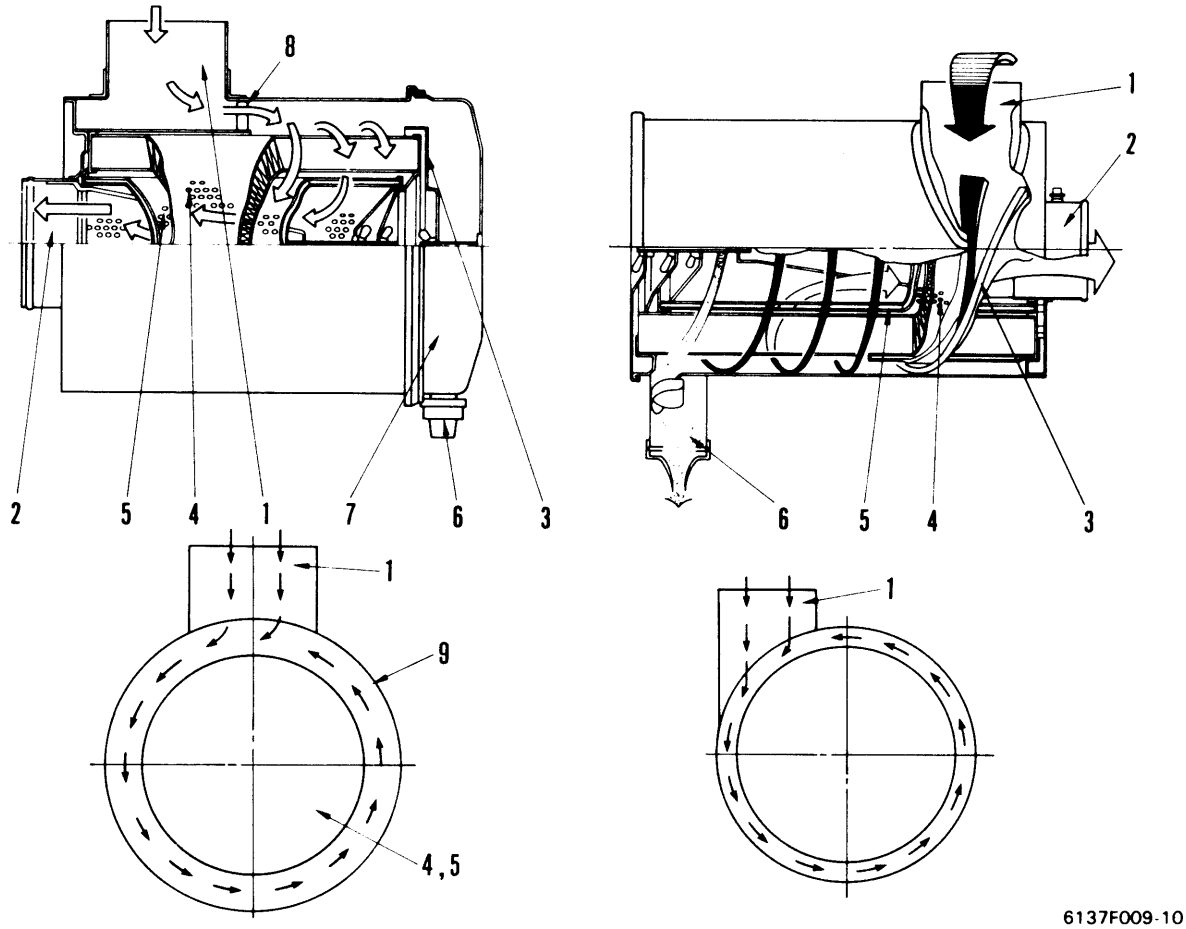
1. After -cooler cover
2. After -cooler core
3. Intake manifold

AIR CLEANER

Current type (FHG)

FTG type



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1. Inlet
2. Outlet
3. Guide vane
4. Primary element
5. Safety element
6. Vacuator
7. Dust pan
8. Diffusion vane (sleeve)
9. Body

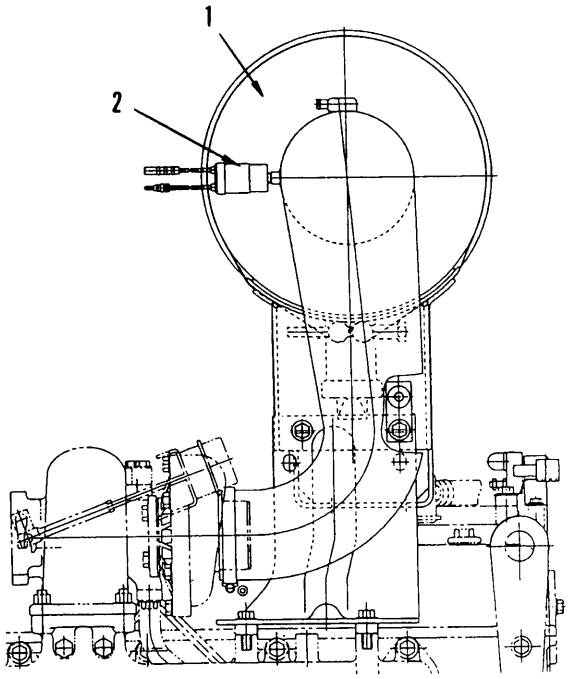
ADVANTAGES

- The diameter of the element is the same but the outside diameter of the body is smaller. The inlet is placed in the direction of connection, so ample centrifugal force can be obtained from a simple spiral guide vane, without using a diffusion vane.
- There is no dust pan of diffusion vane, so the structure is simple.

STRUCTURE

- Air containing dust is sucked in from inlet (1) at a tangent, and the dust is separated by the centrifugal force of guide vane (3). More than 99.9% of the remaining dust is removed by primary element (4), and the cleaned air then passes through safety element (5) and outlet (2), and is sucked into the engine.
  The dust and moisture that is separated by the guide vane (3) rotates around the inside wall of body (9), and goes inside vacuator (6), where is discharged automatically to the outside.

ELECTRONIC DUST INDICATOR



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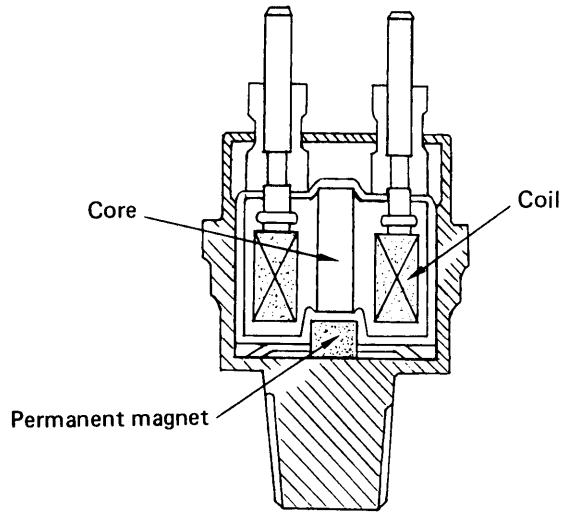

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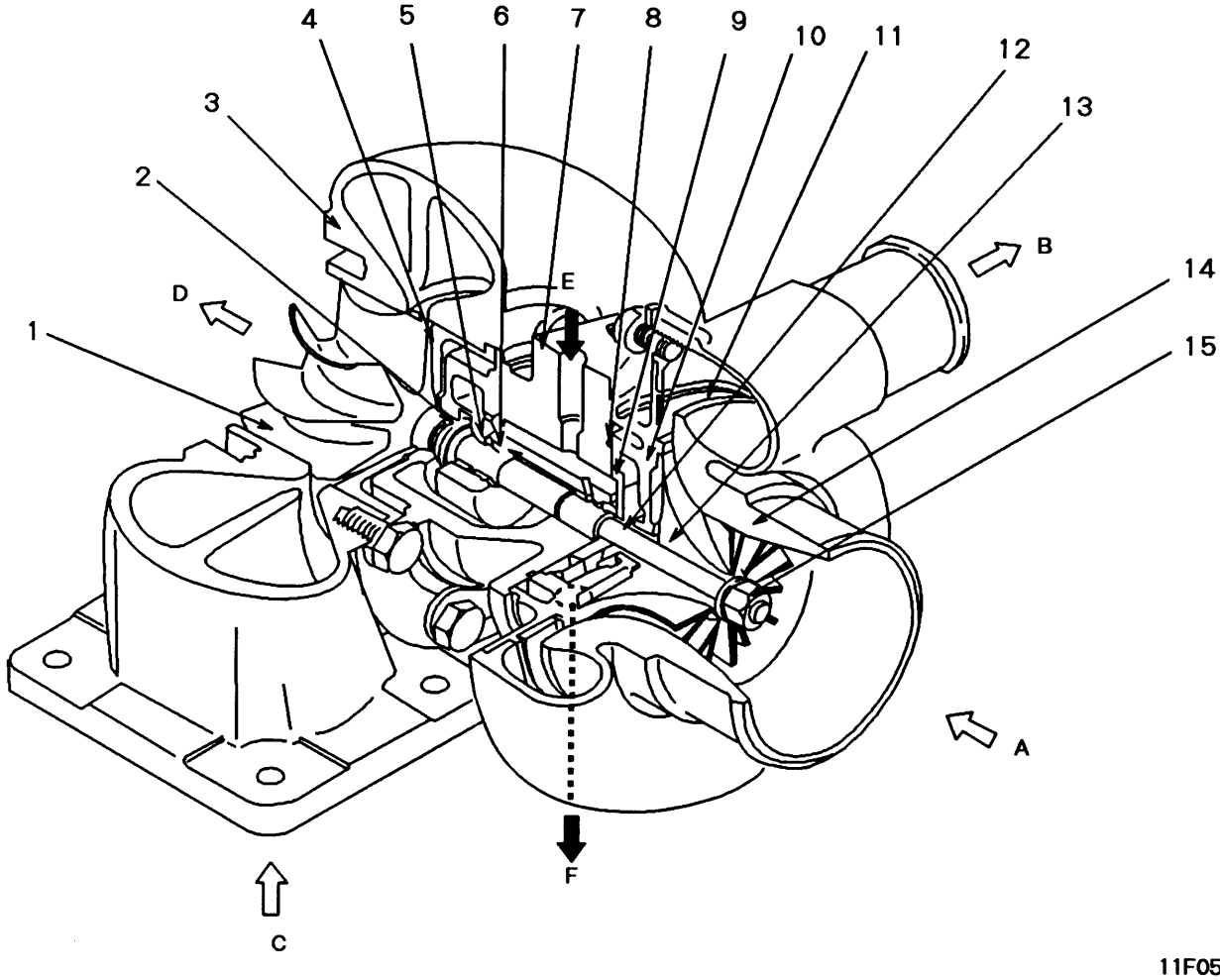
- If air cleaner (1) becomes clogged, the negative pressure inside the intake passage (intake pipe) increases, pushes the spring inside dust indicator sensor (2), and actuates the shaft.
- This is changed into an electromagnetic induction current, which lights up the monitor lamp.

Actuation pressure: 762±58mm H_2O
Power source voltage: DC24 $^{+6}_{-1}$ (V)

TURBOCHARGER

(For D57S-1B, EG150BS-5, PC300-5, DCA180)



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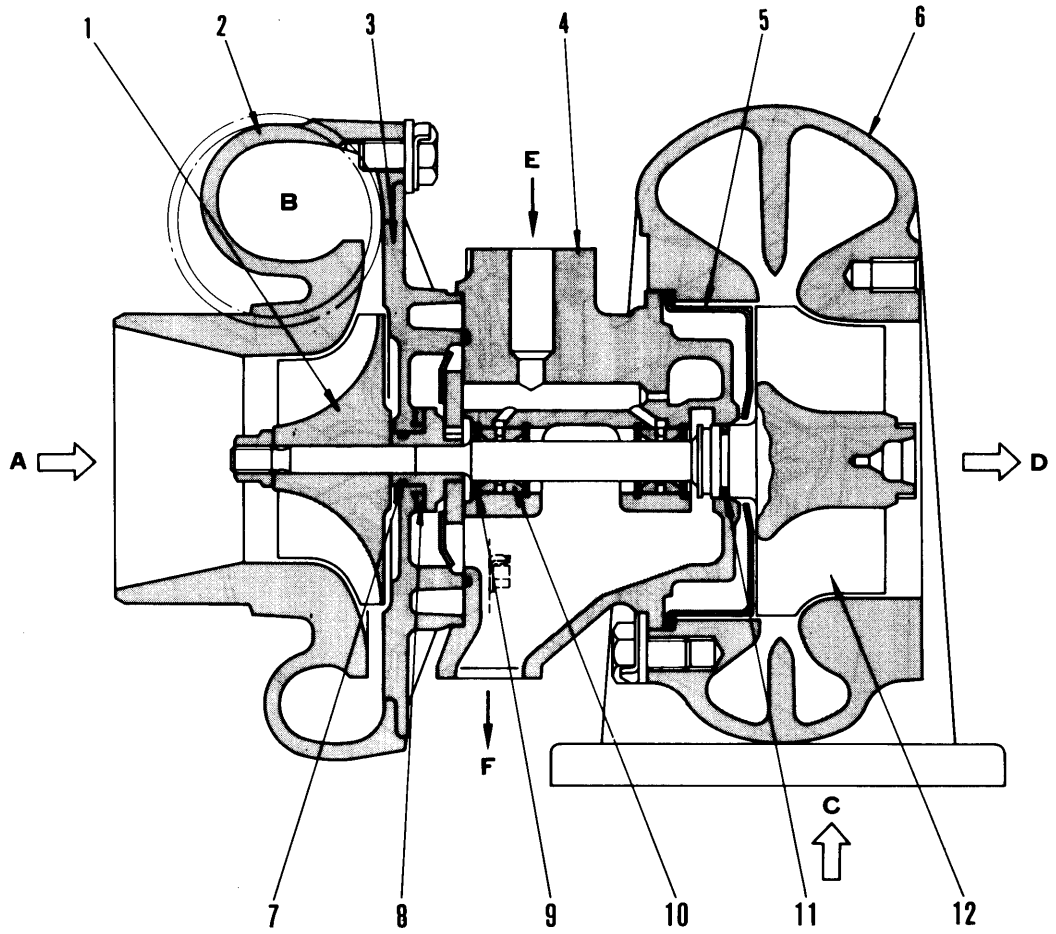
11F059A

1. Turbine impeller	12. Thrust collar	Specifications of turbocharger	
2. Piston ring	13. Blower impeller	Type :	GARRET CO. T04E
3. Turbine housing	14. Blower housing	Overall length :	225mm
4. Shroud	15. Lock nut	Overall width :	210mm
5. Journal bearing		Overall height :	180mm
6. Retaining ring	A. Intake	Weight :	6.5 kg
7. Center housing	B. Air supply	Continuous speed :	125,000 rpm (max.)
8. Seal ring	C. Exhaust (inlet port)	Max. air supply :	22 kg/min.
9. Thrust bearing	D. Exhaust (outlet port)	Compression ratio :	3 (max.)
10. Back plate	E. Oil (inlet port)	Applicable exhaust temp. :	Max.675℃ (at inlet)
11. Spring	F. Oil (outlet port)	Direction of rotation :	Clockwise (as seen from blower side)

TO4E (WITH WESTGATE VALVE) (WA420-3)



6150F106–1

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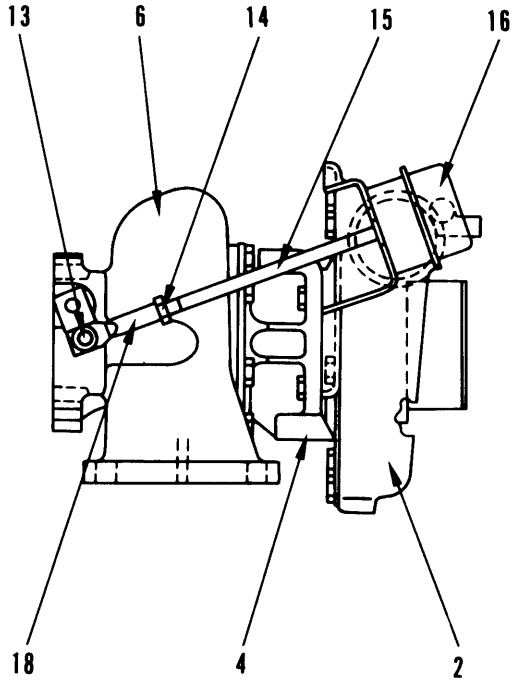
1. Blower impeller
2. Blower housing
3. Back plate
4. Center housing
5. Heat shroud
6. Turbine housing
7. Seal ring
8. Thrust bearing
9. Snap ring
10. Journal bearing
11. Seal ring
12. Shaft & turbine impeller

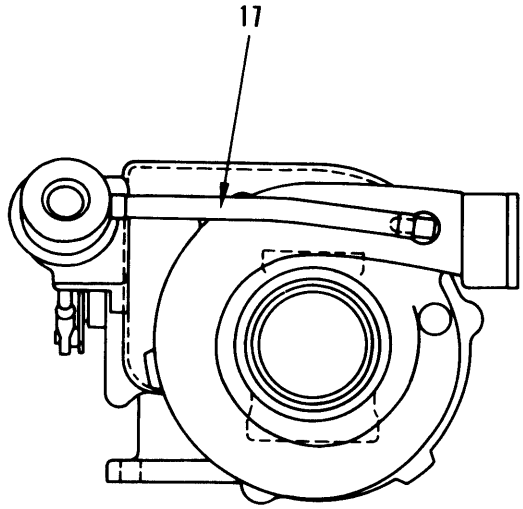
A. Air inlet port
B. Air outlet port
C. Exhaust inlet port
D. Exhaust outlet port
E. Oil inlet port
F. Oil outlet port

Turbocharger specifications

Type:	GARRETT TO4E
Overall length:	229 mm
Overall width:	222 mm
Overall height:	185 mm
Weight:	TO4B: 7 kg
	TO4E: 10 kg
Max. speed:	120,000 rpm

Applicable exhaust temperature: Max. 700°C
Direction of rotation: Clockwise (as seen from blower)





622F01114

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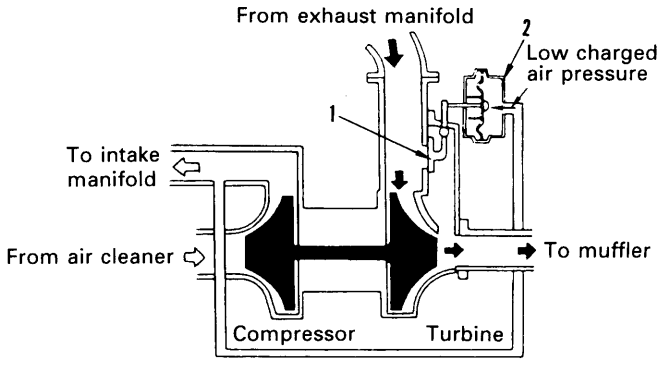
13. Retaining ring
14. Nut, rod end
15. Rod
16. Actuator assembly (swing valve controller)
17. Hose
18. Rod end

Set pressure of actuator
1035 ± 25 mmHg (at 0.38 mm lift)

Outline of Westgate valve

- This valve acts to suppress any unnecessary charged air pressure in order to ensure a suitable charged air pressure (set charged air pressure) and thereby prevent overload on the engine.
- In order to do this, Westgate valve (1) is installed in the exhaust passage before the turbine. When charged air pressure (**A**) near the outlet port of the compressor rises and exceeds the set pressure of actuator (swing valve control) (2), Westgate valve (swing valve) (1) opens.
- Point **c** where engine speed **a** and charged air pressure **b** intersect, is the point where the Westgate valve starts to open.



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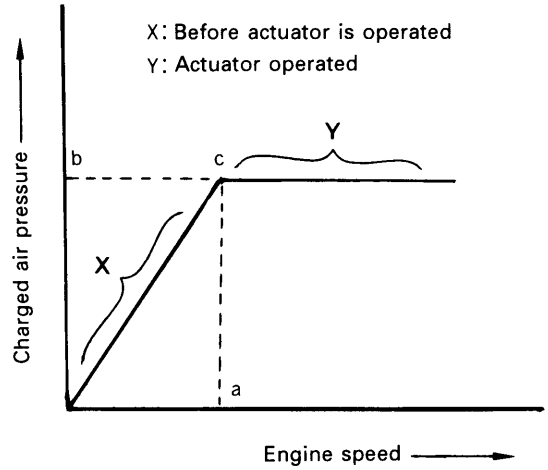

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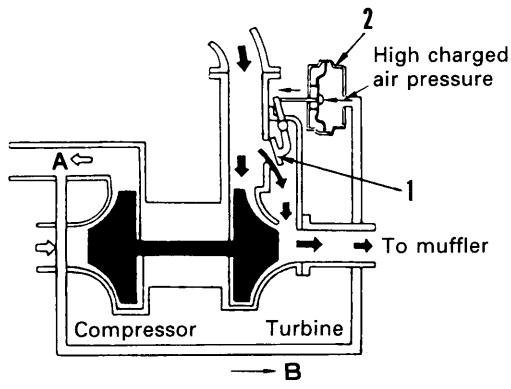
- Charged air pressure (**A**) near the outlet port of the compressor passes through (**B**) and actuates actuator (2). Westgate valve (1) opens and part of the exhaust gas bypasses the turbine, so the output of the turbine drops and the set charged air pressure is maintained.



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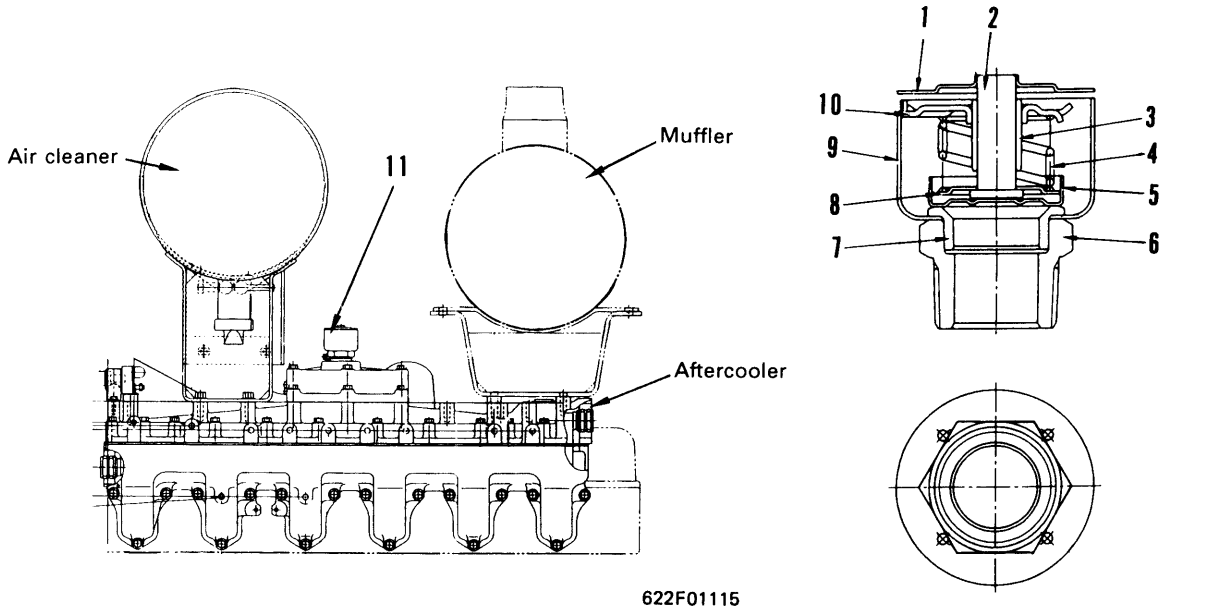
TURBOCHARGER SAFETY VALVE
WA420-3



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622101

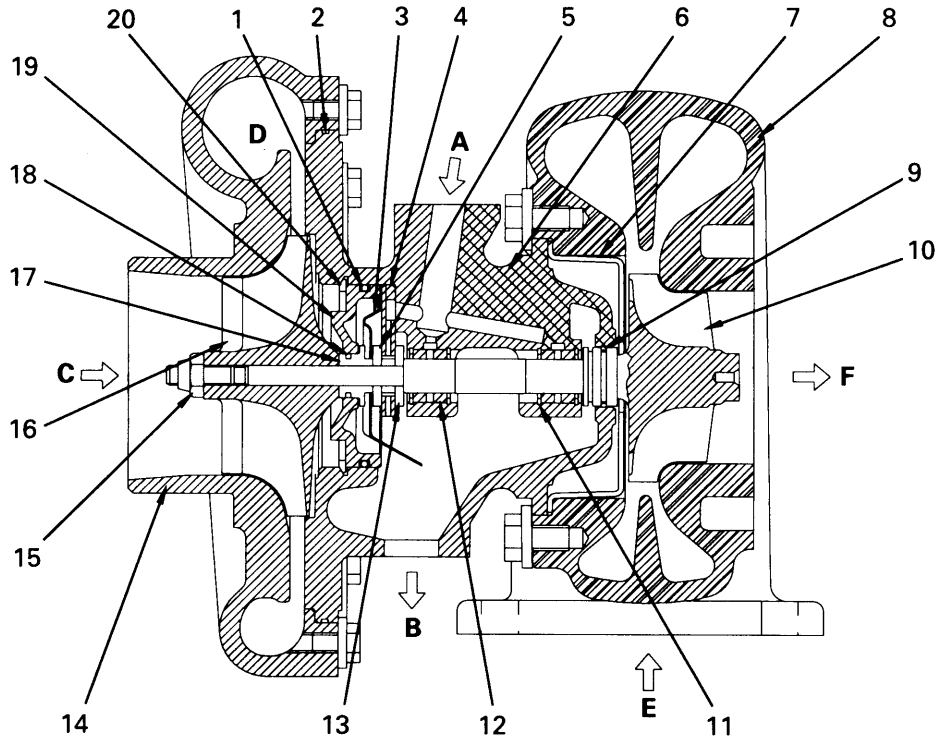
1. Cover
2. Shaft
3. Guide bushing
4. Spring
5. Valve
6. Nut
7. Valve seat
8. Spring seat
9. Casing
10. Retainer
11. Turbocharger safety valve (with Westgate valve)

Actuating pressure
147 ± 11 kPa (1100 ± 80 mmHg)

Outline

- In the same way as with the Westgate valve, safety valve (11) is installed to the intake manifold to release any excess charged air pressure (excess boost pressure) coming from the compressor.

S2B (SCHWITZER)
(For WA320, 380-3)



622101

SKE00087

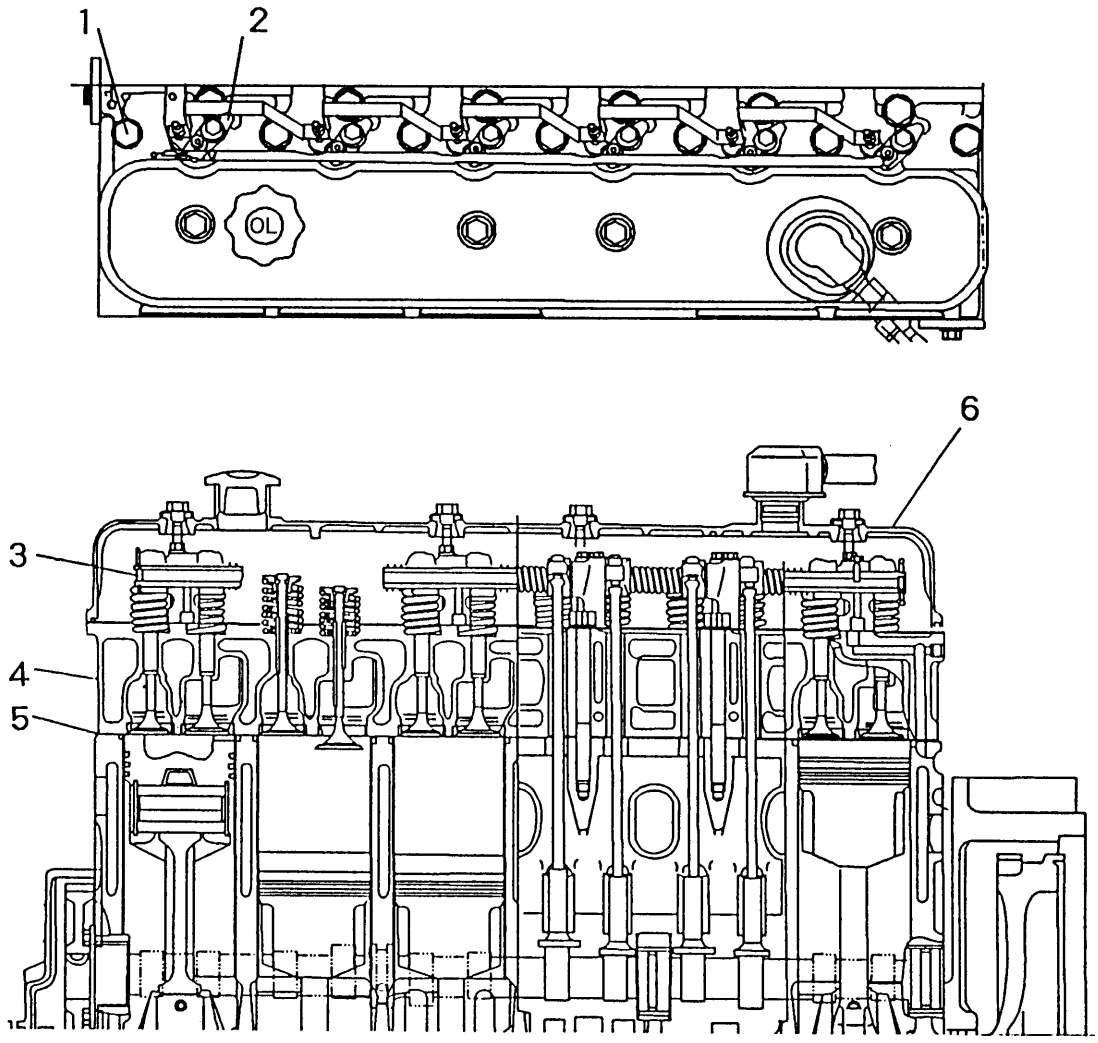
1. O-ring
2. O-ring
3. Oil deflector
4. Thrust bearing
5. Thrust collar (spacer sleeve)
6. Center housing
7. Shroud (back plate)
8. Turbine housing
9. Piston ring
10. Turbine impeller (wheel shaft)
11. Clip
12. Journal bearing
13. Thrust ring
14. Blower housing
15. Locknut
16. Blower impeller
17. Slinger sleeve
18. Piston ring
19. Insert
20. Snap ring

A. Oil inlet (from engine main gallery)
B. Oil outlet (to oil pan)
C. Intake inlet
D. Intake outlet
E. Exhaust inlet
F. Exhaust outlet

Turbocharger
Type: Schwitzer S2B
Overall length: 212 mm
Overall width: 170 mm
Overall height: 168 mm
Weight: 7 kg
Direction of rotation:
Clockwise (as seen from blower end)

ENGINE BODY

CYLINDER HEAD



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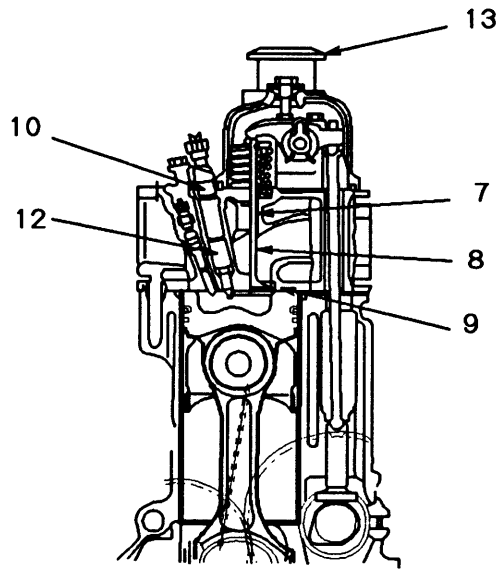
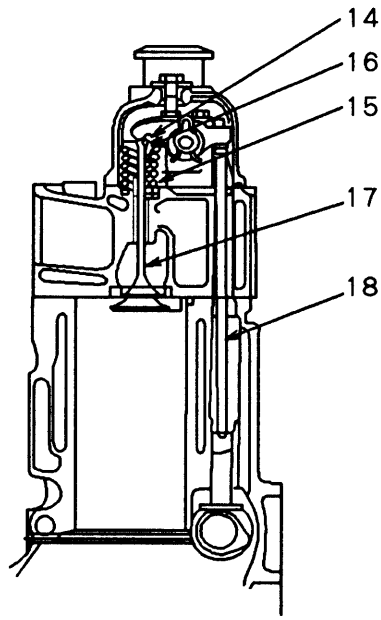
1. Cylinder head mounting bolt
2. Nozzle holder
3. Rocker arm assembly
4. Cylinder head
5. Cylinder head gasket
6. Head cover
7. Valve guide
8. Exhaust valve
9. Valve seat insert
10. Nozzle holder packing
12. Fuel injection nozzle
13. Oil filler cap
14. Valve cotter
15. Valve spring
16. Valve spring seat
17. Intake valve
18. Push rod



Cross section of exhaust valve
(No. 1 cylinder)

KS100008



Cross section of intake valve
(No. 1 cylinder)

KS100009

622101

Cylinder head

Direct injection type, 2 valve, injection nozzle assembled, integrated type

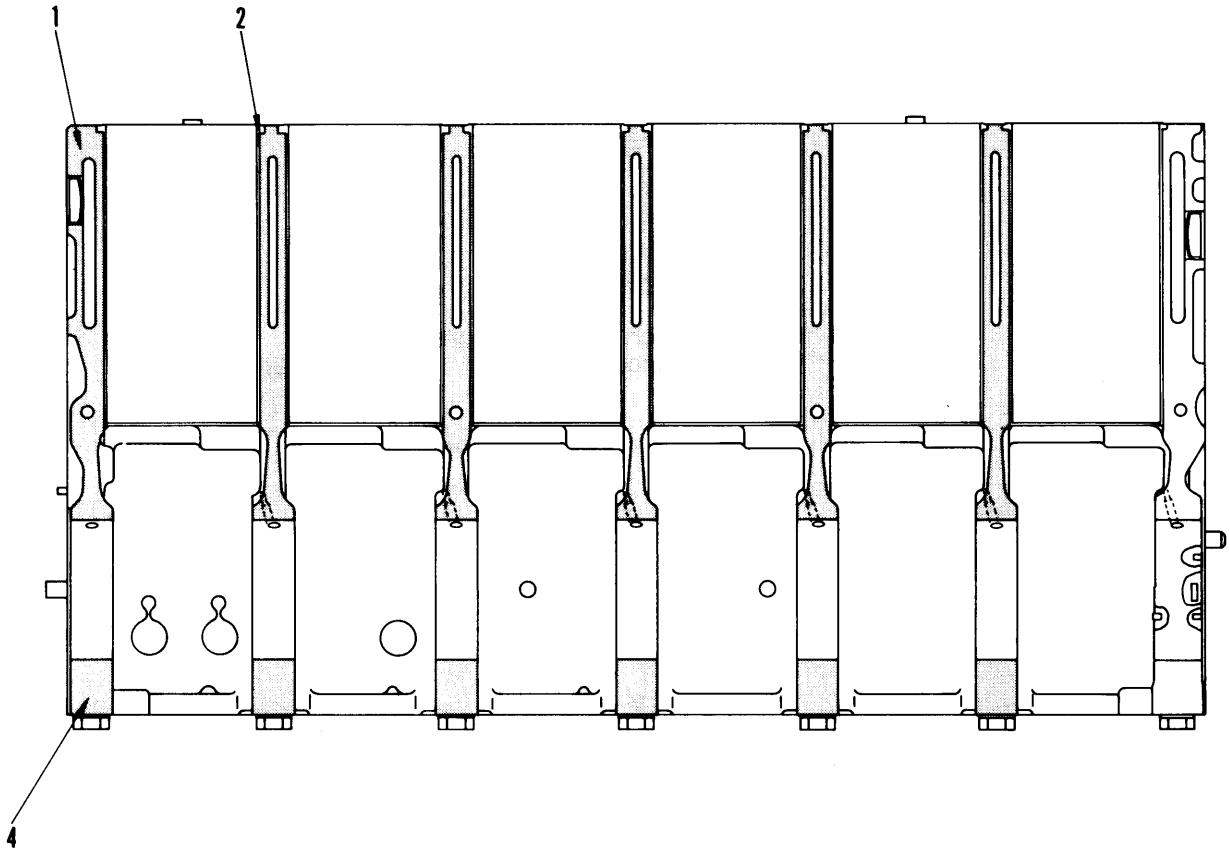
Valve seat

Valve seat insert press fitted for both intake and exhaust valves

Fuel injection nozzle

- Type : Diesel Kiki, Multiple hole nozzle
  : Nippon Denso, Multiple hole nozzle
- Injection pressure (Cracking pressure):
  Differs according to machine model
  See values in STANDARD VALUE TABLE.
- Pressure adjustment: Shim adjustment type

CYLINDER BLOCK



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1. Cylinder block
2. Cylinder liner
3. Main bearing cap bolt
4. Main bearing cap
5. Cam bushing

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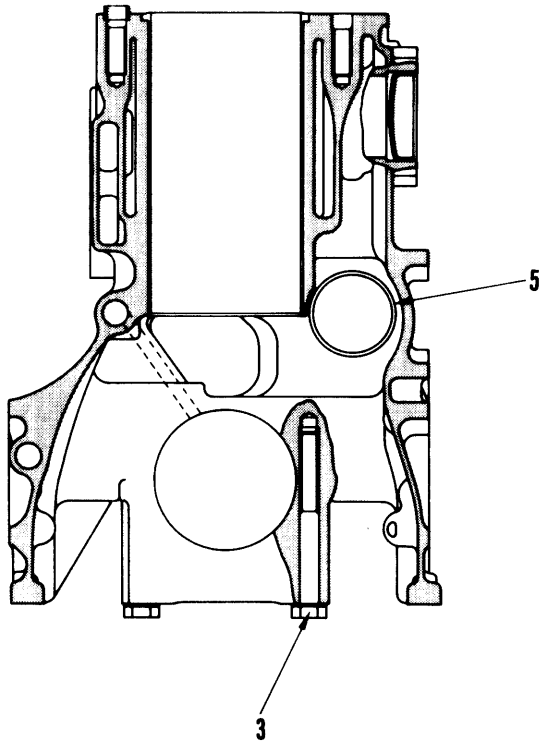


622F01062

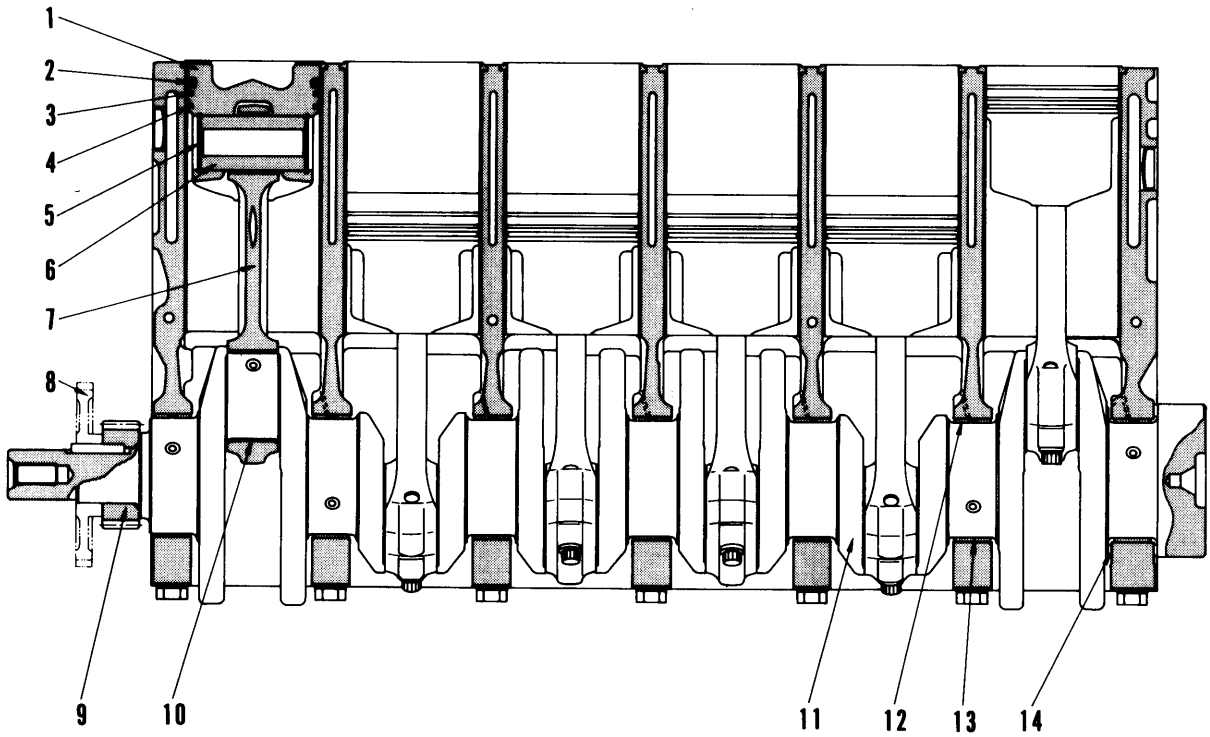
Cylinder block
- Crankshaft: 7 bearings
- Camshaft: 4 bearings

Front seal
- With dust seal, double lip

Cylinder liner
- Dry type

MAIN REVOLVING SYSTEM

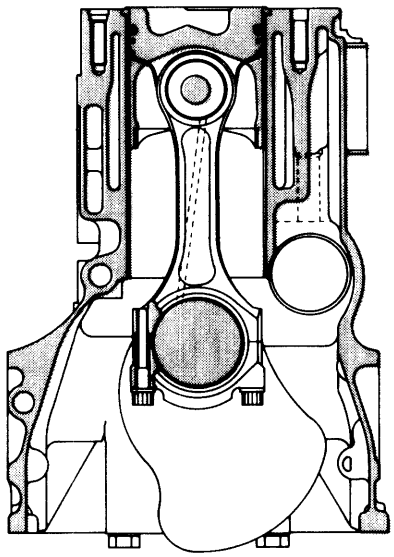
TOROIDAL COMBUSTION CHAMBER



622101

622F01063

1. Piston
2. Top ring
3. Second ring
4. Oil ring
5. Snap ring
6. Piston pin
7. Connecting rod
8. Oil pump drive gear (58 teeth)
9. Crankshaft gear (34 teeth)
10. Conneecting rod bearing
11. Crankshaft
12. Main bearing (upper)
13. Main bearing (lower)
14. Thrust bearing



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622101

Piston
- Aluminum alloy
- Elliptical taper profile, thermal flow type
- Toroidal combustion chamber

Front seal
- Single lip with dust seal

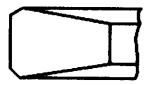
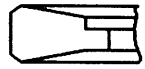
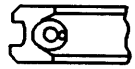
Rear seal
- Double lip
  (PC300-5) (D57S-1B) (WA320, 380-3) (WA420-3)
- Single lip type
- Lay-down lip type

Connection rod bolt
- Screw-in type

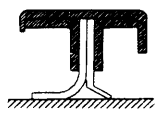
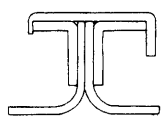
Piston cooling: Yes

Crankshaft
- Stamp forging
- Induction hardening on journal portion and filet portion.

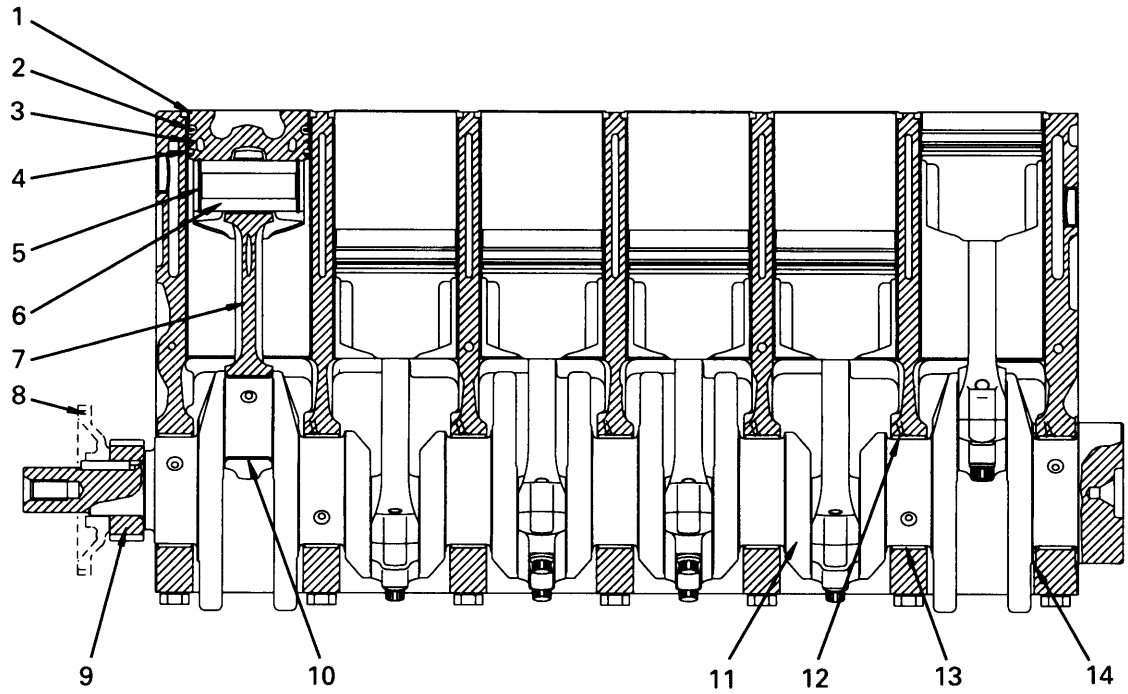
Piston ring

Top ring	Second ring	Oil ring
Both faces: Keystone barrel face Hard chrome plating	Both faces: Keystone teper face Hard chrome plating	With coil expander
		

Seals

Single lip	Lay-down seal lip
 SLE00090	 SLE00091

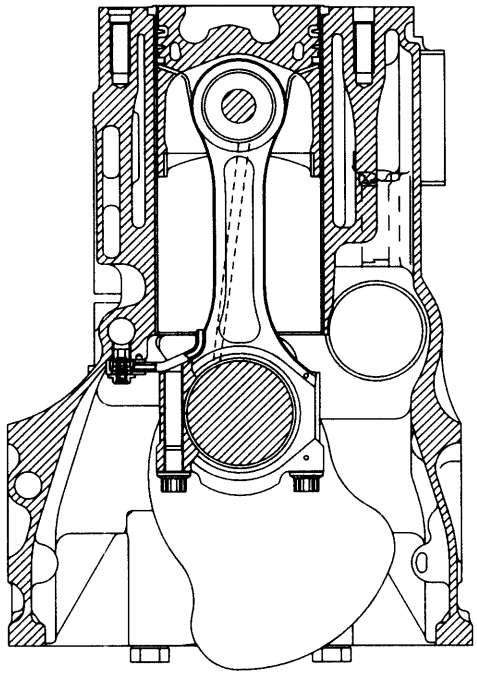
(RE-ENTRANT COMBUSTION CHAMBER)



622101

SKE00088

1. Piston
2. Top ring
3. Second ring
4. Oil ring
5. Snap ring
6. Piston pin
7. Connecting rod
8. Oil pump drive gear (No. of teeth: 58)
9. Crankshaft gear (No. of teeth: 34)
10. Connecting rod bearing
11. Crankshaft
12. Main bearing (upper)
13. Main bearing (lower)
14. Thrust bearing



SKE00089

622101

PISTON

- Aluminium alloy (shaker cooling galley)
- Conical taper profile, thermal flow type
- Re-entrant combustion chamber
- Pin offset (1.1 mm)

Front seal

- Single lip type with dust seal

Rear seal

- Single lip type
- Lay-down seal lip type

Connecting rod bolt

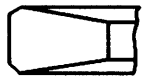
- Screw-in type

Piston cooling: Provided

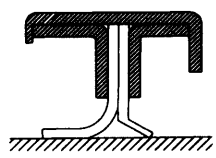
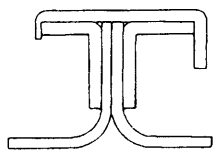
Crankshaft

- Closed die forging
- High induction hardening of journal and fillet

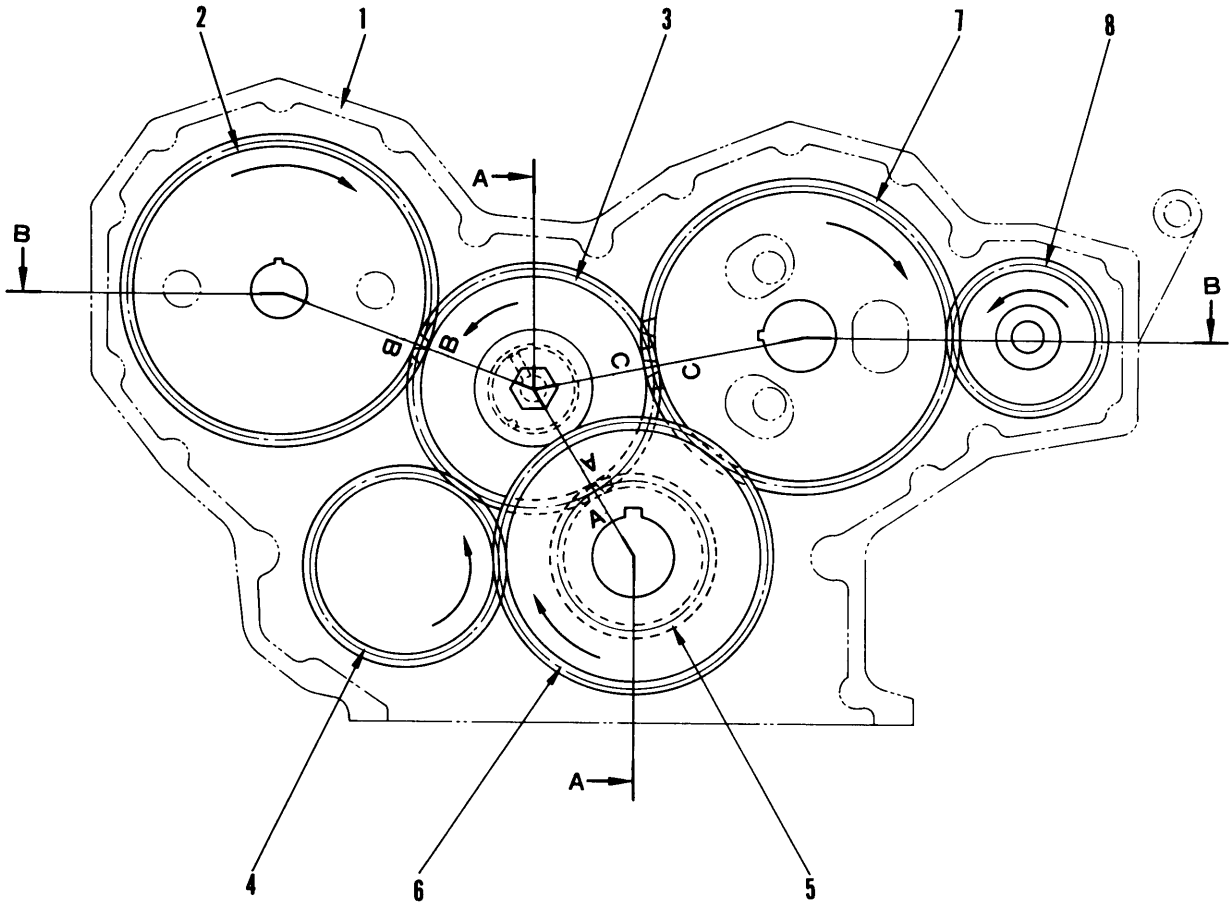
Piston ring

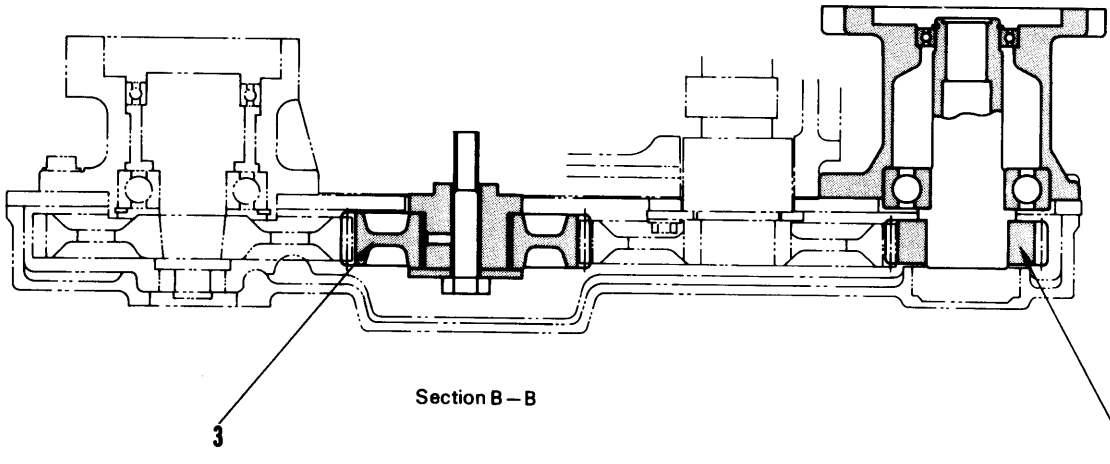
Top ring	Second ring	Oil ring
Keystone barrel face for both faces, hard chrome plating	Keystone taper face for both faces, hard chrome plating, inner cut	With coil expander
		

Seals

Single lip	Lay-down seal lip
 SLE00090	 SLE00091

TIMING GEAR





Section B – B

622101

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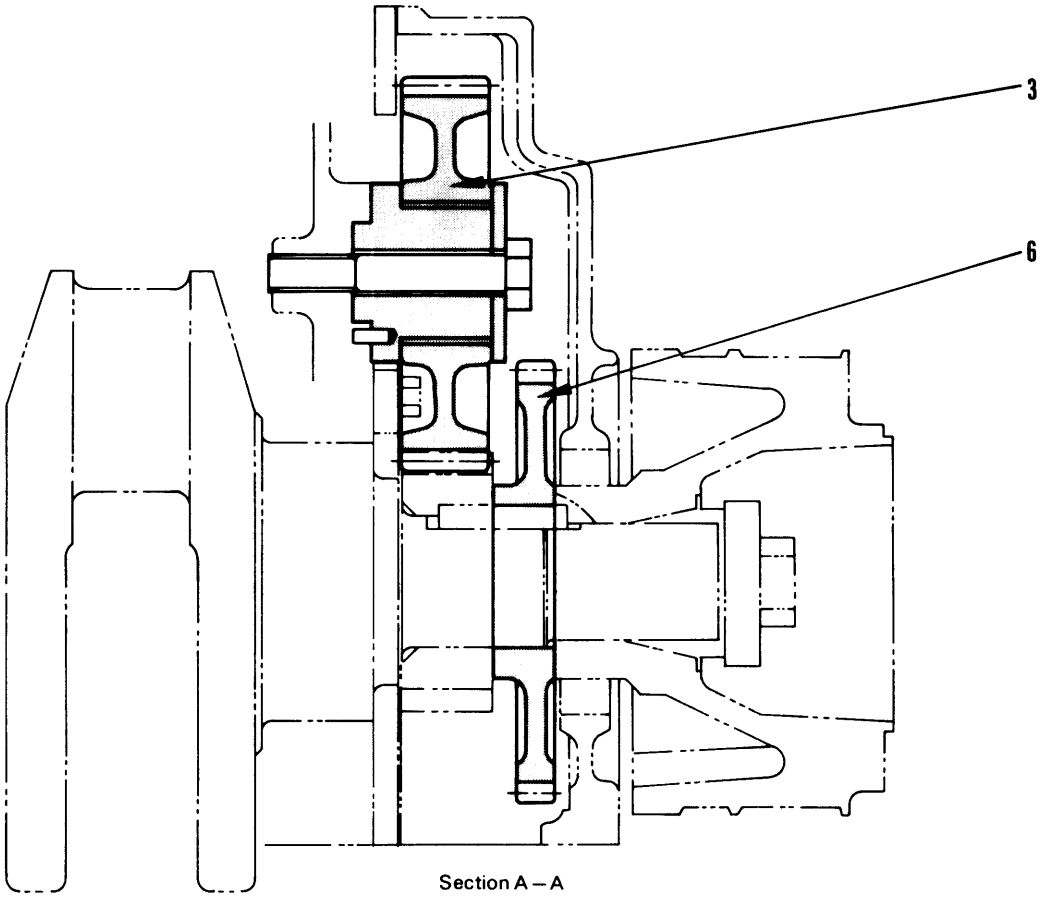

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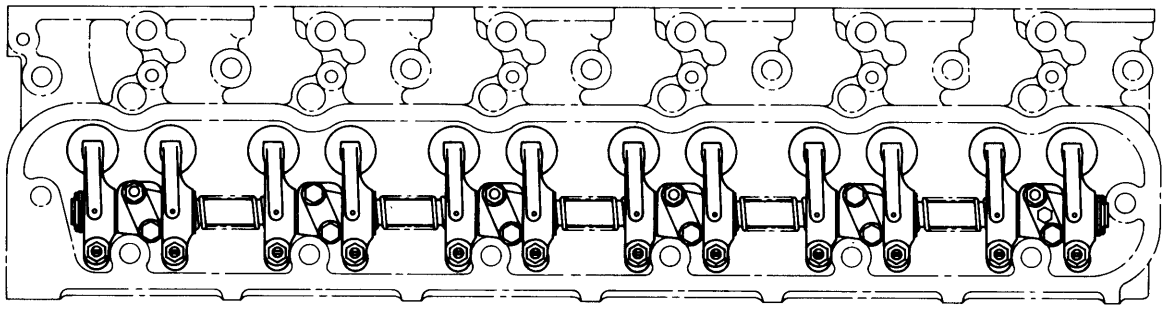
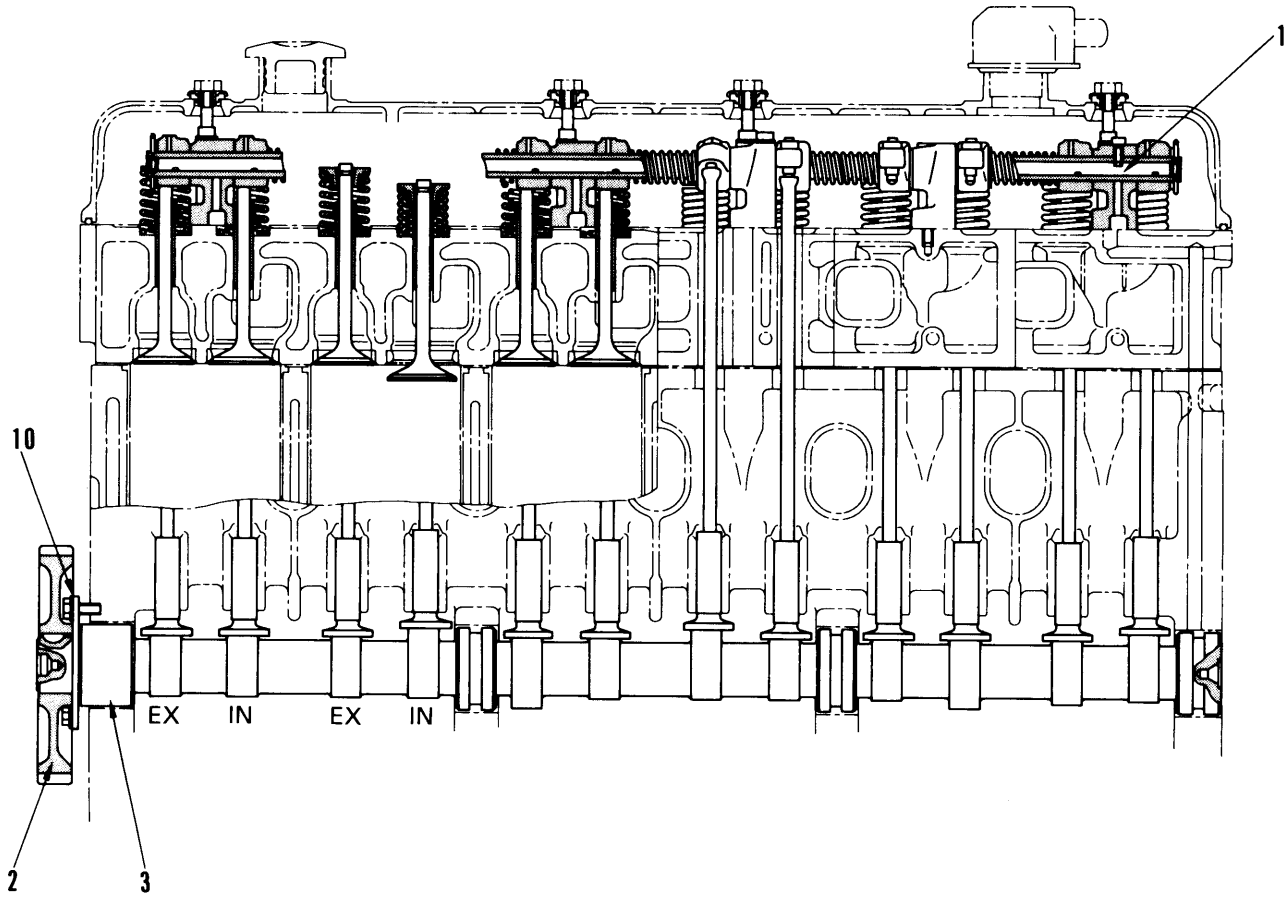
1. Timing gear case
2. Fuel injection pump gear (68 teeth)
3. Idler gear (51 teeth)
4. Oil pump gear (41 teeth)
5. Crankshaft gear (34 teeth)
6. Oil pump drive gear (58 teeth)
7. Camshaft gear (68 teeth)
8. PTO gear (34 teeth)

A,B,C: Match marks for timing gears

VALVE SYSTEM

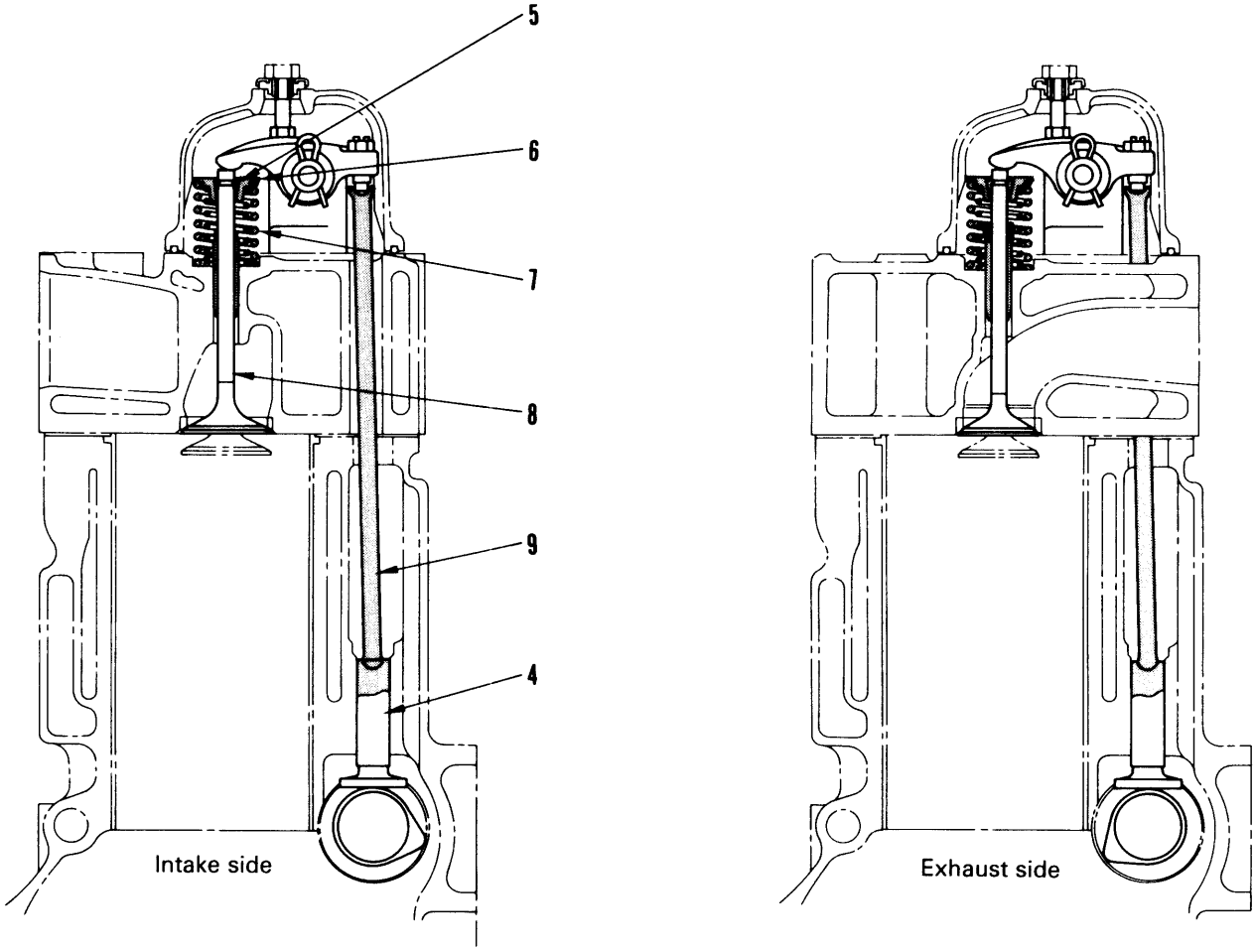




622101

622F01067

1. Rocker arm shaft
2. Cam gear (68 teeth)
3. Cam shaft
4. Cam roller
5. Valve cotter
6. Valve spring seat
7. Valve spring
8. Valve
9. Push rod
10. Thrust plate



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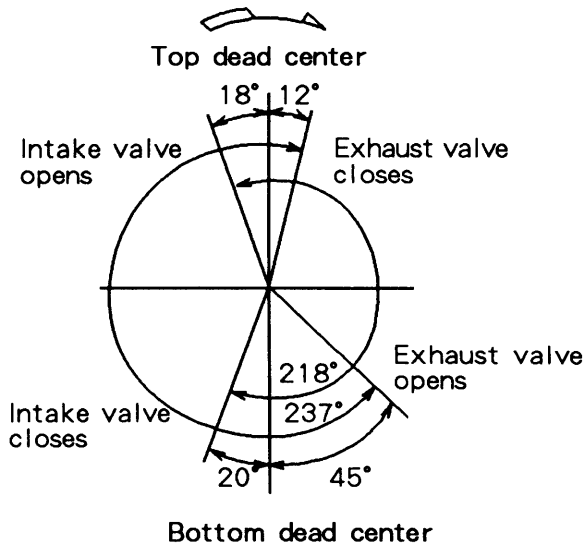
CAMSHAFT

- Stamp forging
- Journal portion, cam portion:
  Induction hardening

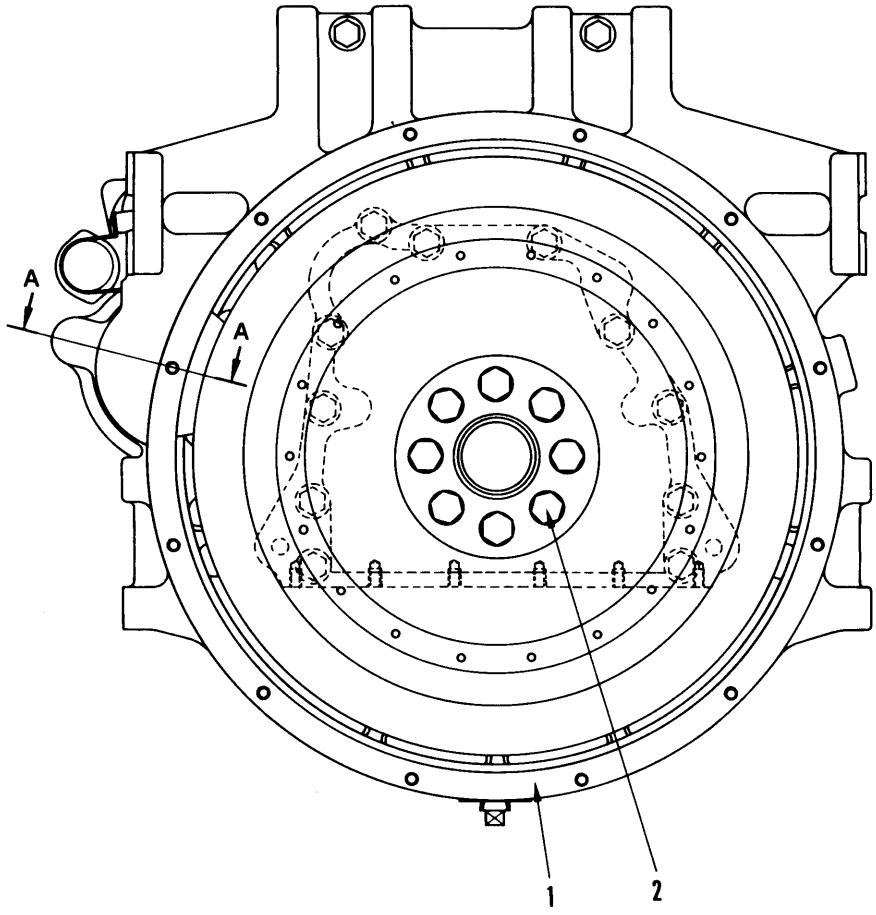
Valve timing



FLYWHEEL AND FLYWHEEL HOUSING

S6D108-1 (For D57S-1B, WA320, 380-3)
SA6D108-1 (WA420-3)

Note: This figure is for S6D108-1.



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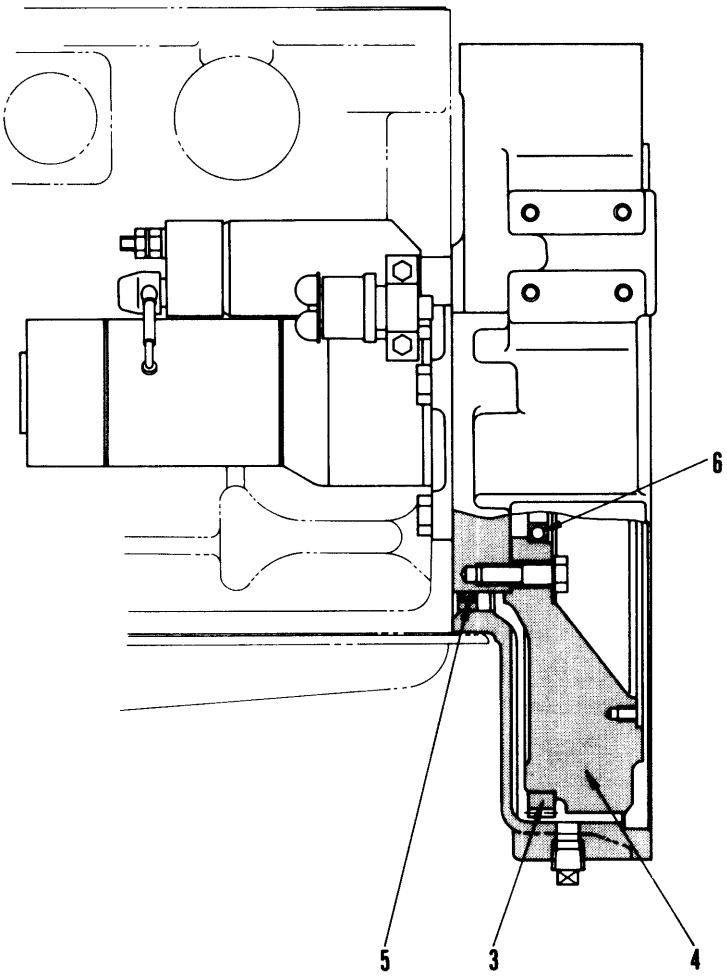
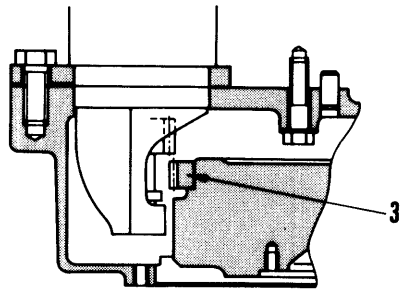
1. Flywheel housing
2. Flywheel mounting bolt
3. Ring gear (134 teeth: For D57S-1B, WA420-3)
   (122 teeth: For WA320, 380-3)
4. Flywheel
5. Crankshaft rear seal
6. Ball bearing (For D57S-1B)





Section A – A

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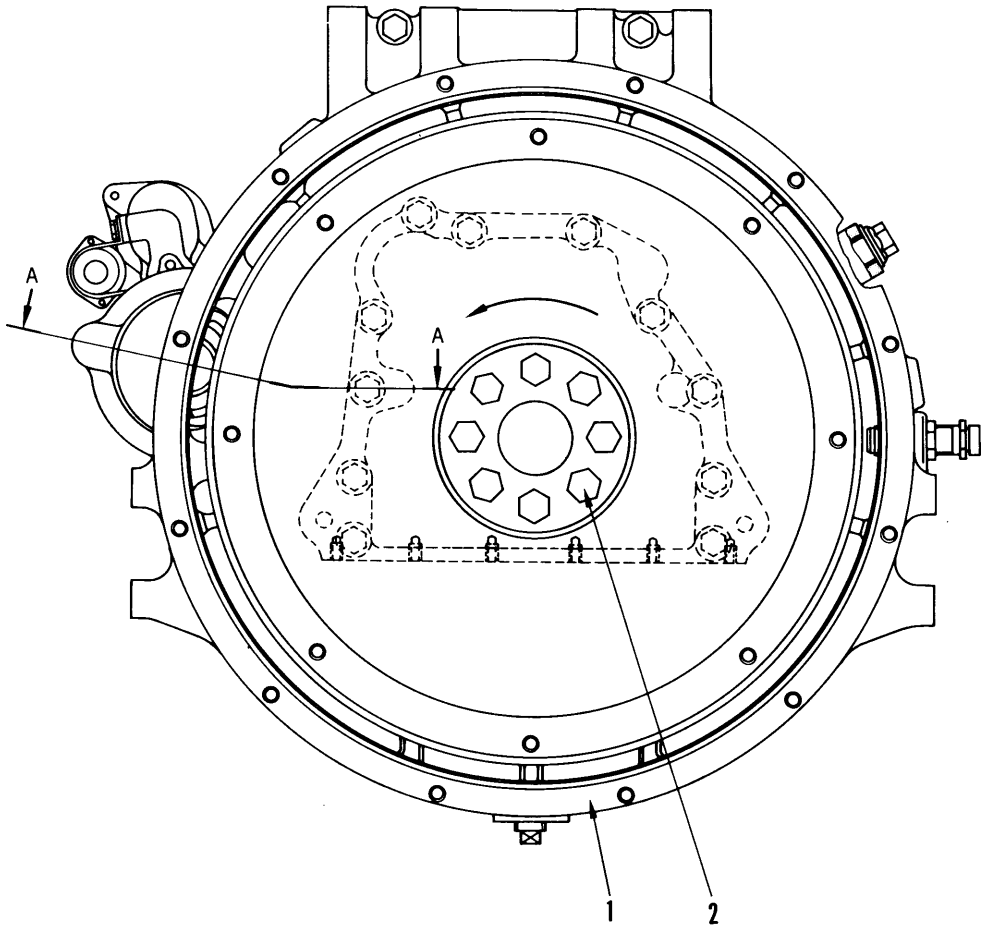
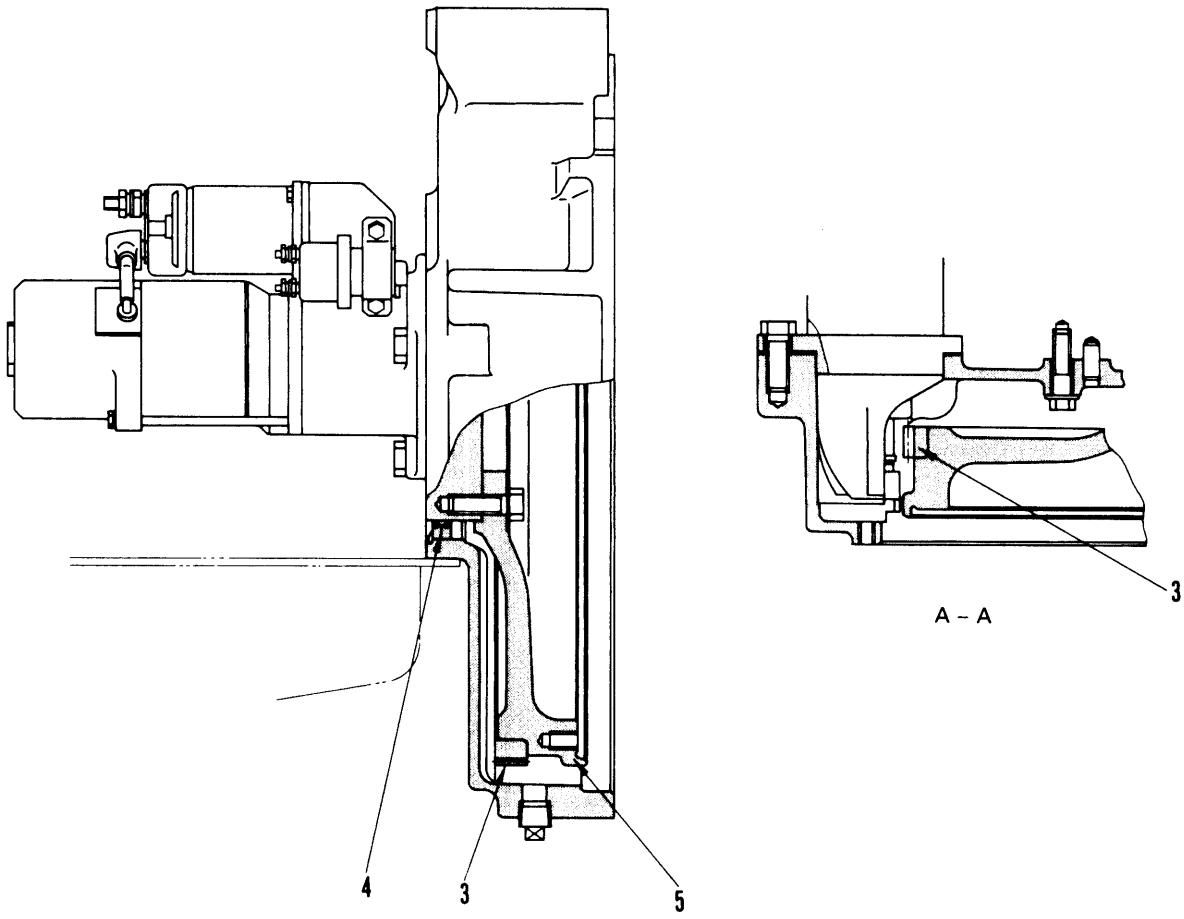
SA6D108-1 (For PC300-5)



622F01071

622101

1. Flywheel housing
2. Flywheel mounting bolt
3. Ring gear (148 teeth)
4. Rear seal
5. Flywheel



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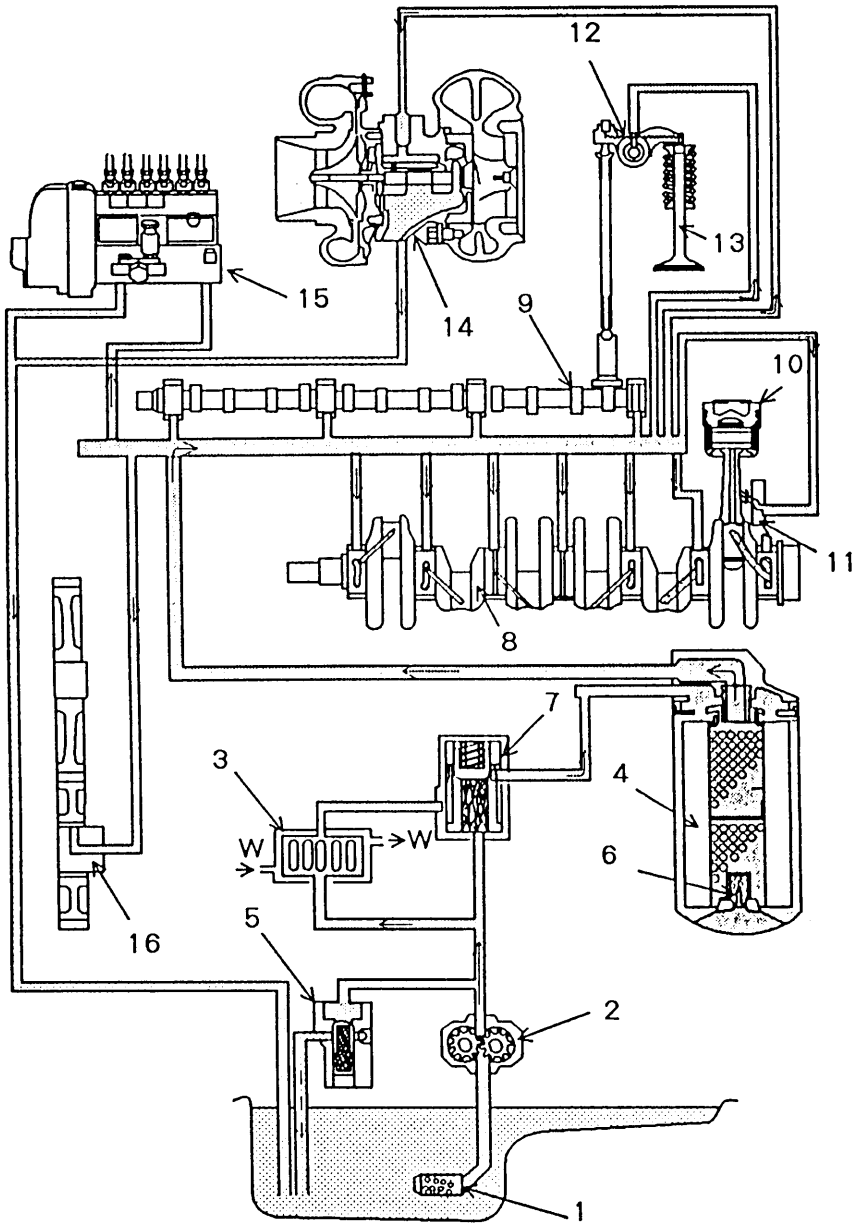
LUBRICATION SYSTEM

LUBRICATION SYSTEM CHART



1. Oil strainer
2. Oil pump
3. Oil cooler
4. Oil filter
5. Regulator valve
6. Safety valve
7. Oil cooler safety valve
8. Crankshaft
9. Camshaft
10. Piston
11. Piston cooling nozzle
12. Rocker arm
13. Intake/exhaust valve
14. Turbocharger
15. Fuel injection pump
16. Timing gear

W. Cooling water

622101

LUBRICATION SYSTEM

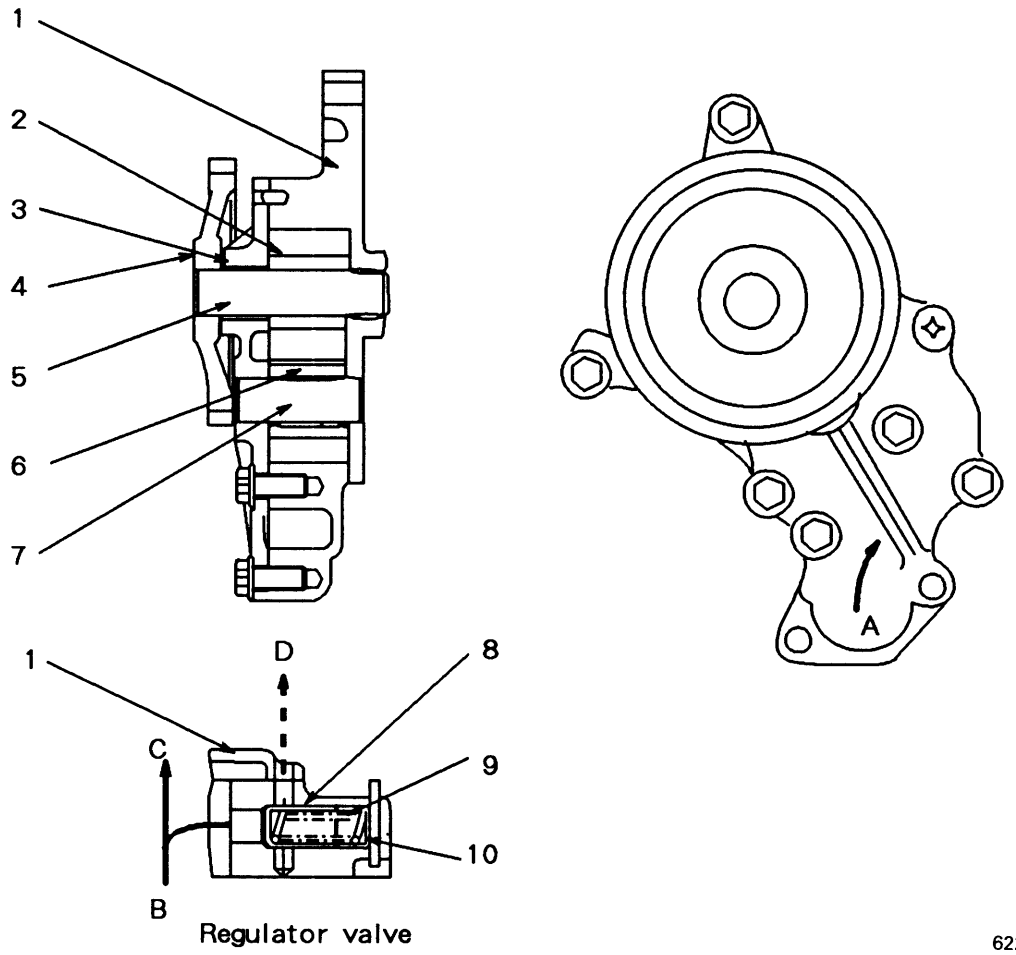
1. Structure of Lubricating system

- The lubricating system consists mainly of the oil strainer, oil pump, oil pump regulator, oil cooler oil filter and safety valve to lubricate various engine parts.

2. Circulation of lubricating oil

- The lube oil flows from the oil pan to the oil pump through the oil strainer where relatively large particles of dust, dirt, or, foreign matter is removed from the oil. The oil pump is driven by the gear in the crankshaft cluster to suck in and charge out the oil under pressure.
- The oil discharged from the pump is cleaned fully through the oil filter(full-flow type). Thus, the oil is distributed to various lubrication points in the engine.
- The oil is cooled, through heat exchanger with the engine cooling water at pipes in the oil bracket or in the oil cooler.

OIL PUMP



Regulator valve

622101

622F01014

1. Oil pump body
2. Drive gear (9teeth)
3. Pump cover
4. Pump drive gear (41teeth)
5. Drive shaft
6. Driven gear (9teeth)
7. Driven shaft
8. Regulator valve
9. Valve spring
10. Valve retainer

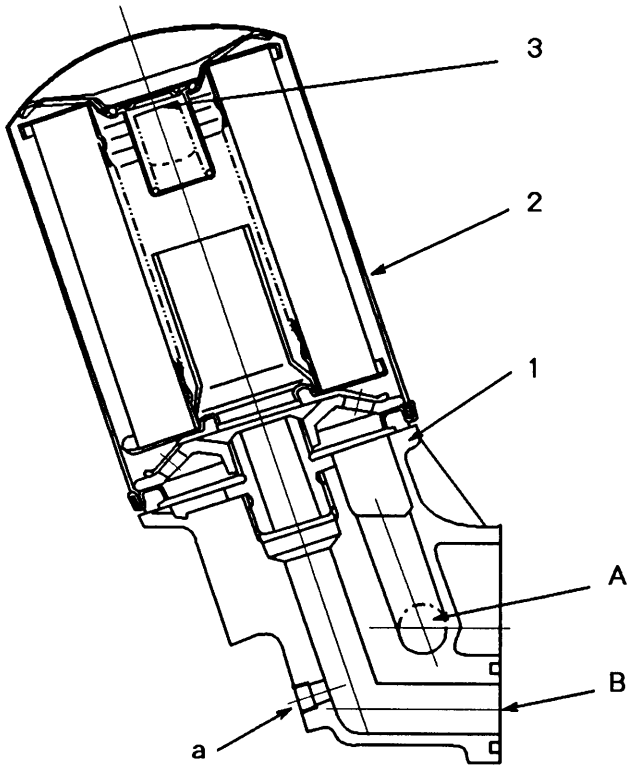
A. From oil strainer
B. From oil pump
C. To engine
D. To oil pan

Oil pump
Type : Gear pump
Speed : Engine speed×1.415

Regulator valve
- Cracking pressure : 8.5±0.5kg/cm²

OIL FILTER (Built-in safety valve)

- **Handstand type**



622F01015

1. Filter bracket
2. Cartridge
3. Safety valve

A. From oil pump
B. To engine

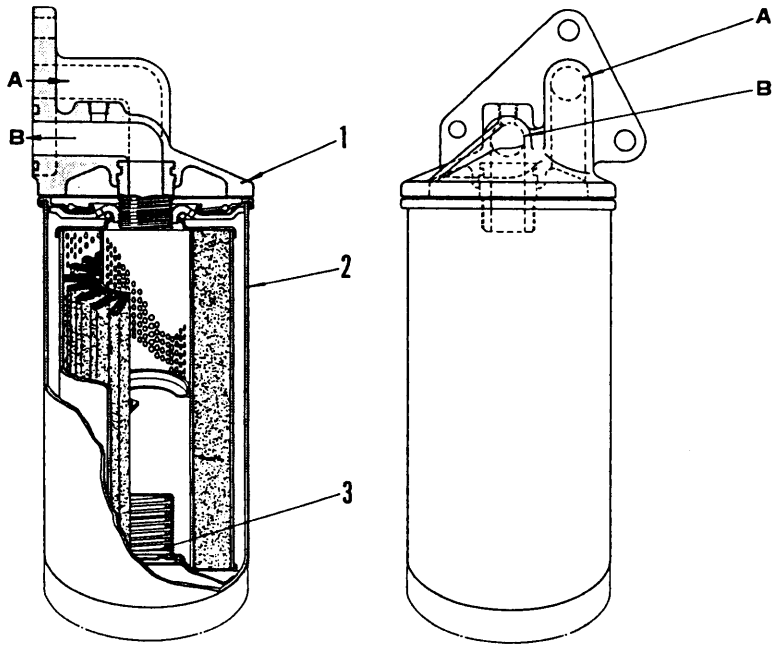
a. Oil pressure tap

Safety valve
Actuating pressure :
0.2 ± 0.02 MPa (2 ± 0.2 kg/cm²)

Oil filter
Filtration area : 0.53m²

622101

- **Suspended type**



6136F017C

1. Filter bracket
2. Cartridge
3. Safety valve

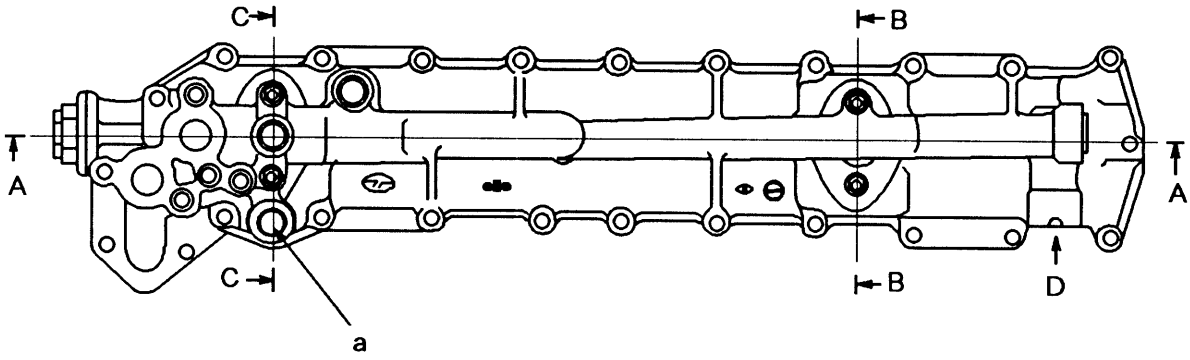
A. From oil pump
B. To engine

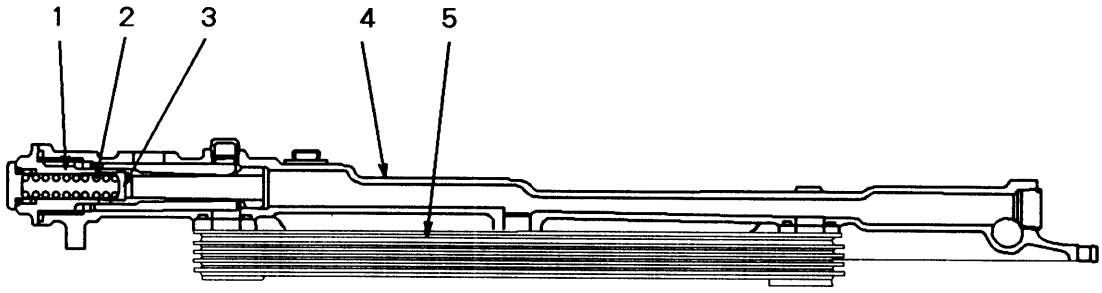
a: Oil pressure pickup port
Oil pressure switch device

Safety valve
Actuation pressure:
0.2 ± 0.02 MPa (2 ± 0.2 kg/cm²)

Oil filter
Filtering area: 0.53 m²

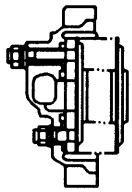
OIL COOLER



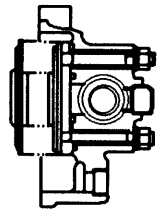


Section A–A

622101



Section B–B



Section C–C

622F01016

1. Valve case
2. valve spring
3. By-pass valve
4. Cooler cover
5. Cooler element

D. From oil pump
a. Water drain port

Oil cooler by-pass valve

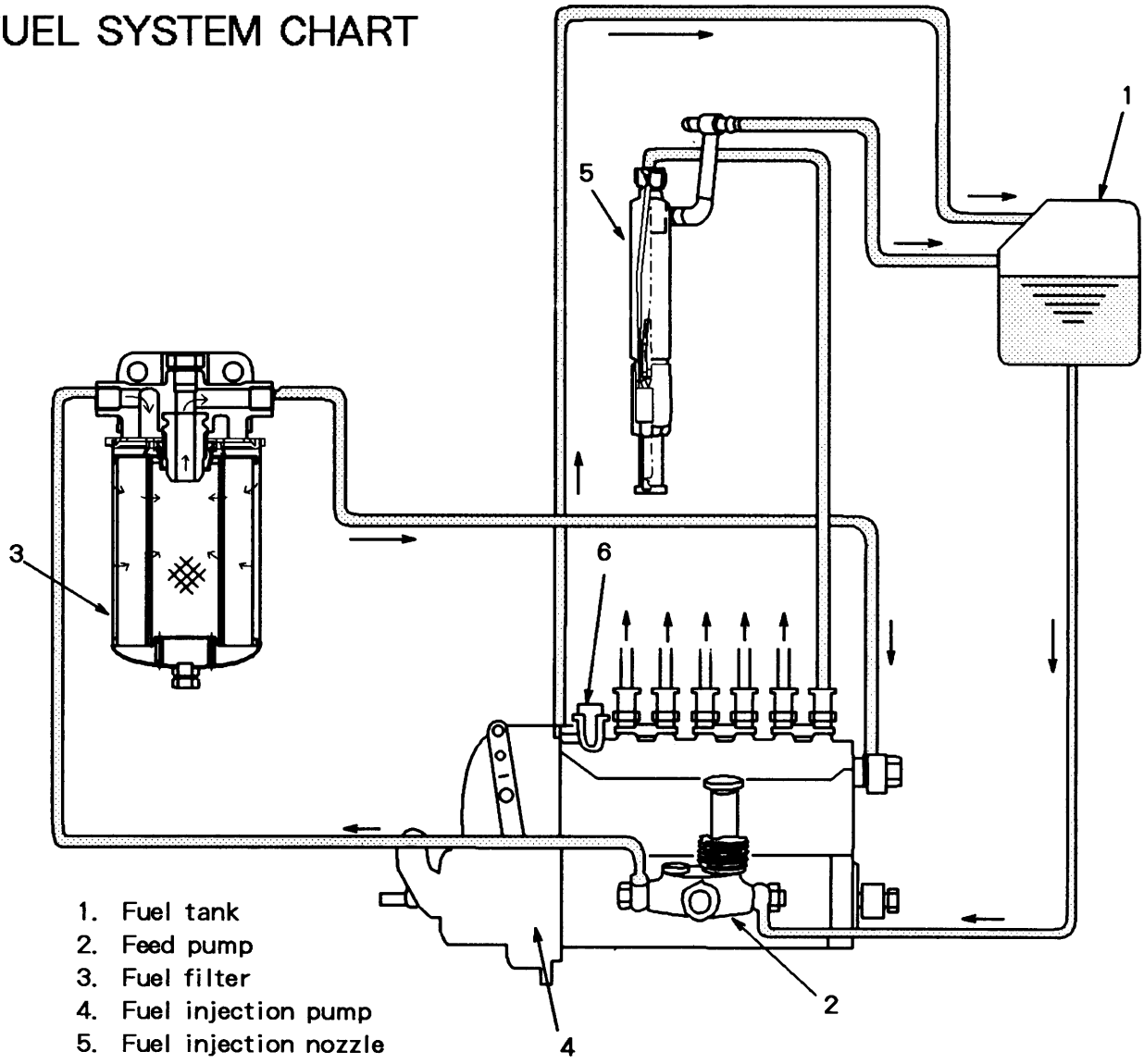
Actuating pressure : 4±0.2kg/cm²

Structure and function

- The oil cooler consists of element and cover. The oil flowing through the cooler element with the cooling fin is cooled properly by the engine cooling water flowing outside the element.

FUEL SYSTEM

FUEL SYSTEM CHART



1. Fuel tank
2. Feed pump
3. Fuel filter
4. Fuel injection pump
5. Fuel injection nozzle
6. Over-flow valve

KS100027

622101

GENERAL DESCRIPTION

1. Structure of fuel system

- The fuel system consists mainly of the fuel tank, feed pump, fuel filter, fuel injection pump, fuel injection nozzles and governor (built as one unit with the fuel injection pump).

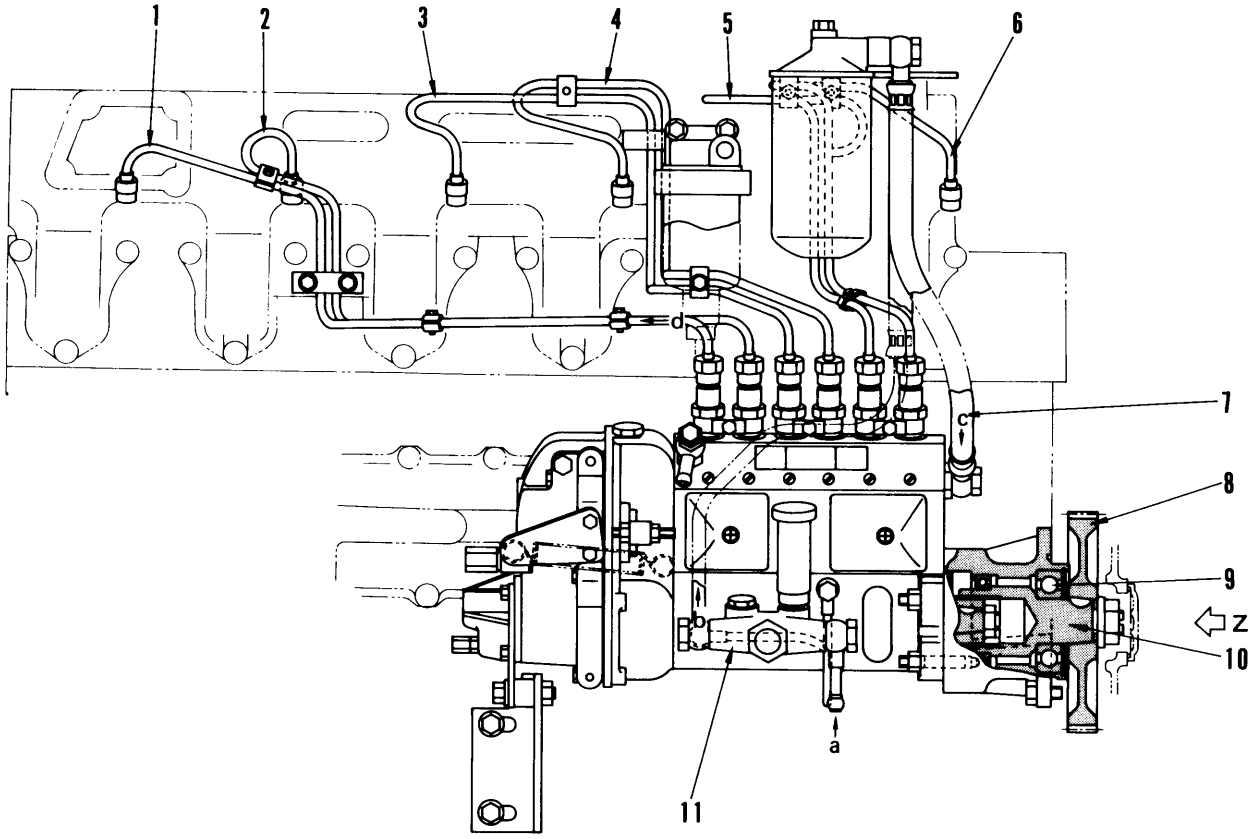
2. Circulation of fuel

1) Fuel is delivered from the fuel tank to the injection pump through the fuel filter by the feed pump driven by the fuel injection pump cam. During the course from the tank to the injection pump, the fuel is cleaned of rough dirt through the gauge filter at the inlet to the feed pump. Then, complete dust removal and water separation from the oil are accomplished through the filter.

2) Fuel entering the injection pump is pressurized by the pump plunger to that required for injection and injected into each cylinder through the injection nozzle in the quantity required, meeting the injection timing for the cylinder.

FUEL INJECTION PUMP (WITH MECHANICAL GOVERNOR)

S6D108-1 (For D57S-1B, WA320, 380-3)



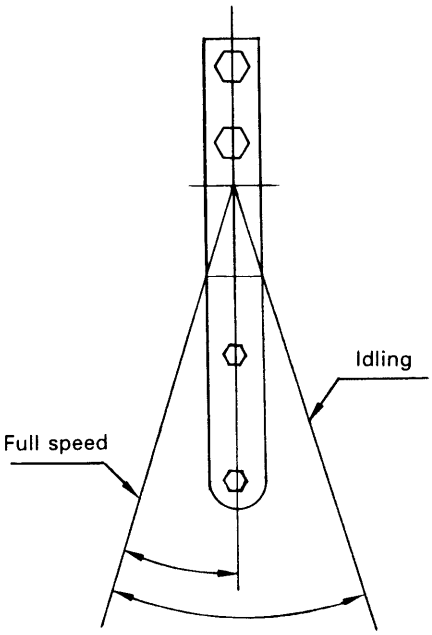
622101

622F01074

1. Fuel injection pipe (No. 6)
2. Fuel injection pipe (No. 5)
3. Fuel injection pipe (No. 4)
4. Fuel injection pipe (No. 3)
5. Fuel injection pipe (No. 2)
6. Fuel injection pipe (No. 1)
7. Fuel hose
8. Injection pump gear
9. Ball bearing
10. Drive shaft
11. Fuel injection pump
12. Fuel filter

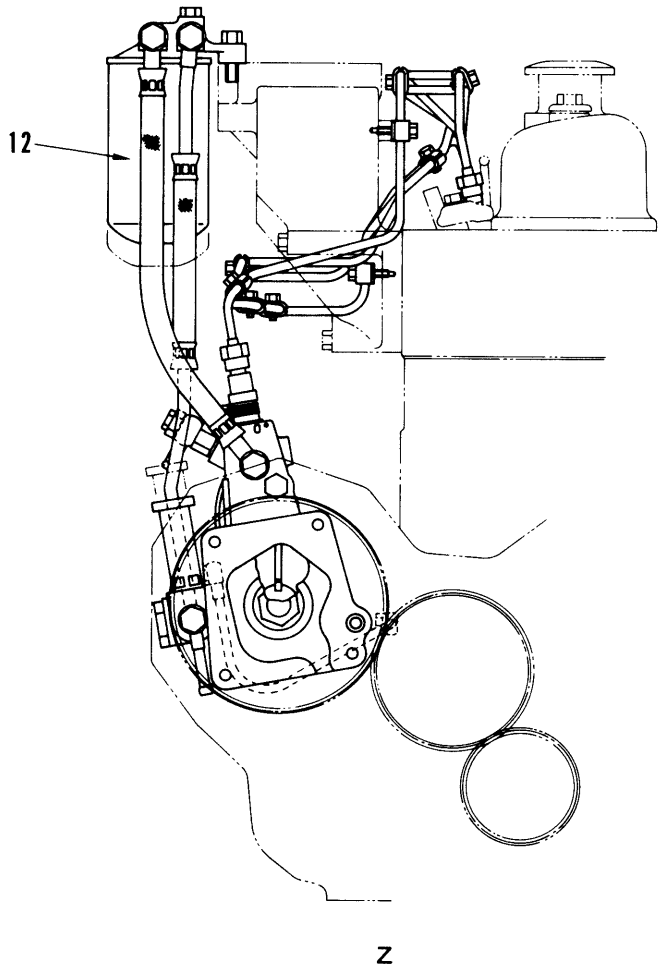
a. From fuel tank
b. To fuel filter
c. To fuel injection pump
d. To injection nozzle

SPEED CONTROL LEVER ANGLE



622F01117

622101



622F01075

Fuel injection pump

Type: Bosch PES-AD

Lubrication method:

Forced lubrication using engine oil

Governor

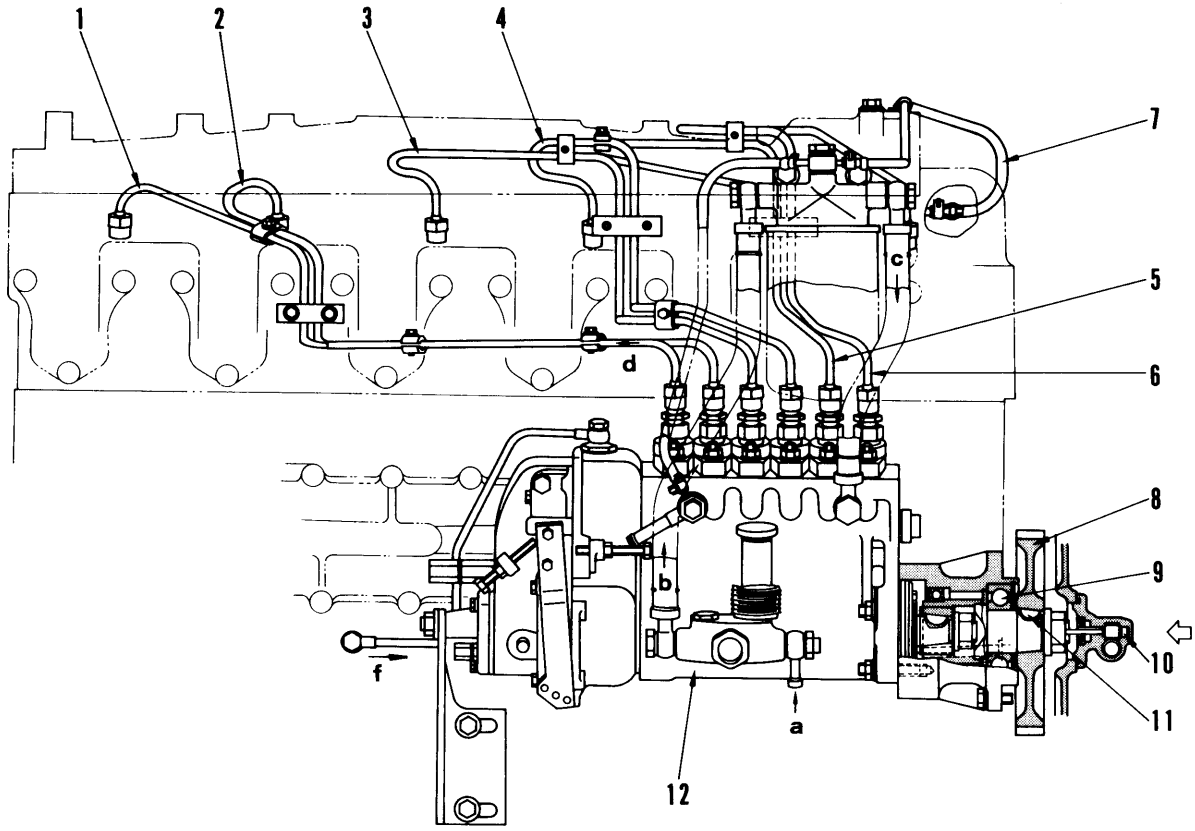
Type: Bosch RSV centrifugal type
All-speed governor

Fuel injection timing:

Differs according to machine model

See values in STANDARD VALUE TABLE.

SA6D108-1 (For PC300-5, WA420-3)



622101

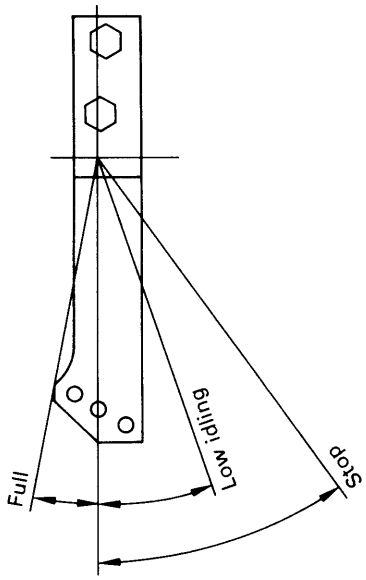
622F01076

1. Fuel injection pipe(No.6)
2. Fuel injection pipe(No.5)
3. Fuel injection pipe(No.4)
4. Fuel injection pipe(No.3)
5. Fuel injection pipe(No.2)
6. Fuel injection pipe(No.1)
7. Fuel hose
8. Injection pump gear
9. Ball bearing
10. Rotation pick-up shaft
11. Drive shaft
12. Fuel injection pump
13. Fuel filter

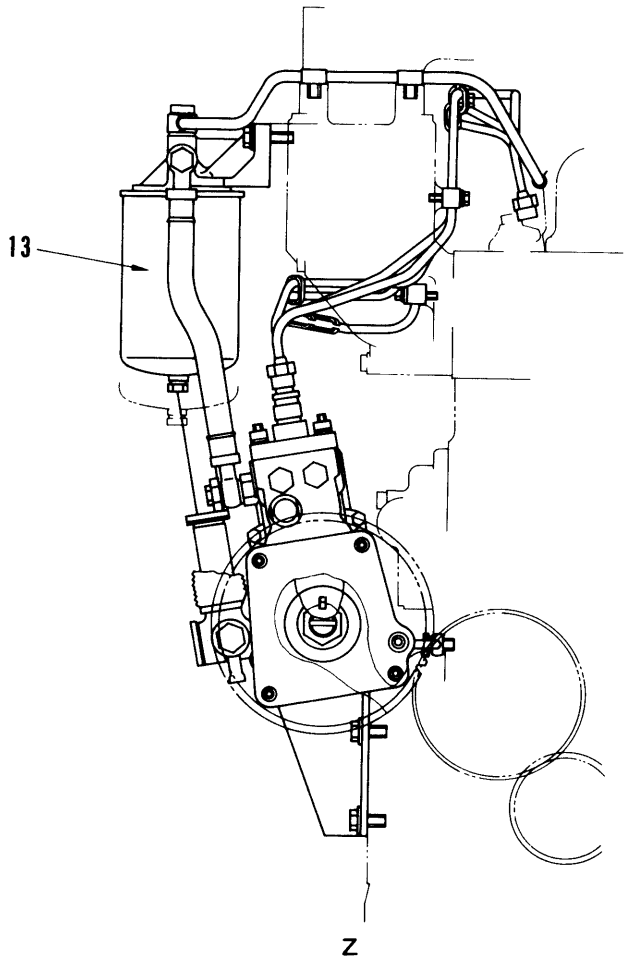
a : From fuel tank (fuel)
b : To fuel filter (fuel)
c : To fuel injection pump (fuel)
d : To injection nozzle (fuel)

f : From cylinder block (oil)

SPEED CONTROL LEVER ANGLE



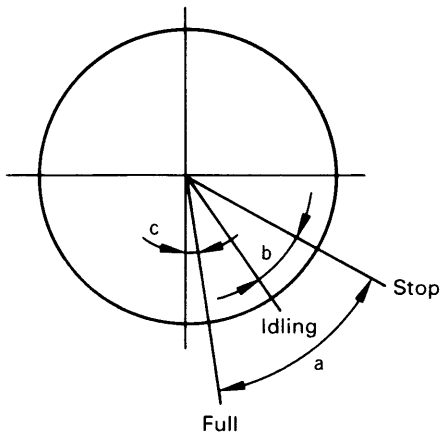
622F01077



622F01078

622101

INJECTION PUMP GOVERNOR LEVER ANGLE



622F01079

a : 53°

b : 26.5°

c : 8.5°

Fuel injection pump

Type: Nippon Denso NB (EP-9)

Lubrication method:

Forced lubrication using engine oil

Governor

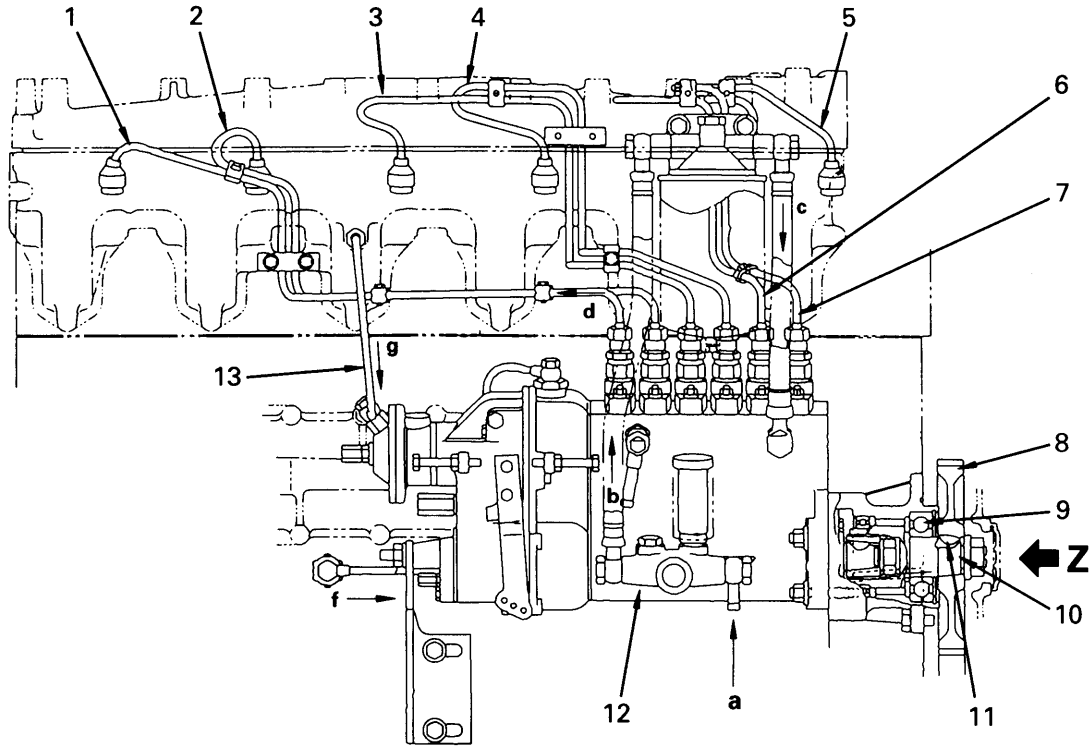
Type: Bosch RSV centrifugal type
All-speed governor

Fuel injection timing:

Differs according to machine model

See values in STANDARD VALUE TABLE.

FUEL INJECTION PUMP (WITH MECHANICAL GOVERNOR) (WITH BOOST COMPENSATOR DEVICE)



622101

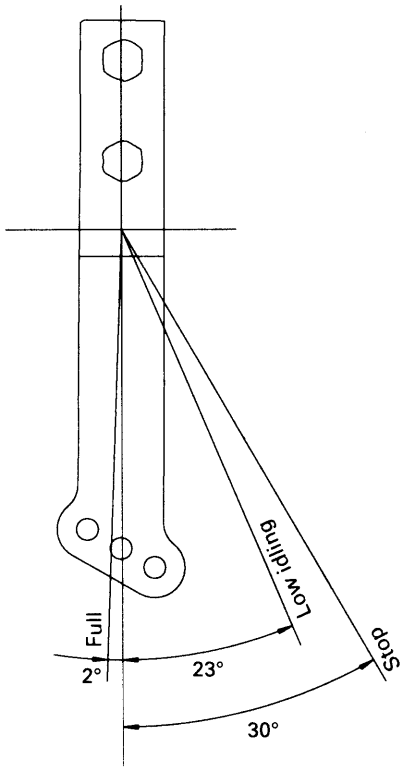
SLE00096

1. Fuel injection pipe (No. 6)
2. Fuel injection pipe (No. 5)
3. Fuel injection pipe (No. 4)
4. Fuel injection pipe (No. 3)
5. Fuel hose
6. Fuel injection pipe (No. 2)
7. Fuel injection pipe (No. 1)
8. Injection pump gear
9. Ball bearing
10. Speed pickup shaft
11. Drive shaft
12. Fuel injection pump
13. Air pipe
14. Fuel filter

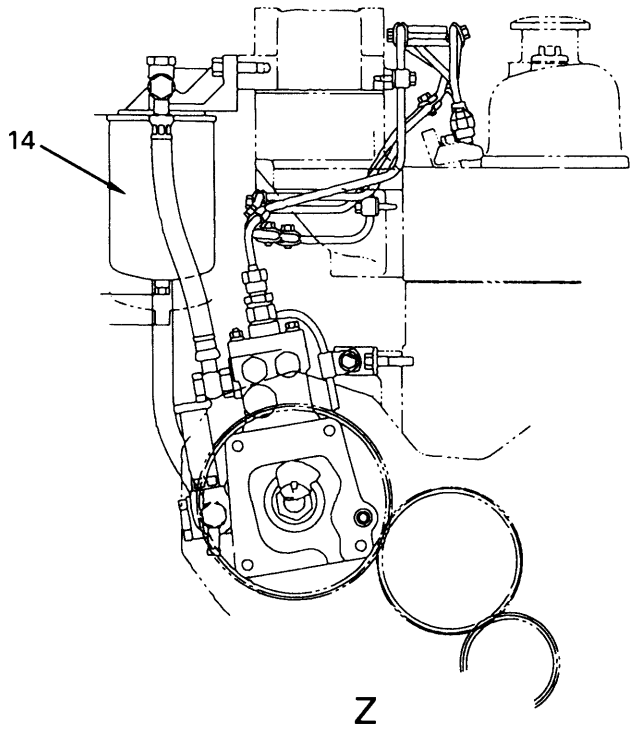
a: From fuel tank
b: To fuel filter
c: To fuel injection pump
d: To injection nozzle
f: From cylinder block
g: To fuel injection pump (boost pressure)

SPEEDCONTROL LEVER ANGLE

622101



SLE00097



SLE00098

Fuel injection pump

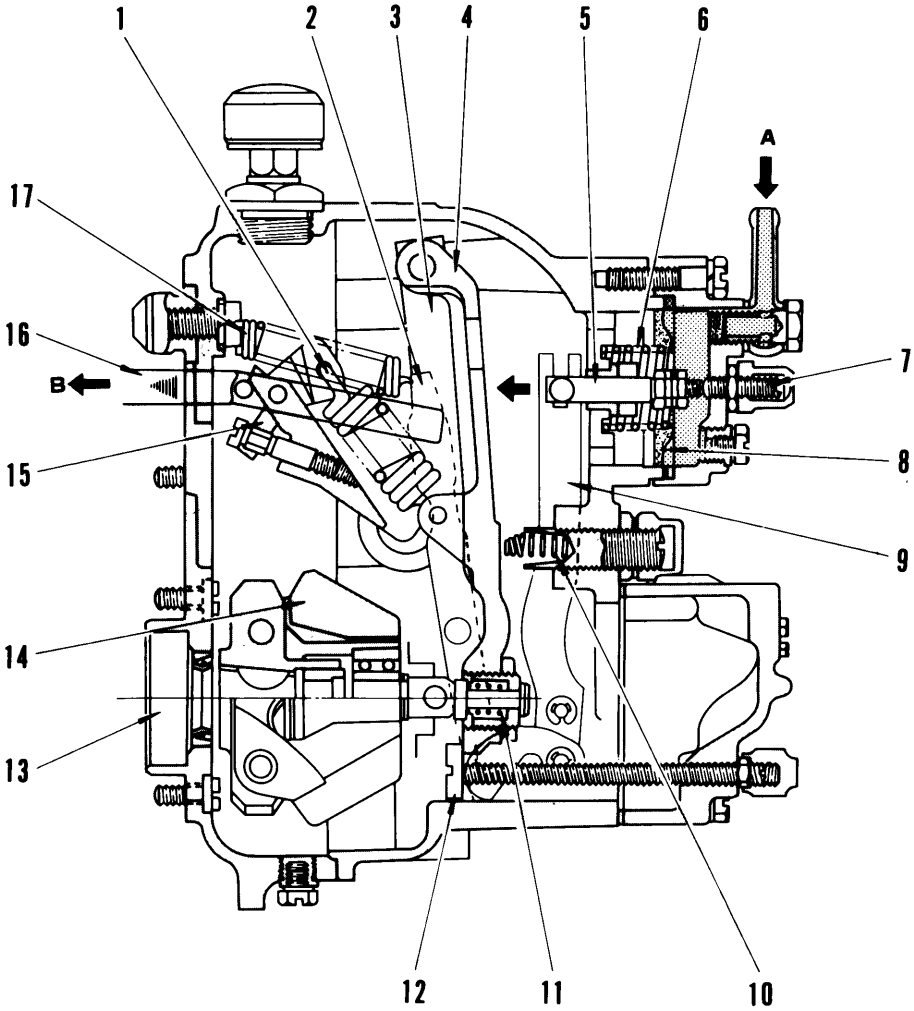
Type: Nippon Denso NB(EP-9)
Lubrication method: Forced lubrication using engine oil

Governor

Type: Bosch RSV centrifugal type
All-speed governor

Fuel injection timing: Differs according to machine model
See values in STANDARD VALUE TABLE.

BOOST COMPENSATOR DEVICE

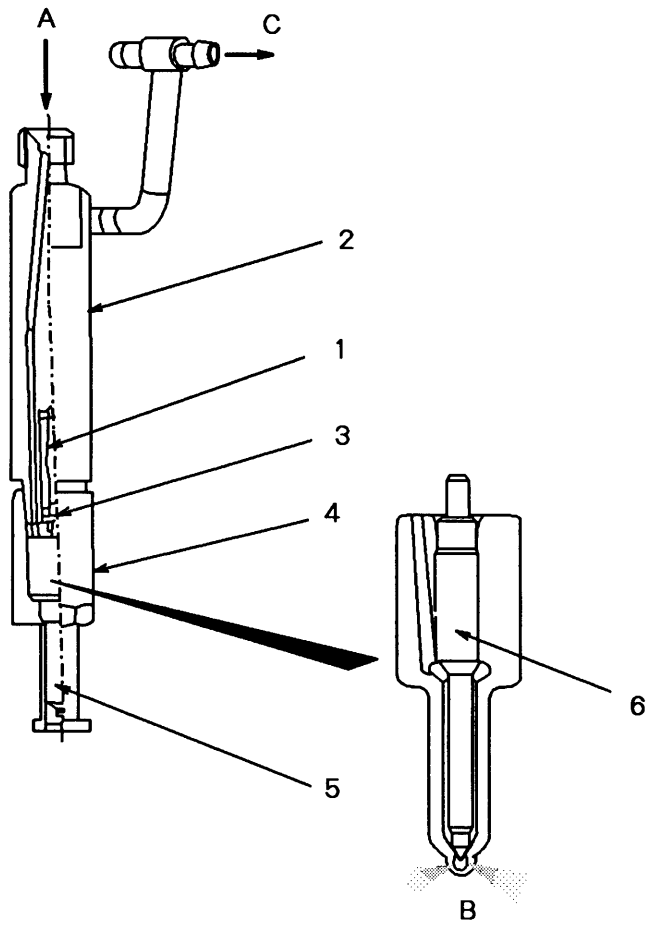


622101

1. Governor spring
2. Floating lever
3. Guide lever
4. Tension lever
5. Push rod
6. Boost compensator spring
7. Adjustment screw
8. Diaphragm
9. Boost compensator lever
10. Idling sub spring
11. Angleich spring
12. Full load stopper
13. Camshaft
14. Flyweight
15. Swivel lever
16. Control rack
17. Start spring

A. Air supply pressure (boost pressure)
B. Fuel increase direction

FUEL INJECTION NOZZLE



622101

1. Nozzle spring
2. Nozzle holder
3. Push rod
4. Retaining cap
5. Nozzle body
6. Nozzle

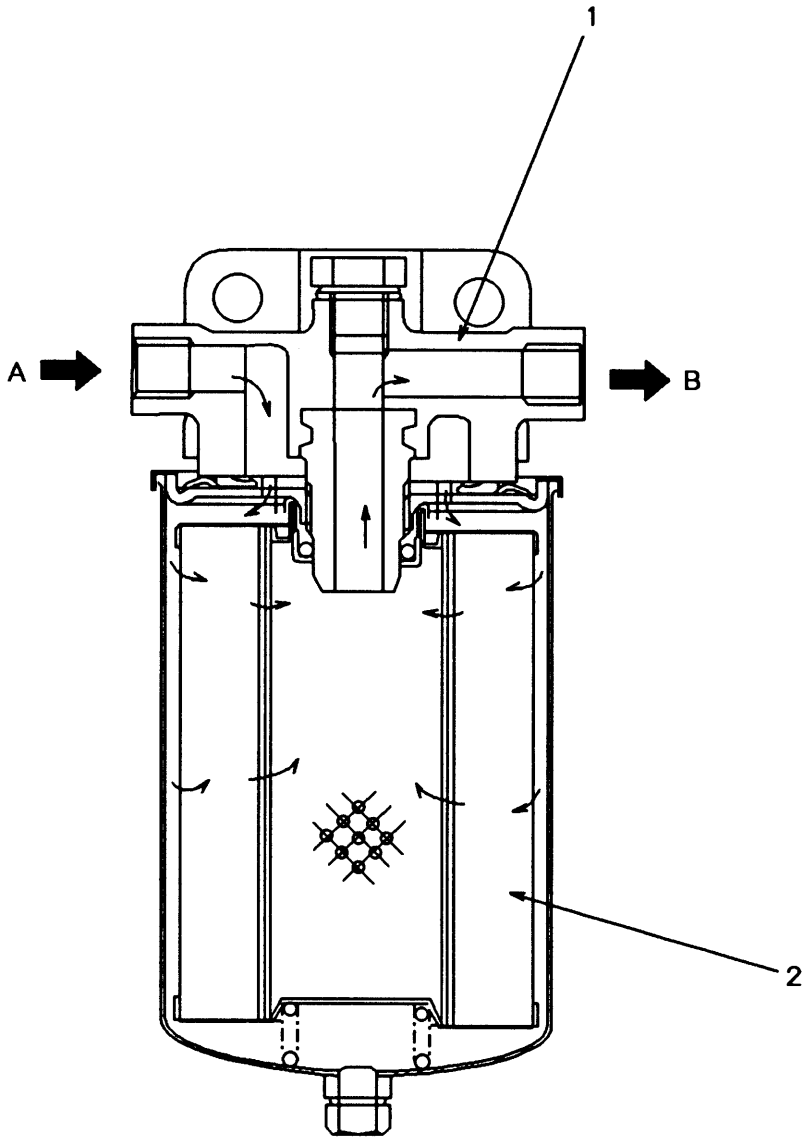
A. From fuel injection pump
B. To cylinder (injection)
C. To fuel tank

FUEL INJECTION NOZZLE

- Maker : DIESEL KIKI (S6D108−1)
  : NIPPON DENSO (SA6D108−1)
- Type : Multi-hole type
- Injection pressure : 235kg/cm² (S6D108−1)
  : 265kg/cm² (SA6D108−1)

★ Adjustment of injection pressure : by shim

FUEL FILTER

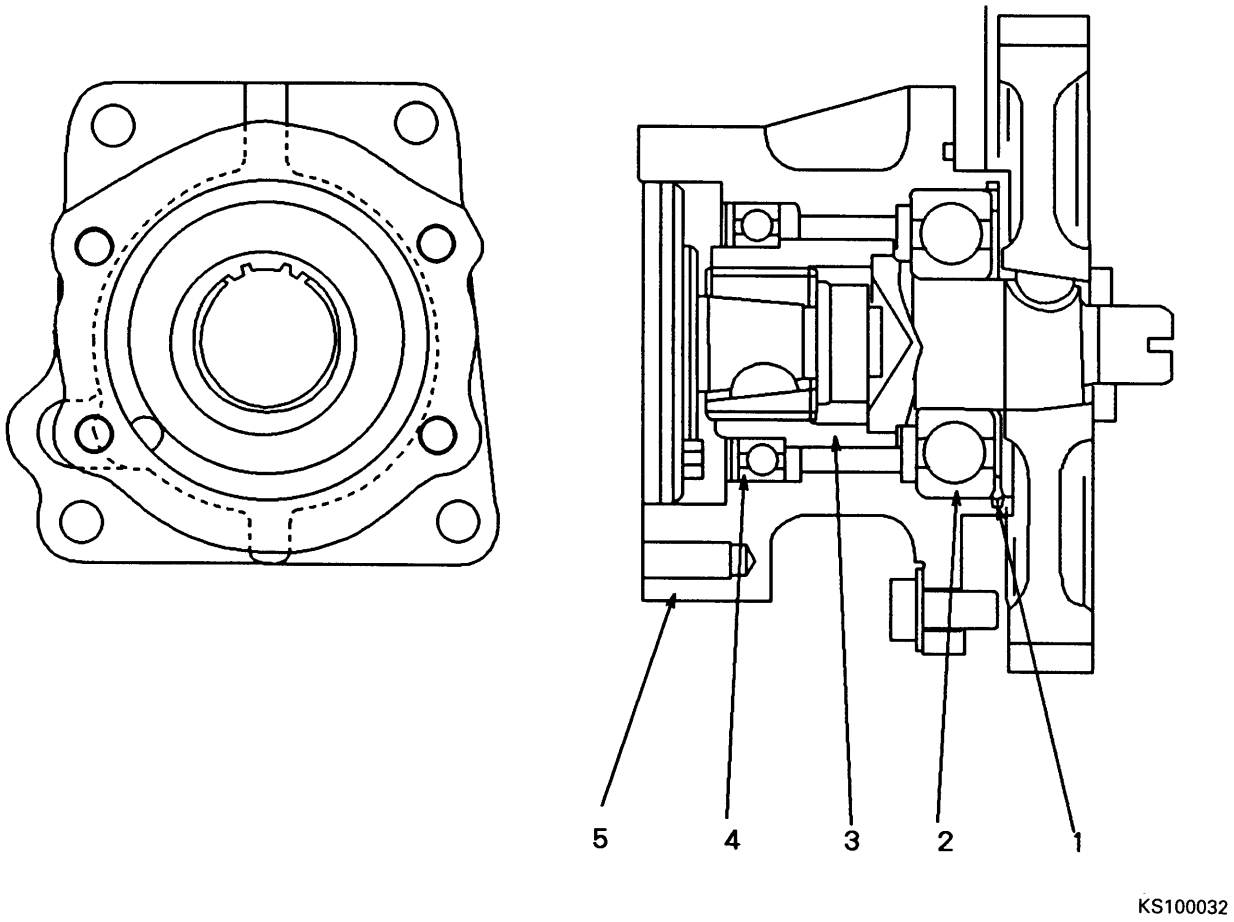


622101

1. Bracket
2. Cartridge
A. From feed pump
B. To injection pump

FUEL FILTER
• Filtration area : 0.5m²

FUEL INJECTION PUMP DRIVE CASE

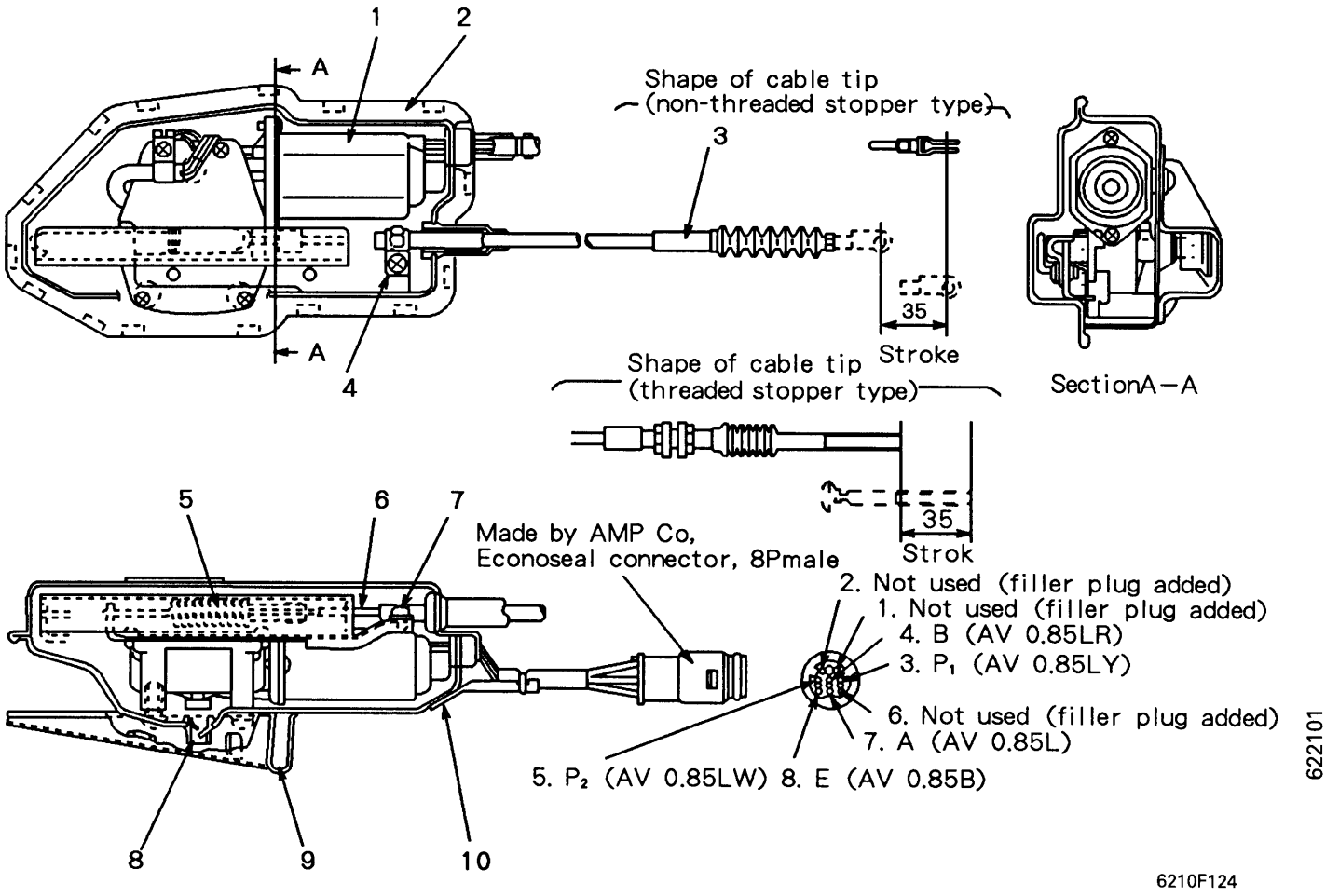


KS100032

622101

1. Snap ring
2. Ball bearing
3. Drive shaft
4. Ball bearing
5. Case

ENGINE STOP MOTOR

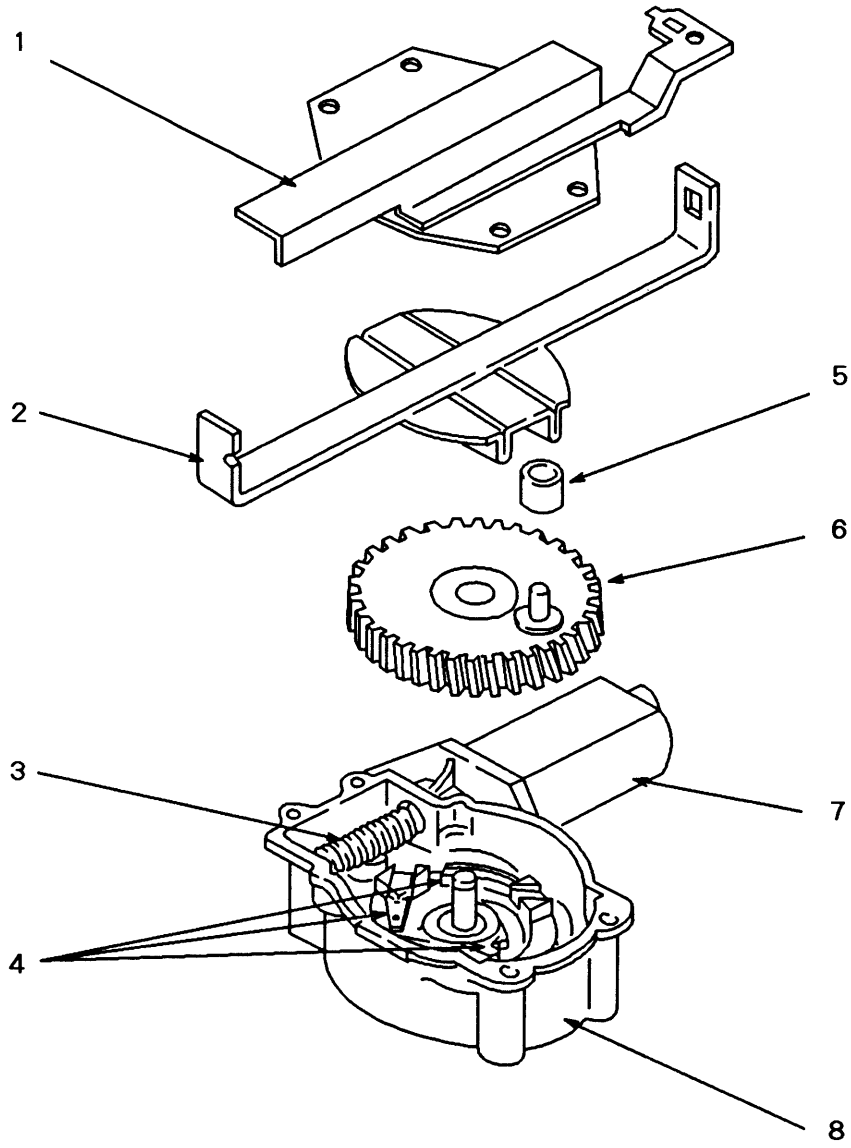


1. Motor assembly
2. Cover
3. Cable assembly
4. Cable clamp
5. Coil spring
6. Cable
7. Screw
8. Breather
9. Bracket assembly
10. Cover assembly

ENGINE STOP MOTOR

- Maker : Jidosha Denki Kogyo Co. Ltd
- Rated voltage : DC24V
- Operating force : 15kg min.
- Stroke : $35^{+1.0}_{-0.4}$mm
- Weight : 1.2kg

STRUCTURAL DRAWING (1)

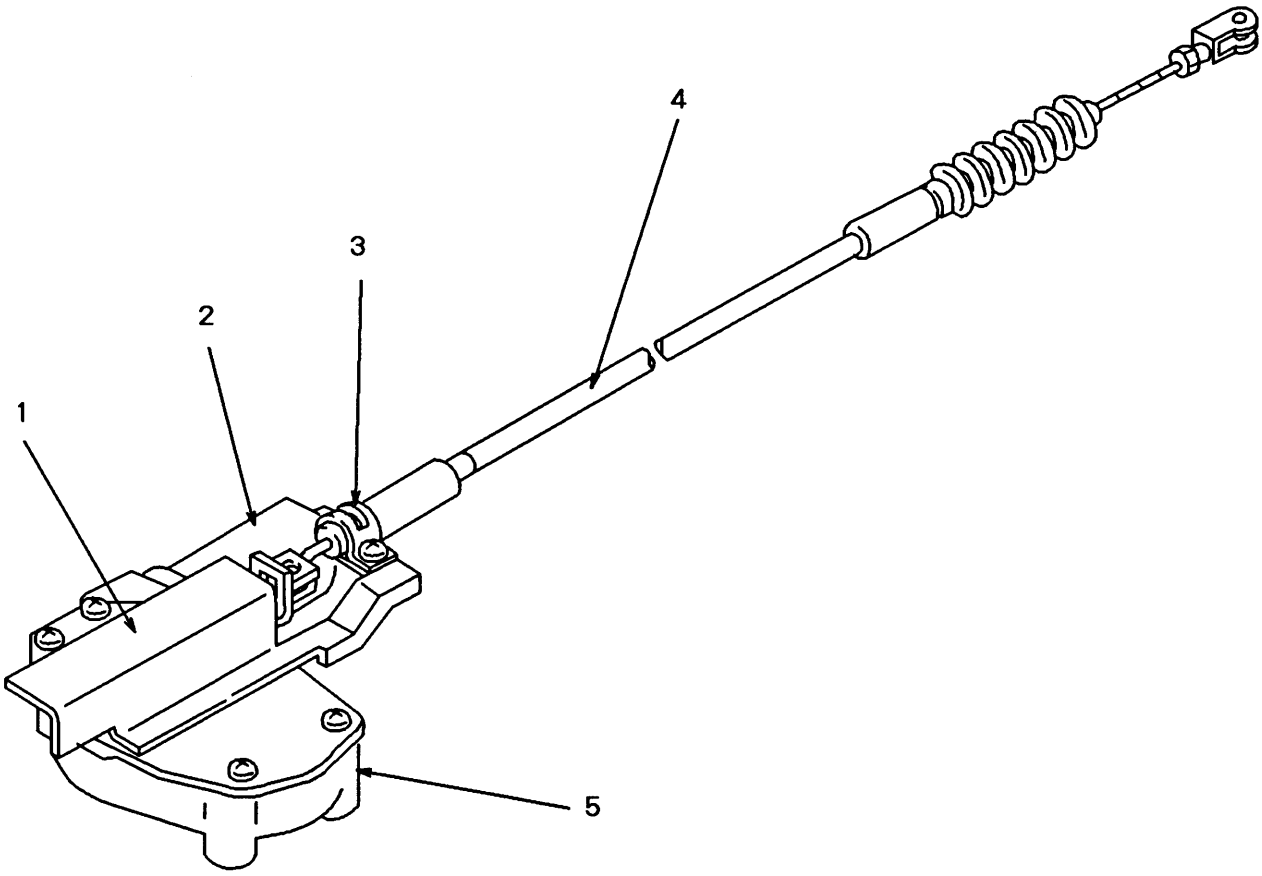


622101

622F01081

1. Gear cover assembly
2. Slider assembly
3. Armature shaft
4. Contactor assembly
5. Roller
6. Worm wheel assembly
7. Motor assembly
8. Gear case assembly

STRUCTURAL DRAWING (2)



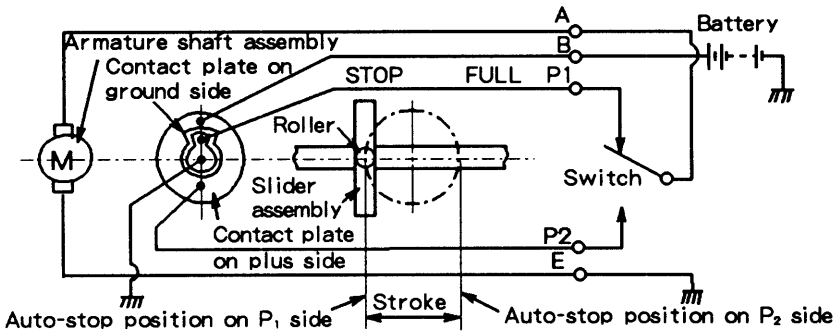
622101

620F01082

1. Gear cover assembly
2. Motor assembly
3. Cable clamp
4. Cable assembly
5. Gear case assembly

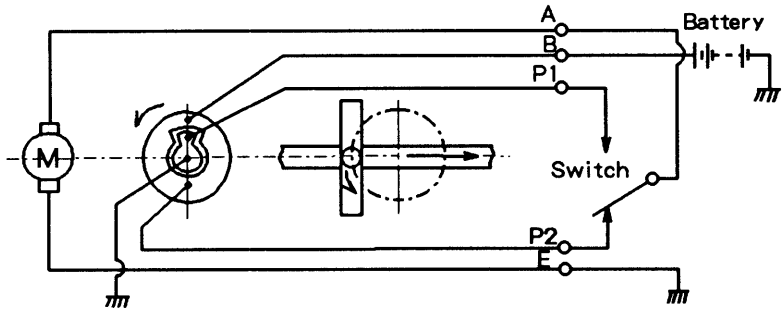
DESCRIPTION OF OPERATION AND CIRCUITS

1. Stop Condition(0° or 360°)



The above drawing shows the stopped condition when a closed circuit has been formed. The slider assembly is stopped at the auto-stop position on the P_1 side.

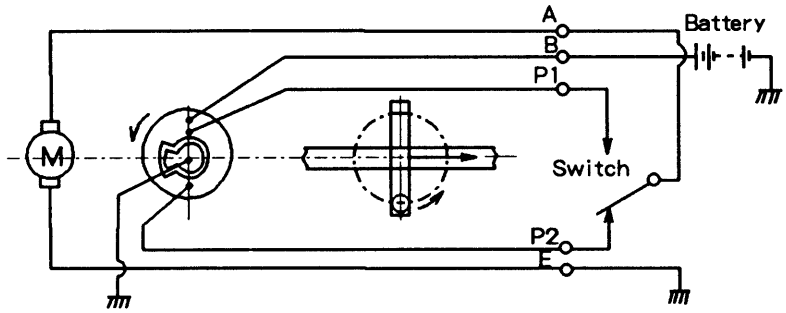
2. When switch is turned (when starting the motor)



When the switch is moved to the P_2 side (starting switch ON), an electric current flows from the plus side contact plate through the P_2 auto-stop terminal and switch and into the armature shaft assembly, thereby starting the motor.

The slider assembly starts to move in the direction of the arrow at the same time as the roller starts to move.

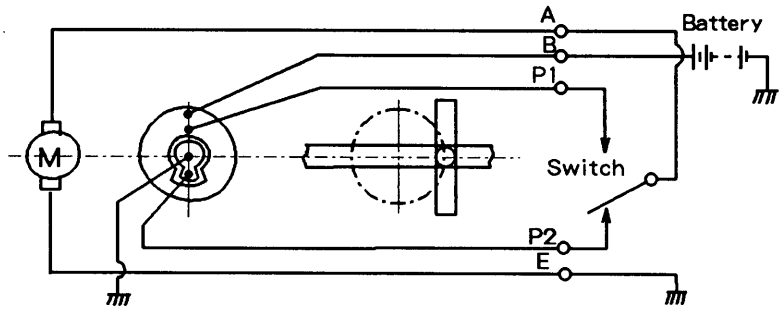
3. Turning Condition (90° in the drawing)



Electric current continues to pass through the armature assembly and the motor continues to turn. Because of the rotation of the roller, the slider assembly also continues to move in the direction of the arrow.

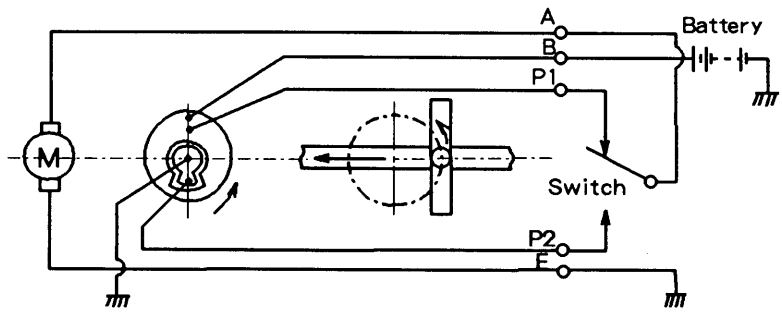
622101

4. When stopped (180°)



A closed circuit is formed when the P_2 auto-stop terminal rides on the minus-side contactor plate, and the motor comes to a sudden stop. The slider assembly also stops.

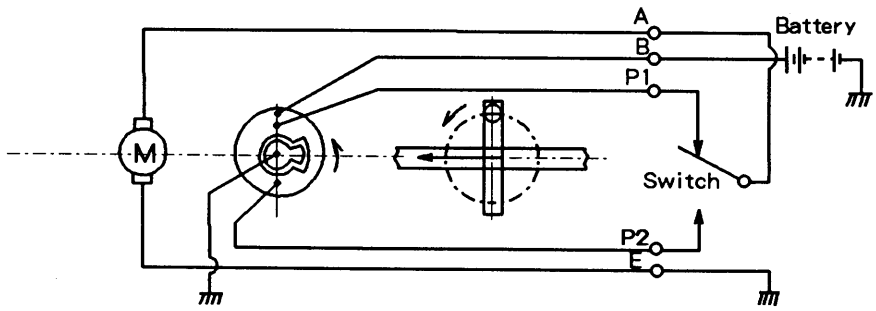
5. When switch is turned (when starting the motor)



When the switch is moved to the P_1 side (starting switch OFF), an electric current flows from the plus contactor plate through the P_1 auto-stop terminal and switch and into the armature shaft assembly, thereby starting the motor.

The slider assembly starts to move in the direction of the arrow at the same time as the roller starts to move.

6. Turning condition (270° in the drawing)



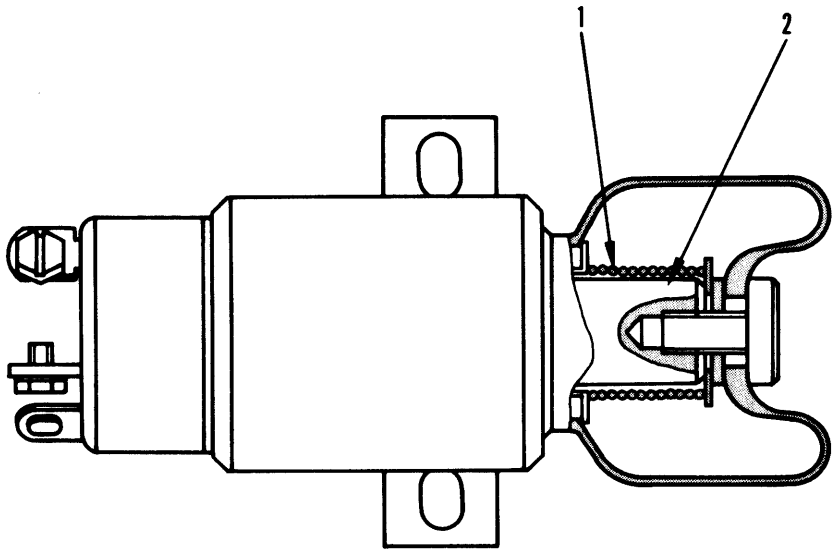
Electric current continues to pass through the armature shaft assembly and the motor continues to turn. The slider assembly also continues to move in the direction of the arrow.

Then the circuit returns to stop condition 1.

622101

FUEL CUT SOLENOID

A. Contact method (continuous when stopped)



622101

622F01080

- When the engine is stopped, electricity passes through the solenoid and the solenoid plunger is pulled electrically. This moves a rod, which moves the injection pump stop lever to the STOP position and cuts the fuel to stop the engine.
  Therefore, this solenoid is only used when stopping the engine; during normal operations, it is in the free position.
- When running the engine, no electricity passes through the solenoid. The solenoid has no magnetic force, so the solenoid shaft is pulled back by the return spring.

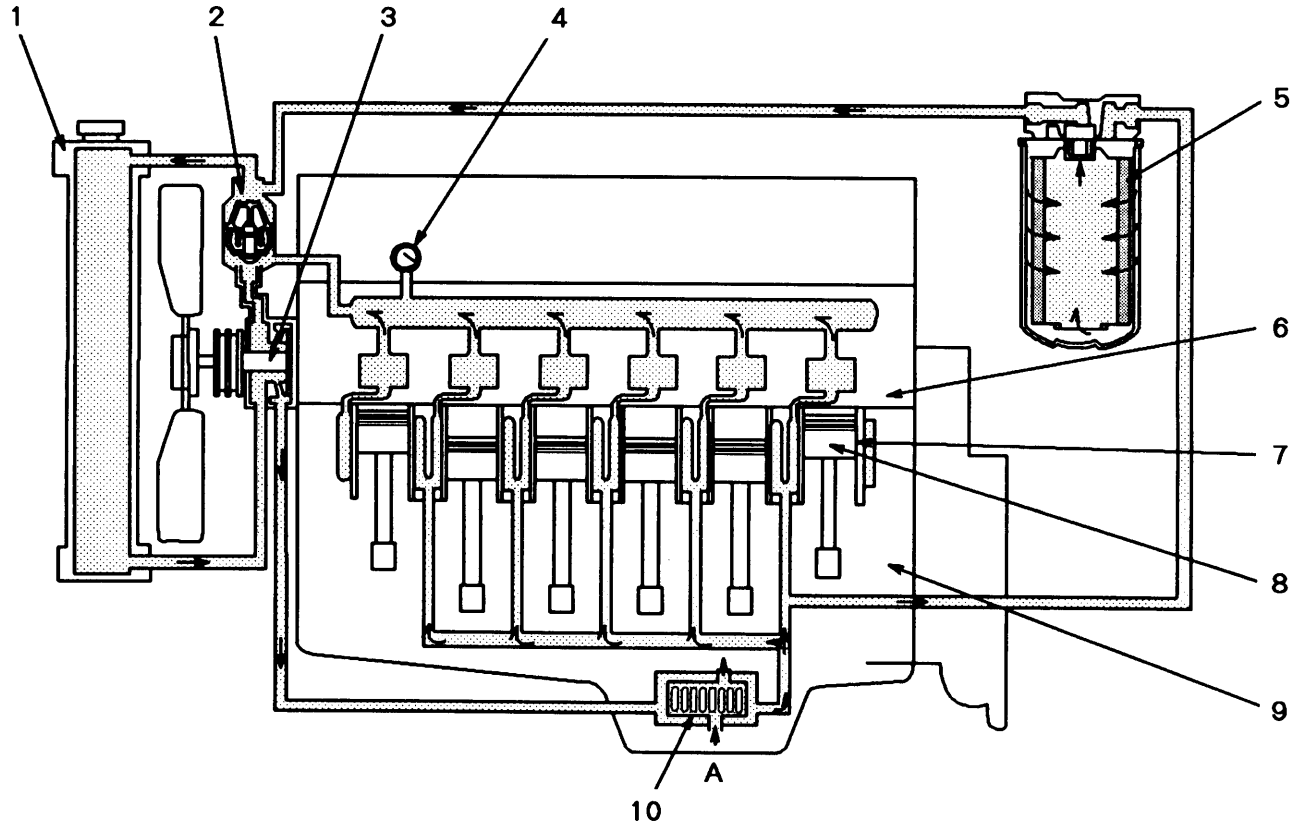
1. Return spring
2. Plunger

COOLING SYSTEM

COOLING SYSTEM CHART

S6D108-1 (D57S-1)

- **Inlet control thermostat**

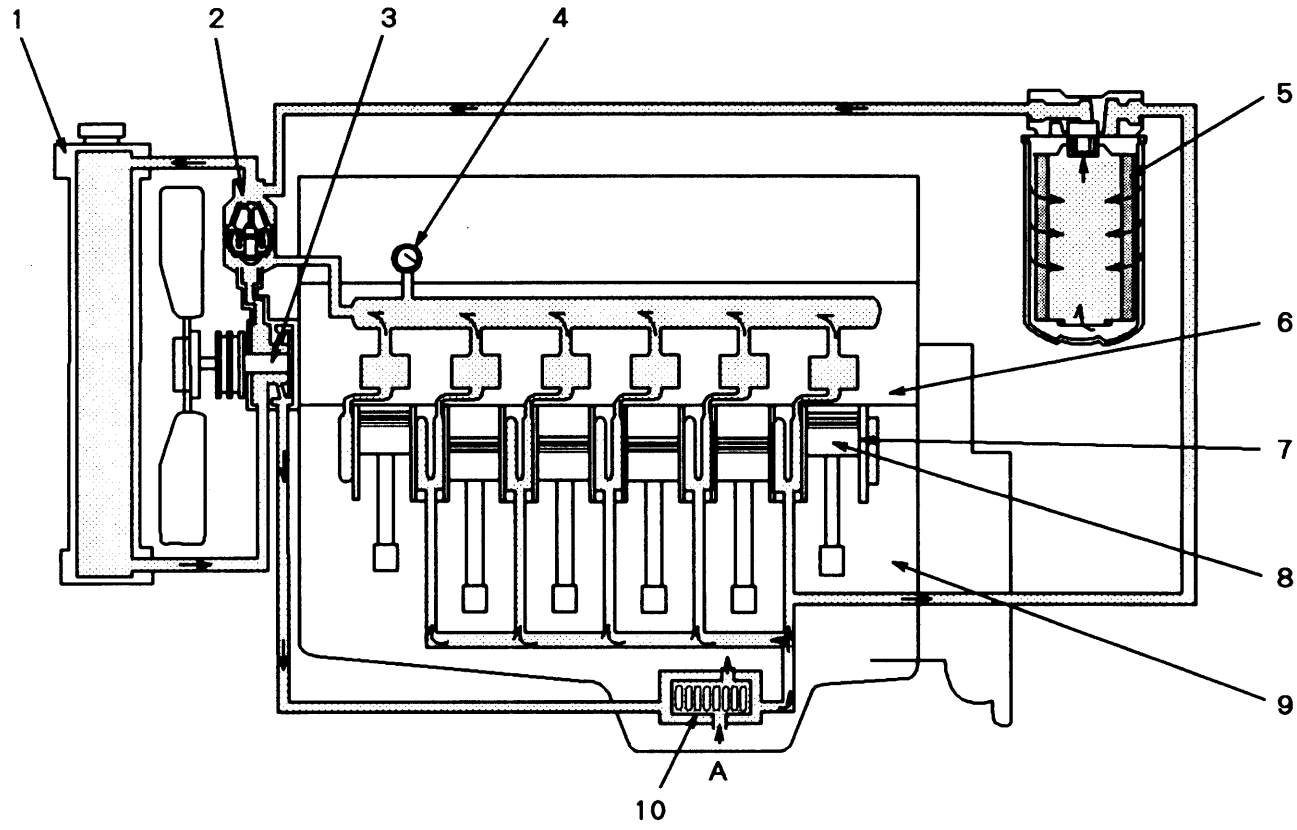


1. Radiator
2. Thermostat
3. Water pump
4. Water temperature gauge
5. Corrosion resistor
6. Cylinder head
7. Cylinder liner
8. Piston
9. Cylinder block
10. Oil cooler

A. From oil pump (oil)

S6D108-1 (WA320, 380-3, EG150BS-5)
SA6D108-1 (WA420-3)

- **Outlet control thermostat**



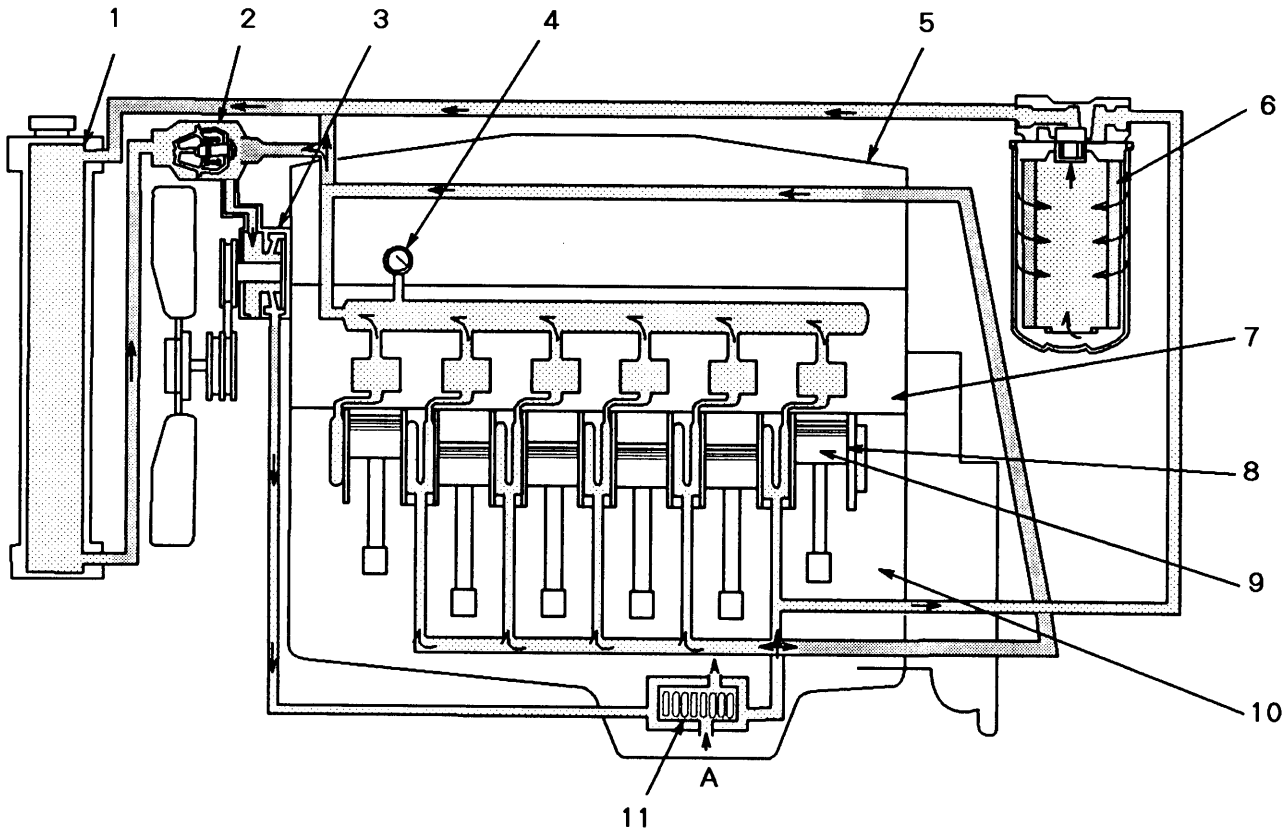
622101

1. Radiator
2. Thermostat
3. Water pump
4. Water temperature gauge
5. Corrosion resistor
6. Cylinder head
7. Cylinder liner
8. Piston
9. Cylinder block
10. Oil cooler

A. From oil pump (oil)

SA6D108-1 (PC300-5) (AUSTOFT)

- **Inlet control thermostat**

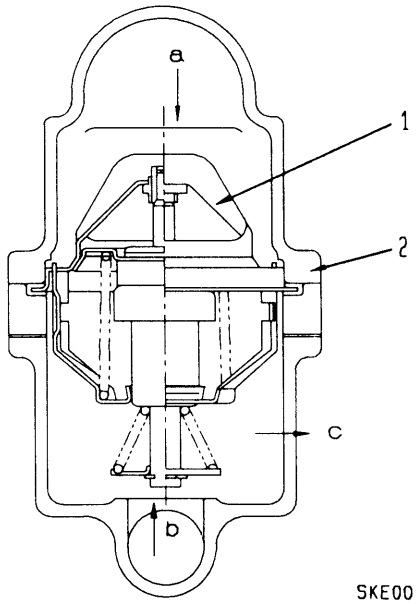


1. Radiator
2. Thermostat
3. Water pump
4. Water temperature gauge
5. After-cooler
6. Corrosion resistor
7. Cylinder head
8. Cylinder liner
9. Piston
10. Cylinder block
11. Oil cooler

A. From oil pump (oil)

THERMOSTAT

INLET CONTROL THERMOSTAT



SKE00101

1. Thermostat
2. Thermostat housing

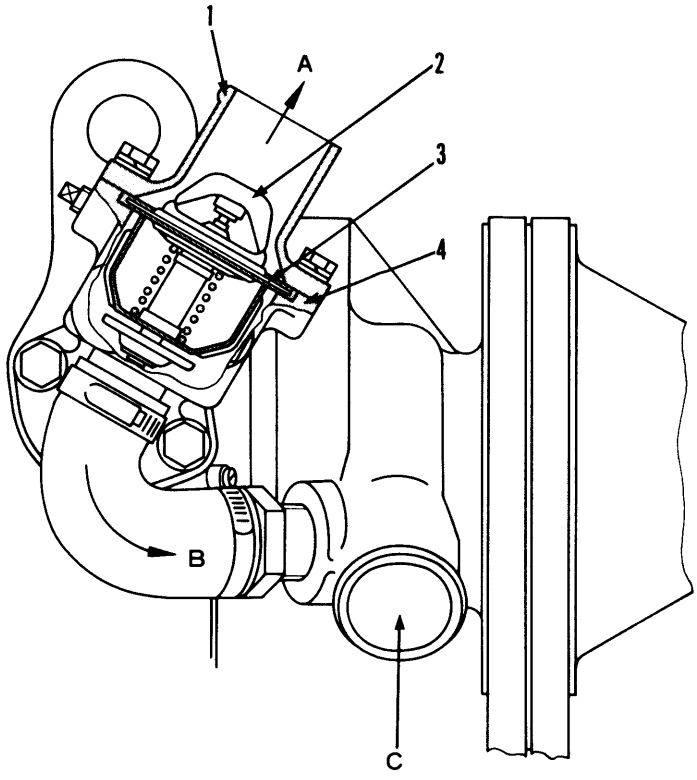
a: Radiator
b: Bypass (from cylinder head)
c: Water pump

Thermostat

Cracking temperature: 71 ± 2°C
Full open temperature: 85°C
Fully open lift: 10 mm

622101

Outlet control thermostat (WA320, 380-3, WA420-3), (EG150BS-5)



6136F023–3A

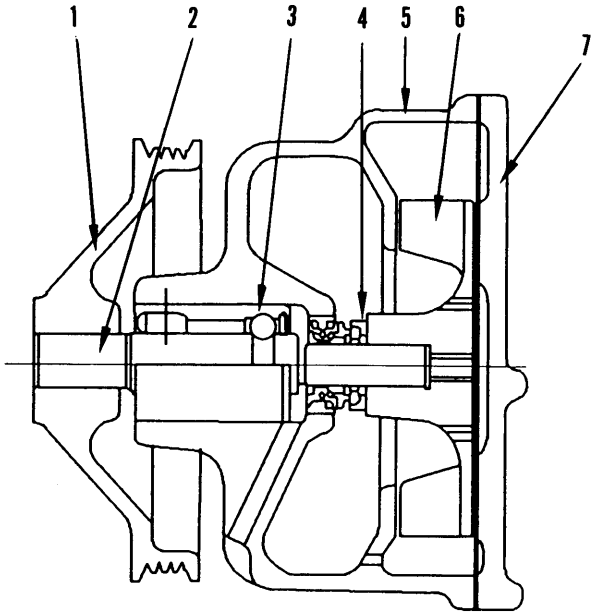
1. Connector
2. Thermostat
3. Gasket
4. Thermostat housing

A. To radiator
B. To water pump
C. From radiator

Thermostat

Cracking temperature: 76.5 ± 2°C
Full open temperature: 90°C
Full open lift: 10 mm

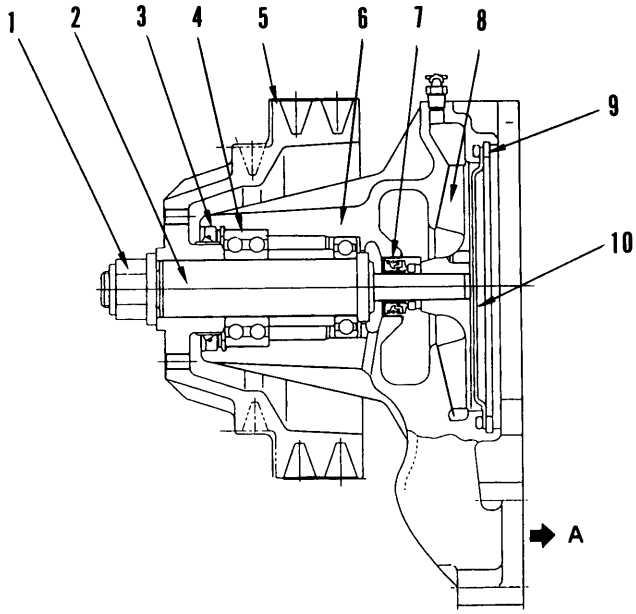
WATER PUMP



622F01119

1. Fan pulley
2. Pump shaft
3. Bearing
4. Water seal
5. Pump body
6. Impeller
7. Pump cover

Engine	Machine model	Outside diameter of pulley (mm)
S6D108-1	D57S-1B	133
SA6D108-1	PC300-5	



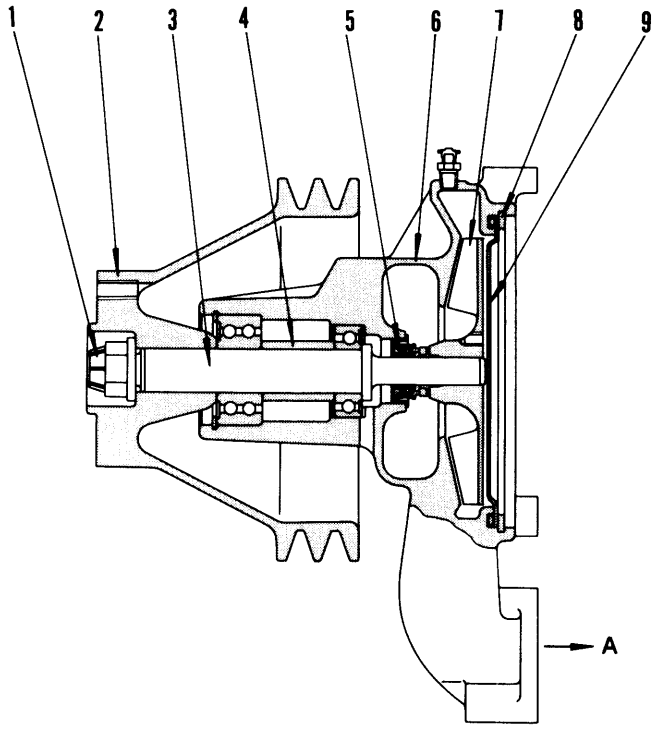
622F01120

1. Lock nut
2. Pump shaft
3. Oil seal
4. Ball bearing
5. Fan pulley
6. Pump body
7. Water seal
8. Impeller
9. Snap ring
10. Pump cover

A. To engine

Engine	Machine model	Outside diameter of pulley (mm)
S6D108-1	WA320-3	235
	WA380-3	225

622101



6138F021–1

1. Nut
2. Fan pulley
3. Pump shaft
4. Spacer
5. Water seal
6. Pump body
7. Impeller
8. Snap ring
9. Pump cover

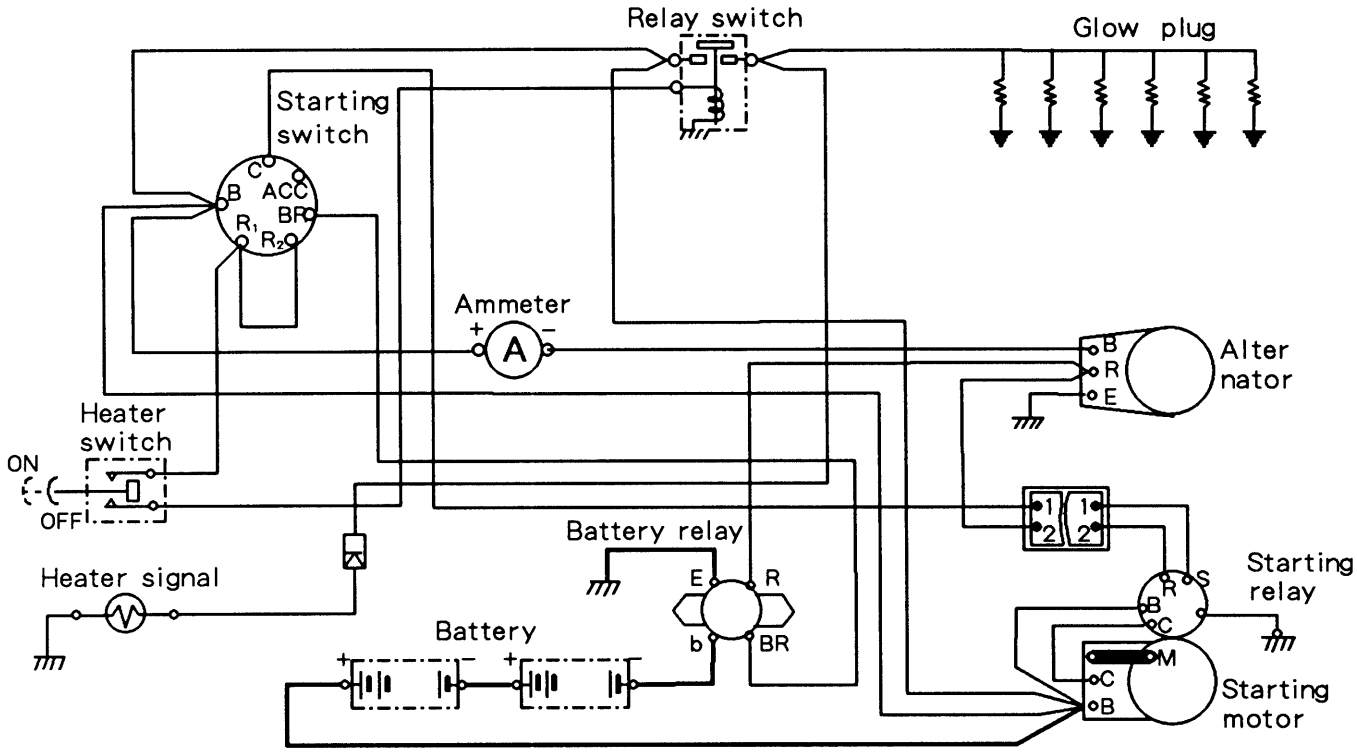
A. To engine

Engine	Machine model	Outside diameter of pulley (mm)
S6D108-1	EG150BS-5	195

622101

ELECTRICAL SYSTEM

WIRING DIAGRAM

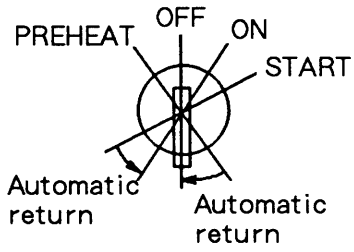


622101

Starting switch connections

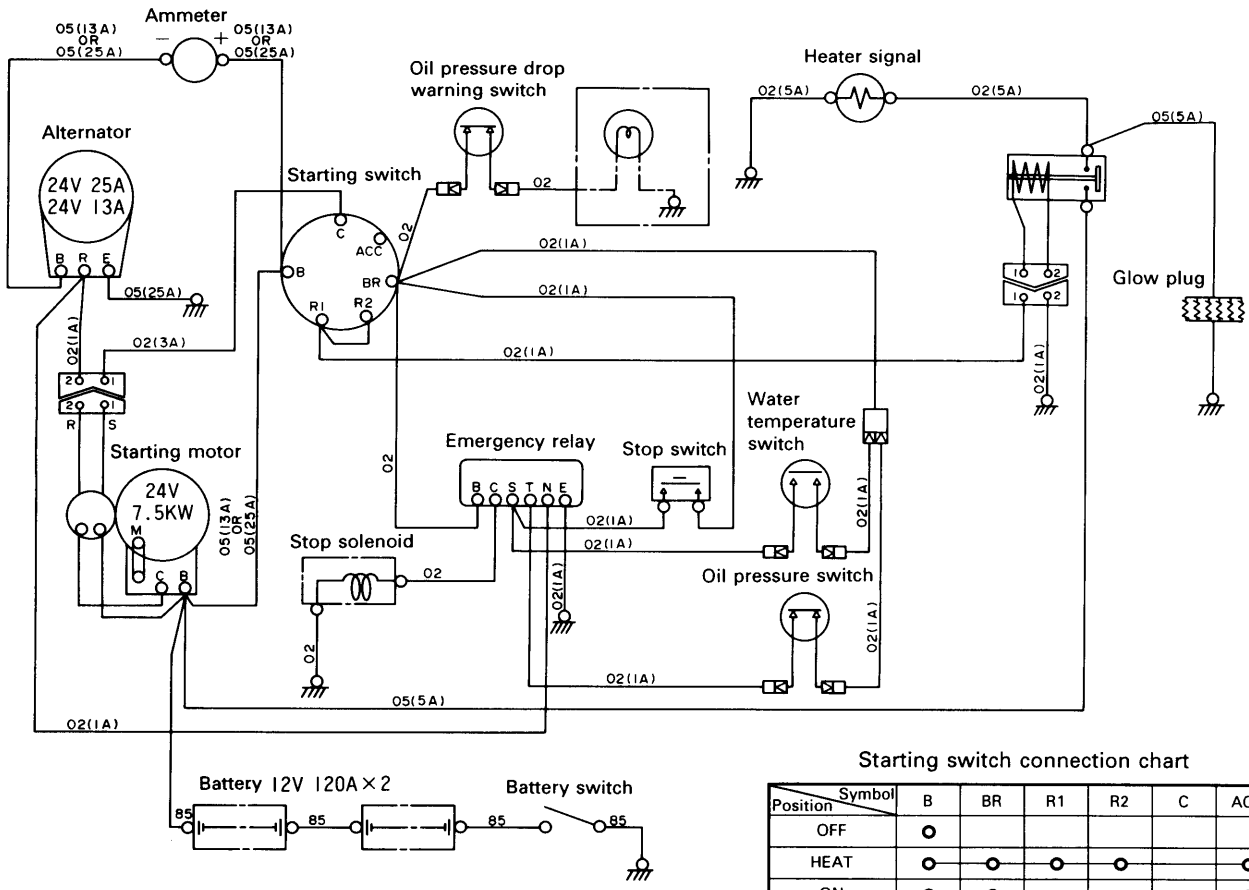
Position \ Symbol	B	BR	R_1	R_2	C	ACC
OFF	○					
PREHEAT	○	○	○			○
ON	○	○				○
START	○	○		○	○	○

Starting switch key positions



622F01085

EG150BS-5



Starting switch connection chart

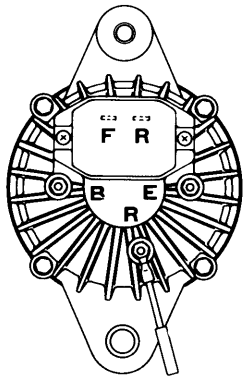
Position \ Symbol	B	BR	R1	R2	C	ACC
OFF	o					
HEAT	o	o	o	o		o
ON	o	o				o
START	o	o	o	o	o	o

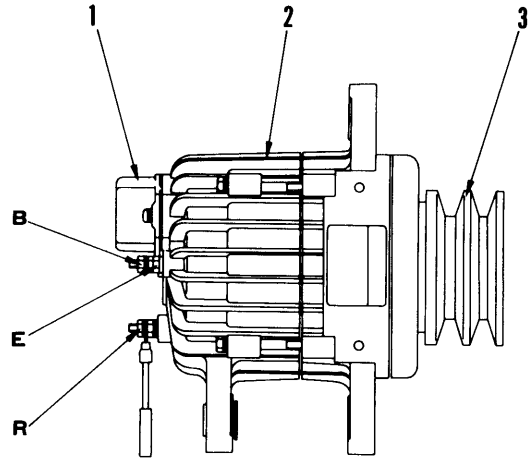
622F01121

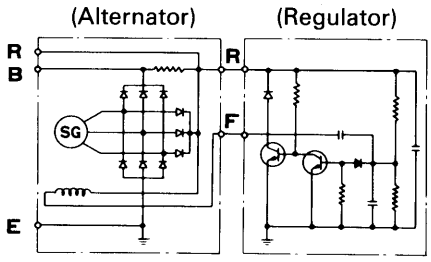
622101

ALTERNATOR

Sealed type







Internal wiring diagram

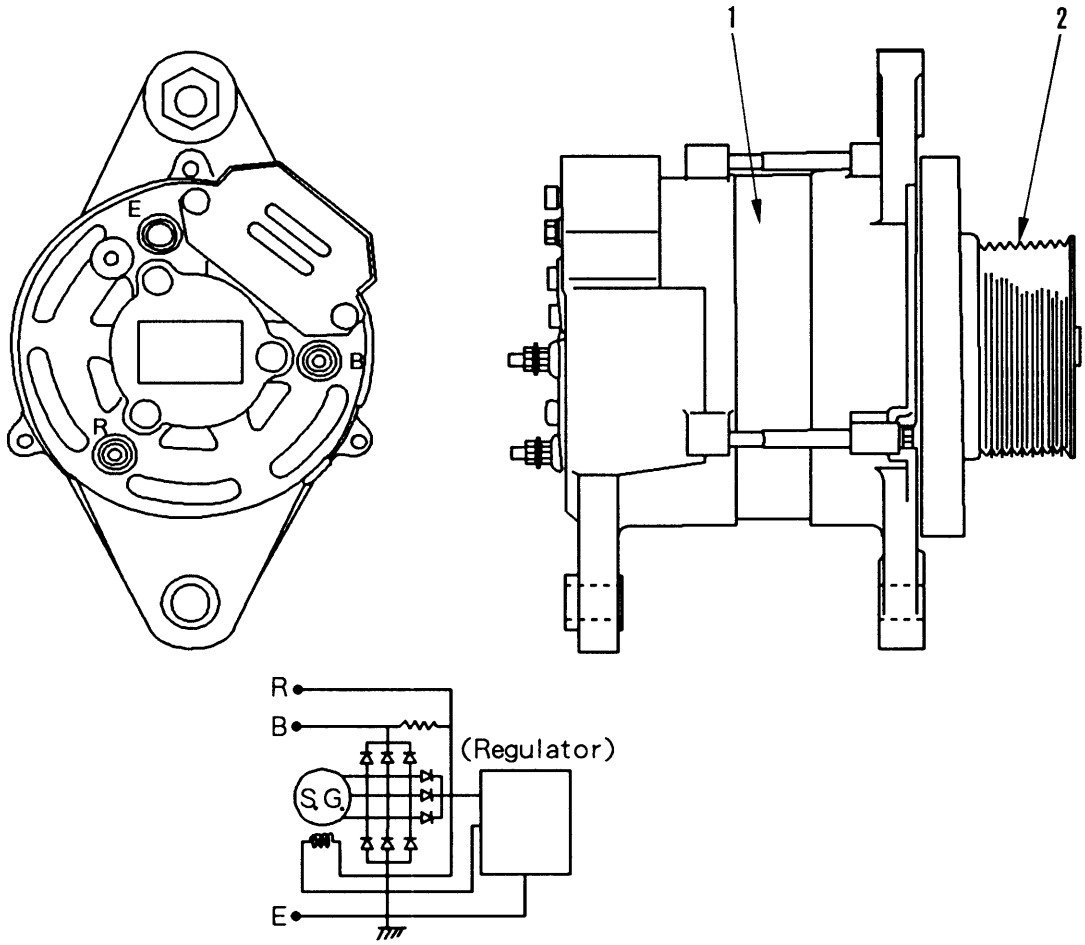
6138F192A

622101

1. Regulator
2. Alternator
3. Alternator pulley

Engine	Machine	Type	Specifications	Weight	Pulley O.D.
S6D108-1	D75S-1	Nikko Denki, sealed type	24 V, 13 A	8.5 kg	95 mm
SA6D108-1	Egypt Eim Power unit	Nikko Denki, sealed type	24 V, 13 A	8.5 kg	95 mm

With built-in regulator (open type)



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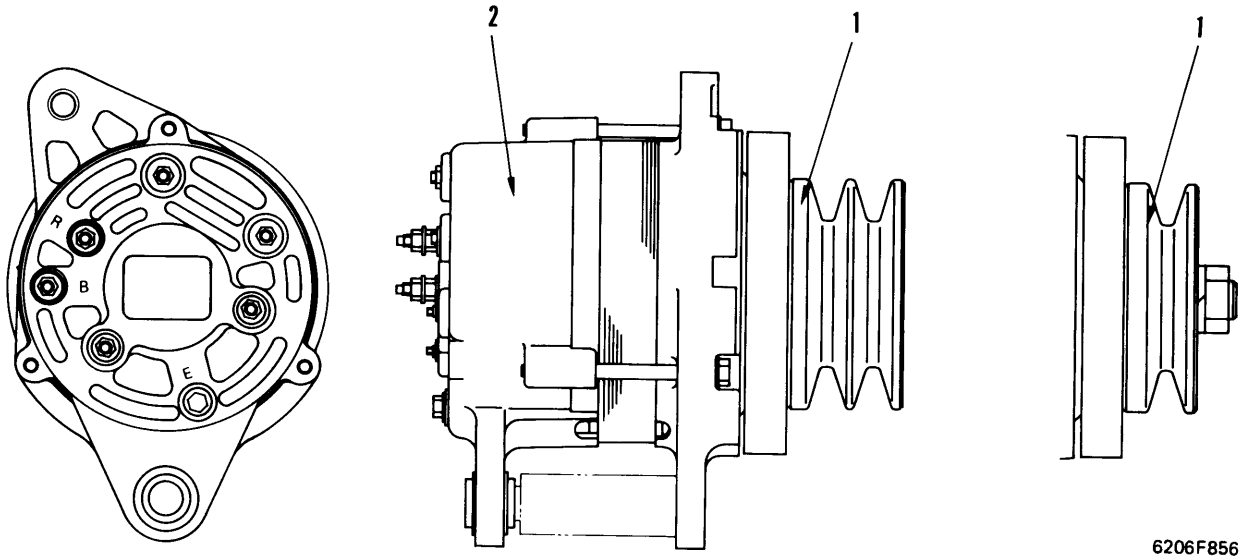
Internal wiring diagram

1. Alternator
2. Alternator pulley

B, E, R: Terminals

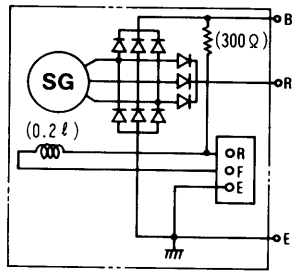
Engine	Machine	Type	Specifications	Weight	Pulley O.D.
S6D108-1	D57S-1 (OP)	Nikko Denki, Open type	24 V, 25 A	8.5 kg	85 mm
SA6D108-1	PC300-5	Nikko Denki, Open type	24 V, 25 A	8.5 kg	88 mm

With built-in regulator (open type)



6206F856

1. Alternator pulley
2. Alternator



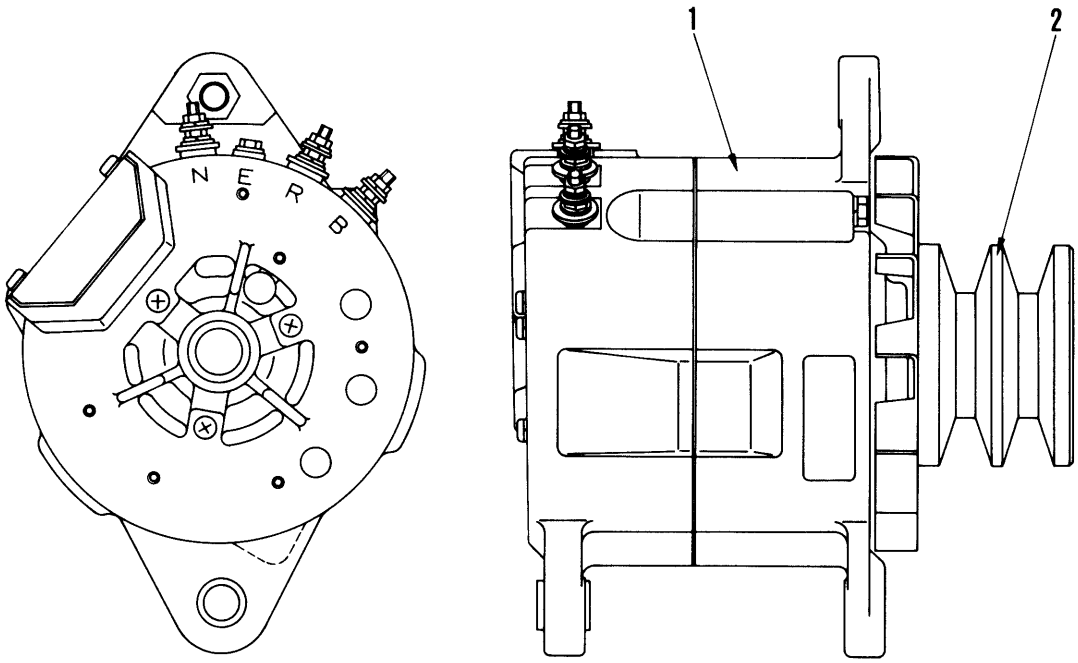
Internal wiring diagram

6206F857

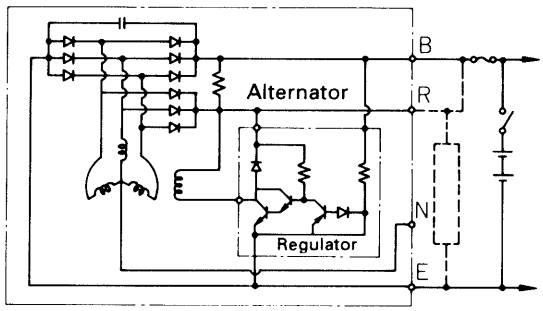
622101

Engine	Machine	Type	Specifications	Weight	Pulley O.D.
S6D108-1	EG150BS-5	Nikko Denki, Open type	24 V, 25 A	6.5 kg	95 mm

With built-in regulator (open type)



Internal wiring diagram



6150F144–1

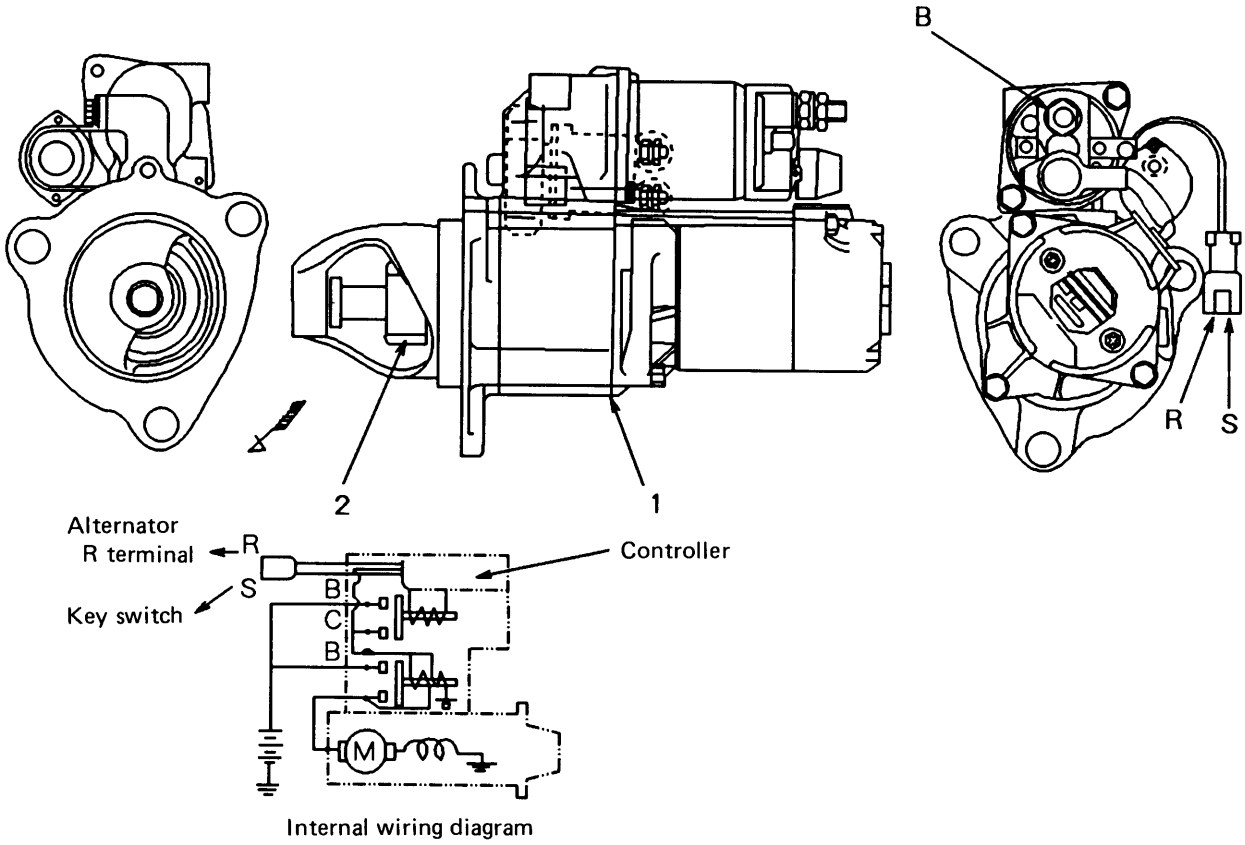
622101

1. Alternator pulley
2. Alternator

B, R, N, E: Terminals

Engine	Machine	Type	Specifications	Weight	Pulley O.D.
S6D108-1	WA320-3 WA380-3	Sawafuji Denki, open type	24 V, 50 A	10 kg	95 mm
SA6D108-1	WA420-3	Sawafuji Denki, open type	24 V, 50 A	10 kg	95 mm

STARTING MOTOR



Internal wiring diagram

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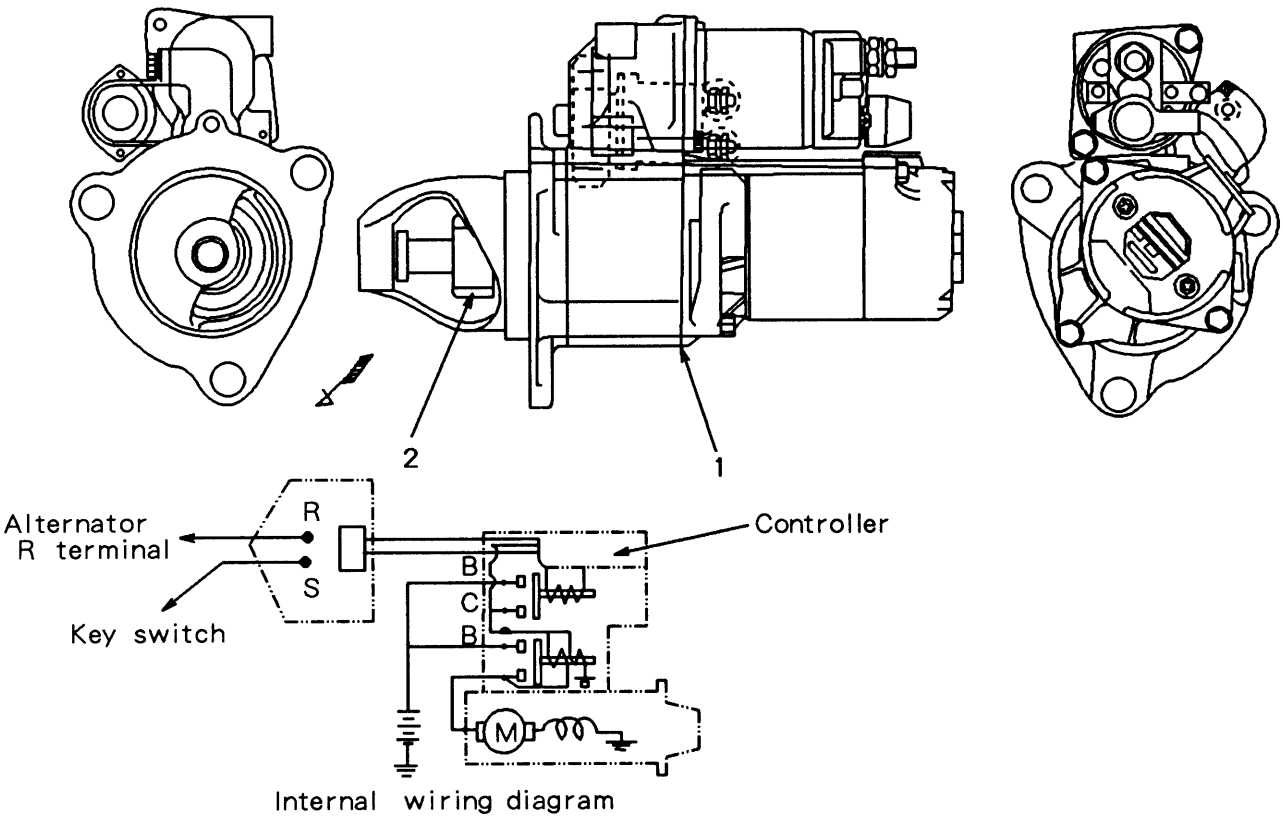
KS100003

1. Starting motor
2. Starting motor pinion
B, R, S : Terminals

Engine	Machine model	Type	Specifications	Weight	No. of pinion teeth
S6D108-1	D57S-1B WA320-3 WA380-3 EG150BS-5	Fujisawa Denki, sealed type (waterproof, oilproof)	24 V, 7.5 kW	14.5 kg	12
SA6D108-1	PC300-5 WA420-3	Fujisawa Denki, sealed type (waterproof, oilproof)	24 V, 7.5 kW	14.5 kg	12

(AUSTOFT)



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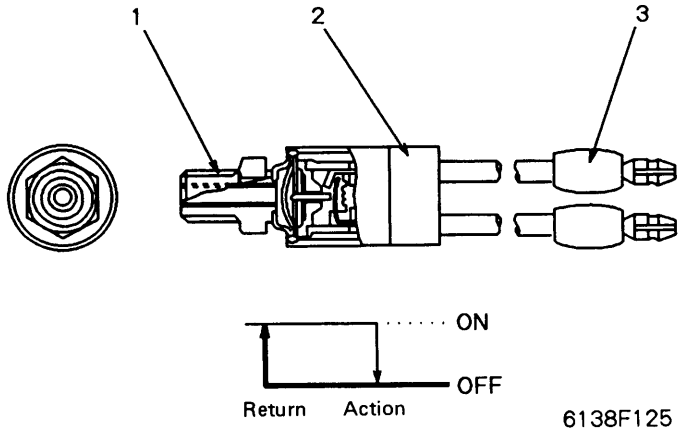
1. Starting motor
2. Starting motor pinion

B,R,S : Terminals

Engine	Machine	Type	Specifications	Weight	No. of pinion teeth
SA6D108−1	AUSTOFT	Sawafuji Denki, sealed type	24V, 7.5kW	14.5kg	12

OIL PRESSURE SWITCH



6138F125

1. Nipple
2. Switch
3. Connector

OIL PRESSURE SWITCH

- Operating point

ON : $0.15\ ^{+0.03}_{-0.02}$ MPa ($1.5\ ^{+0.03}_{-0.02}$ kg/cm²)

OFF : $0.1\ ^{+0.03}_{-0.02}$ MPa ($1.0\ ^{+0.03}_{-0.02}$ kg/cm²)

RELAY SWITCH

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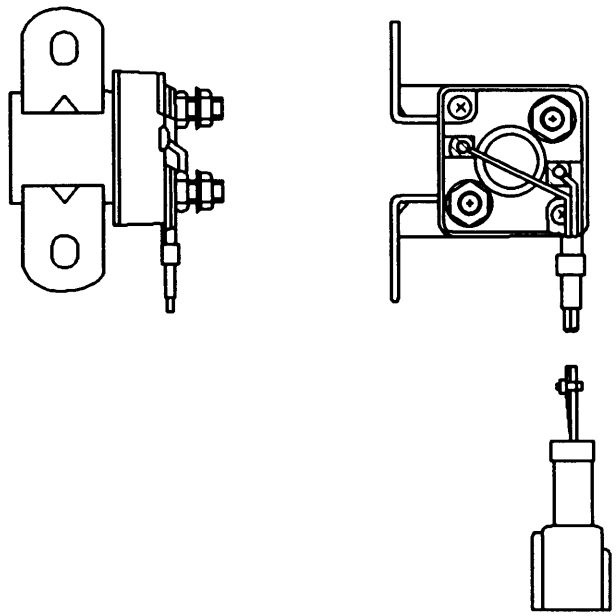
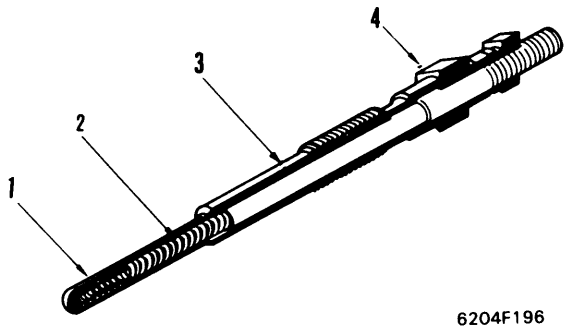
RELAY SWITCH

- Rated voltage : DC 24 V



622F01030

GLOW PLUG (METAL 2-WIRE TYPE GLOW PLUG)



6204F196

1. Heat generation coil (Fe-Cr)
2. Control coil (Fe)
3. Body
4. Rated voltage color marking

Rated voltage (color marking)	Type	Name
24V (Red)	Standard type	Self-control type ceramic glow plug
24V (Red)	Quick glow type	Metal 2-wire type glow plug

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ENGINE
12 TESTING AND ADJUSTING

INTAKE AND EXHAUST SYSTEM
Adjusting valve clearance 12-003

ENGINE BODY
Measuring compression pressure 12-004

FUEL SYSTEM
Testing and adjusting fuel injection timing 12-005
Adjusting fuel cut solenoid link 12-008
Procedure for adjusting engine stop motor cable 12-010
Adjusting engine speed sensor 12-012

PERFORMANCE TEST
Run-in standard 12-013
Performance test criteria 12-014

TESTING AND ADJUSTING DATA
Fuel injection pump calibration data 12-016
Testing and adjusting tool list 12-017
Standard value table 12-018

TROUBLESHOOTING 12-021

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⚠ When carrying out testing and adjusting, or troubleshooting, stop the machine on level ground, fit safety pins, block the wheels, and apply the parking brake.

⚠ When carrying out operations with two or more workers, always use signals, and do not allow any unauthorized person near the machine.

⚠ When checking the water level, if the radiator cap is removed when the engine is hot, boiling water will spurt out and may cause burns, so always wait for the engine to cool down before checking the water level.

⚠ Be extremely careful not to touch any hot parts,

⚠ Be extremely careful not to get caught in the fan or any other rotating parts.

⚠ When removing the plugs or caps from places under hydraulic pressure, water pressure, or air pressure, release the internal pressure first. Fit the measuring tools securely before carrying out any testing, adjusting, or troubleshooting.

★ When using the standard values table for judgement in testing , or troubleshooting, it is necessary to be careful of the following points.

1. The standard values for the new machines in the standard values table are values given as reference from the standards for new machones and machines shipped from the factory. They should be used as values for estimating wear during operation or as target values when carrying out repairs.
2. The failure judgement standard values in the standard value table are values using estimated values based on the results of various tests and standard values for machines shipped from the factory . Use these values for reference together with the repair and operation history of the machine when judging failures.
3. Do not use this standard values table as a standard for judging claims.

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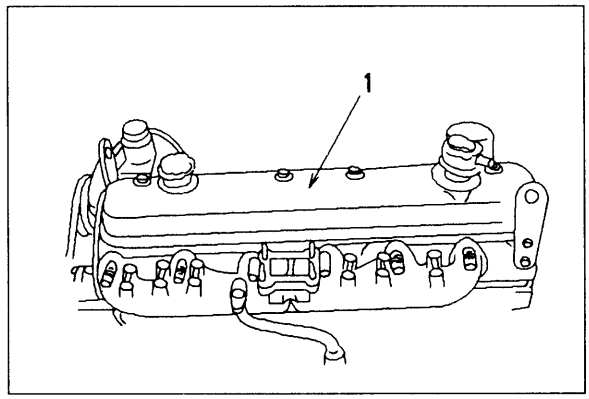
INTAKE AND EXHAUST SYSTEM

ADJUSTING VALVE CLEARANCE

Method of adjusting valve clearance

1. Remove cylinder head cover (1).

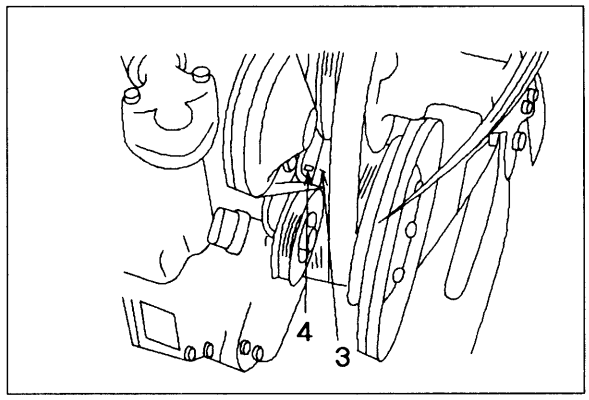


2. Rotate the crankshaft in normal direction to align pointer (4) with the 1-6 TOP mark on crankshaft pulley (3). When rotating, check the movement of the intake valve of No. 6 cylinder.

3. Adjust the clearance of the valves marked ● in the valve arrangement table below.

★ Valve arrangement table

Cylinder No.	1	2	3	4	5	6
Intake valve	●	●	○	●	○	○
Exhaust valve	●	○	●	○	●	○



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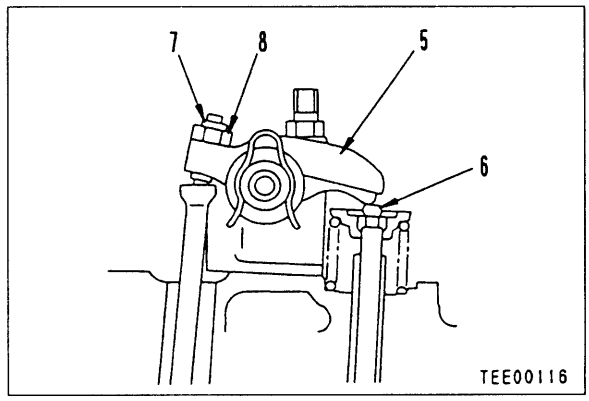
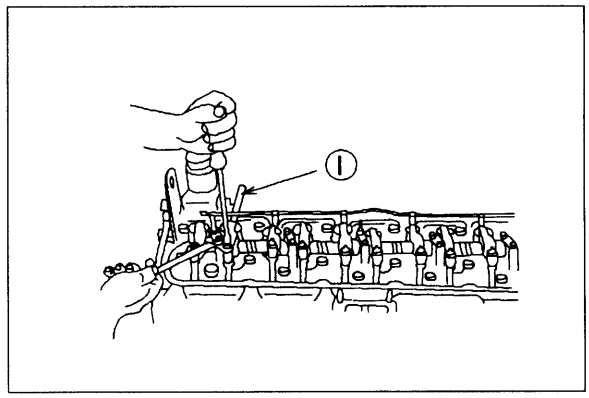
4. Next, rotate the crankshaft one turn in the normal direction and adjust the valve clearance of the remaining valves marked ○.
   ★ To adjust the valve clearance, loosen locknut (8) of adjustment screw (7), then insert feeler gauge ① of the specified thickness between valve stem (6) and rocker arm (5), and adjust with the adjustment screw to a tight fit.



5. Tighten the locknut to keep the adjustment screw in position.

   kgm Locknut : **44.1 ± 4.9Nm (4.5 ± 0.5 kgm)**

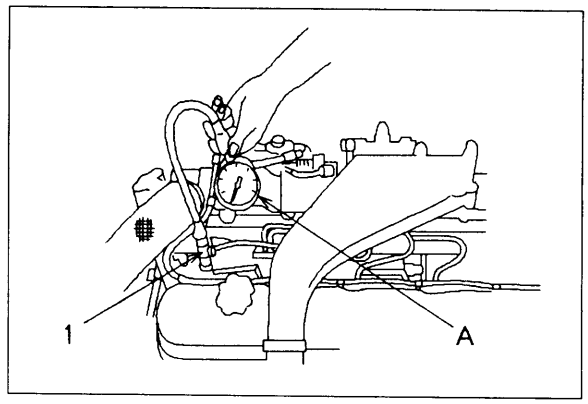


★ Firing order : 1-5-3-6-2-4
★ It is also possible to turn the crankshaft 120° each time and adjust the intake and exhaust valve clearance of each cylinder according to the firing order.
★ For details of the valve clearance, see TESTING AND ADJUSTING, Standard Value Table.

ENGINE BODY

MEASURING COMPRESSION PRESSURE

Method of measuring compression pressure



⚠ When measuring the compression pressure, be careful not to touch the exhaust manifold or muffler, or to get caught in rotating parts.

★ Measure the compression pressure with the engine warmed up. (Oil temperature : 40 - 60°C)

1. Adjust the valve clearance.

   ★ For details, see ADJUSTING VALVE CLEARANCE.

2. Remove the spill pipe, then disconnect the fuel injection tube.

3. Remove the nozzle holder assembly from each cylinder.
   ★ Be careful not to let any dirt or dust get inside.
   ★ When removing the nozzle holder assembly, replace the seat gasket.

4. Install the adapter (1) into the nozzle holder mount of the cylinder to be measured, and tighten to the specified torque.
   kgm Adapter : **4.41 ± 4.9 Nm (4.5 ± 0.5 kgm)**

5. Connect compression gauge **A** to the adapter.

6. Place the fuel control level in the NO INJECTION position. Crank the engine with the starting motor and measure the compression pressure at the point where the gauge indicator remains steady.

   ⚠ If the fuel control lever is not placed at the NO INJECTION position, fuel will spurt out.

   ★ If the adapter mount is coated with a small amount of oil, it will help to prevent leakage.
   ★ For details of the standard values for the compression pressure, see TESTING AND ADJUSTING, Standard Value Table.

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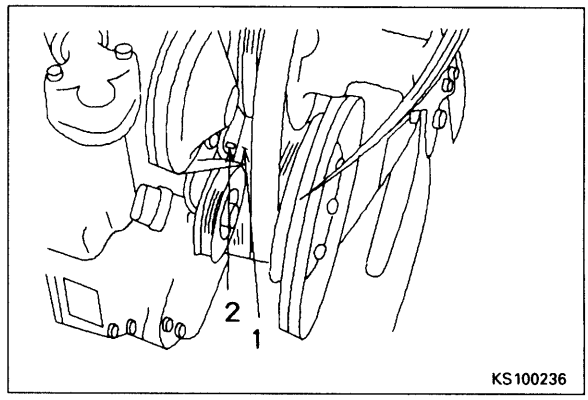
FUEL SYSTEM

TESTING AND ADJUSTING FUEL INJECTION TIMING

The following methods are used for testing and adjusting the fuel injection timing of the injection pump.

- If the injection pump has not been repaired and it is reassembled to the same engine, use the match mark method.
- If the injection pump has been repaired or replaced, use the delivery valve method when assembling the pump.
  - ★ With the delivery valve method, it is necessary to replace the delivery valve copper gasket O-ring with a new part, so prepare a new part before starting the operation.
  - ★ Set the No.1 cylinder at the compression top dead center befor carrying out testing and adjusting.
    For details, see ADJUSTING VALVE CLEARANCE.

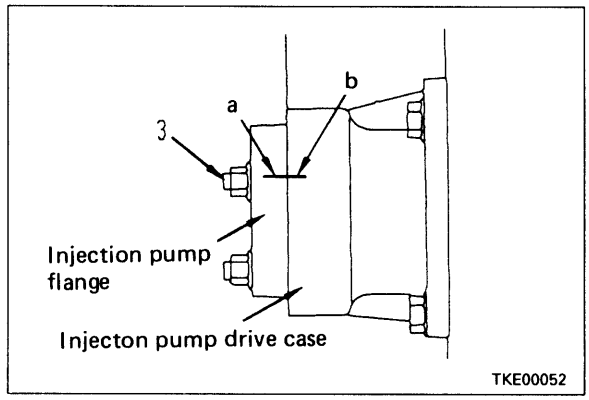


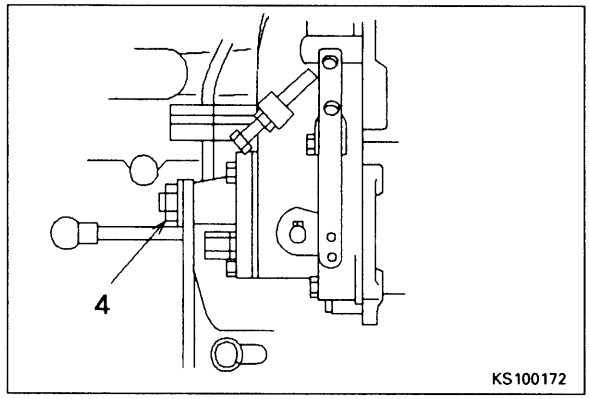
TESTING AND ADJUSTING INJECTION TIMING BY MATCH MARK METHOD

1. Rotate the crankshaft 30 - 40° in the reverse direction from the No.1 cylinder TOP position.

2. Rotate it slowly in the normal direction, and align pointer (2) with the fuel injection timing line on crankshaft pulley (1).

3. Check that line **a** on the injection pump and line **b** on the injection pump drive case are aligned.
   - ★ if the lines are not aligned, loosen nut (3) in the oblong hole and pump mounting nut (4), then move the fuel injection pump to align the line, and tighten the nut.
     kgm Nut : **66.2 ± 7.4 Nm (6.75 ± 0.75 kgm)**



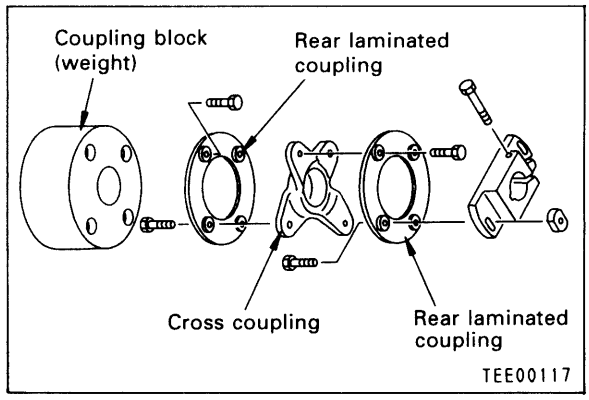


TESTING AND ADJUSTING BY MATCH MARK METHOD (LAMINATED COUPLING TYPE)

1. Carry out Steps 1 and 2 above for the flange type.

2. Check that line (**a**) on the injection pump is aligned with the line on the coupling block (weight).

★ If the lines are not aligned, loosen the bolts of the front laminated and flange couplings, align the lines, then tighten the bolts.
kgm Bolt: 88.3 – 93.2 Nm (9.0 – 9.5 kgm)



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TESTING AND ADJUSTING BY DELIVERY VALVE METHOD

1. Disconnect fuel injection tube (5) from the No.1 cylinder.

2. Remove delivery valve holder (7).

3. Take out spring (8) and delivery valve (9) from inside the delivery valve holder, then assemble the delivery valve holder again.

4. Set the fuel control lever at the FULL position, then operate the priming pump and rotate the crankshaft slowly in the normal direction.
   Check the point where the fuel stops flowing from the delivery valve holder.

5. Check that the injection timing line of the crankshaft pulley (1) and the pointer (2) are aligned at the point where the fuel stops flowing.

   ★ BEYOND injection timing line : Timing RETARTED
   ★ BEFOR injection timing line : Timing ADVANCED

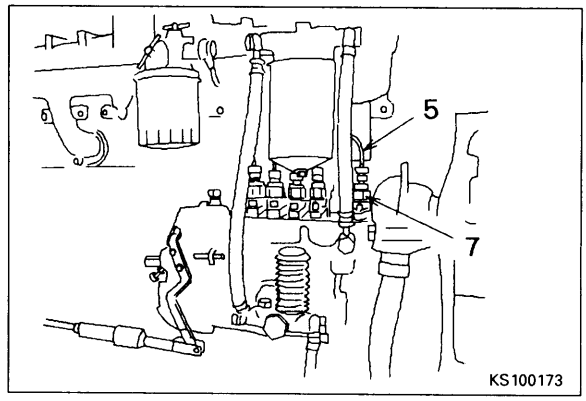
   ★ if the test shows that the injection timing is incorrect, adjust the fuel injection timing as follows.

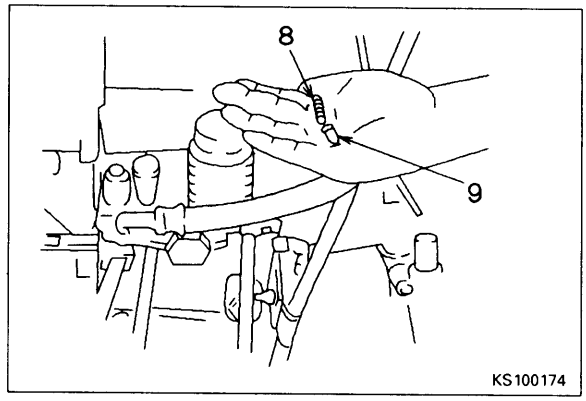
   ★ After testing and adjusting, do not forget to reassemble the spring and delivery valve.

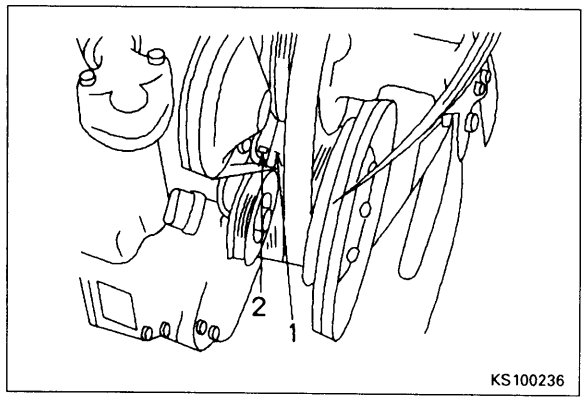
   1) Rotate the crankshaft 30 - 40° in the reverse direction from the No.1 cylinder TOP position.

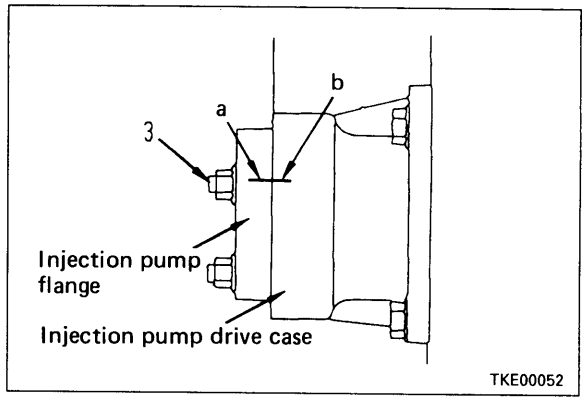
   2) Rotate it slowly in the normal direction, and align pointer (2) with the fuel injection timing line on crankshaft pulley (1).

   3) Loosen nut (3) in the oblong hole in the mounting flange of the fuel injection pump, and pump mounting bolt (4), then operate the priming pump and rotate the pump flange a little at a time. Stop at the point where the fuel stops flowing from the delivery valve holder.









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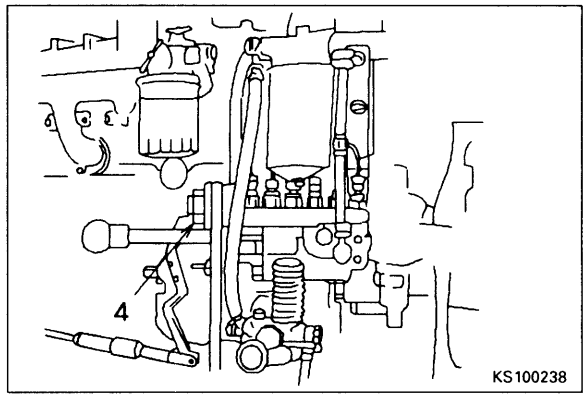
4) Tighten the nut in the oblong hole in the mounting flange of the fuel injection pump, and the pump mounting bolt.

★ Check the injection timing again to confirm that the timing is correct.

5) Make match mark (a) and (b).



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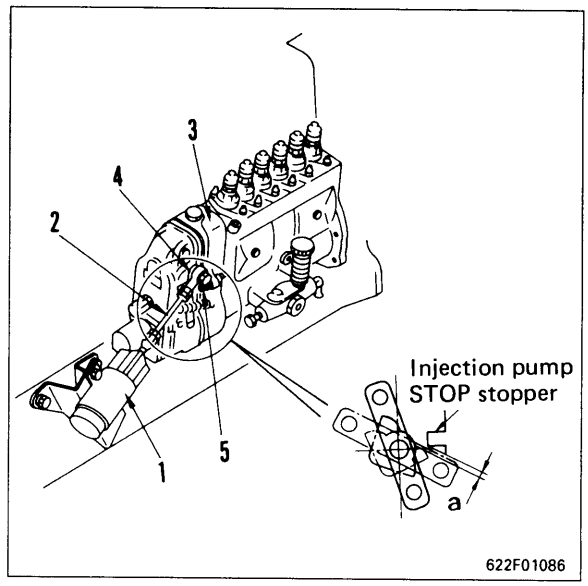
ADJUSTMENT FUEL CUT SOLENOID LINK

1. Stop the engine, connect solenoid (1) and injection pump (3) with rod (2), and assemble temporarily.

2. Pull the rod fully by hand to the solenoid end, and adjust the length of the rod so that there is a clearance of 0.5 - 1.0 mm between stop lever (4) and stopper (5) at the STOP end.

3. Pass electricity through the solenoid and adjust the rod finally so that the clearance between the stop lever and the stopper at the STOP side is dimension **a**.
   ★ Dimension **a** : 0.5 - 1.0 mm

4. Stop and start the engine 2 - 3 times, and check that the solenoid moves smoothly and works properly. If the movement is not smooth, adjust the linkage to improve the movement.



★ Problems caused by improper adjustment of solenoid.

	Problem
• Wnen electricity is passing, clearance between stop lever and stopper at STOP side is 0	• Excessive current flows to solenoid, and solenoid coil burns out. • Injection pump governor is bent and causing scuffuing (Evcessive force is brought to bear on lever)
• When free, clearance between stop lever and stopper at FULL side is too large	• Amount of fuel injected drops, so engine output drops.

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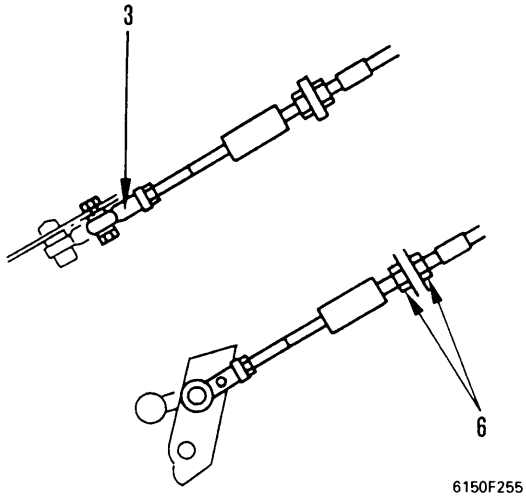
PROCEDURE FOR ADJUSTING ENGINE STOP MOTOR CABLE



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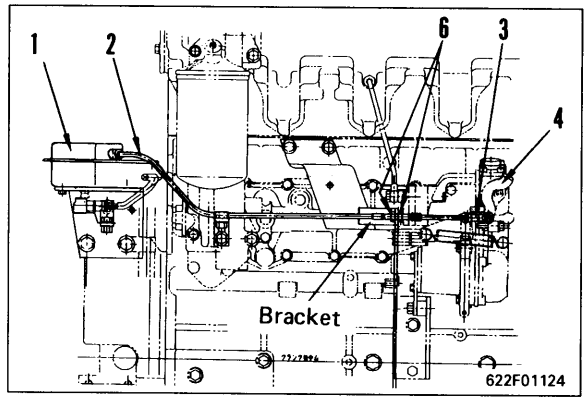
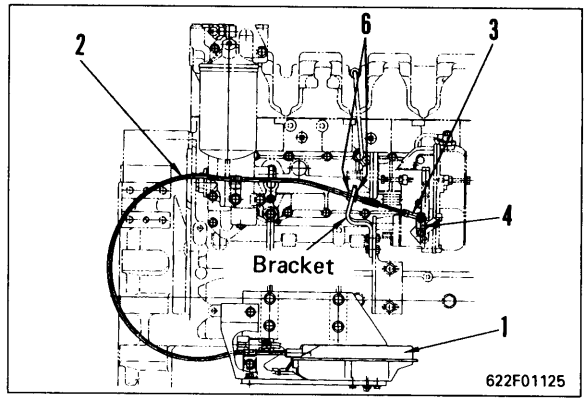
1. Temporarily install ball joint (3) to cable (2) of engine stop motor (1) (tighten fully, then turn back approx. 1/2 turns), then install a ball joint to the stop lever of the fuel injection pump.

2. Pull injection pump stop lever (4) by hand to the ENGINE STOP (NO INJECTION) position, and temporarily fix the cable to the bracket.
   When doing this, put stop lever (4) in contact with ENGINE STOP stopper (5), and temporarily fit the cable to the bracket using the holding nut.
   - ★ Engine stop motor (1) is delivered with cable (2) pulled (engine stop position).
   - ★ Stop lever (4) of the fuel injection pump is at the RUN position when the lever is free. (It is pulled to the RUN position by a spring.)

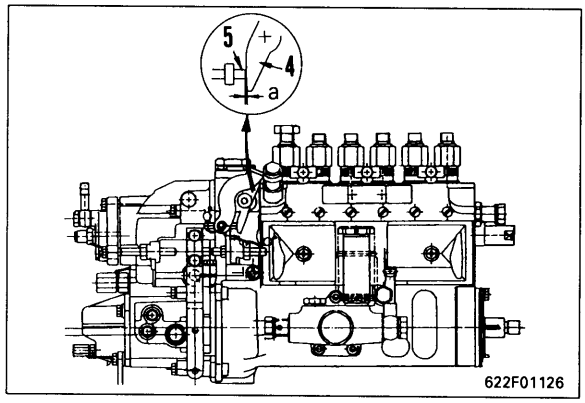
3. Adjust so that clearance a between stop lever (4) of the fuel injection pump and STOP stopper (5) is 1 - 2 mm.
   Carry out the adjustment with nut (6) holding the cable to the bracket, or make fine adjustments by changing the amount that ball joint (3) is screwed in.



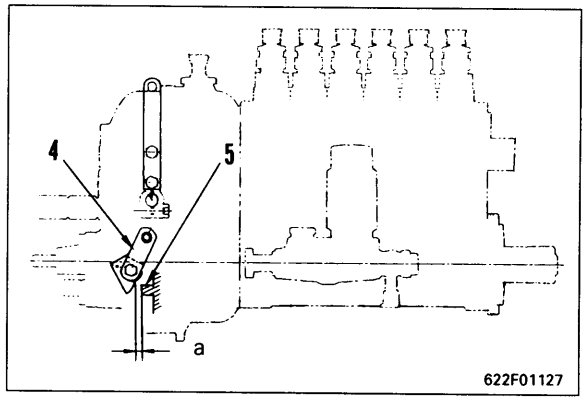
622F01124



622F01125



622F01126



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4. Tighten all bolts and nuts.

5. Turn the engine starting switch ON and OFF repeatedly, and check that engine stop motor (1) and the cable move smoothly. Then check the following points again.
   1) When the engine is running, check visually that there is slack in cable (2) of engine stop motor cable (1), and that stop lever (4) of the fuel injection pump is fully returned to the RUN position.
   2) Check again that the clearance between stop lever (4) and STOP stopper (5) is 1 - 2 mm when the engine is stopped.
   ★ Engine stop motor (1) has limit switches built in on both sides of the cable stroke.
   ★ Engine stop motor stroke: 35 mm
   Fuel injection pump stop lever stroke: 30 mm
   ★ When the engine is running, there is slack in cable (2) of engine stop motor (1), and the RUN position is maintained by the action of a spring (this is frequently built into the fuel injection pump).
   ★ There is a loose spring inside engine stop motor (1), and this absorbs the tolerance of stop motor (1) when the engine is stopped.
   However, if it is absorbed by the loose spring of engine stop motor (1), force is applied to the injection pump, so depending on the model, this may be impossible.
   With such models, if the clearance between stop lever (4) and the STOP stopper is made 0 when the engine is stopped, there is a risk that problems may occur with the injection pump.

★ Problems caused by defective adjustment of the engine stop motor cable.

• When the clearance between the stop lever and STOP stopper is excessive with the engine stop motor cable pulled	• Engine does not stop
• When the clearance between the stop lever and the RUN stopper is excessive at the free position	• Fuel injection amount drops, causing loss of engine output power

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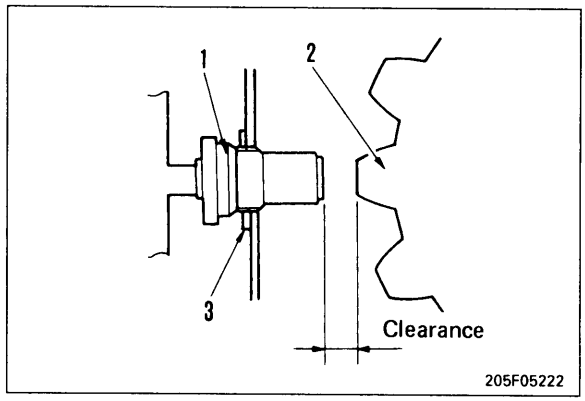
ADJUSTING ENGINE SPEED SENSOR (MECHANICAL GOVERNOR)

1. Screw in until tip of sensor (1) contacts ring gear (2).
2. After sensor (1) contacts gear (2), turn the gear back one turn.
3. Tighten with locknut (3).
   - ★ Be careful to arrange the sensor wiring so that no excessive force is brought to bear on the wiring.
   - ★ Be careful not to scratch or get metal particles on the tip of the sensor.



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RUNNING IN

PERFORMANCE TEST
~~RUN-IN~~ STANDARD

★ Load are given for the case of the dynamometer arm length is 716 mm.
★ This list shows the standard on condition that the fan is removed.

Engine model	Applicable machine	Item		Order 1	2	3	4	5	6
S6D108-1	D57S-1	Running time	min.	2	3	7	10	6	
		Engine speed	rpm	800	1,220	1,540	1,770	1,900	
		Load	N {kg}	0 {0}	279 {28.5}	442 {45.1}	576 {58.9}	718 {73.2}	
		Output	kW {HP}	0 {0}	25.6 {34.3}	51.1 {68.5}	76.7 {103}	102 {137}	
	WA320-3	Running time	min.	2	3	7	10	6	
		Engine speed	rpm	780	1,430	1,860	2,140	2,380	
		Load	N {kg}	0 {0}	186 {19.0}	373 {38.0}	549 {56.0}	735 {75.0}	
		Output	kW {HP}	0 {0}	20.0 {26.8}	52.0 {69.7}	88.1 {118}	131 {176}	
	WA380-3	Running time	min.	2	3	7	10	6	
		Engine speed	rpm	760	1,320	1,715	1,980	2,200	
		Load	N {kg}	0 {0}	226 {23.0}	441 {45.0}	667 {68.0}	883 {90.0}	
		Output	kW {HP}	0 {0}	22.4 {30.0}	56.8 {76.0}	99.0 {133}	145 {195}	
	Generator EG150BS-5 Generator for OEM	Running time	min.	2	3	7	10	6	
		Engine speed	rpm	750	1,130	1,420	1,640	1,800	
		Load	N {kg}	0 {0}	294 {30.0}	588 {60.0}	883 {90.0}	1,180 {120}	
		Output	kW {HP}	0 {0}	25.0 {33.4}	62.7 {84.0}	109 {146}	159 {213}	
		Running time	min.						
		Engine speed	rpm						
		Load	N {kg}						
		Output	kW {HP}						
		Running time	min.						
		Engine speed	rpm						
		Load	N {kg}						
		Output	kW {HP}						
		Running time	min.						
		Engine speed	rpm						
		Load	N {kg}						
		Output	kW {HP}						
		Running time	min.						
		Engine speed	rpm						
		Load	N {kg}						
		Output	kW {HP}						

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★ Load are given for the case of the dynamometer arm length is 716 mm.
★ This list shows the standard on condition that the fan is removed.

Engine model	Applicable machine	Item		Order					
				1	2	3	4	5	6
SA6D108-1	PC300-5	Running time	min.	5	15	5	5	20	
		Engine speed	rpm	700	1,220	1,540	1,700	1,950	
		Load	N {kg}	0 {0}	275 {28.0}	539 {55.0}	814 {83.0}	1,080 {110}	
		Output	kW {HP}	0 {0}	25.0 {34.0}	62.5 {85.0}	108 {147}	158 {215}	
	WA320-3	Running time	min.	2	3	7	10	3	
		Engine speed	rpm	750	1,320	1,715	1,980	2,200	
		Load	N {kg}	0 {0}	255 {26.0}	520 {53.0}	775 {79.0}	1,030 {105}	
		Output	kW {HP}	0 {0}	25.0 {33.8}	67.0 {89.6}	115 {154}	170 {228}	
	Sugar cane harvester AUSTOFT in AUSTRALIA (Engine No. 10001 –10926)	Running time	min.	5	10	10	15	15	5
		Engine speed	rpm	750	1,200	1,700	1,900	2,150	2,400
		Load	N {kg}	0 {0}	490 {50.0}	678 {69.1}	792 {80.8}	887 {90.5}	981 {100}
		Output	kW {HP}	0 {0}	44.0 {59.2}	86.0 {116}	113 {151}	143 {192}	177 {237}
	Sugar cane harvester AUSTOFT in AUSTRALIA (Engine No. 10927 and up)	Running time	min.	5	10	10	15	15	5
		Engine speed	rpm	750	1,200	1,700	1,900	2,150	2,400
		Load	N {kg}	0 {0}	478 {48.7}	669 {68.2}	764 {77.9}	859 {87.6}	955 {97.4}
		Output	kW {HP}	0 {0}	45.0 {60.0}	88.0 {118}	115 {154}	145 {194}	179 {240}
	Generator EG185B-L-1 (for ALGERIA)	Running time	min.	2	3	7	10	3	
		Engine speed	rpm	750	1,130	1,420	1,640	1,800	
		Load	N {kg}	0 {0}	343 {35.0}	686 {70.0}	1,030 {105}	1,370 {140}	
		Output	kW {HP}	0 {0}	29.0 {39.0}	39.0 {98.0}	127 {170}	185 {248}	
	Generator DENYO DCA180	Running time	min.						
		Engine speed	rpm						
		Load	N {kg}						
		Output	kW {HP}						
	SA6D108-M-1	Running time	min.	–	–	–	–	–	–
		Engine speed	rpm						
		Load	N {kg}		(The performance test is not done at factory.)				
		Output	kW {HP}						
		Running time	min.						
		Engine speed	rpm						
		Load	N {kg}						
		Output	kW {HP}						

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PERFORANCE TEST CRITERIA

★ The values in the table are the standard values for machines with the muffler installed, air cleaner installed, air cleaner installed, alternator under no load, and air compressor opened (if installed).
★ The load for the dynamometer are at an arm's length of 716 mm.

*1
994 – 1,059 {101 – 108} (50 Hz)
1,010 – 1,060 {103 – 108} (60 Hz)

*2
1,130 – 1,190 {151 – 121} (50 Hz)
1,130 – 1,200 {116 – 122} (60 Hz)

Engine model	Applicable machine	Test item	Specified value	Engine speed (rpm)	Dynamometer (N {kg})
S6D108-1	D57S-1	Flywheel horsepower	99.3 kW {133 HP}/1,900 rpm (Net)	1,895 – 1,905	738 – 780 {75.3 – 79.5}
		Maximum torque	618 Nm {63.0 kgm}/1,400 rpm (Net)	1,300 – 1,500	885 – 936 {90.2 – 95.5}
		High idling speed	2,050 – 2,150 rpm	2,050 – 2,150	–
		Low idling speed	800 – 850 rpm	800 – 850	–
	WA320-3	Flywheel horsepower	121 kW {163 HP}/2,380 rpm (Net)	2,375 – 2,385	701 – 741 {71.5 – 75.6}
		Maximum torque	647 Nm {66.0 kgm}/1,600 rpm (Net)	1,500 – 1,700	896 – 978 {91.4 – 99.7}
		High idling speed	2,560 – 2,610 rpm	2,560 – 2,610	–
		Low idling speed	780 – 830 rpm	780 – 830	–
	WA380-3	Flywheel horsepower	140 kW {187 HP}/2,200 rpm (Net)	2,195 – 2,205	860 – 911 {87.7 – 92.9}
		Maximum torque	804 Nm {82.0 kgm}/1,500 rpm (Net)	1,400 – 1,600	1,100 – 1,180 {112 – 120}
		High idling speed	2,450 – 2,550 rpm	2,450 – 2,550	–
		Low idling speed	800 – 850 rpm	800 – 850	–
	Generator EG150BS-5 Generator for OEM	Rated flywheel horsepower	113 kW {151 HP}/1,500 rpm (50 Hz) 134 kW {180 HP}/1,800 rpm (60 Hz) (Net)	1,495 – 1,505 (50 Hz) 1,795 – 1,805 (60 Hz)	*1
		Maximum flywheel horsepower	128 kW {171 HP}/1,500 rpm (50 Hz) 152 kW {204 HP}/1,800 rpm (60 Hz) (Net)	1,495 – 1,505 (50 Hz) 1,795 – 1,805 (60 Hz)	*2
		High idling speed	max. 1,575 rpm (Rated, 50 Hz) max. 1,890 rpm (Rated, 60 Hz)	max. 1,575 (Rated, 50 Hz) max. 1,890 (Rated, 60 Hz)	– –
		Low idling speed	700 – 800 rpm	700 – 800	–
		Flywheel horsepower			
		Maximum torque			
		High idling speed			
		Low idling speed			
		Flywheel horsepower			
		Maximum torque			
		High idling speed			
		Low idling speed			
		Flywheel horsepower			
		Maximum torque			
		High idling speed			
		Low idling speed			

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★ For fuel, use ASTM D975 No. 1 or No. 2.
★ For lubricant, use SAE15W-40 or SAE30 oil.

*3
112 – 119 {149 – 160} (50 Hz)
136 – 143 {182 – 192} (60 Hz)

*4
127 – 134 {170 – 179} (50 Hz)
153 – 162 {205 – 217} (60 Hz)

Mpa

Flywheel horsepower (kW {HP})	Torque (Nm {kgm})	Fuel consumption (sec./200cc)	Coolant temperature (°C)	Lubricating oil temperature (°C)	Lubricating oil pressure (kPa {kg/cm²})	Exhaust gas temperature (°C)
105 – 111 (Gross) {141 – 149}	–	min. 25.3	70 – 90	90 – 110	0.3 – 0.5 {3.0 – 5.0}	max. 600
–	633 – 671 (Gross) {64.6 – 68.4}	–	70 – 90	90 – 110	0.3 – 0.5 {3.0 – 5.0}	max. 670
–	–	–	70 – 90	90 – 110	0.3 – 0.5 {3.0 – 5.0}	–
–	–	–	70 – 90	90 – 110	min. 0.12 {min. 1.2}	–
125 – 132 (Gross) {168 – 201}	–	min. 20.0	70 – 90	90 – 110	0.3 – 0.5 {3.0 – 5.0}	max. 600
–	641 – 700 (Gross) {65.4 – 71.4}	–	70 – 90	90 – 110	–	max. 650
–	–	–	70 – 90	90 – 110	–	–
–	–	–	70 – 90	min. 80	min. 0.12 {min. 1.2}	–
142 – 150 (Gross) {190 – 202}	–	min. 18.3	70 – 90	90 – 110	0.3 – 0.5 {3.0 – 5.0}	max. 600
–	641 – 700 (Gross) {65.4 – 71.4}	–	70 – 90	90 – 110	–	max. 670
–	–	–	70 – 90	90 – 110	–	–
–	–	–	70 – 90	min. 80	min. 0.12 {min. 1.2}	–
*3	–	min. 23.2 (50 Hz)	80 – 90	90 – 110	0.3 – 0.5 {3.0 – 5.0}	max. 670
	–	min. 19.5 (60 Hz)	80 – 90	90 – 110	0.3 – 0.5 {3.0 – 5.0}	max. 670
*4	–	–	80 – 90	90 – 110	0.3 – 0.5 {3.0 – 5.0}	max. 700
	–	–	80 – 90	90 – 110	0.3 – 0.5 {3.0 – 5.0}	max. 700
–	–	–	80 – 90	90 – 110	0.3 – 0.5 {3.0 – 5.0}	–
–	–	–	80 – 90	90 – 110	0.3 – 0.5 {3.0 – 5.0}	–
–	–	–	80 – 90	90 – 110	min. 0.12 {min. 1.2}	–

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★ The values in the table are the standard values for machines with the muffler installed, air cleaner installed, air cleaner installed, alternator under no load, and air compressor opened (if installed).
★ The load for the dynamometer are at an arm's length of 716 mm.

*5
1,200 – 1,280 {122 – 130} (50 Hz)
1,200 – 1,280 {122 – 130} (60 Hz)

*6
1,320 – 1,400 {135 – 143} (50 Hz)
1,320 – 1,390 {135 – 142} (60 Hz)

Engine model	Applicable machine	Test item	Specified value	Engine speed (rpm)	Dynamometer (N {kg})
SA6D108-1	PC300-5 PC300HD-5 PC360LC-5	Flywheel horsepower	154 kW {207 HP}/1,950 rpm (Net)	1,945 – 1,955	1,050 – 1,110 {107 – 113}
		Maximum torque	814 Nm {83.0 kgm}/1,500 rpm (Net)	1,400 – 1,600	1,080 – 1,140 {110 – 117}
		High idling speed	2,115 – 2,235 rpm	2,115 – 2,235	–
		Low idling speed	700 – 750 rpm	700 – 750	–
	WA420-3	Flywheel horsepower	162 kW {217 HP}/2,200 rpm (Net)	2,195 – 2,205	971 – 1,070 {99.0 – 109}
		Maximum torque	847 Nm {86.4 kgm}/1,500 rpm (Net)	1,400 – 1,600	1,170 – 1,250 {120 – 128}
		High idling speed	2,425 – 2,525 rpm	2,405 – 2,525	–
		Low idling speed	700 – 750 rpm	700 – 750	–
	Sugar cane harvester AUSTOFT in AUSTRALIA (Engine No. 10001 – 10926)	Flywheel horsepower	179 kW {240 HP}/2,400 rpm (Net)	2,395 – 2,405	945 – 1,040 {96.4 – 107}
		Maximum torque	784 Nm {80.0 kgm}/1,600 rpm (Net)	1,500 – 1,700	1,040 – 1,150 {106 – 117}
		High idling speed	2,560 – 2,640 rpm	2,560 – 2,640	–
		Low idling speed	950 – 1,050 rpm	950 – 1,050	–
	Sugar cane harvester AUSTOFT in AUSTRALIA (Engine No. 10927 and up)	Flywheel horsepower	180 kW {241 HP}/2,500 rpm (Net)	2,495 – 2,505	935 – 984 {95.4 – 100}
		Maximum torque	824 Nm {84.0 kgm}/1,600 rpm (Net)	1,500 – 1,700	1,100 – 1,210 {112 – 123}
		High idling speed	2,700 – 2,750 rpm	2,700 – 2,750	–
		Low idling speed	950 – 1,050 rpm	950 – 1,050	–
	Generator EG180B-L-1 (for ALGERIA)	Long time flywheel horsepower	136 kW {182 HP}/1,500 rpm (Net)	1,495 – 1,505	1,200 – 1,280 {122 – 130}
		Normal flywheel horsepower	150 kW {201 HP}/1,500 rpm (Net)	1,495 – 1,505	1,320 – 1,400 {135 – 143}
		High idling speed	max. 1,575 rpm	max. 1,575	–
		Low idling speed	700 – 750 rpm	700 – 750	–
	Generator DENYO DCA180	Rated flywheel horsepower	136 kW {182 HP}/1,500 rpm (50 Hz) 162 kW {217 HP}/1,800 rpm (60 Hz) (Net)	1,495 – 1,505 (50 Hz) 1,795 – 1,805 (60 Hz)	*5
		Maximum flywheel horsepower	150 kW {201 HP}/1,500 rpm (50 Hz) 178 kW {239 HP}/1,800 rpm (60 Hz) (Net)	1,495 – 1,505 (50 Hz) 1,795 – 1,805 (60 Hz)	*6
		High idling speed	max. 1,575 rpm (Rated, 50 Hz) max. 1,870 rpm (Rated, 60 Hz)	max. 1,575 (Rated, 50 Hz) max. 1,870 (Rated, 60 Hz)	– –
		Low idling speed	700 – 800 rpm	700 – 800	–
	SA6D108-M-1	Maximum horsepower	309 kW {420 HP}/2,700 rpm	2,700	1,548 {158}
		High idling speed	2,920 – 3,120 rpm	2,920 – 3,120	–
		Low idling speed	700 – 750 rpm	700 – 750	–

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★ For fuel, use ASTM D975 No. 1 or No. 2.
★ For lubricant, use SAE15W-40 or SAE30 oil.

*7
135 – 143 {180 – 192} (50 Hz)
162 – 172 {217 – 231} (60 Hz)

*8
148 – 157 {190 – 211} (50 Hz)
178 – 188 {239 – 252} (60 Hz)

Flywheel horsepower (kW {HP})	Torque (Nm {kgm})	Fuel consumption (sec./200cc)	Coolant temperature (°C)	Lubricating oil temperature (°C)	Lubricating oil pressure (MPa {kg/cm²})	Exhaust gas temperature (°C)
153 – 162 (Gross) {205 – 217}	–	min. 18.0	70 – 80	90 – 110	0.3 – 0.5 {3.0 – 5.0}	max. 650
–	770 – 819 (Gross) {78.5 – 83.5}	–	70 – 80	90 – 110	0.3 – 0.5 {3.0 – 5.0}	max. 650
–	–	–	70 – 80	90 – 110	0.3 – 0.5 {3.0 – 5.0}	–
–	–	–	70 – 80	90 – 110	min. 0.12 {min. 1.2}	–
160 – 176 (Gross) {215 – 236}	–	min. 15.0	70 – 90	90 – 110	0.3 – 0.5 {3.0 – 5.0}	max. 600
–	839 – 898 (Gross) {85.6 – 91.6}	–	70 – 90	90 – 110	–	max. 650
–	–	–	70 – 90	90 – 110	–	–
–	–	–	70 – 90	min. 80	min. 0.12 {min. 1.2}	–
170 – 188 (Gross) {228 – 252}	–	min. 15.4	70 – 80	90 – 110	0.3 – 0.5 {3.0 – 5.0}	max. 650
–	745 – 824 (Gross) {76.0 – 84.0}	–	70 – 80	90 – 110	0.3 – 0.5 {3.0 – 5.0}	max. 650
–	–	–	70 – 80	90 – 110	0.3 – 0.5 {3.0 – 5.0}	–
–	–	–	70 – 80	90 – 110	min. 0.12 {min. 1.2}	–
175 – 184 (Gross) {235 – 247}	–	min. 15.4	70 – 80	90 – 110	0.3 – 0.5 {3.0 – 5.0}	max. 650
–	784 – 863 (Gross) {80.0 – 88.0}	–	70 – 80	90 – 110	0.3 – 0.5 {3.0 – 5.0}	max. 650
–	–	–	70 – 80	90 – 110	0.3 – 0.5 {3.0 – 5.0}	–
–	–	–	70 – 80	90 – 110	min. 0.12 {min. 1.2}	–
135 – 143 (Gross) {180 – 192}	–	min. 19.5	70 – 90	90 – 110	0.3 – 0.5 {3.0 – 5.0}	max. 670
149 – 157 (Gross) {199 – 211}	–	min. 19.5	70 – 90	90 – 110	0.3 – 0.5 {3.0 – 5.0}	max. 670
–	–	–	70 – 90	90 – 110	–	–
–	–	–	70 – 90	90 – 110	min. 0.12 {min. 1.2}	–
*7	–	min. 17.8 (50 Hz)	70 – 90	90 – 110	0.3 – 0.5 {3.0 – 5.0}	max. 670
	–	min. 14.8 (60 Hz)	70 – 90	90 – 110	0.3 – 0.5 {3.0 – 5.0}	max. 670
*8	–	–	70 – 90	90 – 110	0.3 – 0.5 {3.0 – 5.0}	max. 670
	–	–	70 – 90	90 – 110	0.3 – 0.5 {3.0 – 5.0}	max. 670
–	–	–	70 – 90	90 – 110	0.3 – 0.5 {3.0 – 5.0}	–
–	–	–	70 – 90	90 – 110	0.3 – 0.5 {3.0 – 5.0}	–
–	–	–	70 – 90	90 – 110	min. 0.12 {min. 1.2}	–
309 {420} (Gross)	1,107 {113.0} (Gross)	–	85	90 – 110	294 – 490 {3.0 – 5.0}	max. 690
–		–	85	90 – 110	294 – 490 {3.0 – 5.0}	
–		–	85	90 – 110	98 {1.0}	

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CALIBRATION DATA

Engine model	Pump assembly No.	Engine serial No.	Applicable machine	Page
S6D108-1	6221-71-1310		D57S-1	12-016-1
	6221-71-1311			12-016-2
	6221-71-1210		WA320-3	12-016-3
	6221-71-1230		WA380-3	12-016-4
	6221-71-1940		Generator EG150BS-5 Generator for OEM	12-016-5
SA6D108-1	6222-71-1110		PC300-5 PC300HD-5 PC360LC-5	12-016-6
	6222-71-1120			
	6222-71-1130			
	6222-71-1410		WA420-3	12-016-7
	6222-71-1920	10001 – 10926	Sugar cane harvester AUSTOFT in AUSTRALIA	12-016-8
	6222-71-1921	10927 and up		12-016-9
	6222-71-1940		Generator EG185B-L-1 (for ALGERIA)	12-016-10
			Generator DENYO DCA180	
	6222-75-1311		SA6D108-M-1	12-016-11

622101

Injection Pump Assembly Number

6221-71-1310 (101605-3990)

( ): Injection pump manufacturer's part No.

Injection Pump Type	Injection pump Manufacturer
PE-AD	ZEXEL

Applicable Machine		Applicable Engine	
Model	Serial No.	Model	Serial No.
D57S-1		S6D108-1	

Injection Pump Specification

Rotating direction	Clockwise
Injection order	1 – 5 – 3 – 6 – 2 – 4
Injection interval	59°30′ – 60°30′
Plunger pre-stroke (mm)	3.55 – 3.65
Delivery valve (mm^3/st) retraction volume	70

Engine Specification

Flywheel horsepower (kW {HP}) / rpm)	107 {143}/1,900 (Gross)
Maximum torque (Nm {kgm}/ rpm)	635 {64.7}/1,400 (Gross)
High idling speed (rpm)	2,050 – 2,150
Low idling speed (rpm)	800 – 850

Pump tester capacity for Service standard	Motor 7.5 kW

Calibration Standard

( ): Injection pump manufacturer's part number

Conditions

- **Service standard** indicates data using calibration test parts.
- **Manufacturer standard** is data for factory test.

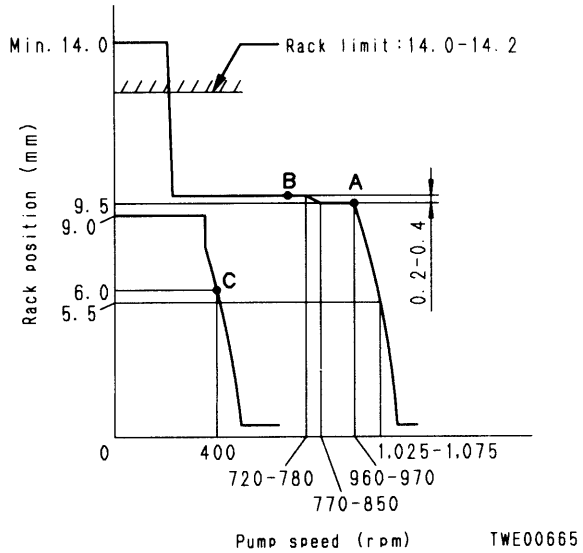
	Service standard	Manufacturer standard
Nozzle & nozzle holder part No.		
Nozzle part No.	(105780-0000)	6221-11-3120 (105017-1120)
Nozzle holder part No.	(105780-8140)	6221-11-3100 (105118-5100)
Injection pipe (mm) (Outside dia. x inside dia. x length)	6 x 2 x 600	6 x 2 x 690
Test oil	ASTM D975 No. 2 diesel fuel or equivalent	
Oil temperature (°C)	40 to 45	
Nozzle opening pressure (MPa{kg/cm²})	17.2 {175}	23.5 {239}
Transfer pump pressure (kPa{kg/cm²})	157 {1.60}	157 {1.60}

Injection volume

- **Rack positions** B to E are the reference volume when adjusting the injection volume.
- Marks ★ are average volumes.

Rack point	Rack position (mm)	Pump speed (rpm)	**Service standard** (cc/1000 st.) Injection volume	**Service standard** (cc/1000 st.) Maximum variance between cylinder	**Manufacturer standard** (cc/1000 st.) Injection volume	**Manufacturer standard** (cc/1000 st.) Maximum variance between cylinder
A (Basic point)	9.5	950	★82.3 – 84.3	max. 3.3	★80.4 – 83.6	max. 3.2
B	9.8	700	★88.4 – 94.4	–	★90.1	–
C	6.0	400	★12.8 – 15.2	max. 2.8	★11.2 – 13.8	max. 2.6
D						
E						

Governor performance curve



622101

Injection Pump Assembly Number

6221-71-1311 (101605-3991)

( ): Injection pump manufacturer's part No.

Injection Pump Type	Injection pump Manufacturer
PE-AD	ZEXEL

Applicable Machine		Applicable Engine	
Model	Serial No.	Model	Serial No.
D57S-1		S6D108-1	

Injection Pump Specification

Rotating direction	Clockwise
Injection order	1 – 5 – 3 – 6 – 2 – 4
Injection interval	59°30′ – 60°30′
Plunger pre-stroke (mm)	3.55 – 3.65
Delivery valve (mm^3/st) retraction volume	70

Engine Specification

Flywheel horsepower (kW {HP}) / rpm)		107 {143}/1,900 (Gross)
Maximum torque	(Nm {kgm}/ rpm)	635 {64.7}/1,400 (Gross)
High idling speed	(rpm)	2,050 – 2,150
Low idling speed	(rpm)	800 – 850

Pump tester capacity for Service standard	Motor 7.5 kW

Calibration Standard

( ): Injection pump manufacturer's part number

Conditions

- **Service standard** indicates data using calibration test parts.
- **Manufacturer standard** is data for factory test.

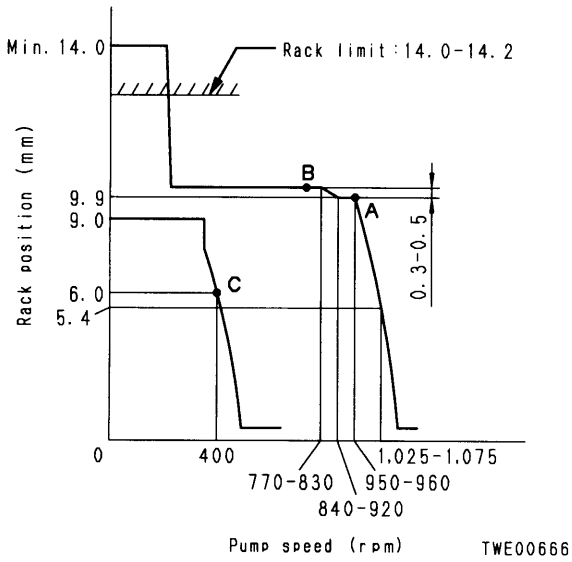
	Service standard	Manufacturer standard
Nozzle & nozzle holder part No.		
Nozzle part No.	(105780-0000)	6221-11-3120 (105017-1120)
Nozzle holder part No.	(105780-8140)	6221-11-3100 (105118-5100)
Injection pipe (mm) (Outside dia. x inside dia. x length)	6 x 2 x 600	6 x 2 x 690
Test oil	ASTM D975 No. 2 diesel fuel or equivalent	
Oil temperature (°C)	40 to 45	
Nozzle opening pressure (MPa{kg/cm²})	17.2 {175}	23.5 {239}
Transfer pump pressure (kPa{kg/cm²})	157 {1.60}	157 {1.60}

Injection volume

- **Rack positions** B to E are the reference volume when adjusting the injection volume.
- Marks ★ are average volumes.

Rack point	Rack position (mm)	Pump speed (rpm)	**Service standard** (cc/1000 st.)		**Manufacturer standard** (cc/1000 st.)	
			Injection volume	Maximum variance between cylinder	Injection volume	Maximum variance between cylinder
A (Basic point)	9.9	950	★82.3 – 84.3	max. 3.3	★87.8	
B	10.3	700	★88.4 – 94.4	–	★103.1	
C	6.0	400	★12.8 – 15.2	max. 2.8	★12.5	
D						
E						

Governor performance curve



622101

Injection Pump Assembly Number

6221-71-1210 (101609-3091)

( ): Injection pump manufacturer's part No.

Injection Pump Type	Injection pump Manufacturer
PE-AD	ZEXEL

Applicable Machine		Applicable Engine	
Model	Serial No.	Model	Serial No.
WA320-3		S6D108-1	

Injection Pump Specification

Rotating direction	Clockwise
Injection order	1 - 5 - 3 - 6 - 2 - 4
Injection interval	59°30' - 60°30'
Plunger pre-stroke (mm)	3.55 - 3.65
Delivery valve (mm^3/st) retraction volume	70

Engine Specification

Flywheel horsepower (kW {HP}) / rpm)	131 {175}/2,380 (Gross)
Maximum torque (Nm {kgm}/ rpm)	661 {67.4}/1,600 (Gross)
High idling speed (rpm)	2,560 - 2,610
Low idling speed (rpm)	780 - 830

Pump tester capacity for Service standard	Motor 7.5 kW

Calibration Standard

( ): Injection pump manufacturer's part number

Conditions

- **Service standard** indicates data using calibration test parts.
- **Manufacturer standard** is data for factory test.

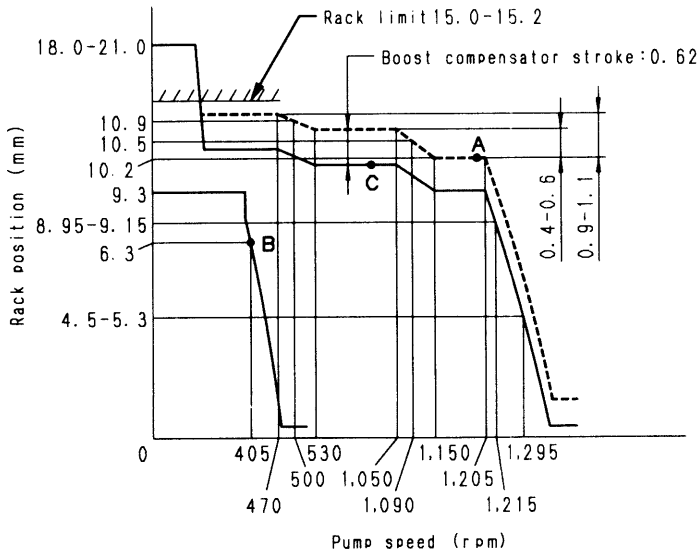
	Service standard	Manufacturer standard
Nozzle & nozzle holder part No.		
Nozzle part No.	(105780-0000)	6221-11-3120 (105017-1120)
Nozzle holder part No.	(105780-8140)	6221-11-3100 (105118-5100)
Injection pipe (mm) (Outside dia. x inside dia. x length)	6 x 2 x 600	6 x 2 x 690
Test oil	ASTM D975 No. 2 diesel fuel or equivalent	
Oil temperature (°C)	40 to 45	
Nozzle opening pressure (MPa{kg/cm^2})	17.2 {175}	23.5 {239}
Transfer pump pressure (kPa{kg/cm^2})	157 {1.60}	157 {1.60}

Injection volume

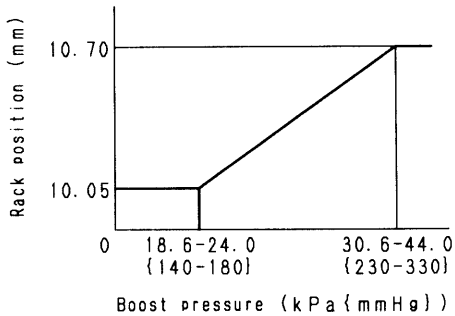
- **Rack positions** B to E are the reference volume when adjusting the injection volume.
- Marks ★ are average volumes.

Rack point	Rack position (mm)	Pump speed (rpm)	**Service standard** (cc/1000 st.) Injection volume	Maximum variance between cylinder	**Manufacturer standard** (cc/1000 st.) Injection volume	Maximum variance between cylinder
A (Basic point)	10.2	1,190	★83.0 - 85.0	max. 3.4	★87.8	
B	6.3	405	★11.3 - 13.7	max. 2.6	★103.1	
C						
D						
E						

Governor performance curve



Boost compensator performance curve



TWE00667

622101

Injection Pump Assembly Number

6221-71-1230 (101609-3101)

( ): Injection pump manufacturer's part No.

Injection Pump Type	Injection pump Manufacturer
PE-AD	ZEXEL

Applicable Machine		Applicable Engine	
Model	Serial No.	Model	Serial No.
WA380-3		S6D108-1	

Injection Pump Specification

Rotating direction	Clockwise
Injection order	1 – 5 – 3 – 6 – 2 – 4
Injection interval	59°30′ – 60°30′
Plunger pre-stroke (mm)	3.55 – 3.65
Delivery valve (mm^3/st) retraction volume	70

Engine Specification

Flywheel horsepower (kW {HP}) / rpm)		149 {200}/2,200 (Gross)
Maximum torque	(Nm {kgm}/ rpm)	816 {83.2}/1,500 (Gross)
High idling speed	(rpm)	2,450 – 2,550
Low idling speed	(rpm)	760 – 810

Pump tester capacity for Service standard	Motor 7.5 kW

Calibration Standard

( ): Injection pump manufacturer's part number

Conditions

- **Service standard** indicates data using calibration test parts.
- **Manufacturer standard** is data for factory test.

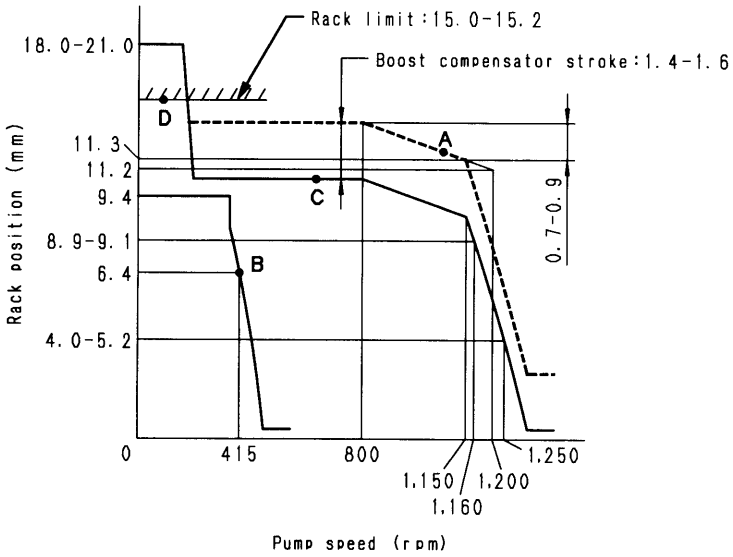
	Service standard	Manufacturer standard
Nozzle & nozzle holder part No.		
Nozzle part No.	(105780-0000)	6221-11-3120 (105017-1120)
Nozzle holder part No.	(105780-8140)	6221-11-3100 (105118-5100)
Injection pipe (mm) (Outside dia. x inside dia. x length)	6 x 2 x 600	6 x 2 x 690
Test oil	ASTM D975 No. 2 diesel fuel or equivalent	
Oil temperature (°C)	40 to 45	
Nozzle opening pressure (MPa{kg/cm^2})	17.2 {175}	23.5 {239}
Transfer pump pressure (kPa{kg/cm^2})	157 {1.60}	157 {1.60}

Injection volume

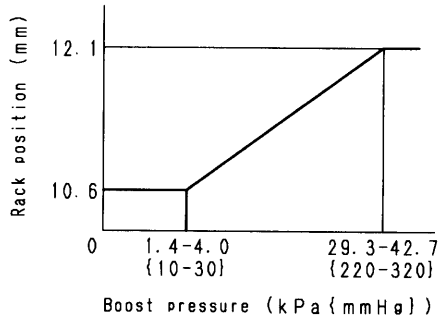
- **Rack positions** B to E are the reference volume when adjusting the injection volume.
- Marks ★ are average volumes.

Rack point	Rack position (mm)	Pump speed (rpm)	**Service standard** (cc/1000 st.)		**Manufacturer standard** (cc/1000 st.)	
			Injection volume	Maximum variance between cylinder	Injection volume	Maximum variance between cylinder
A (Basic point)	11.3	1,100	★102.0 – 104.0	max. 4.2	★105.0	
B	6.4	395	★11.3 – 13.7	max. 2.6	★12.5	
C						
D						
E						

Governor performance curve



Boost compensator performance curve



TWE00668

622101

Injection Pump Assembly Number

6221-71-1940 (101609-3012)

( ): Injection pump manufacturer's part No.

Injection Pump Type	Injection pump Manufacturer
PE-AD	ZEXEL

Applicable Machine		Applicable Engine	
Model	Serial No.	Model	Serial No.
Generator EG150BS-5 Generator for OEM		S6D108-1	

Injection Pump Specification

Rotating direction	Clockwise
Injection order	1 – 5 – 3 – 6 – 2 – 4
Injection interval	59°30′ – 60°30′
Plunger pre-stroke (mm)	3.55 – 3.65
Delivery valve (mm^3/st) retraction volume	70

Engine Specification

Flywheel horsepower (kW {HP}) / rpm)	116 {155}/1,500 (Gross) 140 {104}/1,800 (Gross)
Maximum torque (Nm {kgm}/ rpm)	–
High idling speed (rpm)	Max. 1,575 (50 Hz) Max. 1,890 (60 Hz)
Low idling speed (rpm)	700 – 800

Pump tester capacity for Service standard	Motor 7.5 kW

Calibration Standard

( ): Injection pump manufacturer's part number

Conditions

- **Service standard** indicates data using calibration test parts.
- **Manufacturer standard** is data for factory test.

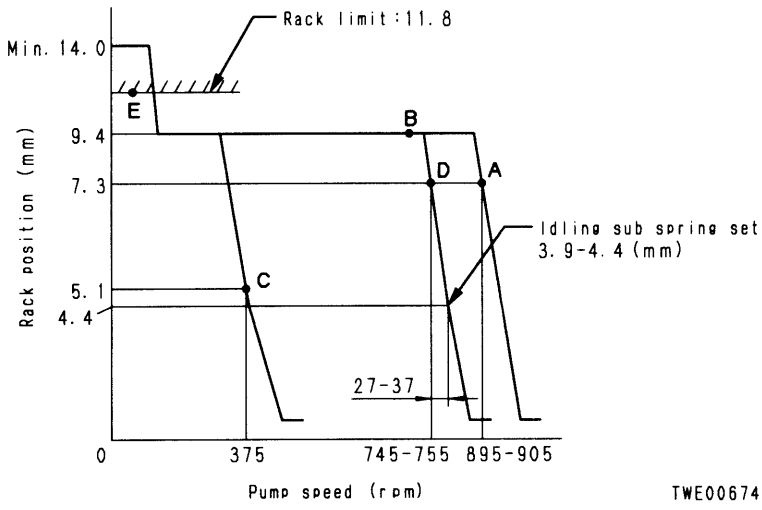
	Service standard	Manufacturer standard
Nozzle & nozzle holder part No.		
Nozzle part No.	(105780-0000)	6221-11-3120 (105017-1120)
Nozzle holder part No.	(105780-8140)	6221-11-3100 (105118-5100)
Injection pipe (mm) (Outside dia. x inside dia. x length)	6 x 2 x 600	6 x 2 x 690
Test oil	ASTM D975 No. 2 diesel fuel or equivalent	
Oil temperature (°C)	40 to 45	
Nozzle opening pressure (MPa{kg/cm²})	17.2 {175}	23.5 {239}
Transfer pump pressure (kPa{kg/cm²})	157 {1.60}	157 {1.60}

Injection volume

- **Rack positions** B to E are the reference volume when adjusting the injection volume.
- Marks ★ are average volumes.

Rack point	Rack position (mm)	Pump speed (rpm)	**Service standard** (cc/1000 st.)		**Manufacturer standard** (cc/1000 st.)	
			Injection volume	Maximum variance between cylinder	Injection volume	Maximum variance between cylinder
A (Basic point)	7.3	900	★81.6 – 83.6	max. 3.4	★81.2	
B	9.4	725	★142.1 – 149.1	–	★150.2	
C	Approx. 5.1	375	★15.2 – 17.6	max. 3.2	★12.5	
D	7.3	750	★80.9	–	★79.7	
E	11.8	100	★208.0 – 228.0	–	★210.0	

Governor performance curve



622101

Injection Pump Assembly Number

6222-71-1110 (191000-7030)
6222-71-1120 (191000-7560)
6222-71-1130

( ): Injection pump manufacturer's part No.

Injection Pump Type	Injection pump Manufacturer
NB (EP-9)	DENSO

Applicable Machine		Applicable Engine	
Model	Serial No.	Model	Serial No.
PC300-5 PC300HD-5 PC360LC-5		SA6D108-1	

Injection Pump Specification

Rotating direction	Clockwise
Injection order	1 – 5 – 3 – 6 – 2 – 4
Injection interval	59°30′ – 60°30′
Plunger pre-stroke (mm)	4.45 – 4.55
Delivery valve (mm³/st) retraction volume	80

Engine Specification

Flywheel horsepower (kW {HP}) / rpm	152 {207}/1,950 (Net)
Maximum torque (Nm {kgm}/ rpm)	814 {83.0}/1,500 (Net)
High idling speed (rpm)	2,125 – 2,235
Low idling speed (rpm)	700 – 750

Pump tester capacity for Service standard	Motor 7.5 kW

Calibration Standard

( ): Injection pump manufacturer's part number

Conditions

- **Service standard** indicates data using calibration test parts.
- **Manufacturer standard** is data for factory test.

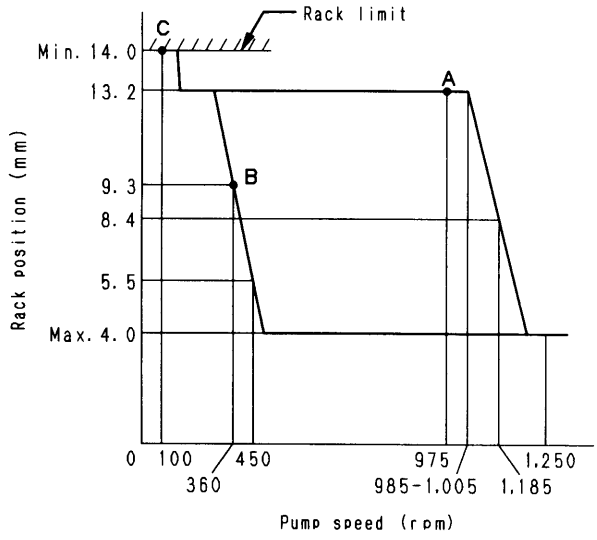
	Service standard	Manufacturer standard
Nozzle & nozzle holder part No.		
Nozzle part No.	(093400-0540)	
Nozzle holder part No.	(093100-0190)	
Injection pipe (mm) (Outside dia. x inside dia. x length)	6 x 2 x 600	
Test oil	ASTM D975 No. 2 diesel fuel or equivalent	
Oil temperature (°C)	40 to 45	
Nozzle opening pressure (MPa{kg/cm²})	17.2 {175}	
Transfer pump pressure (kPa{kg/cm²})	157 {1.60}	

Injection volume

- **Rack positions** B to E are the reference volume when adjusting the injection volume.
- Marks ★ are average volumes.

Rack point	Rack position (mm)	Pump speed (rpm)	**Service standard** (cc/1000 st.) Injection volume	Maximum variance between cylinder	**Manufacturer standard** (cc/1000 st.) Injection volume	Maximum variance between cylinder
A (Basic point)	13.2	975	★137.0 – 147.0	max. 17.0		
B	9.3	360	★19.0 – 23.0	max. 2.1		
C						
D						
E						

Governor performance curve



TWE00669

622101

Injection Pump Assembly Number

6222-71-1410 (092000-0360)

( ): Injection pump manufacturer's part No.

Injection Pump Type	Injection pump Manufacturer
NB (EP-9)	DENSO

Applicable Machine		Applicable Engine	
Model	Serial No.	Model	Serial No.
WA420-3		SA6D108-1	

Injection Pump Specification

Rotating direction	Clockwise
Injection order	1 – 5 – 3 – 6 – 2 – 4
Injection interval	59°30′ – 60°30′
Plunger pre-stroke (mm)	4.45 – 4.55
Delivery valve retraction volume (mm^3/st)	90

Engine Specification

Flywheel horsepower (kW {HP}) / rpm)	171 {232}/2,200 (Gross)
Maximum torque (Nm {kgm}/ rpm)	865 {88.2}/1,500 (Gross)
High idling speed (rpm)	2,425 – 2,525
Low idling speed (rpm)	700 – 750

Pump tester capacity for Service standard	Motor 7.5 kW

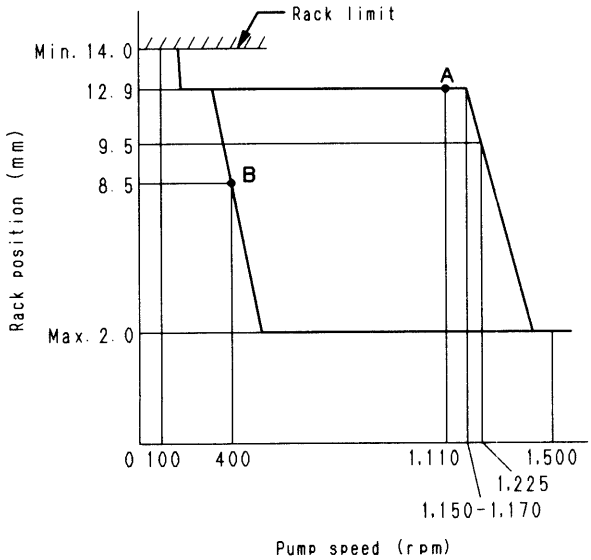
Calibration Standard

( ): Injection pump manufacturer's part number

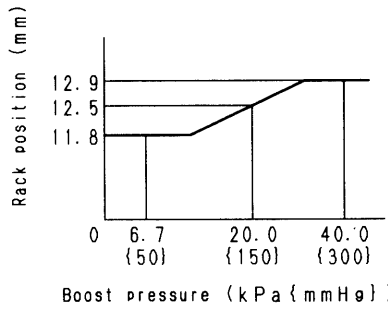
		Service standard	Manufacturer standard
Conditions • **Service standard** indicates data using calibration test parts. • **Manufacturer standard** is data for factory test.	Nozzle & nozzle holder part No.		
	Nozzle part No.	(093400-0540)	
	Nozzle holder part No.	(093100-0190)	
	Injection pipe (mm) (Outside dia. x inside dia. x length)	6 x 2 x 600	
	Test oil	ASTM D975 No. 2 diesel fuel or equivalent	
	Oil temperature (°C)	40 to 45	
	Nozzle opening pressure (MPa{kg/cm²})	17.2 {175}	
	Transfer pump pressure (kPa{kg/cm²})	157 {1.60}	

Injection volume • **Rack positions** B to E are the reference volume when adjusting the injection volume. • Marks ★ are average volumes.	Rack point	Rack position (mm)	Pump speed (rpm)	**Service standard** (cc/1000 st.)		**Manufacturer standard** (cc/1000 st.)	
				Injection volume	Maximum variance between cylinder	Injection volume	Maximum variance between cylinder
	A (Basic point)	12.9	1,100	★145.0 – 155.0	max. 8.0		
	B	8.5	400	★10.0 – 14.0	max. 5.0		
	C						
	D						
	E						

Governor performance curve



Boost compensator performance curve



TWE00670

622101

Injection Pump Assembly Number

6222-71-1920 (191000-7021)

( ): Injection pump manufacturer's part No.

Injection Pump Type	Injection pump Manufacturer
NB (EP-9)	DENSO

Applicable Machine		Applicable Engine	
Model	Serial No.	Model	Serial No.
Sugar cane harvester AUSTOFT in AUSTRALIA		SA6D108-1	

Injection Pump Specification

Rotating direction	Clockwise
Injection order	1 – 5 – 3 – 6 – 2 – 4
Injection interval	59°30′ – 60°30′
Plunger pre-stroke (mm)	4.45 – 4.55
Delivery valve (mm^3/st) retraction volume	80

Engine Specification

Flywheel horsepower (kW {HP}) / rpm)	177 {240}/2,400 ( )
Maximum torque (Nm {kgm}/ rpm)	785 {80.0}/1,600 ( )
High idling speed (rpm)	2,560 – 2,640
Low idling speed (rpm)	950 – 1,050

Pump tester capacity for Service standard	Motor 7.5 kW

Calibration Standard

( ): Injection pump manufacturer's part number

Conditions

- **Service standard** indicates data using calibration test parts.
- **Manufacturer standard** is data for factory test.

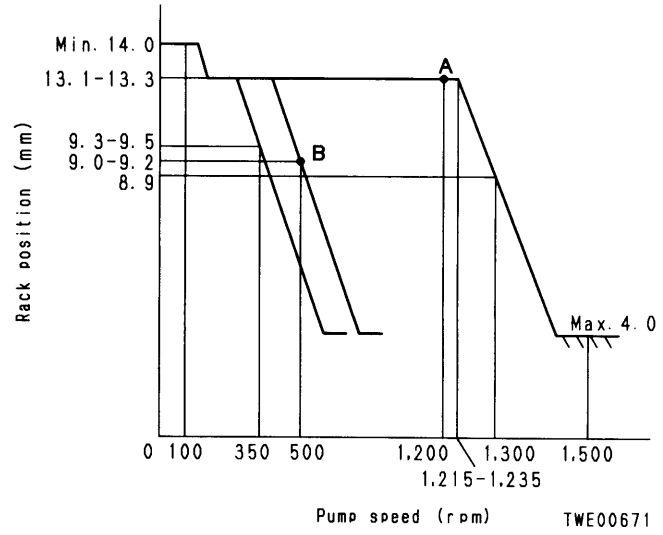
	Service standard	Manufacturer standard
Nozzle & nozzle holder part No.		
Nozzle part No.	(093400-50540)	
Nozzle holder part No.	(093500-0190)	
Injection pipe (mm) (Outside dia. x inside dia. x length)	6 x 2 x 600	
Test oil	ASTM D975 No. 2 diesel fuel or equivalent	
Oil temperature (°C)	40 to 45	
Nozzle opening pressure (MPa{kg/cm²})	17.2 {175}	
Transfer pump pressure (kPa{kg/cm²})	157 {1.60}	

Injection volume

- **Rack positions** B to E are the reference volume when adjusting the injection volume.
- Marks ★ are average volumes.

Rack point	Rack position (mm)	Pump speed (rpm)	**Service standard** (cc/1000 st.)		**Manufacturer standard** (cc/1000 st.)	
			Injection volume	Maximum variance between cylinder	Injection volume	Maximum variance between cylinder
A (Basic point)	13.1	1,200	★134.0 – 144.0	max. 8.0		
B	8.9	500	★13.0 – 17.0	max. 5.0		
C						
D						
E						

Governor performance curve



622101

Injection Pump Assembly Number

6222-71-1921 (191000-7023)

( ): Injection pump manufacturer's part No.

Injection Pump Type	Injection pump Manufacturer
NB (EP-9)	DENSO

Applicable Machine		Applicable Engine	
Model	Serial No.	Model	Serial No.
Sugar cane harvester AUSTOFT in AUSTRALIA		SA6D108-1	

Injection Pump Specification

Rotating direction	Clockwise
Injection order	1 – 5 – 3 – 6 – 2 – 4
Injection interval	59°30′ – 60°30′
Plunger pre-stroke (mm)	4.45 – 4.55
Delivery valve (mm^3/st) retraction volume	80

Engine Specification

Flywheel horsepower (kW {HP}) / rpm)	177 {240}/2,500 ( )
Maximum torque (Nm {kgm}/ rpm)	824 {84.0}/1,600 ( )
High idling speed (rpm)	2,700 – 2,750
Low idling speed (rpm)	950 – 1,050

Pump tester capacity for Service standard	Motor 7.5 kW

Calibration Standard

( ): Injection pump manufacturer's part number

Conditions

- **Service standard** indicates data using calibration test parts.
- **Manufacturer standard** is data for factory test.

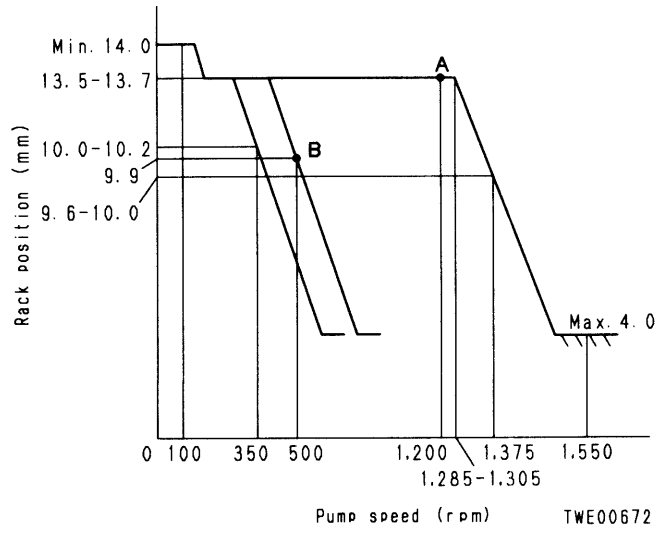
	Service standard	Manufacturer standard
Nozzle & nozzle holder part No.		
Nozzle part No.	(093400-50540)	
Nozzle holder part No.	(093500-0190)	
Injection pipe (mm) (Outside dia. x inside dia. x length)	6 x 2 x 600	
Test oil	ASTM D975 No. 2 diesel fuel or equivalent	
Oil temperature (°C)	40 to 45	
Nozzle opening pressure (MPa{kg/cm²})	17.2 {175}	
Transfer pump pressure (kPa{kg/cm²})	157 {1.60}	

Injection volume

- **Rack positions** B to E are the reference volume when adjusting the injection volume.
- Marks ★ are average volumes.

Rack point	Rack position (mm)	Pump speed (rpm)	**Service standard** (cc/1000 st.) Injection volume	**Service standard** (cc/1000 st.) Maximum variance between cylinder	**Manufacturer standard** (cc/1000 st.) Injection volume	**Manufacturer standard** (cc/1000 st.) Maximum variance between cylinder
A (Basic point)	13.6	1,250	★143.0 – 153.0	max. 8.0		
B	9.9	500	★27.0 – 31.0	max. 5.0		
C						
D						
E						

Governor performance curve



Injection Pump Assembly Number

6222-71-1940 (191000-8240)

( ): Injection pump manufacturer's part No.

Injection Pump Type	Injection pump Manufacturer
NB (EP-9)	DENSO

Applicable Machine		Applicable Engine	
Model	Serial No.	Model	Serial No.
Generator EG185B-L-1 (for ALGELIA)		SA6D108-1	

Injection Pump Specification

Rotating direction	Clockwise
Injection order	1 – 5 – 3 – 6 – 2 – 4
Injection interval	59°30′ – 60°30′
Plunger pre-stroke (mm)	4.45 – 4.55
Delivery valve (mm³/st) retraction volume	80

Engine Specification

Flywheel horsepower (kW {HP}) / rpm)	153 {208}/1,500 (Gross, 50 Hz) 183 {249}/1,800 (Gross, 60 Hz)
Maximum torque (Nm {kgm}/ rpm)	–
High idling speed (rpm)	Max. 1,575 (50 Hz) Max. 1,890 (60 Hz)
Low idling speed (rpm)	700 – 800

Pump tester capacity for Service standard	Motor 7.5 kW

Calibration Standard

( ): Injection pump manufacturer's part number

Conditions

- **Service standard** indicates data using calibration test parts.
- **Manufacturer standard** is data for factory test.

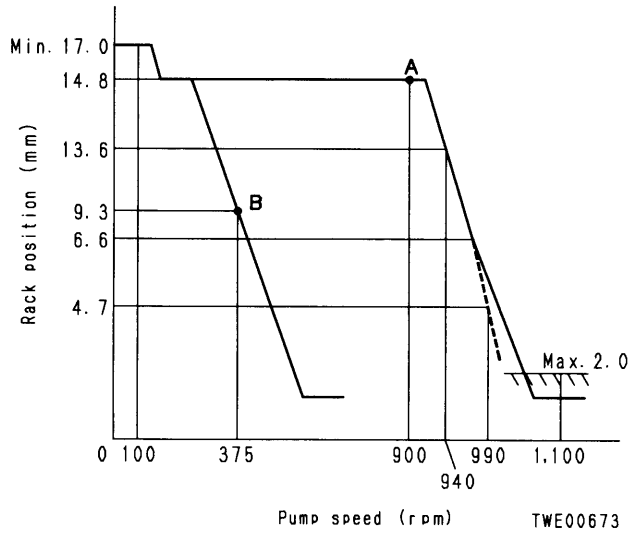
	Service standard	Manufacturer standard
Nozzle & nozzle holder part No.		
Nozzle part No.	(093400-0540)	
Nozzle holder part No.	(093500-0190)	
Injection pipe (mm) (Outside dia. x inside dia. x length)	6 x 2 x 600	
Test oil	ASTM D975 No. 2 diesel fuel or equivalent	
Oil temperature (°C)	40 to 45	
Nozzle opening pressure (MPa{kg/cm²})	17.2 {175}	
Transfer pump pressure (kPa{kg/cm²})	157 {1.60}	

Injection volume

- **Rack positions** B to E are the reference volume when adjusting the injection volume.
- Marks ★ are average volumes.

Rack point	Rack position (mm)	Pump speed (rpm)	**Service standard** (cc/1000 st.)		**Manufacturer standard** (cc/1000 st.)	
			Injection volume	Maximum variance between cylinder	Injection volume	Maximum variance between cylinder
A (Basic point)	14.8	900	★172.0 – 182.0	max. 4.5		
B	9.3	375	★11.0 – 15.0	max. 10.0		
C						
D						
E						

Governor performance curve



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Injection Pump Assembly Number

6222-75-1311 (092000-3500)

( ): Injection pump manufacturer's part No.

Injection Pump Type	Injection pump Manufacturer
NB (EP-9)	DENSO

Applicable Machine		Applicable Engine	
Model	Serial No.	Model	Serial No.
SA6D108-M-1		SA6D108-1	

Injection Pump Specification

Rotating direction	Clockwise
Injection order	1 – 5 – 3 – 6 – 2 – 4
Injection interval	59°30′ – 60°30′
Plunger pre-stroke (mm)	3.65 – 3.75
Delivery valve (mm³/st) retraction volume	100

Engine Specification

Maximum fywheel horsepower (kW {HP}/ rpm)	309 {420}/2,700 (Gross)
Maximum torque (Nm {kgm}/ rpm)	–
High idling speed (rpm)	2,920 – 3,020
Low idling speed (rpm)	700 – 750

Pump tester capacity for Service standard	

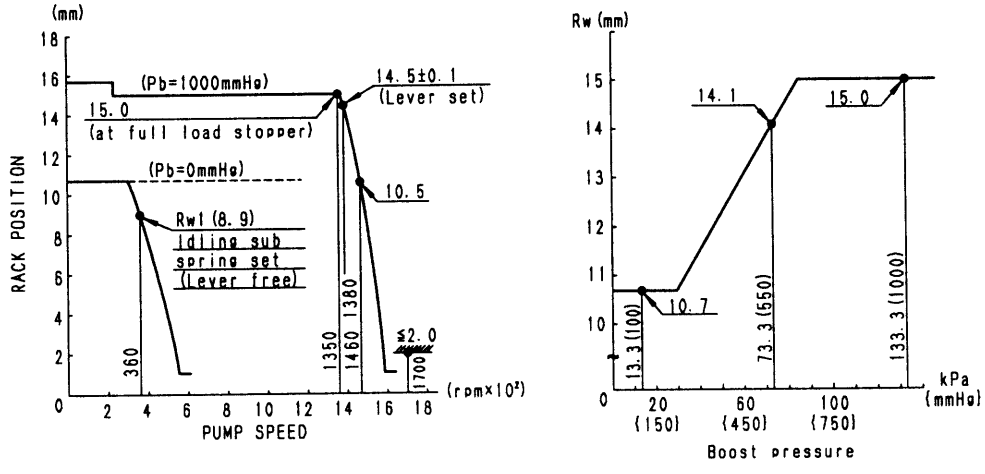
Calibration Standard

( ): Injection pump manufacturer's part number

		Service standard	Manufacturer standard
Conditions • **Service standard** indicates data using calibration test parts. • **Manufacturer standard** is data for factory test.	Nozzle & nozzle holder part No.		
	Nozzle part No.	(093400-0540)	
	Nozzle holder part No.	(093100-0190)	
	Injection pipe (mm) (Outside dia. x inside dia. x length)	6 x 2 x 600	
	Test oil	ASTM D975 No. 2 diesel fuel or equivalent	
	Oil temperature (°C)	40 to 45	
	Nozzle opening pressure (MPa{kg/cm²})	17.2 {175}	
	Transfer pump pressure (kPa{kg/cm²})	157 {1.60}	

Injection volume • **Rack positions** B to E are the reference volume when adjusting the injection volume. • Marks ★ are average volumes.	Rack point	Rack position (mm)	Pump speed (rpm)	**Service standard** (cc/1000 st.)		**Manufacturer standard** (cc/1000 st.)	
				Injection volume	Maximum variance between cylinder	Injection volume	Maximum variance between cylinder
	A (Basic point)	15.0	1,350	197.0 – 207.0	max. 8		
	B	8.9	360	27.0 – 31.0	max. 5		
	C						
	D						
	E						

Governor performance curve



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TESTING AND ADJUSTING TOOL LIST

No.	Testing and measuring item	Fault finding tool	Part No.	Remarks
1	Engine speed	Multi-tachometer	799-203-8000	Digital reading : 60—20,000rpm
2	Battery S.G.	Battery coolant tester	795-500-1001	1.100 — 1.300
3	Freezing temperature of cooling water			−5 — −50℃
4	Water temperature, oil temperature, air intake temperature	Thermistor temperature gauge	790-500-1300	0 — 200℃
5	Exhaust temperature			0 — 1,000℃
6	Lubricating oil pressure	Engine pressure measuring kit	799-203-2002	0 — 10 kg/cm²
7	Fuel pressure			0 — 20 kg/cm²
8	Intake pressure, exhaust pressure			0 — 1,500mmHg
9	Blow-by pressure			0 — 1,000mmH_2O
10	Intake resistance			−1,000 — 0mmH_2O
11	Compression pressure	Compression gauge	795-502-1203	0 —70 kg/cm²
12	Blow-by pressure	Blow-by checker	799-201-1503	0 — 500 mmH_2O
13	Valve clearance	Feeler gauge	795-116-1330	0.35,0.65mm
			795-125-1330	0.25,0.45mm
14	Exhaust gas color	Handy smoke checker	799-201-9000	Dirtiness 0 — 70% with standard color (Dirtiness% × 1/10 ≒ Bosch scale)
15	Water and fuel content in oil	Engine oil checker	799-201-6000	Provided with 0.1 and 0.2 water content standard sample
16	Fuel injection pressure Fuel injection nozzle spray condition	Nozzle tester	Commercially available	0 — 300 kg/cm²
17	Coolant quality	Water quality tester	799-202-7001	PH, nitrite ion concentration
18	Pressure valve function Leakage in cooling system	Radiator cap tester	799-202-9001	0 — 2 kg/cm²
19	Radiator blockage	Anemometer (Air speed gauge)	799-202-2001	1 — 40 m/s
20	Engine cranking	Cranking kit	795-610-1000	
		Barring device	795-215-1600	
20	Electrical circuit	Tester	Commercially available	Current, Voltage, Resistance

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TESTING AND ADJUSTING DATA

Engine model				S6D108-1			
Applicable machine model				D57S-1		WA320-3	
Classification	Item	Condition, etc.	Unit	Standard value	Permissible value	Standard value	Permissible value
Performance	Engine speed	High idling speed	rpm	2,050 – 2,150	2,050 – 2,150	2,560 – 2,610	2,560 – 2,610
		Low idling speed	rpm	800 – 850	800 – 850	780 – 830	780 – 830
	Necessary starting speed	0°C (Without starting aid)	rpm	min. 130	100	min. 130	100
		–20°C (With starting aid)	rpm	min. 100	100	min. 100	100
Intake, exhaust system	Intake resistance	At all speed	kPa {mmH_2O}	max. 2.94 {max. 300}	7.47 {762}	max. 2.94 {max. 300}	7.47 {762}
	Boost pressure	At rated flywheel horsepower	kPa {mmHg}	73.2 – 86.5 {550 – 650}	56.0 {420}	113 – 146 {850 – 1,100}	86.5 {650}
	Exhaust pressure (Turbine inlet pressure)	At rated flywheel horsepower	kPa {mmHg}	65.2 – 77.1 {490 – 580}	50.5 {380}	93.1 – 120 {700 – 900}	66.5 {500}
	Exhaust temperature (Turbine inlet temp.)	All speed (20°C)	°C	max. 650	700	max. 650	700
	Exhaust gas color	Quick acceleration (Low idle → High idle)	Bosch index	max. 5.0	7.0	max. 5.5	7.5
		At rated flywheel horsepower		max. 3.0	4.0	max. 2.5	3.5
		High idling speed		max. 1.0	2.0	max. 1.0	2.0
	Valve clearance (When engine is hot or cold)	Intake valve	mm	0.34	–	0.34	–
		Exhaust valve	mm	0.66	–	0.66	–
Engine body	Compression pressure (SAE30 or SAE15W-40)	Oil temperature: 40 – 60°C (Engine speed: 250 – 300 rpm)	MPa {kg/cm²}	min. 2.9 {min. 30}	2.4 {24}	min. 2.9 {min. 30}	2.4 {24}
	Blow-by pressure (SAE30 or SAE15W-40)	At rated flywheel horsepower (Water temperature: Min. 70°C)	kPa {mmH_2O}	max. 0.78 {max. 80}	1.57 {160}	max. 0.78 {max. 80}	1.57 {160}
Lubrication system	Oil pressure (Oil temperature: Min. 80°C)	At rated flywheel horsepower SAE30 or SAE15W-40 oil	kPa {kg/cm²}	0.30 – 0.50 {3.0 – 5.0}	0.21 {2.1}	0.30 – 0.50 {3.0 – 5.0}	0.21 {2.1}
		SAE10W oil	kPa {kg/cm²}	0.25 – 0.45 {2.5 – 4.5}	0.18 {1.8}	0.25 – 0.45 {2.5 – 4.5}	0.18 {1.8}
		At low idling SAE30 or SAE15W-40 oil	kPa {kg/cm²}	min. 0.12 {min. 1.2}	0.07 {0.7}	min. 0.12 {min. 1.2}	0.07 {0.7}
		SAE10W oil	kPa {kg/cm²}	min. 0.10 {min. 1.0}	0.07 {0.7}	min. 0.10 {min. 1.0}	0.07 {0.7}
	Oil temperature	All speed (Oil in oil pan)	°C	90 – 110	120	90 – 110	120
	Oil consumption ratio	At continuous rated horsepower (Ratio to fuel consumption)	%	max. 0.5	1.0	max. 0.5	1.0
Fuel system	Fuel injection pressure	Nozzle tester	MPa {kg/cm²}	23.5 – 24.5 {240 – 250}	18.4 {188}	23.5 – 24.5 {240 – 250}	18.4 {188}
	Fuel injection timing	B.T.D.C.	degree	21 – 23	–	21 – 23	–
Cooling system	Radiator pressure valve	Opening pressure (Differential pressure)	kPa {kg/cm²}	60 – 80 {0.6 – 0.8}	60 – 80 {0.6 – 0.8}	60 – 80 {0.6 – 0.8}	60 – 80 {0.6 – 0.8}
	Fan speed	At rated engine speed	rpm	1,795 – 1,905	1,795	1,535 – 1,635	1,535
	Fan belt tension	Deflects when pushed with a force of 60 N {6 kg}	mm	5 – 7	9	5 – 10	5 – 10

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S6D108-1

WA380-3		Generator EG150BS-5 Generator for OEM					
Standard value	Permissible value	Standard value	Permissible value	Standard value	Permissible value	Standard value	Permissible value
2,450 – 2,550	2,450 – 2,550	1,565 – 1,575 (50Hz) 1,870 – 1,890 (60Hz)	1,565 – 1,575 (50Hz) 1,870 – 1,890 (60Hz)				
810 – 840	810 – 840	700 – 800	700 – 800				
min. 130	100	min. 130	100				
min. 100	100	min. 100	100				
max. 2.94 {max. 300}	7.47 {762}	max. 2.94 {max. 300}	7.47 {762}				
126 – 160 {950 – 1,200}	100 {750}	*1					
93.1 – 120 {700 – 900}	66.5 {500}						
max. 650	700	max. 700	700				
max. 5.5	7.5	–	–				
max. 2.5	3.5	max. 2.0	3				
max. 1.0	2.0	max. 1.0	2.0				
0.34	–	0.34	–				
0.66	–	0.66	–				
min. 2.9 {min. 30}	2.4 {24}	min. 2.9 {min. 30}	2.4 {24}				
max. 0.78 {max. 80}	1.57 {160}	max. 1.47 {max. 150}	2.94 {300}				
0.30 – 0.50 {3.0 – 5.0}	0.21 {2.1}	0.30 – 0.50 {3.0 – 5.0}	0.21 {2.1}				
0.25 – 0.45 {2.5 – 4.5}	0.18 {1.8}	0.25 – 0.45 {2.5 – 4.5}	0.18 {1.8}				
min. 0.12 {min. 1.2}	0.07 {0.7}	min. 0.12 {min. 1.2}	0.07 {0.7}				
min. 0.10 {min. 1.0}	0.07 {0.7}	min. 0.10 {min. 1.0}	0.07 {0.7}				
90 – 110	120	90 – 110	120				
max. 0.5	1.0	max. 0.5	1.0				
23.5 – 24.5 {240 – 250}	18.4 {188}	26.5 – 27.5 {270 – 280}	20.8 {212}				
21 – 23	–	18 – 20	–				
60 – 80 {0.6 – 0.8}	60 – 80 {0.6 – 0.8}	40 – 60 {0.4 – 0.6}	40 – 60 {0.4 – 0.6}				
1,490 – 1,590	1,490 – 1,590	1,085 – 1,155 (50 Hz) 1,305 – 1,385 (60 Hz)	1,085 – 1,155 (50 Hz) 1,305 – 1,385 (60 Hz)				
5 – 10	5 – 10	–	–				

*1	Standard value				Permissible value			
	At rated		At max.		At rated		At max.	
	50 Hz	60 Hz	50 Hz	60 Hz	50 Hz	60 Hz	50 Hz	60 Hz
Boost pressure	min. 97.1 {min. 730}	min. 136 {min. 1,020}	min. 117 {min. 880}	min. 160 {min. 1,200}	81.0 {610}	113 {850}	97.8 {735}	133 {1,000}
Exhaust pressure	min. 66.5 {min. 500}	min. 109 {min. 820}	min. 77.1 {min. 580}	min. 125 {min. 940}	52.5 {395}	85.7 {645}	60.5 {455}	98.4 {740}

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Engine model				SA6D108-1			
Applicable machine model				PC300-5, PC300HD-5 PC360LC-5		WA420-3	
Classification	Item	Condition, etc.	Unit	Standard value	Permissible value	Standard value	Permissible value
Performance	Engine speed	High idling speed	rpm	2,115 – 2,235	2,115 – 2,235	2,425 – 2,525	2,425 – 2,525
		Low idling speed	rpm	700 – 750	700 – 750	750 – 800	750 – 800
	Necessary starting speed	0°C (Without starting aid)	rpm	min. 130	100	min. 110	900
		–20°C (With starting aid)	rpm	min. 100	100	min. 90	900
Intake, exhaust system	Intake resistance	At all speed	kPa {mmH_2O}	max. 2.94 {max. 300}	6.23 {635}	max. 2.94 {max. 300}	7.47 {762}
	Boost pressure	At rated flywheel horsepower	kPa {mmHg}	73.2 – 86.5 {550 – 650}	100 {750}	113 – 146 {850 – 1,100}	79.8 {600}
	Exhaust pressure (Turbine inlet pressure)	At rated flywheel horsepower	kPa {mmHg}	65.2 – 77.1 {490 – 580}	66.5 {500}	126 – 146 {950 – 1,100}	99.8 {750}
	Exhaust temperature (Turbine inlet temp.)	All speed (20°C)	°C	max. 650	650	max. 650	700
	Exhaust gas color	Quick acceleration (Low idle → High idle)	Bosch index	max. 4.0	6.0	max. 5.5	7.5
		At rated flywheel horsepower		–	–	max. 2.0	3.0
		High idling speed		max. 1.5	–	max. 1.0	2.0
	Valve clearance (When engine is hot or cold)	Intake valve	mm	0.34	–	0.34	–
		Exhaust valve	mm	0.66	–	0.66	–
Engine body	Compression pressure (SAE30 or SAE15W-40)	Oil temperature: 40 – 60°C (Engine speed: 250 – 300 rpm)	MPa {kg/cm^2}	min. 2.7 {min. 28}	2.3 {23}	min. 2.7 {min. 28}	2.3 {23}
	Blow-by pressure (SAE30 or SAE15W-40)	At rated flywheel horsepower (Water temperature: Min. 70°C)	kPa {mmH_2O}	max. 1.47 {max. 150}	2.94 {300}	max. 1.47 {max. 150}	2.94 {300}
Lubrication system	Oil pressure (Oil temperature: Min. 80°C)	At rated flywheel horsepower SAE30 or SAE15W-40 oil	kPa {kg/cm^2}	0.30 – 0.50 {3.0 – 5.0}	0.21 {2.1}	0.30 – 0.50 {3.0 – 5.0}	0.21 {2.1}
		SAE10W oil	kPa {kg/cm^2}	0.25 – 0.45 {2.5 – 4.5}	0.18 {1.8}	0.25 – 0.45 {2.5 – 4.5}	0.18 {1.8}
		At low idling SAE30 or SAE15W-40 oil	kPa {kg/cm^2}	min. 0.12 {min. 1.2}	0.07 {0.7}	min. 0.12 {min. 1.2}	0.07 {0.7}
		SAE10W oil	kPa {kg/cm^2}	min. 0.10 {min. 1.0}	0.07 {0.7}	min. 0.10 {min. 1.0}	0.07 {0.7}
	Oil temperature	All speed (Oil in oil pan)	°C	90 – 110	120	90 – 110	120
	Oil consumption ratio	At continuous rated horsepower (Ratio to fuel consumption)	%	max. 0.5	1.0	max. 0.5	1.0
Fuel system	Fuel injection pressure	Nozzle tester	MPa {kg/cm^2}	26.5 – 27.5 {270 – 280}	20.2 {212}	26.5 – 27.5 {270 – 280}	20.2 {212}
	Fuel injection timing	B.T.D.C.	degree	15 – 17	–	21 – 23	–
Cooling system	Radiator pressure valve	Opening pressure (Differential pressure)	kPa {kg/cm^2}	40 – 60 {0.4 – 0.6}	40 – 60 {0.4 – 0.6}	60 – 80 {0.6 – 0.8}	60 – 80 {0.6 – 0.8}
	Fan speed	At rated engine speed	rpm	1,520 – 1,600	1,520	1,600 – 1,700	1,600
	Fan belt tension	Deflects when pushed with a force of 60 N {6 kg}	mm	3 *2	3 *2	5 – 10	5 – 10

*2 . . . .Between water pump and fan pulley: 6 (mm)

*3	Long time rated	Normal
Boost pressure	min. 112 {min. 840}	min. 129 {min .970}
Exhaust pressure	min. 67.8 {min. 510}	min. 77.1 {min. 580}

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Sugar cane harvester AUSTOFT in AUSTRALIA (Serial No. 10001 – 10926)		Sugar cane harvester AUSTOFT in AUSTRALIA (Serial No. 10927 and up)		Generator EG185B-L-1 (for ALGERIA)		Generator DENYO DCA180	
Standard value	Permissible value	Standard value	Permissible value	Standard value	Permissible value	Standard value	Permissible value
2,560 – 2,640	2,560 – 2,640	2,700 – 2,750	2,700 – 2,750	1,565 – 1,575	1,565 – 1,575	1,565 – 1,575 (50Hz) 1,870 – 1,890 (60Hz)	1,565 – 1,575 (50Hz) 1,870 – 1,890 (60Hz)
950 – 1,050	950 – 1,050	950 – 1,050	950 – 1,050	700 – 800	700 – 800	700 – 800	700 – 800
min. 130	100	min. 130	100	min. 130	100	min. 130	100
min. 100	100	min. 100	100	min. 100	100	min. 100	100
max. 2.94 {max. 300}	6.23 {635}	max. 2.94 {max. 300}	6.23 {635}	max. 2.94 {max. 300}	7.47 {762}	max. 2.94 {max. 300}	7.47 {762}
120 {900}	102 {765}	120 {900}	89.8 {675}	*3	–	*4	
104 {min. 780}	57.8 {555}	min. 106 {min. 800}	57.8 {555}		–		
max. 650	650	max. 650	650	max. 670	700	max. 650	700
–	–	–	–	–	–	–	–
max. 7.3	9.3	–	–	max. 1.5	2.5	max. 1.5	2.5
max. 1.5	2.5	max. 1.5	2.5	max. 1.0	2	max. 1.0	2
0.34	–	0.34	–	0.34	–	0.34	–
0.66	–	0.66	–	0.66	–	0.66	–
min. 2.7 {min. 28}	2.3 {23}	min. 2.7 {min. 28}	2.3 {23}	min. 2.7 {min. 28}	2.3 {23}	min. 2.7 {min. 28}	2.3 {23}
max. 1.47 {max. 150}	2.94 {300}	max. 1.47 {max. 150}	2.94 {300}	max. 1.96 {max. 200}	3.92 {400}	max. 1.96 {max. 200}	3.92 {400}
0.30 – 0.50 {3.0 – 5.0}	0.21 {2.1}	0.30 – 0.50 {3.0 – 5.0}	0.21 {2.1}	0.30 – 0.50 {3.0 – 5.0}	0.21 {2.1}	0.30 – 0.50 {3.0 – 5.0}	0.21 {2.1}
–	–	–	–	0.25 – 0.45 {2.5 – 4.5}	0.18 {1.8}	0.25 – 0.45 {2.5 – 4.5}	0.18 {1.8}
min. 0.12 {min. 1.2}	0.07 {0.7}	min. 0.12 {min. 1.2}	0.07 {0.7}	min. 0.12 {min. 1.2}	0.07 {0.7}	min. 0.12 {min. 1.2}	0.07 {0.7}
–	–	–	–	min. 0.10 {min. 1.0}	0.07 {0.7}	min. 0.10 {min. 1.0}	0.07 {0.7}
90 – 110	120	90 – 110	120	90 – 110	120	90 – 110	120
max. 0.5	1.0	max. 0.5	1.0	max. 0.5	1.0	max. 0.5	1.0
26.0 – 27.0 {265 – 275}	23.3 {238}	26.0 – 27.0 {265 – 275}	23.3 {238}	26.5 – 27.5 {270 – 280}	20.8 {212}	26.5 – 27.5 {270 – 280}	20.8 {212}
23 – 25	–	23 – 25	–	16 – 18	–	16 – 18	–
–	–	–	–	40 – 60 {0.4 – 0.6}	40 – 60 {0.4 – 0.6}	40 – 60 {0.4 – 0.6}	40 – 60 {0.4 – 0.6}
1,755 – 1,845	1,755 – 1,845	1,870 – 1,905	1,870 – 1,905	1,085 – 1,155	1,085 – 1,155	1,305 – 1,385 (50 Hz) 1,085 – 1,155 (60 Hz)	1,305 – 1,385 (50 Hz) 1,085 – 1,155 (60 Hz)
5 – 10	12	5 – 10	12	5 – 10	5 – 10	5 – 10	5 – 10

*4	Standard value				Permissible value			
	At rated		At max.		At rated		At max.	
	50 Hz	60 Hz	50 Hz	60 Hz	50 Hz	60 Hz	50 Hz	60 Hz
Boost pressure	min. 112 {min. 840}	min. 146 {min. 1,100}	min. 129 {min. 970}	min. 164 {min. 1,230}	93.5 {703}	122 {921}	108 {812}	137 {1,030}
Exhaust pressure	min. 67.8 {min. 510}	min. 105 {min. 790}	min. 77.1 {min. 580}	min. 118 {min. 890}	56.8 {427}	87.9 {661}	64.5 {485}	91.8 {690}

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Engine model				SA6D108-1			
Applicable machine model				SA6D108-M-1			
Classification	Item	Condition, etc.	Unit	Standard value	Permissible value	Standard value	Permissible value
Performance	Engine speed	High idling speed	rpm	2,920 – 3,120	2,920 – 3,120		
		Low idling speed	rpm	700 – 750	700 – 750		
	Necessary starting speed	0°C (Without starting aid)	rpm	min. 130	100		
		–20°C (With starting aid)	rpm	–	–		
Intake, exhaust system	Intake resistance	At all speed	kPa {mmH_2O}	max. 2.94 {max. 300}	–		
	Boost pressure	At rated flywheel horsepower	kPa {mmHg}	–	–		
	Exhaust pressure (Turbine inlet pressure)	At rated flywheel horsepower	kPa {mmHg}	–	–		
	Exhaust temperature (Turbine inlet temp.)	All speed (20°C)	°C	max. 690	700		
	Exhaust gas color	Quick acceleration (Low idle → High idle)	Bosch index	Torque converter selection is done by A.D.E., so there is no criteria value.			
		At rated flywheel horsepower					
		High idling speed					
	Valve clearance (When engine is hot or cold)	Intake valve	mm	0.34	–		
		Exhaust valve	mm	0.66	–		
Engine body	Compression pressure (SAE30 or SAE15W-40)	Oil temperature: 40 – 60°C (Engine speed: 250 – 300 rpm)	MPa {kg/cm^2}	min. 2.7 {min. 28}	min. 2.3 {min. 23}		
	Blow-by pressure (SAE30 or SAE15W-40)	At rated flywheel horsepower (Water temperature: Min. 70°C)	kPa {mmH_2O}	max. 1.96 {max. 200}	2.94 {300}		
Lubrication system	Oil pressure (Oil temperature: Min. 80°C)	At rated flywheel horsepower SAE30 or SAE15W-40 oil	MPa {kg/cm^2}	0.30 – 0.50 {3.0 – 5.0}	0.21 {2.1}		
		SAE10W oil	MPa {kg/cm^2}	–	–		
		At low idling SAE30 or SAE15W-40 oil	MPa {kg/cm^2}	min. 0.12 {min. 1.2}	0.07 {0.7}		
		SAE10W oil	MPa {kg/cm^2}	–	–		
	Oil temperature	All speed (Oil in oil pan)	°C	90 – 110	120		
	Oil consumption ratio	At continuous rated horsepower (Ratio to fuel consumption)	%	max. 0.5	1.0		
Fuel system	Fuel injection pressure	Nozzle tester	MPa {kg/cm^2}	26.0 – 27.0 {265 – 275}	21.6 {220}		
	Fuel injection timing	B.T.D.C.	degree	21 – 23	–		
Cooling system	Radiator pressure valve	Opening pressure (Differential pressure)	kPa {kg/cm^2}	–	–		
	Fan speed	At rated engine speed	rpm	–	–		
	Fan belt tension	Deflects when pushed with a force of 60 N {6 kg}	mm	–	–		

*2 . . . .Between water pump and fan pulley: 6 (mm)

*3	Long time rated	Normal
Boost pressure	min. 112 {min. 840}	min. 129 {min .970}
Exhaust pressure	min. 67.8 {min. 510}	min. 77.1 {min. 580}

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TROUBLESHOOTING

Points to remember when troubleshooting 12-023
Method of using troubleshooting chart 12-024

S-1 Starting performance is poor (Starting always takes time) 12-028

S-2 Engine does not start
① Engine does not turn 12-029
② Engine turns but no exhaust gas comes out (Fuel is not being injected) 12-030
③ Exhaust gas comes out but engine does not start (Fuel is being injected) 12-031

S-3 Engine does not pick up smoothly (Follow-up is poor) 12-032

S-4 Engine stops during operations 12-033

S-5 Engine does not rotate smoothly (hunting) 12-034

S-6 Engine lacks output (no power) 12-035

S-7 Exhaust gas is black (incomplete combustion) 12-036

S-8 Oil consumption is excessive (or exhaust gas is blue) 12-037

S-9 Oil becomes contaminated quickly 12-038

S-10 Fuel consumption is excessive 12-039

S-11 Oil is in cooling water, or water spurts back, or water level goes down 12-040

S-12 Oil pressure lamp lights up (drop in oil pressure) 12-041

S-13 Oil level rises 12-042

S-14 Water temperature becomes too high (overheating) 12-043

S-15 Abnormal noise is made 12-044

S-16 Vibration is excessive 12-045

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POINTS TO REMEMBER WHEN TROUBLESHOOTING

Troubleshooting means locating the basic cause of the failure, and carrying out swift repairs, and ensuring that the failure does not occur again.
When carrying out troubleshooting, it is of course important to understand the structure and function. But to carry out the troubleshooting effectively, a quick method is to carry out troubleshooting using the problems mentioned by the operator as a guide in locating the cause.

1. **Do not disassemble the machine simply because there is a failure**
   If the machine is disassembled immediately just because there is a fuilure:
   - Unrelated or unnecessary places are also disassembled
   - It becomes difficult to locate the cause of the failure

   This means that there is not only a waste of time and money on replacement parts, oil, and grease, but this action will also lose the confidence of the user and operator.
   For this reason also, it is important to carry out troubleshooting based on full investigation before starting and troubleshooting following the correct order.

2. **Questions to ask the user and operator**
   1) Are there any problems other than those already reported?
   2) Did anything unusual happen before the failure occurred?
   3) Did the failure occur suddenly, or had the condition of the machine been poor before the failure occurred?
   4) What were the conditions when the failure occurred?
   5) Had any repairs been carried ot before the failure occurred?
   6) Had any similar failure occurred before?

3. **Checks before troubleshooting**
   1) Check the oil level.
   2) Check for any external leakage of oil from the piping and hydraulic equipment.
   3) Check the travel of the control levers.
   4) Other maintenance items can also be carried out visually, so carry out any check that is considered necessary.

4. **Confirming failure**
   Check the degree of the problem to judge for yourself if it is really a failure, or if there is some problem in the handling or operation of the machine.
   ★ When driving the machine and re-enacting the failure, be sure that the investigation or measurement does not make the failure worse.

5. **Troubleshooting**
   Narrow down the causes of the failure from the results of the questions and checks in the above Items 2 — 4, then follow the troubleshooting flow chart to locate the failure.
   ★ Basic procedure for troubleshooting
      1) Start from the simple places.
      2) Start from the most probable places.
      3) Investigate related parts also.

6. **Basic action to remedy cause of failure**
   Even if the failure is repaired, if the root cause of the failure is not repaired, the same failure will occur again.
   To prevent this, it is necessary to investigate why the failure occurred, and to remove the root cause of the failure.

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METHOD OF USING TROUBLESHOOTING CHART

This troubleshooting chart is divided into three sections: **questions, check items, and troubleshooting.** The questions and check items are used to pinpoint high probability causes that can be located from the failure symptoms or simple inspection without using troubleshooting tools.

Next, troubleshooting tools or direct inspection are used to check the high probability causes to make final confirmation.

[Questions]

Sections Ⓐ + Ⓑ in the chart on the right corresponds to the items where answers can be obtained from the user. The items in Ⓑ are items that can be obtained from the user, depending on the user's level.

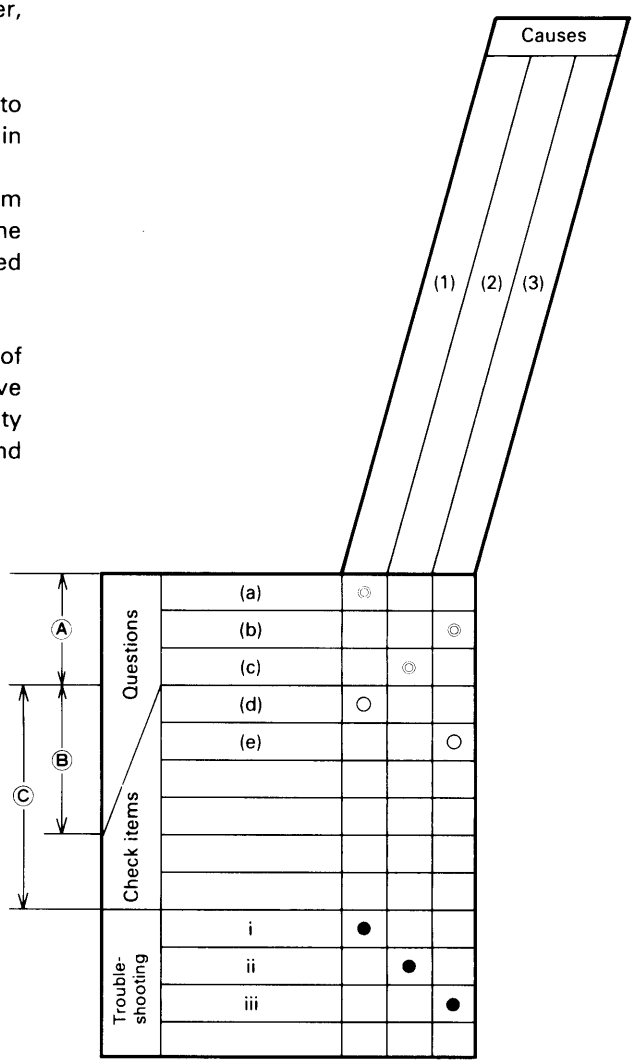
[Check items]

The serviceman carries out simple inspection to narrow down the causes. The items under Ⓒ in the chart on the right correspond to this.

The serviceman narrows down the causes from information Ⓐ that he has obtained from the user and the results of Ⓒ that he has obtained from his own inspection.

[Troubleshooting]

Troubleshooting is carried out in the order of probability, starting with the causes that have been marked as having the highest probability from information gained from **[Questions]** and **[Check items]**.



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The basic method of using the troubleshooting chart is as follows.

Items listed for **[Questions]** and **[Check items]** that have a relationship with the Cause items are marked with ○, and of these, causes that have a high probability are marked with ◎.

Check each of the **[Questions]** and **[Check items]** in turn, and marked the ○ or ◎ in the chart for items where the problem appeared. The vertical column (Causes) that has the highest number of points is the most probable cause, so start troubleshooting for that item to make final confirmation of the cause.

※1. For **[Confirm recent repair history]** in the **[Questions]** Section, ask the user, and mark the Cause column with △ to use as reference for locating the cause of the failure. However, do not use this when making calculations to narrow down the causes.

※2. Use the △ in the Cause column as reference for **[Degree of use (Operated for long period)]** in the **[Questions]** section as reference. As a rule, do not use it when calculating the points for locating the cause, but it can be included if necessary to determine the order for troubleshooting.

			Causes						
			Seized turbocharger, interference	Clogged air cleaner element	Worn piston ring, cylinder	Clogged, seized injection nozzle	Improper injection timing	Defective injection pump (excessive injection)	
※1	Confirm recent repair history								
※2	Degree of use	Operated for long period		△	△	△			

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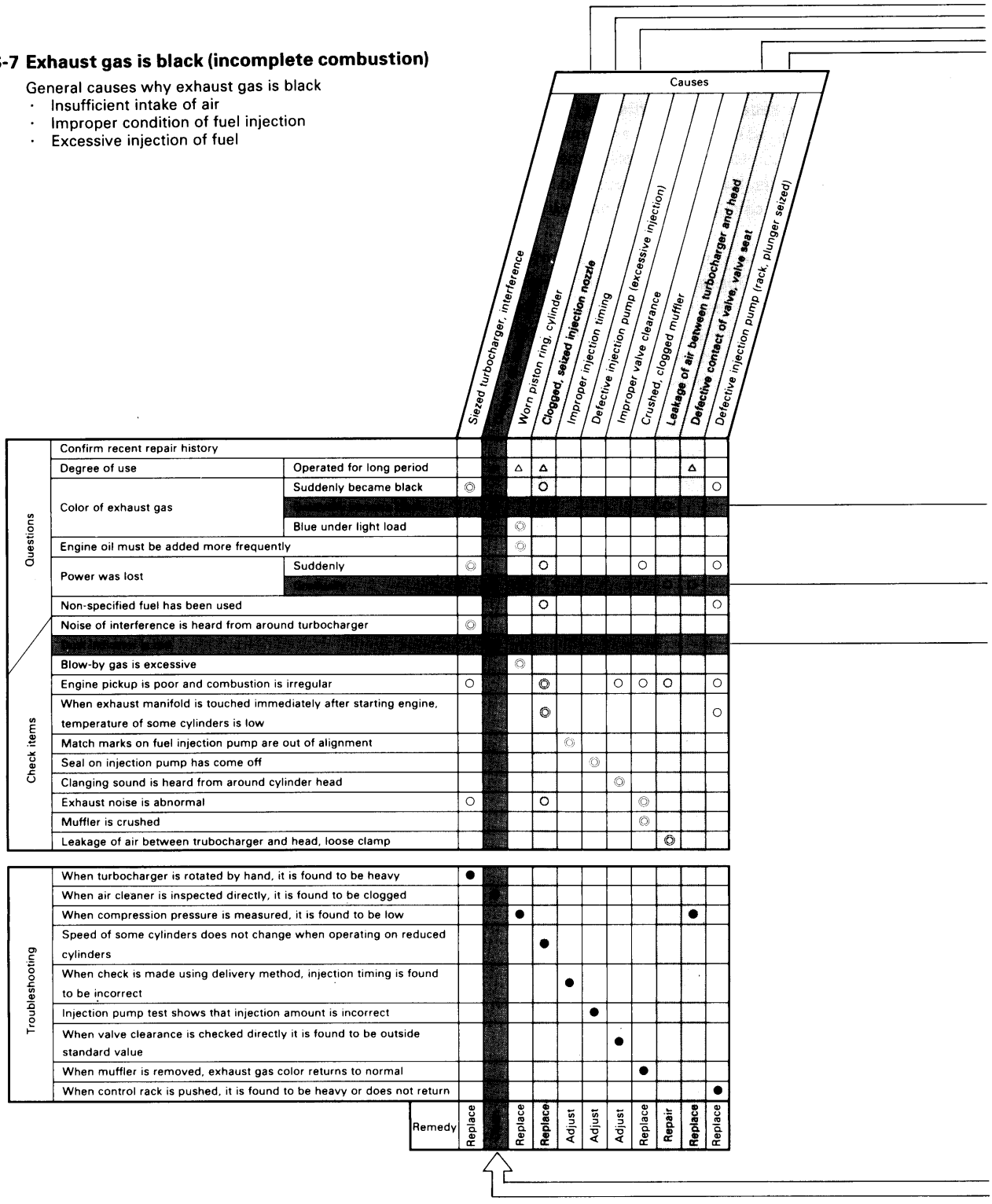
· Example of troubleshooting when exhaust gas is black

Let us assume that [Clogged air cleaner] is taken to be the cause of black exhaust gas. Three symptoms have causal relationship with this problem: [Exhaust gas slowly became black], [Power slowly became weaker], and [Dust indicator is red].

If we look from these three symptoms to find the causes, we find that there is a relationship with five causes. Let us explain here the method of using this causal relationship to pinpoint the most probable cause.

S-7 Exhaust gas is black (incomplete combustion)

General causes why exhaust gas is black
- Insufficient intake of air
- Improper condition of fuel injection
- Excessive injection of fuel



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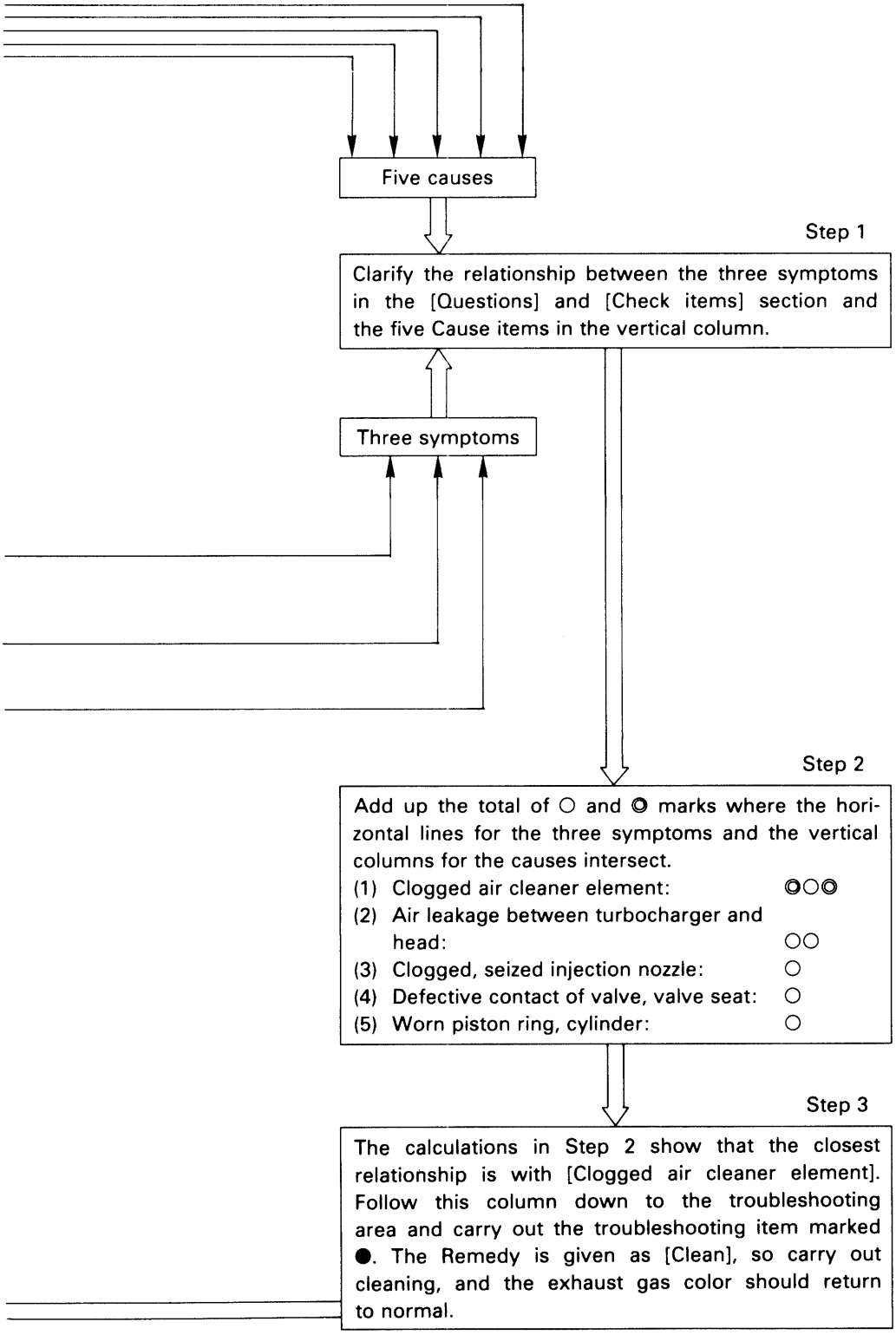
Five causes
Step 1
Clarify the relationship between the three symptoms in the [Questions] and [Check items] section and the five Cause items in the vertical column.
Three symptoms
Step 2
Add up the total of ○ and ◎ marks where the horizontal lines for the three symptoms and the vertical columns for the causes intersect.
(1) Clogged air cleaner element: ◎○◎
(2) Air leakage between turbocharger and head: ○○
(3) Clogged, seized injection nozzle: ○
(4) Defective contact of valve, valve seat: ○
(5) Worn piston ring, cylinder: ○
Step 3
The calculations in Step 2 show that the closest relationship is with [Clogged air cleaner element]. Follow this column down to the troubleshooting area and carry out the troubleshooting item marked ●. The Remedy is given as [Clean], so carry out cleaning, and the exhaust gas color should return to normal.

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S-1 Starting performance is poor (Starting always takes time)

General causes why starting performance is poor

- Defective electrical system
- Insufficient supply of fuel
- Insufficient intake of air
- Improper selection of fuel
  (At ambient temperature of −10°C or below, use ASTM D975 No. 1, and −10°C or above, use ASTM D975 No. 2 diesel fuel.)
  ★ Battery charging rate.

Ambient temperature \ Charging rate	100%	90%	80%	75%	70%
20°C	1.28	1.26	1.24	1.23	1.22
0°C	1.29	1.27	1.25	1.24	1.23
−10°C	1.30	1.28	1.26	1.25	1.24

- The specific gravity should exceed the value for the charging rate of 70% in the above table.
- In cold weather the specific gravity must exceed the value for the charging rate of 75% in the above table.

Legend
○ : Possible causes (judging from Questions and check items)
◌ : Most probable causes (judging from Questions and Check items)
△ : Possible causes due to length of use (used for a long period)
● : Items to confirm the cause.

			Causes: Worn piston ring, cylinder	Defective contact of valve, valve seat	Clogged air cleaner element	Clogged fuel filter, strainer	Clogged feed pump strainer	Defective glow plug	Defective glow relay	Defective glow timer	Defective regulator	Defective alternator	Defective or deteriorated battery	Defective injection nozzle	Defective injection timing	Defective injection pump (rack, plunger stuck)	Leakage, clogging, air in fuel system	Clogged fuel tank air breather hole
Questions	Confirm recent repair history																	
	Degree of use	Operated for long period			△	△	△						△					
	Ease of starting	Gradually became worse	◌	◌														
		Starts when warm						◌	◌	◌			◌					
	Indicator lamp does not light up							◌	◌	◌								
	Engine oil must be added more frequently		◌															
	Replacement of filters has not been carried out according to operation manual				◌	◌	◌						○		○			
	Dust indicator is red				◌													
	Non-specified fuel has been used					○	○						○		○			
	Battery charge lamp is ON									◌	◌							
	Starting motor cranks engine slowly											◌						
	When exhaust manifold is touched immediately after starting engine, temperature of some cylinders is low												◌					
Check items	Engine does not pick up smoothly, and combustion is irregular		○	○									◌					
	Blow-by gas is excessive		◌															
	Match marks on fuel injection pump are out of alignment													◌				
	Mud is stuck to fuel tank cap																	○
	When engine is cranked with starting motor, 1) Little fuel comes out even when injection pump sleeve nut is loosened														◌			
	2) Little fuel comes out even when fuel filter air bleed plug is loosened				◌	◌									◌			
	Leakage from fuel piping														○	◌		
	There is hunting from engine (rotation is irregular)				○	○										◌	○	
Troubleshooting	When compression pressure is measured, it is found to be low		●	●														
	When air element is inspected directly, it is found to be clogged				●													
	When fuel filter, strainer are inspected directly, they are found to be clogged					●											●	
	When feed pump strainer is inspected directly, it is found to be clogged						●											
	Heater mount does not become warm							●	●	●								
	Voltage is 26 — 30V between alternator terminal B and terminal E with engine at low idling	Yes									●							
		No										●						
	Either specific gravity of electrolyte or voltage of battery is low												●					
	Speed of some cylinders does not change when operating on reduced cylinders													●				
	When check is made using delivery method, injection timing is found to be incorrect														●			
	When control rack is pushed, it is found to be heavy or does not return (when blind plug at rear of pump is removed, it can be seen that plunger control sleeve does not move)															●		
	When fuel cap is inspected directly, it is found to be clogged																	●
	Remedy		Replace	Repair	Clean	Clean	Clean	Replace	Replace	Replace	Replace	Replace	Replace	Replace	Adjust	Replace	Repair	Clean

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S-2 Engine does not start

① Engine does not turn

General causes why engine does not turn

- Internal parts of engine seized
  - ★ If internal parts of the engine are seized, carry out troubleshooting for "Engine stops during operations".
- Failure in power train
- Defective electrical system

Legend
○ : Possible causes (judging from Questions and check items)
: Most probable causes (judging from Questions and Check items)
△ : Possible causes due to length of use (used for a long period)
● : Items to confirm the cause.

			Causes							
			Defective wiring of starting circuit	Defective or deteriorated battery	Defective starting motor	Broken ring gear	Defective safety relay or safety switch	Defective battery relay	Defective battery terminal connection	Defective starting switch
Questions	Confirm recent repair history									
	Degree of use	Operated for long period		△		△				
	Condition of horn when starting switch is turned ON	Horn does not sound							○	○
		Horn sound level is low								
Check items	When starting switch is turned to START, pinion moves out, but	Rotating speed is slow								
		Makes grating noise								
		Soon disengages again								
		Makes rattling noise and does not turn		○	○		○			
	When starting switch is turned to START, pinion does not move out			○						○
	When starting switch is turned to ON, there is no clicking sound			○						
	Battery terminal is loose									
	When battery is checked, battery electrolyte is found to be low									
Troubleshooting	Specific gravity of electrolyte, voltage of battery is low		●							
	For the following conditions 1) — 5), turn the starting switch OFF, connect the cord, and carry out troubleshooting at ON									
	1) When terminal B and terminal C of starting switch are connected, engine starts									●
	2) When ternimal B and terminal C of starting motor are connected, engine starts			●						
	3) When terminal B and terminal C of safety relay are connected, engine starts					●				
	4) When terminal of safety switch and terminal B of starting motor are connected, engine starts					●				
	5) There is no 24V voltage between battery relay terminal B and terminal E						●			
	When ring gear is inspected directly, tooth surface is found to be chipped				●					
		Remedy	Carry out troubleshooting for defective wiring of starting circuit	Replace	Replace	Replace	Replace	Replace	Replace	Replace

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② Engine turns but no exhaust gas comes out (Fuel is not being injected)

General causes why engine turns but no exhaust gas comes out

- Supply of fuel impossible
- Supply of fuel is extremely small
- Improper selection of fuel (particularly in winter)

Standards for use of fuel

Type of fuel	Ambient temperature
	−22 −4 14 32 50 68 86 104 122°F −30 −20 −10 0 10 20 30 40 50°C
Diesel fuel	ASTM D975 No. 2 ASTM D975 No. 1

Legend
○ : Possible causes (judging from Questions and check items)
◌ : Most probable causes (judging from Questions and Check items)
△ : Possible causes due to length of use (used for a long period)
● : Items to confirm the cause.

		Causes: Broken injection pump drive shaft, key	Defective injection pump (rack, plunger seized)	Seized, broken feed pump piston	Clogged fuel filter, strainer	Clogged feed pump strainer	Lack of fuel	Clogged, leaking fuel piping	Clogged fuel tank air breather hole	Improper fuel used
Questions	Confirm recent repair history									
	Degree of use — Operated for long period				△	△			△	
	Exhaust gas suddenly stops coming out (when starting again)	◌	◌	◌						
	Replacement of filters has not been carried out according to operation manual				◌	◌				
	Fuel tank is found to be empty						◌			
	There is leakage from fuel piping							◌		
	Mud is stuck to fuel tank cap								◌	
Check items	When fuel filter is drained, fuel does not come out									◌
	When engine is cranked with starting motor, 1) Injection pump coupling does not rotate	◌								
	2) No fuel comes out even when fuel filter air bleed plug is loosened	◌			○	○				○
	3) No fuel spurts out even when injection pipe sleeve nut is loosened	◌	◌	◌						
	Rust and water are found when fuel is drained				○	○				
Troubleshooting	Check injection pump directly	●								
	When control rack is pushed, it is found to be heavy, or does not return		●							
	Check feed pump directly			●						
	When fuel filter, strainer are inspected directly, they are found to be clogged				●					●
	When feed pump strainer is inspected directly, it is found to be clogged					●				
	When fuel cap is inspected directly, it is found to be clogged								●	
	Remedy	Replace	Replace	Replace	Clean	Clean	Add	Repair	Repair	Replace

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③ Exhaust gas comes out but engine does not start (Fuel is being injected)

General causes why exhaust gas comes out but engine does not start

- Lack of rotating force due to defective electrical system
- Insufficient supply of fuel
- Insufficient intake of air
- Improper selection of fuel

Legend
○ : Possible causes (judging from Questions and check items)
: Most probable causes (judging from Questions and Check items)
△ : Possible causes due to length of use (used for a long period)
● : Items to confirm the cause.

		Causes: Defective, broken valve system (valve, rocker lever, etc.)	Defective injection pump (rack, plunger stuck)	Worn piston ring, cylinder	Clogged fuel filter, strainer	Clogged feed pump strainer	Clogged air cleaner element	Defective glow plug	Defective glow relay	Defective glow timer	Defective or deteriorated battery	Leakage, clogging, air in fuel system	Clogged injection nozzle, defective spray	Clogged fuel tank air breather hole	Improper fuel used
Questions	Confirm recent repair history														
	Degree of use — Operated for long period			△	△	△						△			
	Suddenly failed to start														
	When engine is cranked, abnormal noise is heard from around head														
	Engine oil must be added more frequently														
	Non-specified fuel has been used		○									○			
	Replacement of filters has not been carried out according to operation manual														
	Rust is found when fuel is drained														
	Dust indicator is red														
	Indicator lamp does not light up														
	Starting motor cranks engine slowly														
	Mud is stuck to fuel tank cap													○	
	When fuel lever is placed at FULL position, it does not contact stopper		○												
Check items	When engine is cranked with starting motor, 1) Little fuel comes out even when injection pump sleeve nut is loosened														
	2) Little fuel comes out even when fuel filter air bleed plug is loosened														○
	There is leakage from fuel piping														
	When exhaust manifold is touched immediately after starting engine, temperature of some cylinder is low														
	When fuel filter is drained, no fuel comes out														
Troubleshooting	Remove head cover and check directly	●													
	When control rack is pushed, it is found to be heavy, or does not return		●												
	When compression pressure is measured, it is found to be low			●											
	When fuel filter, strainer are inspected directly, they are found to be clogged				●										●
	When feed pump strainer is inspected directly, it is found to be clogged					●									
	When air element is inspected directly, it is found to be clogged						●								
	Heater mount does not become warm							●	●	●					
	Either specific gravity of electrolyte or voltage of battery is low										●				
	When feed pump is operated, there is no response, or pump is heavy											●			
	Speed of some cylinders does not change when operating on reduced cylinders												●		
	When fuel cap is inspected directly, it is found to be clogged													●	
	Remedy	Replace	Replace	Replace	Clean	Clean	Clean	Replace	Replace	Replace	Replace	Repair	Clean	Clean	—

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S-3 Engine does not pick up smoothly (Follow-up is poor)

General causes why engine does not pick up smoothly

- Insufficient intake of air
- Insufficient supply of fuel
- Improper condition of fuel injection
- Improper fuel used

Legend
○ : Possible causes (judging from Questions and check items)
◎ : Most probable causes (judging from Questions and Check items)
△ : Possible causes due to length of use (used for a long period)
● : Items to confirm the cause.

			Causes: Clogged air cleaner element	Clogged fuel filter, strainer	Clogged feed pump strainer	Clogged injection nozzle, defective spray	Seized injection pump plunger	Worn piston ring, cylinder	Seized turbocharger, interference	Improper valve clearance	Clogged fuel tank air breather hole	Clogged, leaking fuel piping	Defective contact of valve, valve seat
Questions	Confirm recent repair history												
	Degree of use	Operated for long period	△	△	△			△					△
	Replacement of filters has not been carried out according to operation manual												
	Non-specified fuel is being used			◎	◎	◎	◎						
	Engine oil must be added more frequently							◎					
	Rust and water are found when fuel is drained				◎								
	Dust indicator is red		◎										
	Noise of interference is heard from around turbocharger								◎				
Check items	Engine pick-up suddenly became poor					○			◎		○	○	
	Color of exhaust gas	Blue under light load						◎					
		Black	◎			◎			◎				○
	Clanging sound is heard from around cylinder head									◎			
	Mud is stuck to fuel tank cap										◎		
	There is leakage from fuel piping											◎	
	High idling speed under no load is normal, but speed suddenly drops when load is applied				◎						○		
	There is hunting from engine (rotation is irregular)			○	◎	○					○		
	When exhaust manifold is touched immediately after starting engine, temperature of some cylinders is low				◎		○						
	Blow-by gas is excessive							◎					
Troubleshooting	When air element is inspected directly, it is found to be clogged		●										
	When fuel filter, strainer are inspected directly, they are found to be clogged			●									
	When feed pump strainer is inspected directly, it is found to be clogged				●								
	Speed of some cylinders does not change when operating on reduced cylinders					●							
	When control rack is pushed, it is found to be heavy, or does not return						●						
	When compression pressure is measured, it is found to be low							●					●
	When turbocharger is rotated by hand, it is found to be heavy								●				
	When valve clearance is checked directly, it is found to be outside standard value									●			
	When fuel cap is inspected directly, it is found to be clogged										●		
	When feed pump is operated, operation is too light or too heavy											●	
		Remedy	Clean	Clean	Clean	Repair	Replace	Replace	Replace	Adjust	Clean	Repair	Replace

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S-4 Engine stops during operations

General causes why engine stops during operations

- Seized parts inside engine
- Insufficient supply of fuel
- Overheating
  - ★ If there is overheating and insufficient output, carry out troubleshooting for overheating.
- Failure in power train
  - ★ If the engine stops because of a failure in the power train, carry out troubleshooting for the chassis.

Legend
○ : Possible causes (judging from Questions and check items)
: Most probable causes (judging from Questions and Check items)
△ : Possible causes due to length of use (used for a long period)
● : Items to confirm the cause.

			Causes													
			Broken, seized piston, connecting rod	Broken, seized crankshaft bearing	Broken valve system (valve, rocker lever, etc.)	Broken, seized gear train	Broken pump auxiliary equipment	Broken fuel pump drive shaft, key	Lack of fuel	Clogged fuel filter, strainer	Clogged feed pump strainer	Broken, seized feed pump piston	Clogged, leaking fuel piping	Clogged fuel tank air breather hole	Defective injection pump (rack, plunger stuck)	Failure in chassis power train
Questions	Confirm recent repair history															
	Degree of use	Operated for long period							△	△						
	Condition when engine stopped	Abnormal noise was heard and engine stopped suddenly									○			○		
		Engine overheated and stopped		○			○									
		Engine stopped slowly							○	○						
		There was hunting and engine stopped							○	○			○			
	Fuel gauge lamp lights up															
	Fuel tank is found to be empty															
	Replacement of filters has not been carried out according to operation manual															
	Non-specified fuel is being used								○	○	○			○		
	When feed pump is operated, there is no response or it is heavy								○	○						
	Mud is stuck to fuel tank cap															
	Engine turns, but stops when transmission control lever is operated															
Check items	Try to turn by hand using barring tool	Does not turn at all														
		Turns in opposite direction														
		Moves amount of backlash														
		Shaft does not turn														
	Rust and water are found when fuel is drained															
	Metal particles are found when oil is drained								○	○						
Troubleshooting	Remove oil pan and check directly		●	●												
	Remove head cover and check directly				●											
	When gear train is inspected, it does not turn					●										
	Turns when pump auxiliary equipment is removed						●									
	When fuel filter, strainer are inspected directly, they are found to be clogged								●							
	When feed pump strainer is inspected directly, it is found to be clogged									●						
	Check feed pump directly										●					
	When control rack is pushed, it is found to be heavy or does not return													●		
		Remedy	Replace	Replace	Replace	Replace	Replace	Replace	Add	Clean	Clean	Replace	Repair	Clean	Replace	—

Carry out troubleshooting in chassis volume

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S-5 Engine does not rotate smoothly (hunting)

General causes why engine does not rotate smoothly

- Air in fuel system
- Defective governor mechanism
- Defective engine throttle controller mechanism (engine throttle controller type)
  - ★ If there is no hunting when the engine throttle controller rod is disconnected, carry out troubleshooting for the electrical system.

Legend
○ : Possible causes (judging from Questions and check items)
◌ : Most probable causes (judging from Questions and Check items)
△ : Possible causes due to length of use (used for a long period)
● : Items to confirm the cause.

			Causes: Defective operation of governor	Defective adjustment of governor	Defective operation of control rack	Low speed is too low	Lack of fuel	Clogged feed pump strainer	Clogged fuel filter, strainer	Clogged, air in circuit between fuel tank and feed pump	Clogged, air in circuit between feed pump and nozzle	Clogged fuel tank air breather hole
Questions	Confirm recent repair history											
	Degree of use	Operated for long period						△	△			
	Condition of hunting	Occurs at certain speed range	◌	◌	◌	○						
		Occurs at low idling	○			◌		○	○	○	○	
		Occurs even when speed is raised	○	○	○							○
		Occurs on slopes					◌					
	Fuel tank is found to be empty						◌					
	Replacement of filters has not been carried out according to operation manual							◌	◌			
	Rust is found when fuel is drained							○	○			
Check items	Leakage from fuel piping									◌	◌	
	When feed pump is operated, 1) No response, light, return is quick									◌	◌	
	2) No response, light, return is normal									◌		
	Engine speed sometimes rises too high		◌	◌								
	Engine is sometimes difficult to stop		◌		◌							
	Seal on injection pump has come off			◌		◌						
Troubleshooting	When governor lever is moved it is found to be stiff		●		●							
	When injection pump is tested, governor is found to be improperly adjusted			●								
	When control rack is pushed, it is found to be heavy, or does not return				●							
	When fuel cap is inspected directly, it is found to be clogged					●						●
	When feed pump strainer is inspected directly, it is found to be clogged						●					
	When fuel filter, strainer are inspected directly, they are found to be clogged							●				
		Remedy	Adjust	Adjust	Adjust	Adjust	Add	Claen	Clean	Repair	Repair	Clean

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S-6 Engine lacks output (no power)

General causes why engine lacks output

- Insufficient intake of air
- Insufficient supply of fuel
- Improper condition of fuel injection
- Improper fuel used
  (if non-specified fuel is used, output drops)
- Lack of output due to overheating
  - ⋆ If there is overheating and insufficient output, carry out troubleshooting for overheating.

Legend
○ : Possible causes (judging from Questions and check items)
: Most probable causes (judging from Questions and Check items)
△ : Possible causes due to length of use (used for a long period)
● : Items to confirm the cause.

			Causes: Clogged air cleaner element	Seized turbocharger, interference	Worn piston ring, cylinder	Clogged fuel filter, strainer	Clogged feed pump strainer	Clogged injection nozzle, defective spray	Seized injection pump plunger	Improper valve clearance	Defective contact of valve, valve seat	Bent fuel lever linkage, defective adjustment	Clogged, leaking fuel piping	Clogged fuel tank air breather hole
Questions	Confirm recent repair history													
	Degree of use	Operated for long period	△		△	△	△			△				
	Power was lost	Suddenly												
		Gradually	○		○	○	○	○		○				
	Engine oil must be added more frequently													
	Replacement of filters has not been carried out according to operation manual													
	Non-specified fuel is being used													
	Dust indicator is red													
	Color of exhaust gas	Black												
		Blue under light load												
Check items	Noise of interference is heard from around turbocharger													
	Blow-by gas is excessive													
	Engine pickup is poor and combustion is irregular							○					○	○
	High idling speed under no load is normal, but speed suddenly drops when load is applied													○
	When exhaust manifold is touched immediately after starting engine, temperature of some cylinders is low								○					
	There is hunting from engine (rotation is irregular)					○	○						○	○
	Clanging sound is heard from around cylinder head													
	High idling speed of engine is low							○						
	Leakage from fuel piping													
Troubleshooting	When air element is inspected directly, it is found to be clogged		●											
	When trubocharger is rotated by hand, it is found to be heavy			●										
	When compression pressure is measured, it is found to be low				●						●			
	When fuel filter, strainer are inspected directly, they are found to be clogged					●								
	When feed pump strainer is inspected directly, it is found to be clogged						●							
	Speed of some cylinders does not change when operating on reduced cylinders							●						
	When control rack is pushed, it is found to be heavy, or does not return								●					
	When valve clearance is checked directly, it is found to be outside standard value									●				
	When lever is placed at FULL position, it does not contact stopper											●		
	When feed pump is operated, operation is too light or too heavy												●	
	When fuel cap is inspected directly, it is found to be clogged													●
		Remedy	Clean	Replace	Replace	Clean	Clean	Repair	Replace	Adjust	Replace	Adjust	Repair	Clean

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S-7 Exhaust gas is black (incomplete combustion)

General causes why exhaust gas is black

- Insufficient intake of air
- Improper condition of fuel injection
- Excessive injection of fuel

Legend
○ : Possible causes (judging from Questions and check items)
: Most probable causes (judging from Questions and Check items)
△ : Possible causes due to length of use (used for a long period)
● : Items to confirm the cause.

			Causes: Siezed turbocharger, interference	Clogged air cleaner element	Worn piston ring, cylinder	Clogged, seized injection nozzle	Improper injection timing	Defective injection pump (excessive injection)	Improper valve clearance	Crushed, clogged muffler	Leakage of air between turbocharger and head	Defective contact of valve, valve seat	Defective injection pump (rack, plunger seized)
Questions	Confirm recent repair history												
	Degree of use	Operated for long period		△	△	△						△	
	Color of exhaust gas	Suddenly became black				○							○
		Gradually became black				○					○		
		Blue under light load											
	Engine oil must be added more frequently												
	Power was lost	Suddenly				○				○			○
		Gradually		○	○						○	○	
	Non-specified fuel is being used					○							○
Check items	Noise of interference is heard from around turbocharger												
	Dust indicator is red												
	Blow-by gas is excessive												
	Engine pickup is poor and combustion is irregular		○						○	○	○		○
	When exhaust manifold is touched immediately after starting engine, temperature of some cylinders is low												○
	Match marks on fuel injection pump are out of alignment												
	Seal on injection pump has come off												
	Clanging sound is heard from around cylinder head												
	Exhaust noise is abnormal		○			○							
	Muffler is crushed									○			
	Leakage of air between trubocharger and head, loose clamp										◎		
Troubleshooting	When turbocharger is rotated by hand, it is found to be heavy		●										
	When air cleaner is inspected directly, it is found to be clogged			●									
	When compression pressure is measured, it is found to be low				●							●	
	Speed of some cylinders does not change when operating on reduced cylinders					●							
	When check is made using delivery method, injection timing is found to be incorrect						●						
	Injection pump test shows that injection amount is incorrect							●					
	When valve clearance is checked directly it is found to be outside standard value								●				
	When muffler is removed, exhaust gas color returns to normal									●			
	When control rack is pushed, it is found to be heavy, or does not return												●
		Remedy	Replace	Clean	Replace	Replace	Adjust	Adjust	Adjust	Replace	Repair	Replace	Replace

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S-8 Oil consumption is excessive (or exhaust gas is blue)

★ Do not run the engine at idling for more than 20 minutes continuously. (Both low and high idling)

General causes why oil consumption is excessive

- Abnormal combustion of oil
- External leakage of oil
- Wear of lubrication system

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Legend
○ : Possible causes (judging from Questions and check items)
: Most probable causes (judging from Questions and Check items)
△ : Possible causes due to length of use (used for a long period)
● : Items to confirm the cause.

			Causes: Broken piston ring	Worn piston ring, cylinder liner	Clogged breather or breather hose	Leakage from oil filter, oil cooler	Leakage from oil piping	Leakage from oil drain plug	Leakage from oil pan, cylinder head, etc.	Broken oil cooler	Worn seal at turbine end	Worn seal at blower end	Turbocharger: Worn, broken rear seal, seal surface	Turbocharger: Dust sucked in from intake system	Turbocharger: Worn valve (stem, guide), broken seal
Questions	Confirm recent repair history														
	Degree of use	Operated for long period		△						△	△			△	
	Oil consumption suddenly increased								○						
	Engine oil must be added more frequently								○						
	Engine oil becomes contaminated quickly		○		○										
	Exhaust gas is blue under light load														
	Amount of blow-by gas	Abnormally excessive									○			○	
		None			●										
Check items	Area around engine is dirty with oil					●									
	There is oil in engine cooling water														
	When exhaust pipe is removed, inside is found to be dirty with oil													○	
	Inside of turbocharger intake pipe is dirty with oil														
	Oil level in clutch or TORQFLOW transmission damper chamber rises														
	Clamps for intake system are loose														

		Remedy: Replace	Replace	Clean	Repair	Repair	Repair	Repair	Replace	Replace	Replace	Repair	Repair	Repair
Troubleshooting	When compression pressure is measured, it is found to be low	●	●											
	When breather element is inspected, it is found to be clogged with dirty oil			●										
	There is external leakage of oil from engine				●	●	●	●						
	Pressure-tightness test of oil cooler shows there is leakage								●					
	Excessive play of turbocharger shaft									●	●			
	Check rear seal directly											●		
	When intake manifold is removed, dust is found inside												●	
	When intake manifold is removed, inside is found to be dirty with oil													●

S-9 Oil becomes contaminated quickly

General causes why oil becomes contaminated quickly

- Intake of exhaust gas due to internal wear
- Clogging of lubrication passage
- Improper combustion
- Improper oil used
- Operation under excessive load

Legend
○ : Possible causes (judging from Questions and check items)
◎ : Most probable causes (judging from Questions and Check items)
△ : Possible causes due to length of use (used for a long period)
● : Items to confirm the cause.

			Causes: Worn piston ring, cylinder	Clogged breather, breather tube	Clogged oil filter	Worn valve, valve guide	Clogged oil cooler	Clogged turbocharger drain pipe	Defective seal at turbocharger turbine end	Defective safety valve	Exhaust gas is black
Questions	Confirm recent repair history										
	Degree of use	Operated for long period	△			△			△		
	Engine oil must be added more frequently		◎								
	Non-specified fuel is being used				○						
Check items	Color of exhaust gas	Blue under light load	◎								
		Black									◎
	Amount of blow-by gas	Abnormally excessive	◎			○		○	○		
		None		◎							
	Oil filter caution lamp stays on even when oil pressure rises				◎					○	
	When oil filter is inspected, metal particles are found		○		◎	○					
	When exhaust pipe is removed, inside is found to be dirty with oil					◎					
	Engine oil temperature rises quickly						◎				
Troubleshooting	When compression pressure is measured, it is found to be low		●			●					
	When breather element is inspected directly, it is found to be clogged with dirty oil, or hose is broken			●							
	When oil filter is inspected directly, it is found to be clogged				●						
	When oil cooler is inspected directly, it is found to be clogged						●				
	Turbocharger drain tube is clogged							●			
	Excessive play of turbocharger shaft								●		
	When safety valve is directly inspected, spring is found to be catching or broken									●	
			Carry out troubleshooting for "Exhaust is black".								
	Remedy		Replace	Clean	Replace	Replace	Clean	Clean	Replace	Replace	—

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S-10 Fuel consumption is excessive

General causes why fuel consumption is excessive

- Leakage of fuel
- Improper condition of fuel injection
- Excessive injection of fuel

Legend
○ : Possible causes (judging from Questions and check items)
: Most probable causes (judging from Questions and Check items)
△ : Possible causes due to length of use (used for a long period)
● : Items to confirm the cause.

			Causes: Defective injection pump (excessive injection)	Defective injection nozzle spray	Defective injection pump plunger	Improper fuel injection timing	External leakage from fuel piping, fuel filter	Leakage of fuel inside head cover	Defective oil seal inside feed pump (piston)	Defective adjustment of fuel lever linkage
Questions	Confirm recent repair history									
	Degree of use	Operated for long period		△	△				△	
	Condition of fuel consumption	More than for other machines of same model				○				
		Gradually increased		○	○					
		Suddenly increased					○	○		
	Exhaust gas color	Black		○		○				○
		White						○		
Check items	Seal on injection pump has come off									
	There is irregular combustion									
	When exhaust manifold is touched immediately after starting engine, temperature of some cylinders is low				○					
	Match mark on injection pump is misaligned					●				
	There is external leakage of fuel from engine						●			
	Engine oil level rises and smells of diesel fuel		○					●	●	
	Engine low idling speed is high		○							●
Troubleshooting	Injection pump test shows that injection amount is excessive		●							
	Speed of some cylinders does not change when operating on reduced cylinders			●						
	When control rack is pushed, it is found to be heavy, or does not return				●					
	When check is made using delivery method, injection timing is found to be incorrect					●				
	Remove head cover and check directly							●		
	Remove feed pump and check directly								●	
	When engine speed is measured, low idling speed is found to be high									●
		Remedy	Adjust	Replace	Replace	Adjust	Repair	Repair	Repair	Adjust

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S-11 Oil is in cooling water, or water spurts back, or water level goes down

General causes why oil is in cooling water

- Internal leakage in lubrication system
- Internal leakage in cooling system

Legend
○ : Possible causes (judging from Questions and check items)
◌ : Most probable causes (judging from Questions and Check items)
△ : Possible causes due to length of use (used for a long period)
● : Items to confirm the cause.

			Causes: Broken oil cooler core, O-ring	Broken head, head gasket	Insufficient protrusion of liner	Broken oil cooler for power train	Broken liner O-ring, holes caused by pitting	Internal cracks in cylinder block
Questions	Confirm recent repair history							
	Degree of use	Operated for long period	△				△	
	Oil level	Suddenly increased	○	○		○		
		Gradually increased					○	○
Check items	Hard water is being used as cooling water		○				○	
	Engine oil level has risen, oil is cloudy white		◌				○	○
	Excessive air bubbles inside radiator, spurts back			◌	◌			
	Hydraulic oil, torque converter, transmission oil is cloudy white					◌		
	When hydraulic oil, torque converter, transmission oil is drained, water is found					◌		
Trouble-shooting	Pressure-tightness test of oil cooler shows there is leakage		●			●		
	Pressure-tightness test of cylinder head shows there is leakage			●				
	Remove cylinder head and check directly				●			
	Remove oil pan and check directly						●	●
		Remedy	Replace	Replace	Replace	Replace	Replace	Replace

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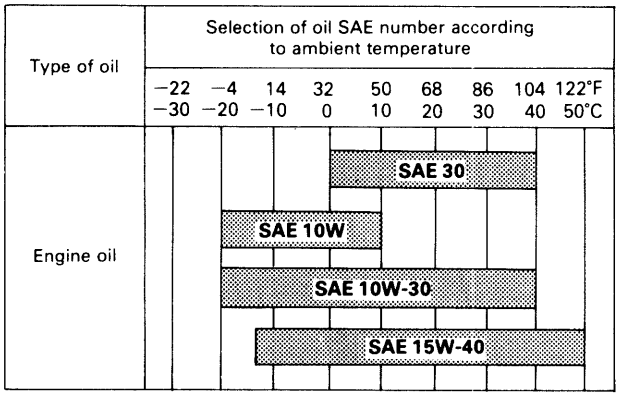
S-12 Oil pressure lamp lights up (drop in oil pressure)

General causes why oil pressure lamp lights up

- Leakage, clogging, wear of lubricating system
- Defective oil pressure control
- Improper oil used (improper viscosity)
- Deterioration of oil due to overheating

★ Standards for engine oil selection



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Legend
○ : Possible causes (judging from Questions and check items)
: Most probable causes (judging from Questions and Check items)
△ : Possible causes due to length of use (used for a long period)
● : Items to confirm the cause.

			Causes: Clogged oil filter	Worn bearing journal	Clogged strainer inside oil pan	Clogged, broken oil pipe inside oil pan	Broken suction pipe brazing	Defective oil pump	Insufficient oil in oil pan	Defective regulator valve	Defective relief valve	Leaking, crushed hydraulic piping	Defective oil level sensor	Defective oil pressure sensor	Water, fuel in oil
Questions	Confirm recent repair history														
	Degree of use	Operated for long period	△	△				△							
	Replacement of filters has not been carried out according to operation manual														
	Caution lamp lights up										○				
	Non-specified fuel has been used		○	○											
	Condition when oil pressure lamp lights up	Lights up at low idling								○					
		Lights up at low, high idling						○	○	○					
		Lights up on slopes													
		Sometimes lights up										○	○		
Check items	There is clogging, leakage from hydraulic piping (external)														
	Oil level sensor lamp lights up														
	When oil level in oil pan is checked, it is found to be low														
	Metal particles are found when oil is drained														
	Metal particles are stuck to oil filter element							○							
	Oil is cloudy white or smells of diesel oil														
Troubleshooting	When oil filter is inspected directly, it is found to be clogged		●	●											
	Remove oil pan and check directly				●	●	●								
	Oil pump rotation is heavy, there is play							●							
	There is catching of relief valve or regulator valve, spring or valve guide is broken									●	●				
	When oil level sensor is replaced, oil pressure sensor lamp goes out												●		Carry out troubleshooting for "Oil level rises".
	When oil pressure is measured, it is found to be within standard value													●	
		Remedy	Clean	Clean	Clean	Clean	Repair	Replace	Add	Adjust	Adjust	Repair	Replace	Replace	—

S-13 Oil level rises

★ If there is oil in the cooling water, carry out troubleshooting for "Oil is in cooling water".

General causes why oil level rises

- Water in oil (cloudy white)
- Fuel in oil (diluted, and smells of diesel fuel)
- Entry of oil from other component

Legend
○ : Possible causes (judging from Questions and check items)
◌ : Most probable causes (judging from Questions and Check items)
△ : Possible causes due to length of use (used for a long period)
● : Items to confirm the cause.

		Causes: Broken oil cooler core, O-ring	Defective nozzle holder sleeve	Broken head, head gasket	Clogged water pump breather hole (including precombustion chamber)	Worn, damaged rear seal surface	Defective seal of pump or auxiliary equipment	Leakage of fuel from piping inside head cover	Defective part inside injection pump (flange type)	Defective thermostat seat	Damaged liner O-ring, holes made by pitting	Cracks inside cylinder block
Questions	Confirm recent repair history											
	Degree of use — Operated for long period		△		△	△	△				△	
	There is oil in radiator cooling water	◌	○	○							○	○
	Exhaust gas is white		◌					○		○		
	When engine is first started, drops of water come from muffler		◌									
	Leave radiator cap open. When engine is run at idling, an abnormal number of bubbles appear, or water spurts back			◌							○	
Check items	Water pump breather hole is clogged with mud				◌							
	When water pump breather hole is clean, water comes out				◌							
	Oil level goes down in clutch, TORQFLOW transmission, or damper chamber					◌						
	Oil level goes down in hydraulic tank						◌					
	Engine oil smells of diesel fuel						◌	◌	◌			
	Fuel is added more frequently						◌	◌	◌			
Troubleshooting	Pressure-tightness test of oil cooler shows there is leakage	●										
	Pressure-tightness test of cylinder head shows there is leakage		●									
	When compression pressure is measured, it is found to be low			●								
	Remove water pump and check directly				●							
	Check rear seal directly					●						
	When pump auxiliary equipment is removed, seal is found to be broken						●					
	Remove head cover and check directly							●				
	Remove injection pump and check directly								●			
	There is improper contact of thermostat seat valve									●		
	Remove oil pan and check directly										●	●
	Remedy	Replace	Replace	Replace	Replace	Repair	Replace	Repair	Replace	Repair	Replace	Replace

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S-14 Water temperature becomes too high (overheating)

General causes why water temperature becomes too high

- Lack of cooling water (deformation, damage of fan)
- Drop in heat dissipation efficiency
- Defective cooling circulation system
- Rise in oil temperature of power train

★ Carry out troubleshooting for chassis.

Legend
○ : Possible causes (judging from Questions and check items)
: Most probable causes (judging from Questions and Check items)
△ : Possible causes due to length of use (used for a long period)
● : Items to confirm the cause.

			Causes											
			Broken water pump	Clogged, crushed radiator fin	Clogged radiator core	Defective thermostat (does not open)	Defective water temperature gauge	Insufficient cooling water	Fan belt slipping, worn fan pulley	Clogged, broken oil cooler	Defective pressure valve	Broken head, head gasket	Damaged liner O-ring, holes made by pitting	Rise in torque converter oil temperature
Questions	Confirm recent repair history													
	Degree of use	Operated for long period		△	△							△	△	
	Condition of overheating	Suddenly overheated						○	○					
		Always tends to overheat				○			○					
	Water temperature gauge	Rises quickly						○						
		Does not go down from red range					●							
Check items	Radiator water level sensor lights up							●						
	Fan belt whines under sudden load								●					
	Cloudy white oil is floating on cooling water									●				
	Cooling water flows out from overflow hose										●			
	Excessive air bubbles inside radiator, water spurts back											●		
	Engine oil level has risen, oil is cloudy white								○				●	
	There is play when fan pulley is rotated		●											
	Radiator shroud, inside of underguard are clogged with dirt or mud			●					●					
	When light bulb is held behind radiator, no light passes through			●										
	Water is leaking because of cracks in hose or loose clamps							●						
	Belt tension is found to be slack								●					
	Power train oil temperature enters red range before engine water temperature													●

		Carry out troubleshooting for chassis
Troubleshooting	Temperature difference between top and bottom radiator tanks is excessive	●
	Temperature difference between top and bottom radiator tanks is slight	●
	When water filler port is inspected, the core is found to be clogged	●
	When a function test is carried out on the thermostat, it does not open even at the cracking temperature	●
	When water temperature is measured, it is found to be normal	●
	When oil cooler is inspected directly, it is found to be clogged	●
	When measurement is made with radiator cap tester, set pressure is found to be low	●
	When compression pressure is measured, it is found to be low	●
	Remove oil pan and check directly	●
Remedy		—
	Replace	
	Repair	
	Repair	
	Replace	
	Replace	
	Add	
	Repair	
	Replace	
	Replace	
	Replace	
	Replace	

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S-15 Abnormal noise is made

★ Judge if the noise is an internal noise or an external noise.

General causes why abnormal noise is made

- Abnormality due to defective parts
- Abnormal combustion noise
- Air sucked in from intake system

Legend
○ : Possible causes (judging from Questions and check items)
◎ : Most probable causes (judging from Questions and Check items)
△ : Possible causes due to length of use (used for a long period)
● : Items to confirm the cause.

			Causes: Worn piston ring, cylinder liner	Seized turbocharger, interference	Missing, seized bushing	Clogged, seized injection nozzle	Defective injection pump (rack, plunger seized)	Defective injection pump (excessive injection)	Deformed fan, interference of fan belt	Improper adjustment of valve clearance	Broken valve system (valve, rocker lever, etc.)	Improper gear train backlash	Leakage of air between turbocharger and head	Defect inside muffler (dividing board out of position)
Questions	Confirm recent repair history													
	Degree of use	Operated for long period	△											
	Condition of abnormal noise	Gradually occurred	○						○					
		Suddenly occurred		○	○					○				
	Non-specified fuel is being used					○	○							
	Engine oil must be added more frequently		◎											
	Color or exhaust gas	Blue under light load	◎											
		Black		◎						○			○	
	Metal particles are found in oil filter		◎		◎									
	Blow-by gas is excessive		◎											
	Noise of interference is heard from around turbocharger			◎										
	Engine pickup is poor and combustion is irregular					◎								
Check items	When exhaust manifold is touched immediately after starting engine, temperature of some cylinders is low					◎	○							
	Seal on injection pump has come off							◎						
	Abnormal noise is loud when accelerating engine					○	○	○	○	○		○		
	Clanging sound is heard from around cylinder head									◎	◎			
	Leakage of air between turbocharger and head, loose clamp												◎	
	Vibrating noise is heard from around muffler													◎
Troubleshooting	When compression pressure is measured, it is found to be low		●											
	When trubocharger is rotated by hand, it is found to be heavy			●										
	Remove gear cover and check directly				●							●		
	Speed of some cylinders does not change when operating on reduced cylinders					●								
	When control rack is pushed, it is found to be heavy or does not return						●							
	Injection pump test shows that injection amount is incorrect							●						
	Fan is deformed, or belt is loose								●					
	When valve clearance is checked directly, it is found to be outside standard value									●				
	Remove cylinder head cover and check directly										●			
	When muffler is removed, abnormal noise disappers													●
	Remedy		Replace	Replace	Replace	Replace	Replace	Adjust	Repair	Adjust	Replace	Repair	Repair	Replace

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S-16 Vibration is excessive

★ If there is abnormal noise together with the vibration, carry out troubleshooting for "Abnormal noise is made".

General causes why vibration is excessive

- Defective parts (abnormal wear, breakage)
- Improper alignment
- Abnormal combustion

Legend
○ : Possible causes (judging from Questions and check items)
: Most probable causes (judging from Questions and Check items)
△ : Possible causes due to length of use (used for a long period)
● : Items to confirm the cause.

			Causes: Worn connecting rod, main bearing	Worn balancer, cam bushing	Worn support pilot	Loose engine mounting bolts, broken cushion	Broken part inside output shaft (damper)	Misalignment between engine and power train	Improper gear train backlash	Valve system (valve, rocker lever, etc.) stuck	Defective injection pump (excessive injection)
Questions	Confirm recent repair history										
	Degree of use	Operated for long period	△	△	△	△					
	Condition of vibration	Suddenly increased					○			○	
		Gradually increased	○	○	○	○					
	Non-specified fuel has been used		○	○							
Check items	Metal particles are found in oil filter		○	○							
	Metal particles are found when oil is drained		○	○							
	Oil pressure is low at low idling		○	○							
	Vibration occurs at mid-range speed					○	○				
	Vibration follows engine speed				○	○	○	○	○		
	Exhaust gas is black									○	○
	Seal on injection pump has come off										△
Troubleshooting	Remove oil pan and check directly		●								
	Remove side cover and check directly			●							
	Check directly for worn support pilot, play				●						
	Check directly for loose engine mounting bolts, broken cushion					●					
	Check inside of output shaft (damper) directly						●				
	When radial runout, face runout are measured, they are found to be outside standard value							●			
	Remove front cover and check directly								●		
	Remove head cover and check directly									●	
	Injection pump test shows that injection amount is incorrect										●
		Remedy	Replace	Replace	Replace	Replace	Replace	Repair	Repair	Replace	Adjust

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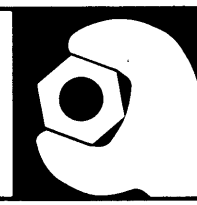
ENGINE

13 DISASSEMBLY AND ASSEMBLY



Overall disassembly 13-002
Overall assembly 13-014

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★ The description of overall engine disassembly and assembly given in this section is based on the SA6D108-1 engine, assuming the use of an overhaul stand.
★ The work procedure may differ slightly from that given here depending upon the machine in which the engine is mounted, engine accessories and also the particular stand used, however it is fundamentally the same.
★ Use the correct service tools when performing disassembly and assembly.

OVERALL DISASSEMBLY

Special tools

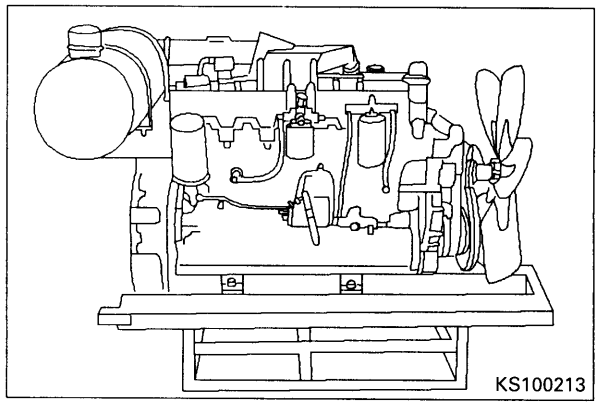
	Part No.	Part Name	Q'ty
A	–	Engine stand	1
B	790-501-2000	Engine overhaul stand	1
	790-345-1070	Bracket	1
C	795-102-2101	Spring washer	1
D	795-100-2800	Piston ring tool	1
E	790-472-2000	Liner puller	1

Preparatory work
- Clean of all mud and dirt.
- Drain cooling water and engine oil.

Engine oil : Approx. 22 ℓ (S6D108)
: Approx. 25 ℓ (SA6D108)

- Prepare a stable engine stand **A** so that the engine will not overturn, and set the engine securely on the stand.

kg Engine assembly : Approx. 700 kg (S6D108)
: Approx. 770 kg (SA6D108)
(Differs according to machine)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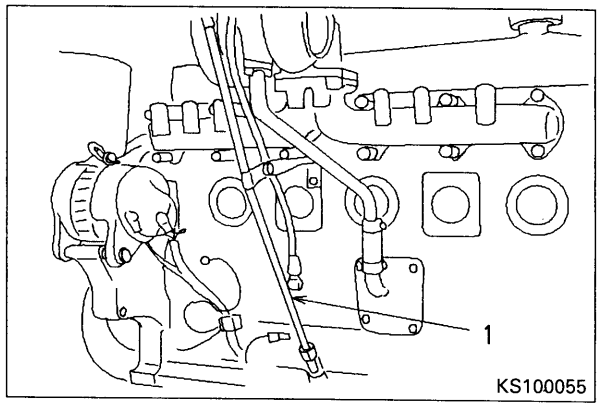
1. **Oil dipstick guide**
Remove dipstick guide (1).

2. **Remove starting motor**
Remove starting motor (1A).

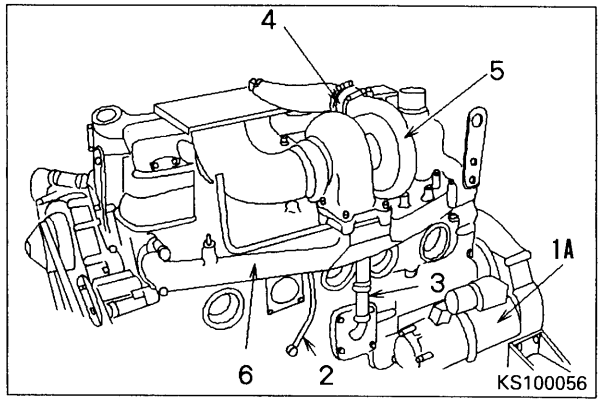
3. **Turbocharger, exhaust manifold assembly**
1) Disconnect turbocharger inlet tube (2) and outlet tube (3).
2) Disconnect intermediate connector (4) between turbocharger and aftercooler. (SA6D108)
2A) Disconnect intermediate connector (4) from intake manifold. (S6D108)
3) Remove turbocharger (5) and exhaust manifold assembly (6).



KS100055

4. **Setting engine in engine overhaul stand**
Install engine on engine overhaul stand.

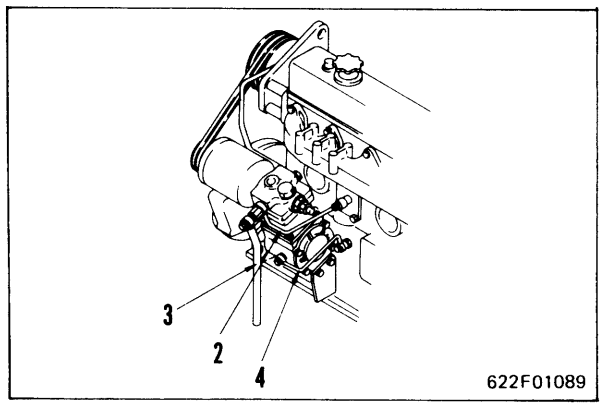
kg Engine assembly : Approx. 700 kg
(Differs according to machine)



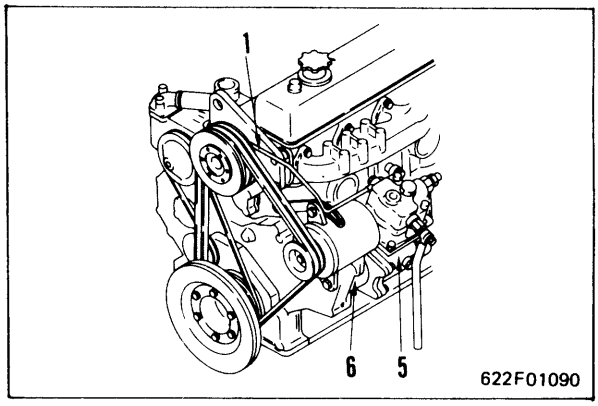
KS100056

4-1. Air compressor

1) Disconnect water tubes (1),(2) and drain hose (3).
2) Disconnect oil tube (4).



3) Remove air compressor assembly (5).
4) Remove drive case assembly (6).



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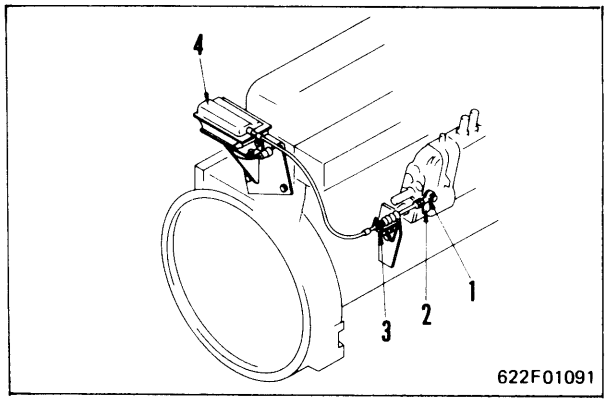
4-2. Engine stop motor (when equipped)

1) Remove rod end (1) of engine stop motor cable from stop lever (2) of fuel injection pump.
2) Remove cable from bracket (3).
3) Remove engine stop motor (4).

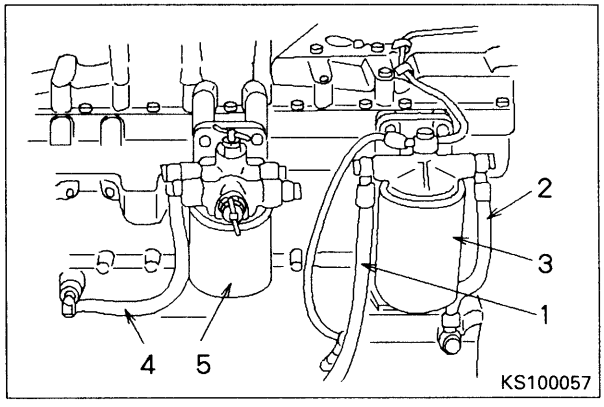


5. Fuel filter

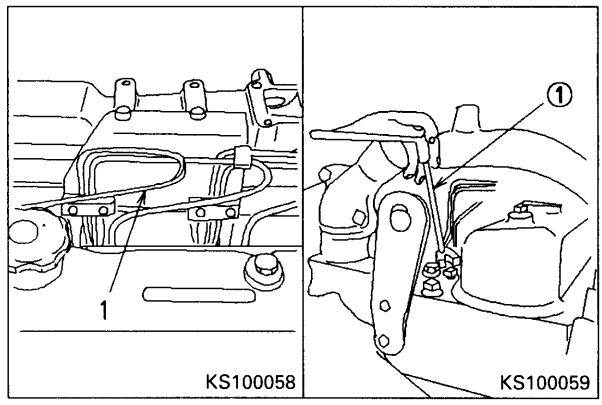
Disconnect fuel filter inlet hose (1) and outlet hose (2) at fuel injection pump end, then remove fuel filter (3).

6. Corrosion resistor (when equipped)

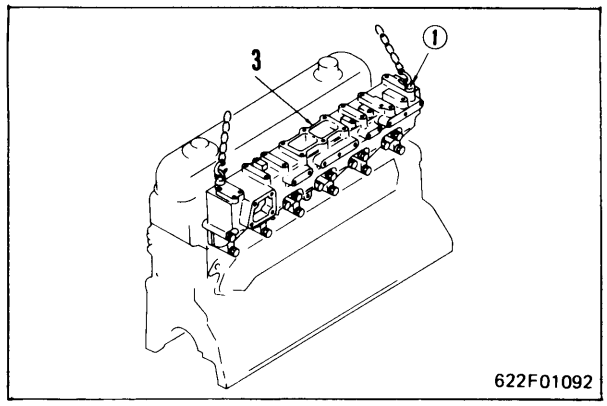
Disconnect water hose (4) and corrosion resistor (5).



7. **Fuel injection pipe**
Remove fuel injection pipe (1).
★ Remove sleeve nuts at nozzle holder side using tool ①.



8. **Intake manifold (S6D108)**
Using eyebolts ① (Dia. = 8 mm, Pitch = 1.25). Sling intake manifold assembly (3).



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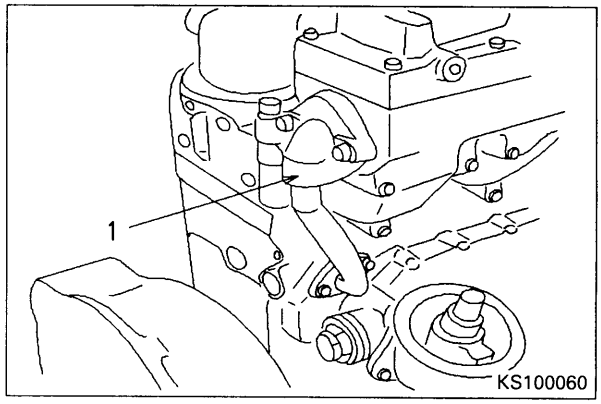
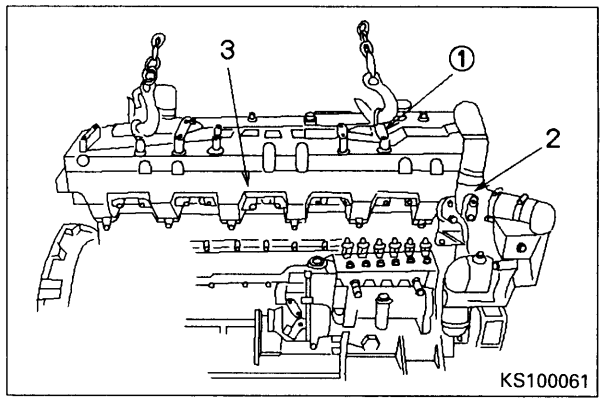
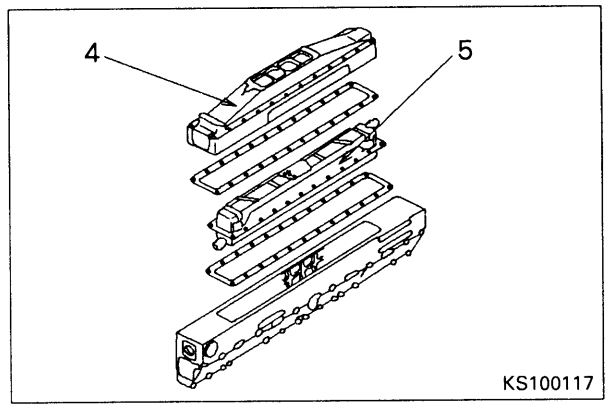
8-1. Aftercooler, intake manifold (SA6D108)
1) Disconnect aftercooler inlet tube (1).



2) Disconnect aftercooler outlet tube (2).
3) Using eyebolt ① (8 mm, Pitch = 1.25), sling inlet manifold assembly (3).

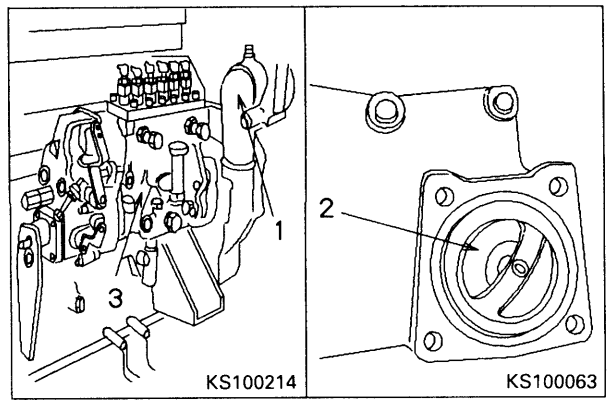


4) Remove cover (4), then remove aftercooler (5).



9. Thermostat

1) Remove connector (1).
2) Remove thermostat (2).



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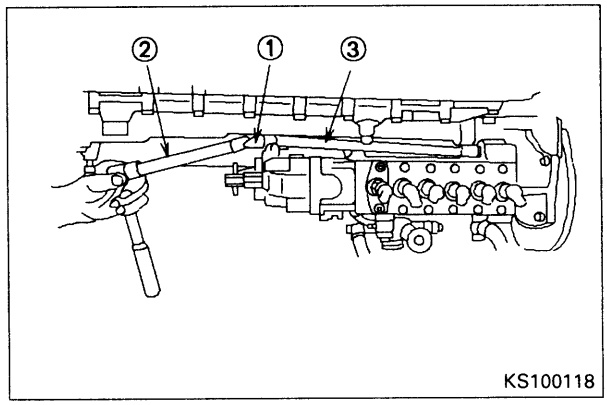
10. Fuel injection pump

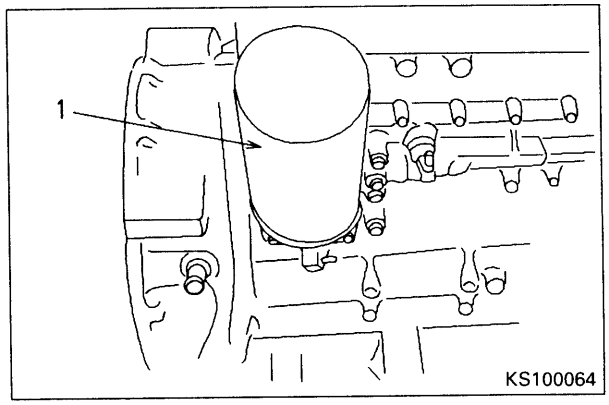
Remove fuel injection pump (3).

★ Loosen these two nuts from pump rear using socket wrench, universal joint ① and extensions ② and ③.
- Extension ② : 300 mm
- Extension ③ : 100 mm



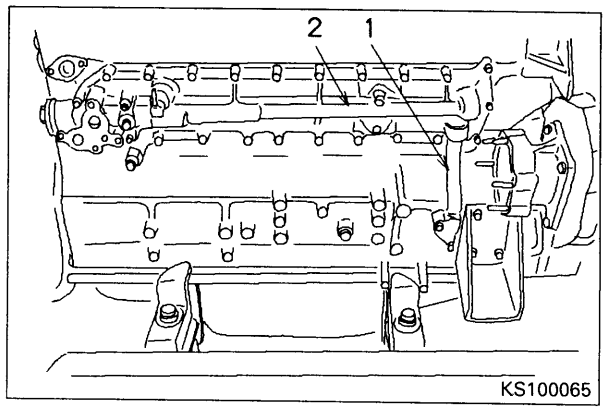
11. Oil filter

Remove oil filter (1) together with bracket.



12. Oil cooler

1) Remove oil cooler tube (1).
2) Remove oil cooler (2).

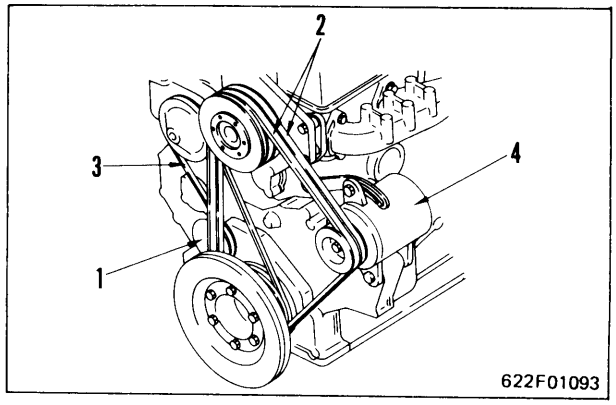


13. Tension pulley

Remove tension pulley (1).

14. Fan belt, water pump belts

1) Loosen mounting bolt of alternator, move alternator to inside, and remove fan belt (2).
2) Remove water pump belt (3).



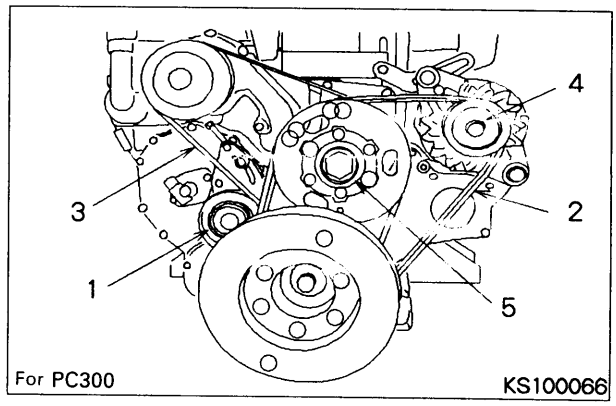
15. Alternator

Remove alternator (4).

16. Fan pulley drive assembly

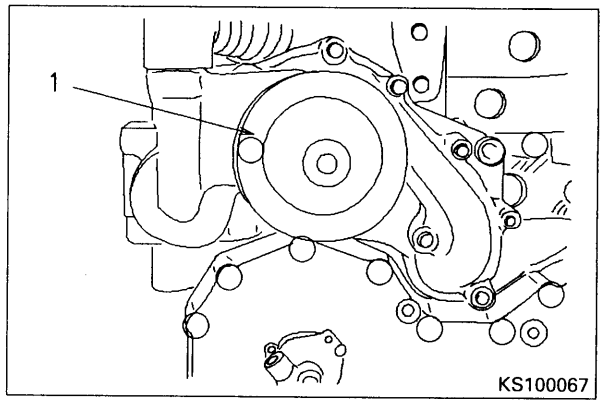
Remove fan pulley drive assembly (5).

★ Insert tool from peeping holes and loosen mounting bolts.



17. Water pump

Remove water pump (1).



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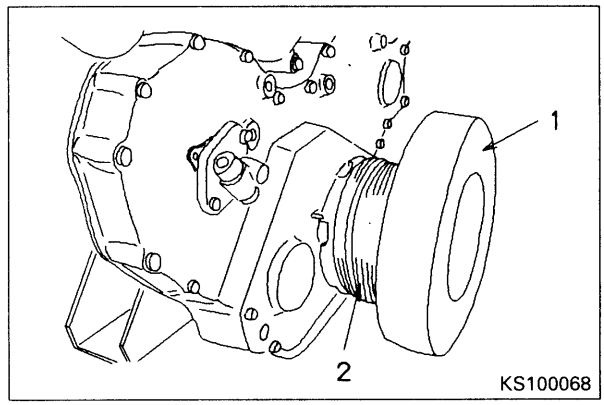
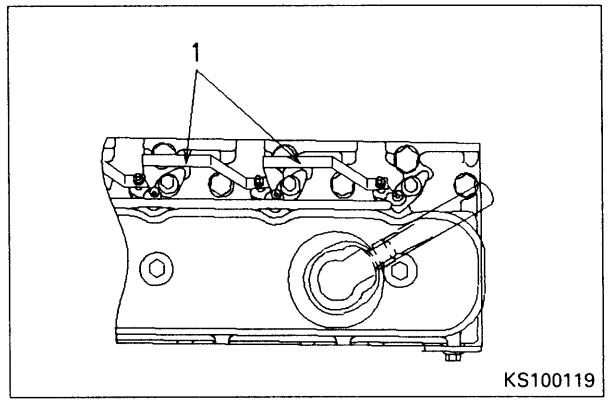
18. Vibration damper
Remove vibration damper (1).

19. Crankshaft pulley
Remove crankshaft pulley (2).



20. Lead
Remove lead (1).



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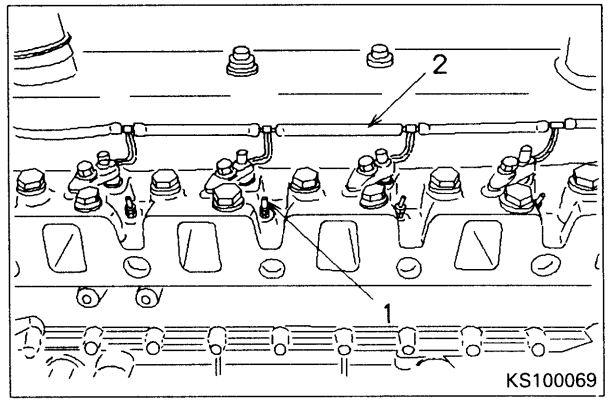
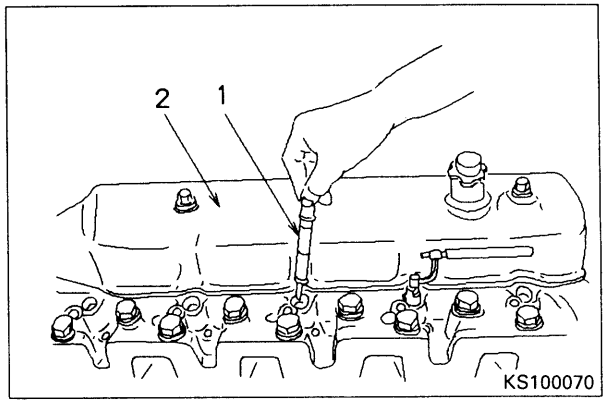
21. Glow plug
Remove glow plug (1).

22. Spill hose
Remove spill hose (2).



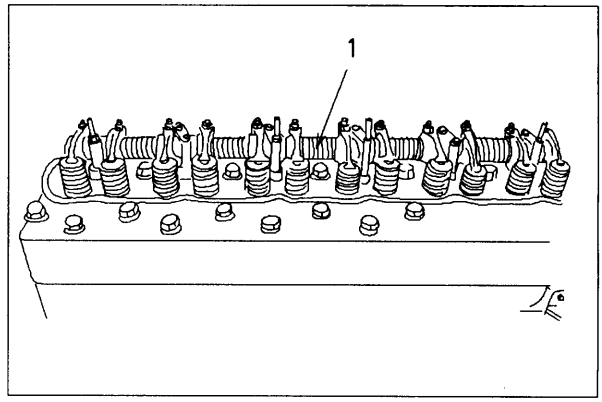
23. Nozzle holder
Remove nozzle holder (1).

24. Cylinder head cover
Remove cylinder head cover (2).



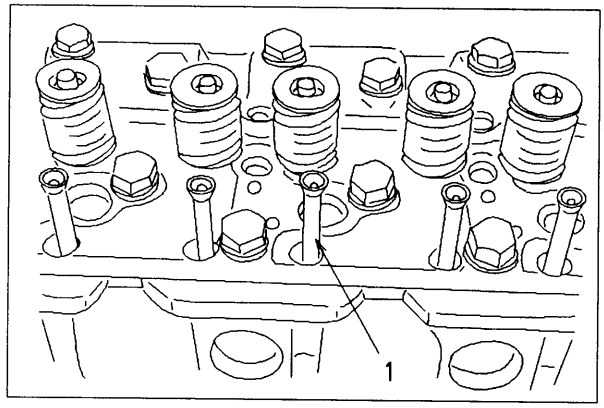
25. Rocker arm assembly

1) Loosen lock nut of adjustment screw, then loosen each adjustment screw 2 to 3 turns.
   ★ Loosen the adjustment screw at this step to avoid excessive pressure being brought to the push rods when installing the rocker arm assembly.
2) Remove rocker arm assembly (1).



26. Push rods

Remove push rods (1).



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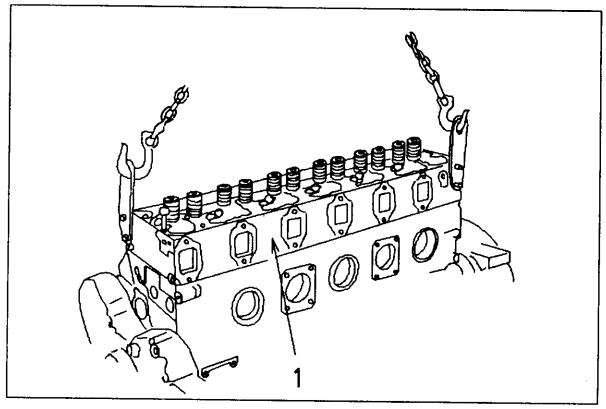
27. Cylinder head

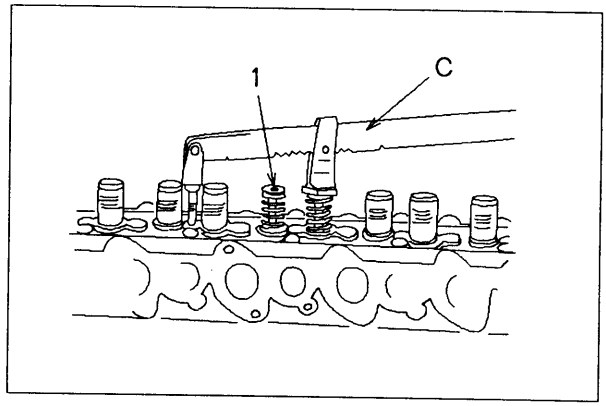
1) Remove mounting bolts of cylinder head.
2) Remove cylinder head (1).

kg Cylinder head assembly : 63 kg

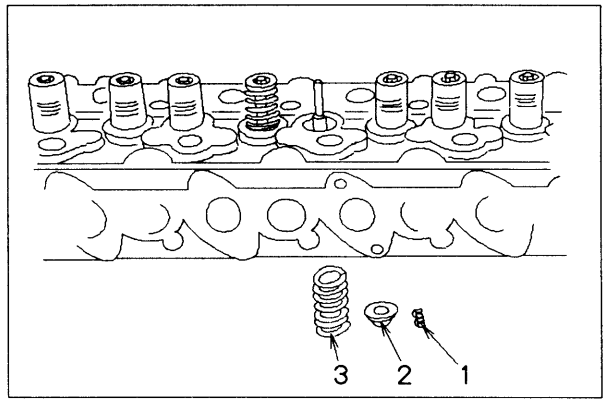
3) Remove cylinder head gasket.



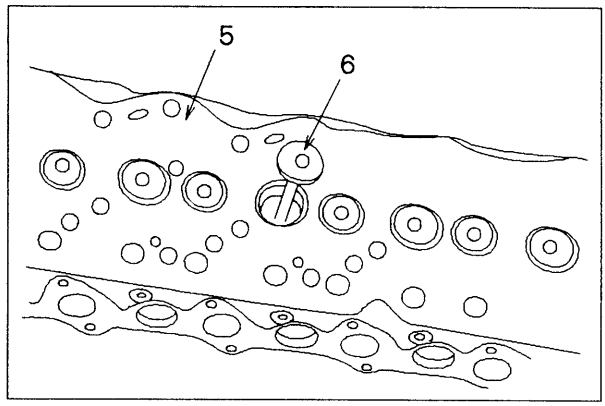
- Disassemble cylinder head assembly as follows.
  1) Using spring pusher **C**, compress valve spring and remove valve cotter (1).



2) Slowly release spring tension and remove spring guide (2), valve spring (3).



3) Lift up cylinder head (5) and remove valves (6).



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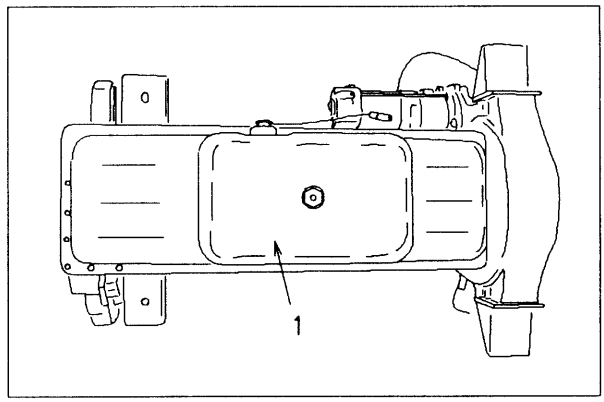
28. Oil pan

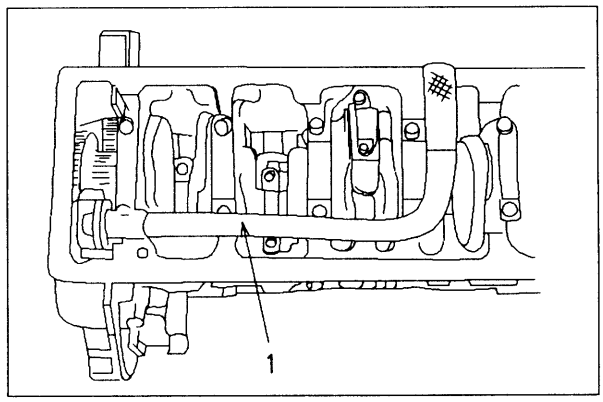
Remove oil pan (1).

★ Be careful not to deform or damage the oil pan when removing, as this will cause oil leakage.

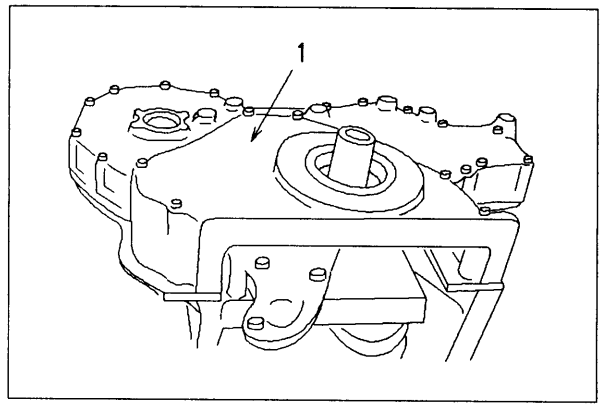


29. Suction tube

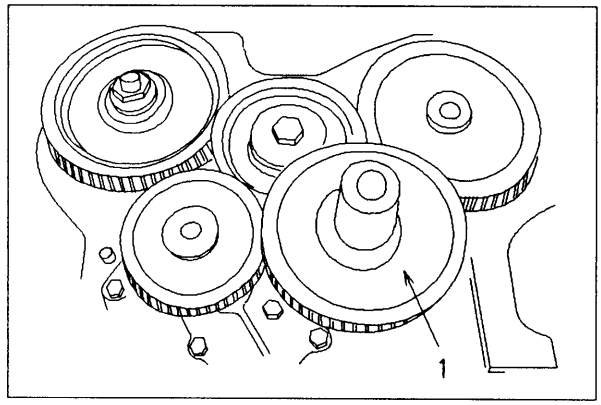
Remove suction tube (1).



30. Gear case cover
Remove gear case cover (1).



31. Drive gear for oil pump
Remove drive gear for oil pump (1).



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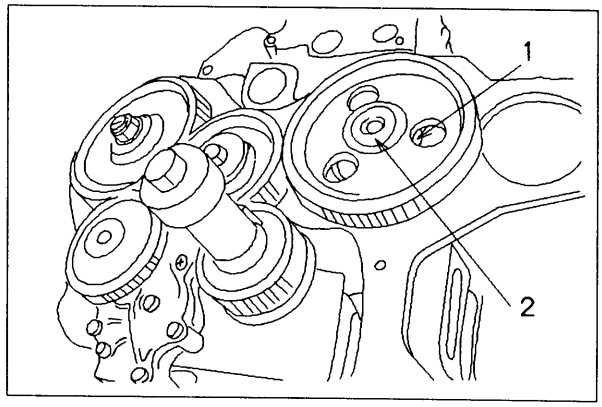
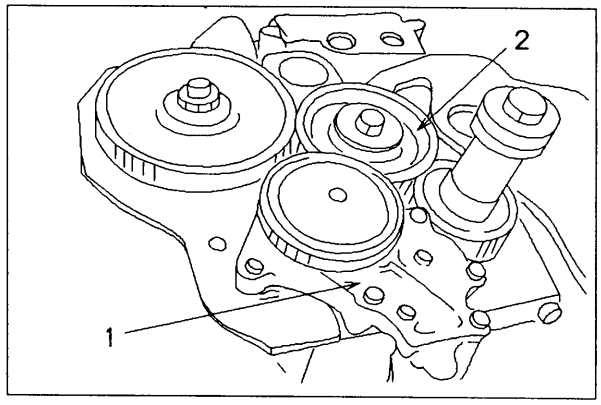
32. Camshaft
1) Remove thrust plate (1).
2) Remove camshaft (2).



33. Oil pump
Remove oil pump (1).

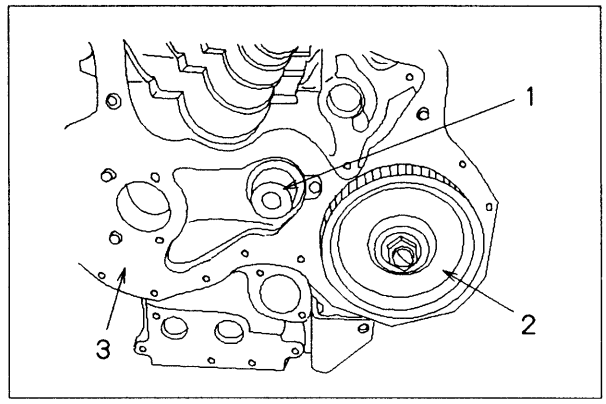
34. Idler gear
Remove idler gear (2).



35. Idler shaft
Remove idler shaft (1).

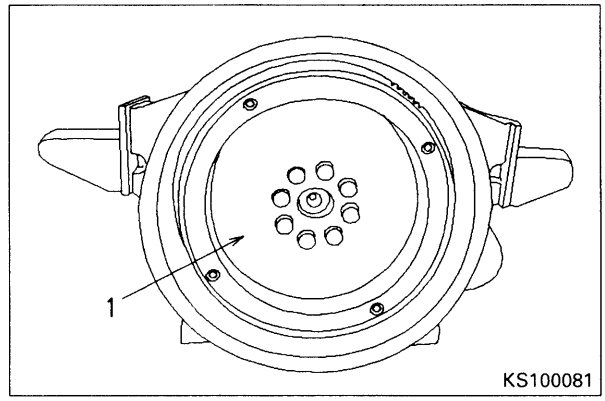
36. Drive gear for fuel injection pump
Remove drive gear (2) for injection pump.

37. Front plate
Remove front plate (3).



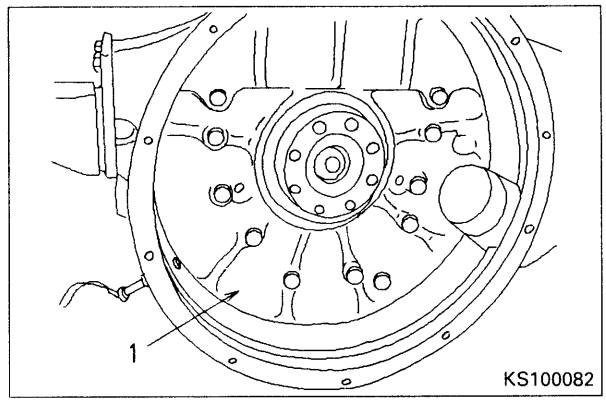
38. Flywheel
Remove flywheel (1).

kg Flywheel : 62.5 kg (S6D108)
: 31.3 kg (SA6D108)
(Differs according to the machine)



39. Flywheel housing
Remove flywheel housing (1).

kg Flywheel housing : 41.0 kg (S6D108)
: 46.5 kg (SA6D108)
(Differs according to the machine)



40. Piston, connecting rod assembly

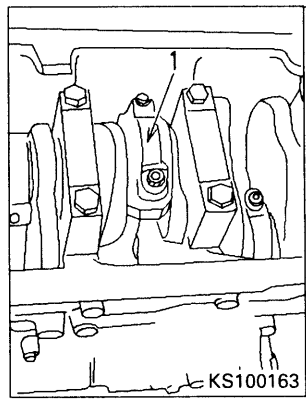
★ To avoid damage when removing the piston, remove carbon sludge from the upper inside surface of the liner with fine emery paper.

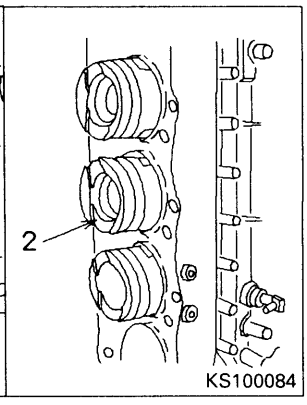
1) Rotate crankshaft so that piston to be removed comes to bottom dead center.
2) Remove connecting rod cap (1).
3) Using wooden bar, push piston and connecting rod from oil pan side. Support piston (2) at cylinder head side and remove.

★ When removing, be careful not to damage the inside surface of the liner with the corners of the connecting rod.

4) Remove remaining pistons and connecting rods in the same way.

★ Keep the pistons and connection rods in a safe place and be careful not to damage the sliding surface of the piston or the bearing.





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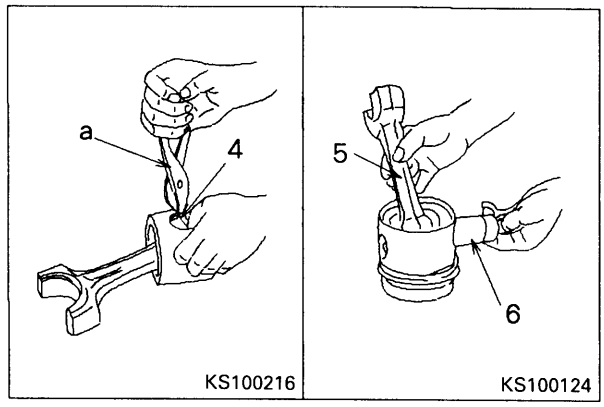
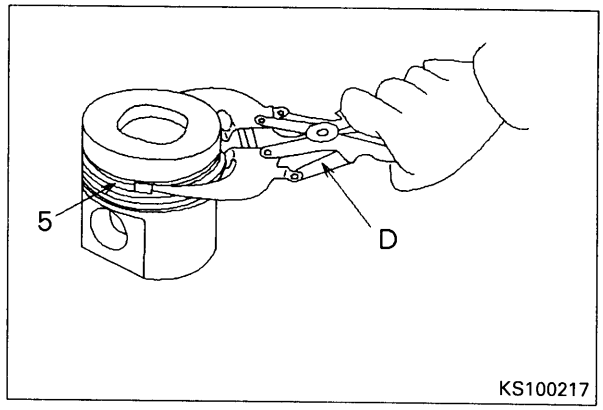
★ Disassemble piston and connecting rod as follows.
1) Using plier (a), remove snap spring (4).
2) Hold connecting rod (5) by hand, and tap out piston pin (6) from the opposite side.
3) Disconnect piston assembly and connecting rod.
4) Remove snap ring in the opposite side.



5) Using piston ring tool **D**, remove rings in turn, starting with top ring (5).
★ Keep piston, connecting rod, bearing, piston rings and piston pin in sets according to cylinder number.



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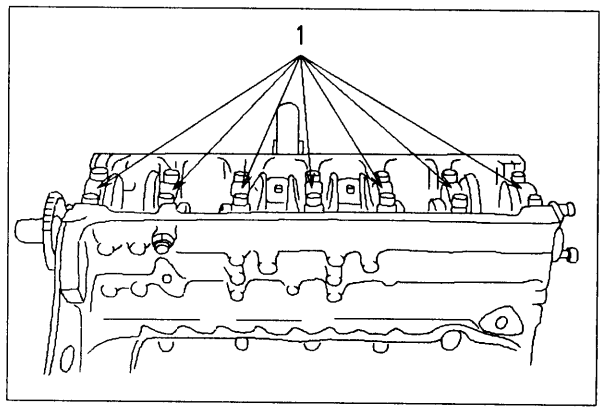
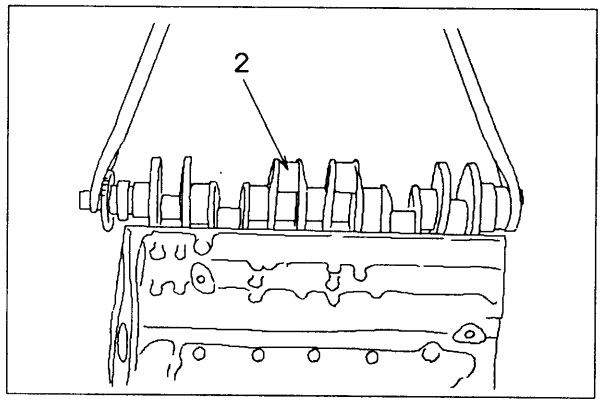
41. Crankshaft
- Turn over engine so that crankshaft side is at top.

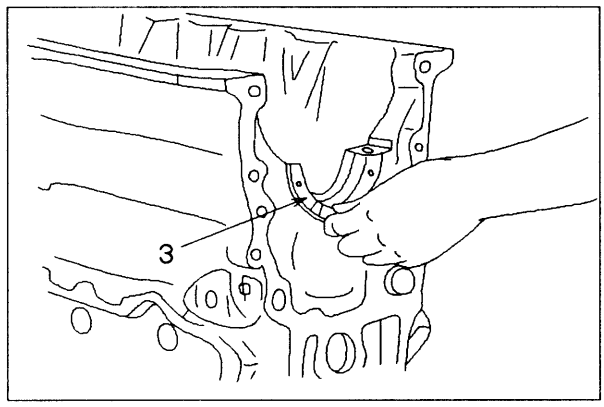
1) Remove main bearing caps (1).
★ The lower thrust bearings are assembled on both sides of the No. 7 main bearing cap, so after removing, mark the position for assembly.



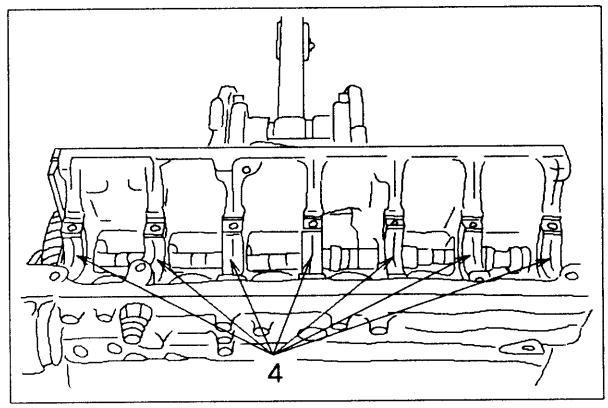
2) Using a nylon sling, remove crankshaft (2).
★ When raising the crankshaft, be careful not to damage by letting it hit the cylinder block.
★ Keep the crankshaft in a safe place, and be careful not to damage the sliding surface.



3) Remove upper thrust bearings (3) for crankshaft side.



4) Remove upper bearings (4).
★ Mark the positions for assembly of the main bearing cap, main bearing and thrust bearing with a tag or felt pen. Keep in sets according to the cap number. Keep them in a safe place and be careful not to damage them.



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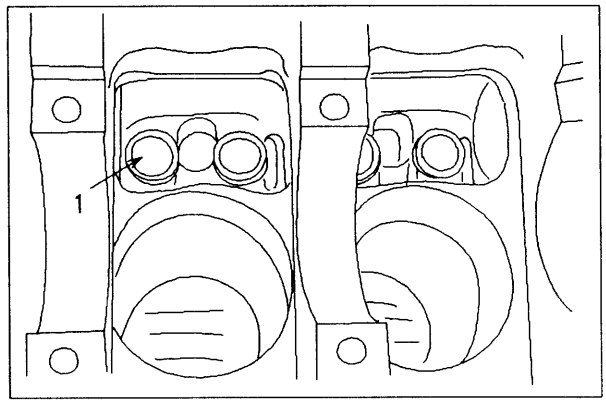
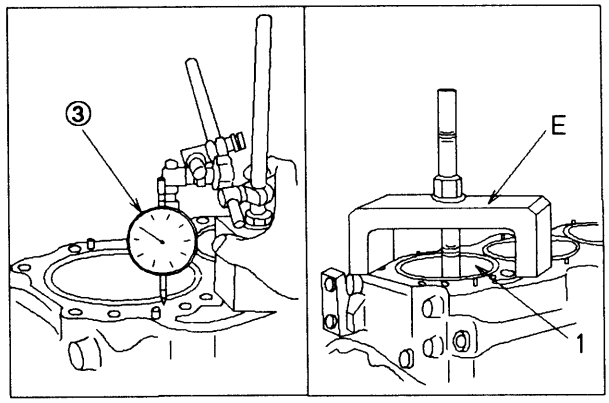
42. Tappets
Remove tappets (1).



43. Cylinder liner sleeve
- Before removing the cylinder liner sleeve if necessary using a dial gauge ③, measure the protrusion of the liner sleeve.
- Using liner puller **E**, remove cylinder liner sleeve (1).



OVERALL ASSEMBLY

Special tools

	Part No.	Part Name	Q'ty
A	–	Engine stand	1
B	790-501-2000	Engine overhaul stand	1
	790-345-1070	Bracket	1
C	795-215-1711	Liner driver	1
D	–	Expander	1
E	795-102-2101	Valve pusher	1
F	–	Feeler gauge	1
G	–	Push tool for rear seal (A)	1
H	–	Push tool for rear seal (B)	1

Preparatory work

Install adapter plate on cylinder block, raise and set on engine overhaul stand **B**.

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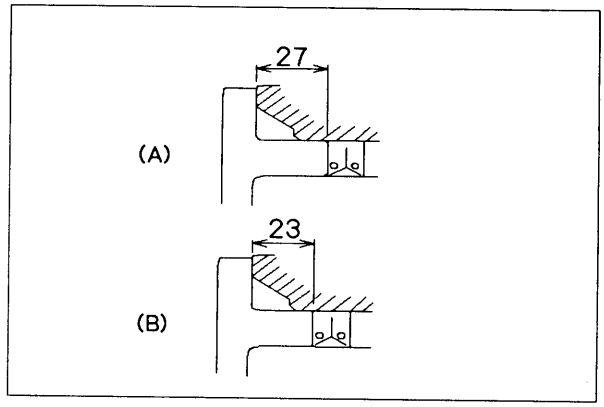
1. Cylinder liner sleeve

★ When cylinder liners are disassembled, follow the next procedure.

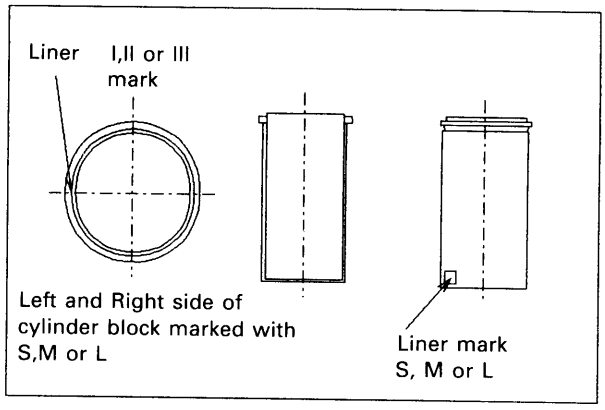
★ For each cylinder, check that the mark of the cylinder liner and the stamped mark (S or M,L) on the top face of right side of the cylinder block are correctly coincide.

Block mark	Liner Part No.	Liner mark	
		Bottom	Top
S	6222-21-2210	S	I
M	6222-21-2220	M	II
L	6222-21-2230	L	III

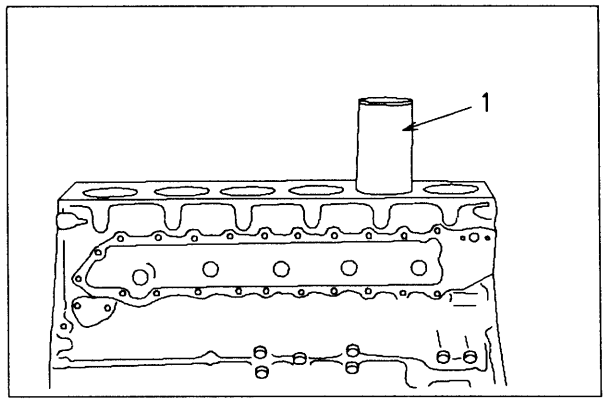


★ Clean the press-fit surface of the cylinder liner and cylinder block thoroughly. (Completely remove the rust preventive oil from the liner)

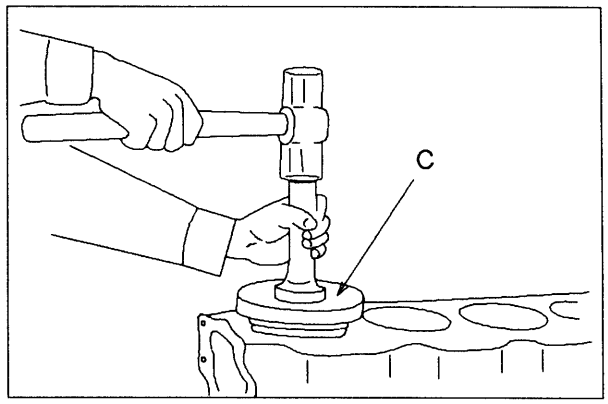
★ Coat the press-fit surface of the cylinder liner and cylinder block thinly with engine oil (EO-30).



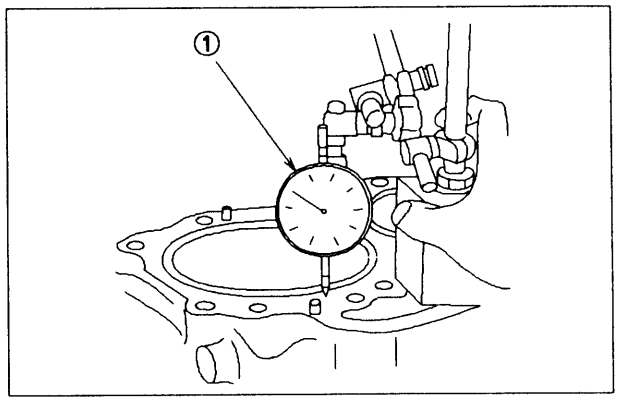
1) Set cylinder liner (1) on cylinder block.
   ★ Set cylinder liner (1) with its mark facing to the front of the engine.



2) Using tool **C**, press fit liner in block.
   ★ Press-fit slowly for the first 10 – 20 mm stroke and make sure that the liner is not inclined.
   ★ If the liner is inclined, there is a danger that it will crack. Use a pulling tool to remove it and press-fit from the beginning again.
   ★ If there is any dust or dirt on the press-fit surface of the liner or the bottom surface of the liner flange, the liner will be deformed or the protrusion will not be even. Never try to install the liner by putting a wooden block on top of the liner and hammering the liner into the block.

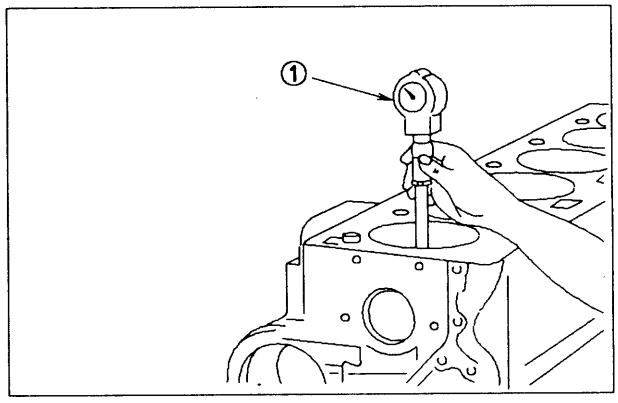


3) Measure protrusion of cylinder liner
   After press-fiting the cylinder liner, measure the amount that the cylinder liner protrudes.
   ★ Protrusion of cylinder liner : 0.05 to 0.13 mm



4) Measure inside diameter of cylinder liner
   After press-fitting the cylinder liner, measure the inside diameter of the cylinder liner and check that it is within the standard value.

   Inside diameter ; ø 108 $^{+\ 0.0320}_{-\ 0.0004}$



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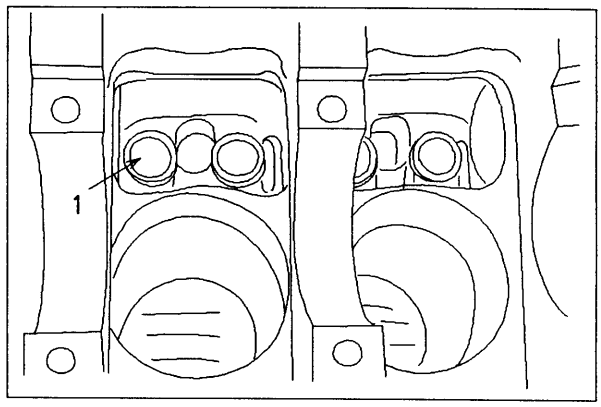
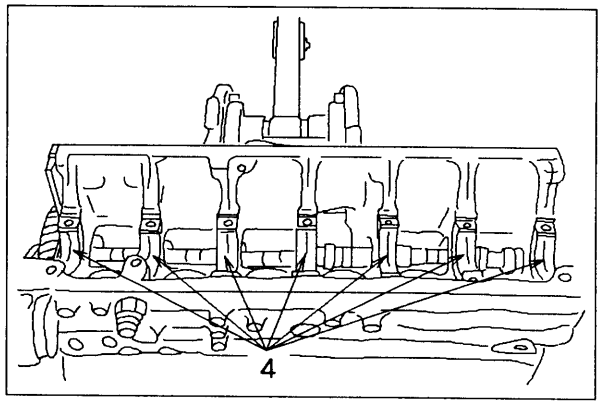
2. Tappets

1) Turn over engine so that crankshaft side is at top.
2) Assemble tappets (1).
   ★ Check that tappets move up and down smoothly.

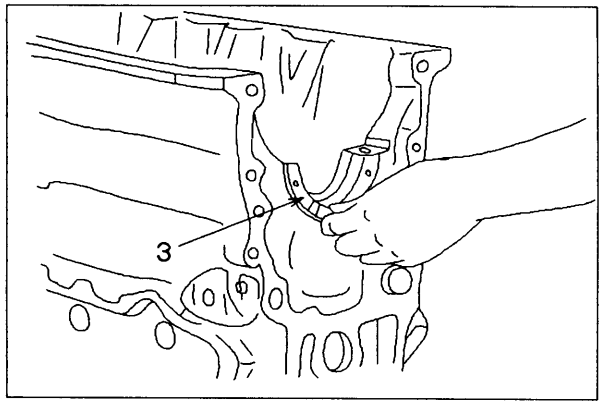


3. Crankshaft

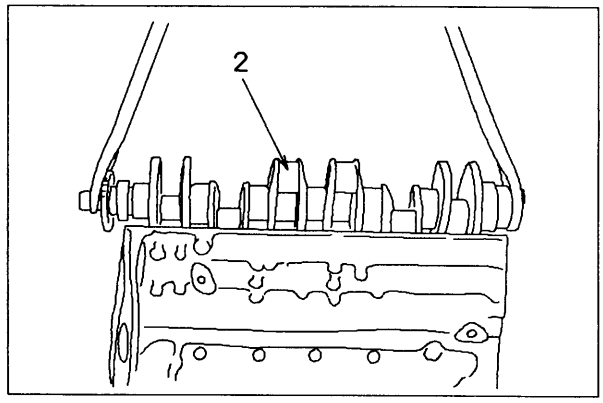
1) Align lug of upper main bearings (4) with slot in cylinder block, and install.
   ★ After installing the bearing, coat the sliding surface with engine oil.



2) Install upper thrust bearing (3) for crankshaft side.
   ★ Check that the protrusion of the roll pin is 1.5 to 1.9 mm.
   ★ Install the thrust bearings with the grooved face to the outside.
   ★ Coat the sliding surface of the thrust bearings with engine oil.



3) Using a nylon sling, raise crankshaft (2) and set in position in cylinder block.
   ★ When installing the crankshaft, be careful not to damage by letting it hit the cylinder block.



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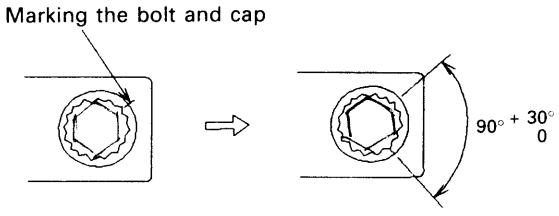
4) Align lug of lower main bearing (5) with slot in main bearing cap and install bearing in cap.
5) Assemble lower thrust bearings (6) on both sides of No. 7 main cap bearing.
   ★ Check that the protrusion of the roll pin is 1.5 to 1.9 mm.
   ★ Install the thrust bearing with the grooved face to the outside.
6) Assemble main bearing cap (1).
   ★ Coat the sliding surface of the bearing with engine oil before installing.
   ★ Match bearing No. and block No., and install the main bearing cap with the raising letter "F" facing the front of the engine.
7) Tighten bolts of main bearing cap as follows.
   ★ Coat the threads of the bolts and the seat face with engine oil (EO-30) before tightening the bolts.
   ★ Tighten bolts beginning from the center cap and continue to the outside caps in turn.
   ★ Tighten according to the next steps as follows.

   kgm Main bearing cap

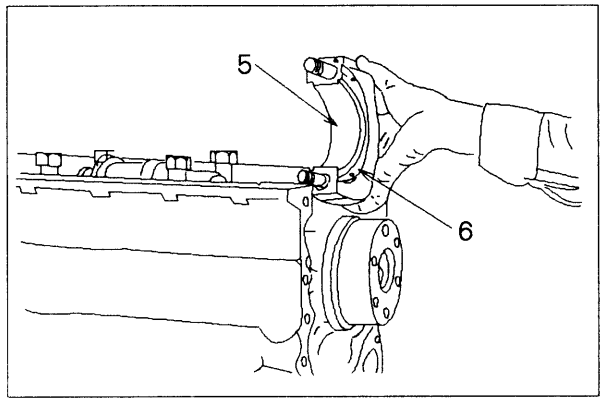
Unit : kgm

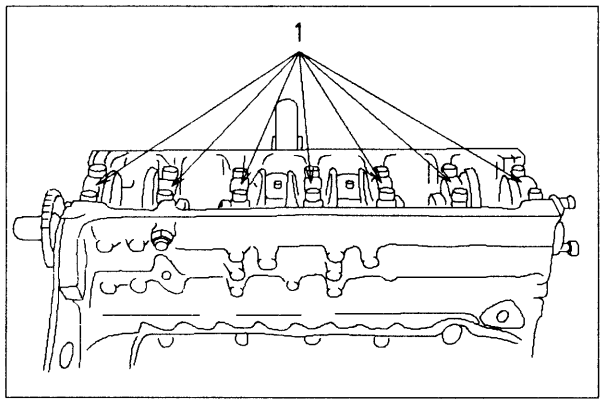
Order	Target	Range
1st step	8	7 – 9
2nd step	16	15.5 – 16.5
3rd step	After marking the bolts and cap by felt pen. Turn over the bolt more 90°–120°	

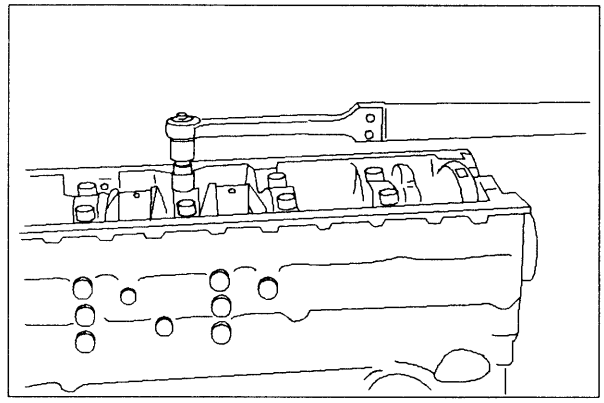


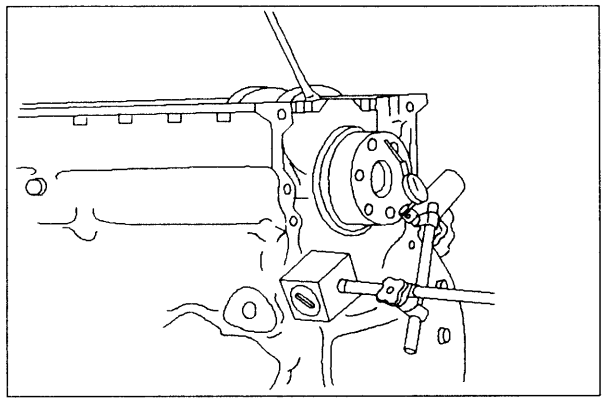
   ★ After tightening the bolts, put one mark on the bolt head with the pointer. If the No. of mark exceeds 5, discard the old bolt and replace with the new bolt.
   ★ After tightening the bolts, check that the crankshaft rotates smoothly.

8) Measure end play of crankshaft.
   After tightening the main bearing cap, measure the end play of the crankshaft.
   ★ End play of the crankshaft : 0.14 to 0.315 mm









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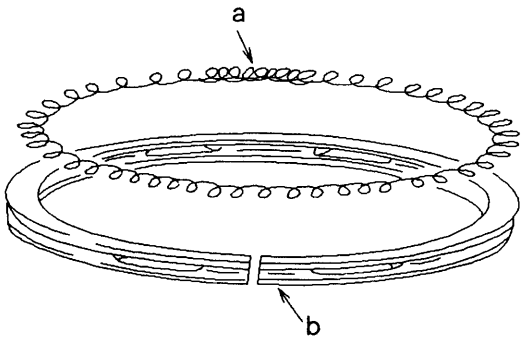
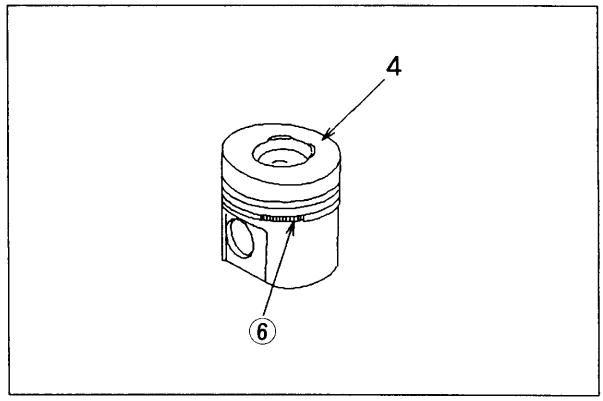
4. Piston connecting rod assembly

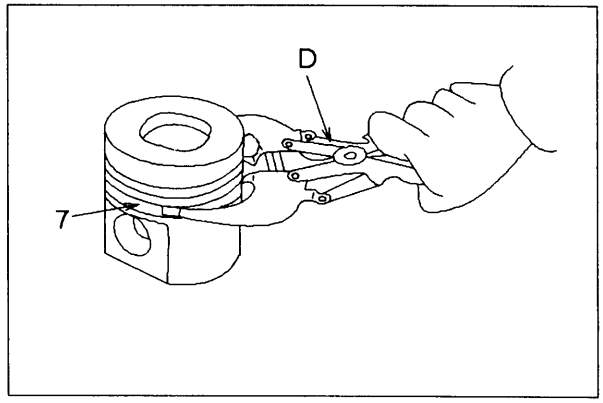
★ Assemble piston rod and connecting rod assembly as follows.

1) Install expander ⑥ on piston (4).
2) Using tool **D**, install oil ring (7) .
   - ★ Install the piston ring with the stamped mark at the opening facing up.
   - ★ When fitting the oil ring, check that the expander is fitted completely inside the oil ring.
   - ★ Position the expander and oil ring as shown in the diagram.

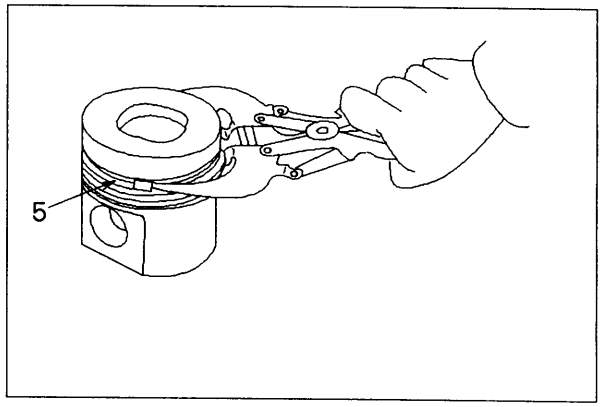


a: Join of coil
b: End gap

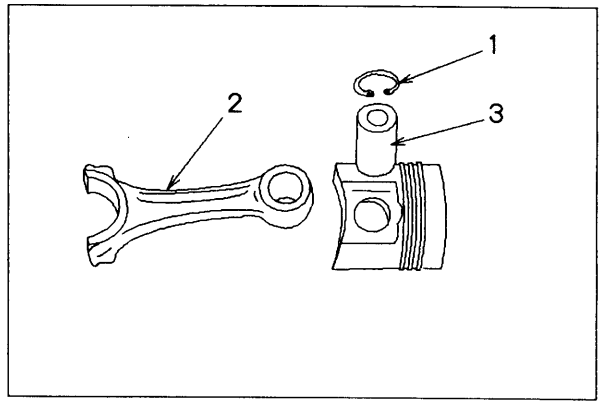




3) Install compression ring (5).



4) Set "FRONT" mark on piston head and raised number on connecting rod facing to the same direction. Insert piston pin (3) and assemble connecting rod (2) with piston pin
   - ★ If the piston pin will not go in easily, warm the piston in hot water before installing.
   - ★ Match the cylinder numbers on the piston and the connecting rod.
   - ★ Use an electric pen to mark the cylinder number on the connecting rod.
5) Install snap ring (1) in both sides.



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Raise up cylinder block putting flywheel housing underside.

★ Set the crankshaft pin at the bottom dead center in the cylinder where the piston and connecting rod assembly is to be installed.

★ Assemble the upper bearing with the connecting rod aligning the bearing lug with the slot in the connecting rod.

★ Coat the inside surface of the cylinder, the surface of the piston rings and connecting rod bearing surface with engine oil (EO-30).

1) Align openings of piston rings as shown in diagram.

2) Insert piston and connecting rod assembly (2) from cylinder head side as far as piston ring position.
   ★ Assemble the piston with the raised mark "FRONT" facing the front of the engine.

3) Using piston holder **F**, compress piston rings and push piston head with a wooden bar. Then pull big end of connecting rod and fit on crankshaft pin.

4) Align slot in connecting rod cap with lug in lower bearing of connecting rod and assemble bearing.

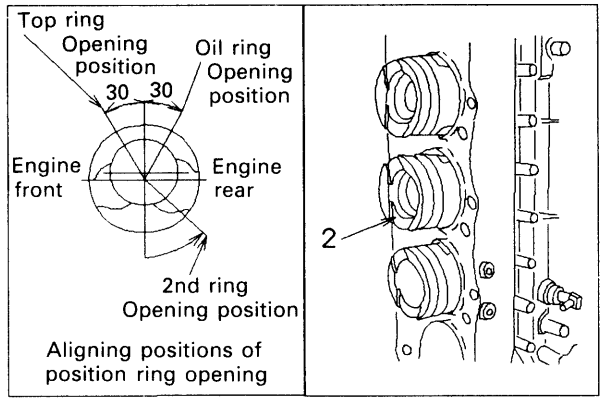
5) Match cylinder number stamped on connecting rod cap with cylinder number stamped on connecting rod.
   Install connecting rod cap (1) so that stamped number is for cam side.
   ★ Coat connecting rod cap bearing with engine oil.

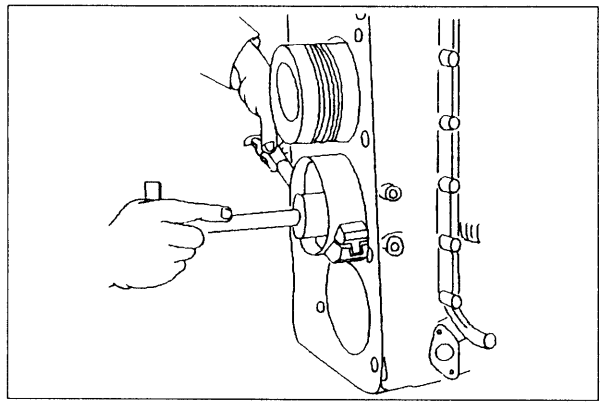
6) Assemble connecting rod cap as follows.
   ★ Coat the threads of the bolts and the seat face with engine oil (EO30-CD) before tightening the bolts.
   ★ Tighten the bolts uniformly in turn.
   kgm Connecting rod cap bolt

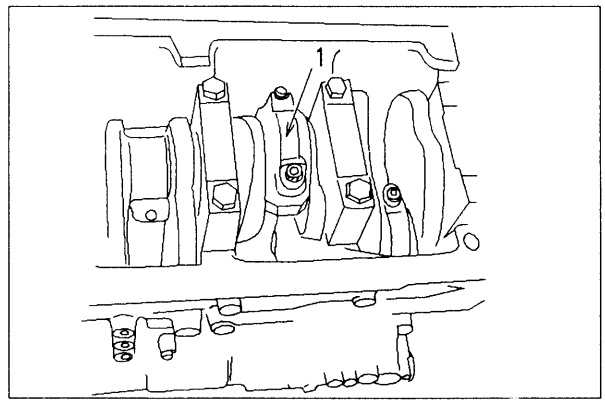
1st step	Target 7.5 Range 7.3 – 7.7 kgm
2nd step	After marking the bolts and cap by felt pen, turn over the bolt more 90° – 120°.

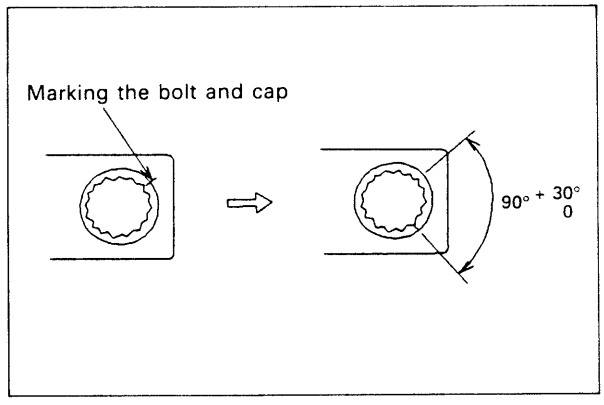
★ After tightening the bolts, put one mark on the bolt head with the pointer. If the No. of marks exceeds 5, discard the old bolt and replace with the new bolt.

★ After tightening the bolt, check that the crankshaft rotates smoothly. There must be no abnormality.









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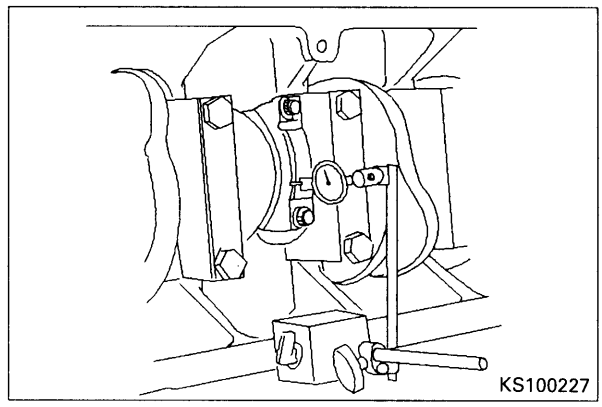
7) Measure side clearance of connecting rod cap.
After installing the piston and connecting rod assembly, measure the side clearance between the cap and the side face of the crankshaft.
★ Side clearance of cap : 0.16 to 0.33 mm.

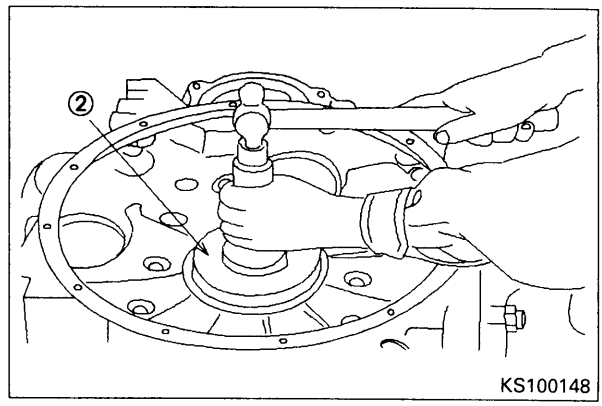


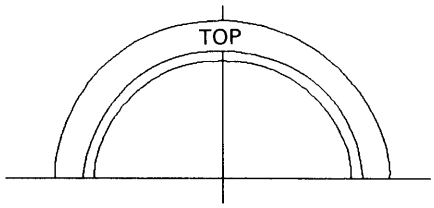
5. Flywheel housing

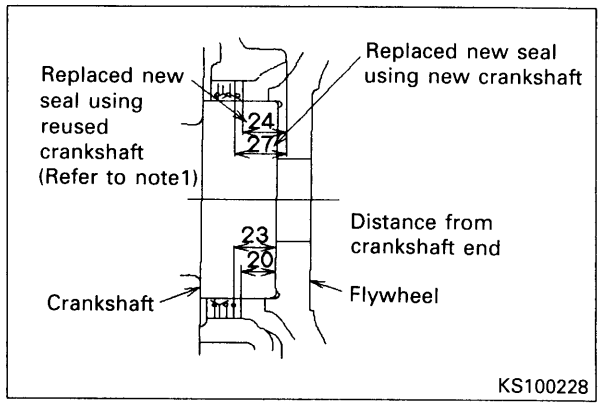
1) Using push tool ② (O.D. 150 mm), press fit rear seal in housing.

Note 1: If there is any wear on the lip contract surface (over 0.1 mm deep enough for fingernails to scratch) or if it is worn as mirror surface, move the rear seal about 3 mm toward engine rear when assembling.

Note 2 : When double lip seal is installed.







2) Align dowel pin holes and install flywheel housing (1).

Coat lip surface of rear seal with grease (G2-LI).(about 3 cc)

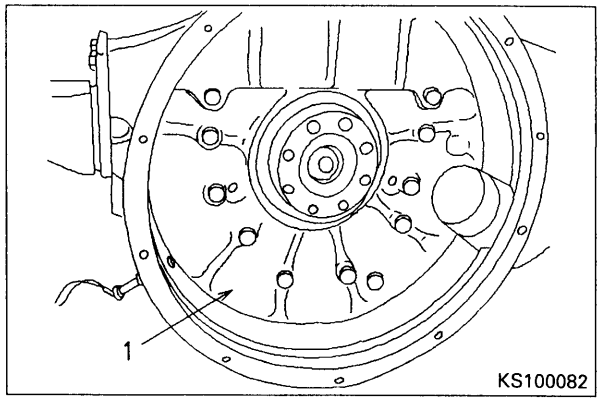
Coat front surface of housing with gasket paste (LG-7)

kgm Flywheel housing mounting bolt : 10 – 12.5 kgm

★ Measure face and radial runout of flywheel housing.

Face runout : within 0.35 mm

Radial runout: within 0.3 mm



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6. Flywheel

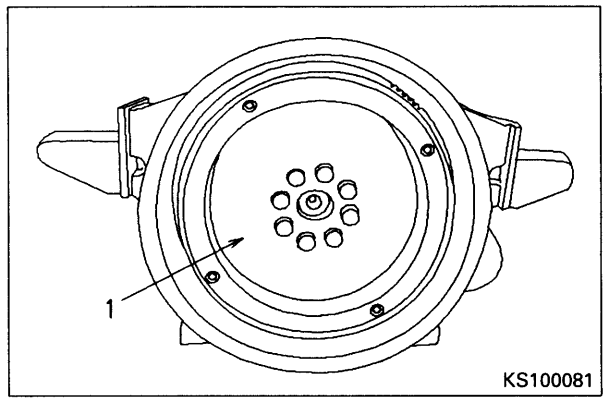
1) Install flywheel (1) on crankshaft.
2) Tighten flywheel mounting bolts as follows.
   - ★ Coat the threads of the bolts, the seat face, and the washers with engine oil (EO30–CD).
   - ★ Tighten the bolts in the order given in the diagram, and to the following tightening torques.

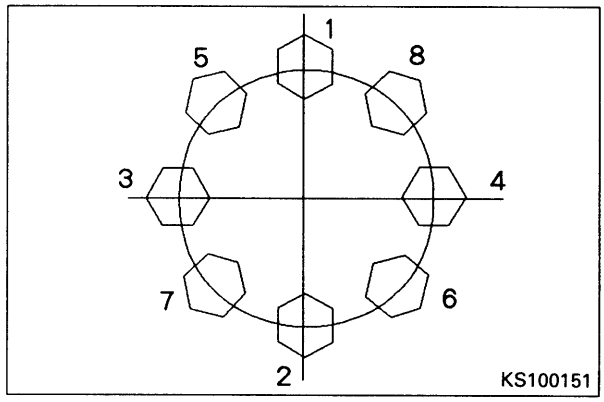
   kgm Flywheel mounting bolt :

Unit : kgm

Order	Target	Range
1st step	9	6 – 12
2nd step	19	18 – 20

3) Measure face runout and radial runout of flywheel.
   - ● After installing the flywheel, measure the face runout and radial runout.
   - ★ Repair limit of face runout : 0.2 mm
   - ★ Repair limit of radial runout : 0.15 mm





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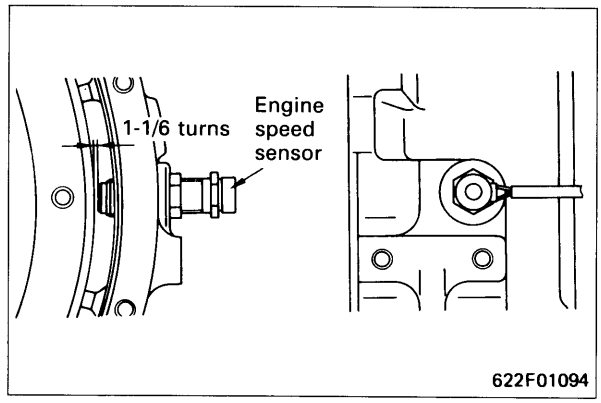
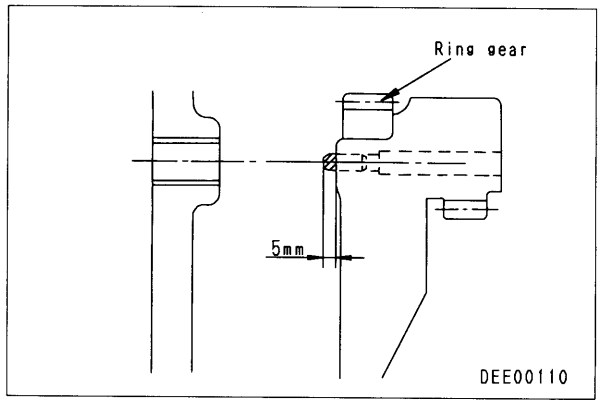
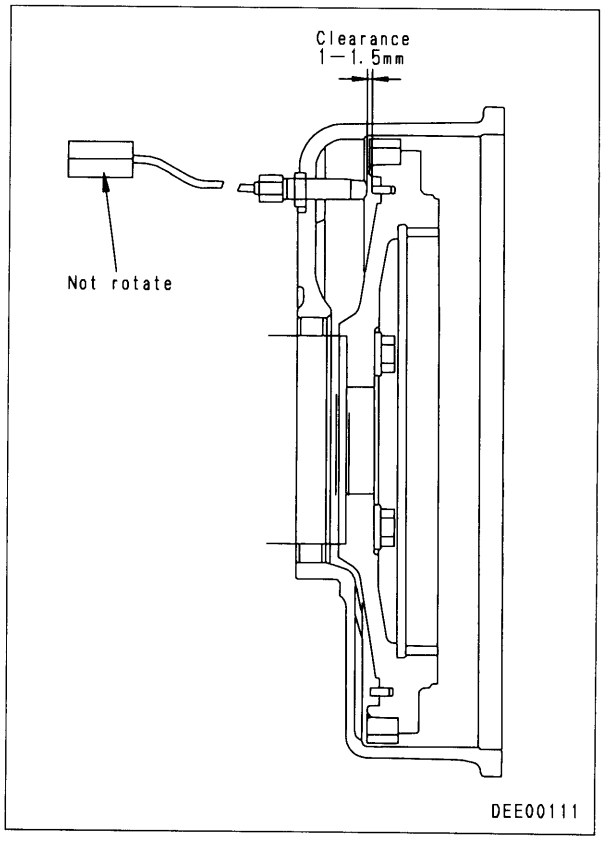
6-1 Engine speed sensor (when equipped)

- Screw in the speed sensor until it contacts the ring gear, then turn 1-1/6 turns and lock in position. (PC300-5)
  kgm Locknut : 6 ± 1 kgm
- Put the speed sensor in contact with the flywheel pin, then turn back 1 turn. (WA320, 380, 420-3)
  kgm Locknut : 5 ± 0.5 kgm
  Coat the thread with hydraulic sealant.







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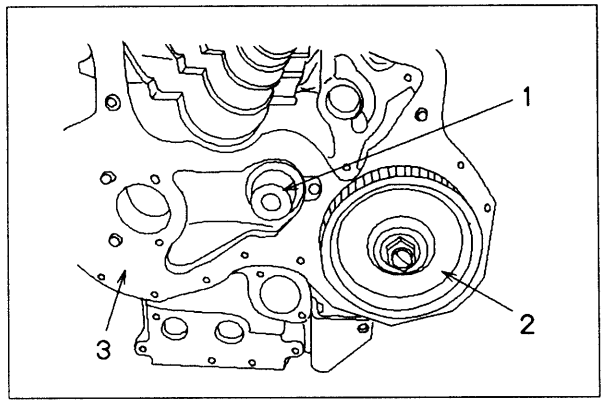
7. **Front plate**
   Install the front plate (3).

8. **Drive gear for fuel injection pump with drive case assembly**
   Install drive gear (2) for fuel injection pump with drive case assembly.
   kgm Nut : 16 – 18 kgm

9. **Idler shaft**
   Install idler shaft (1) .



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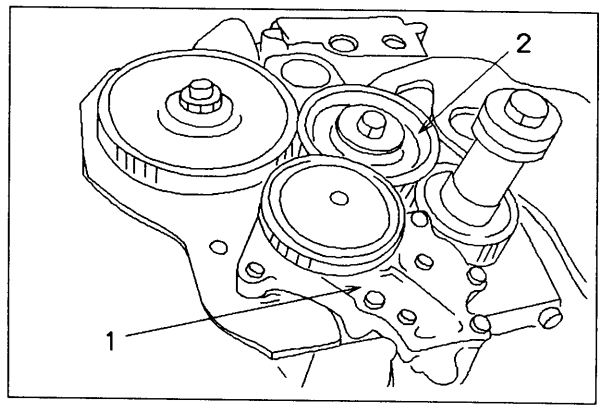
10. Idler gear

Install idler gear (2).

kgm Gear mounting : 14 – 18 kgm

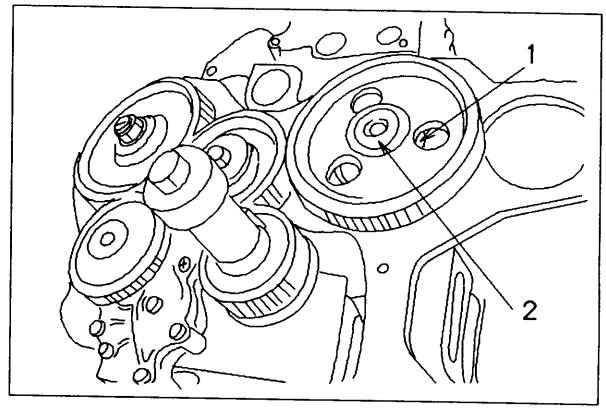


11. Oil pump

Install oil pump (1).

12. Camshaft

1) Assemble camshaft (2).
   - ★ Be careful not to damage the cam bushings when installing.
   - ★ Push camshaft center softly. Must not knock the gear with hammer.
2) Install thrust plate (1).



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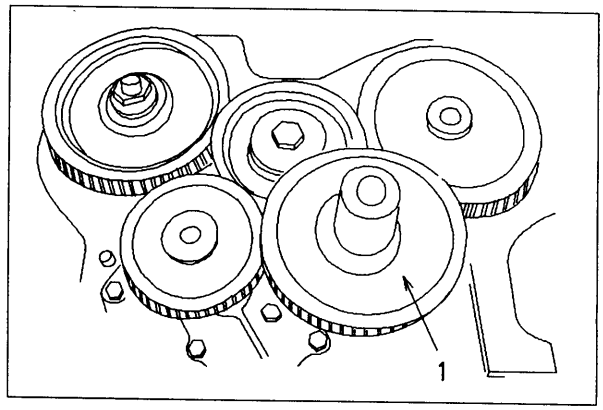
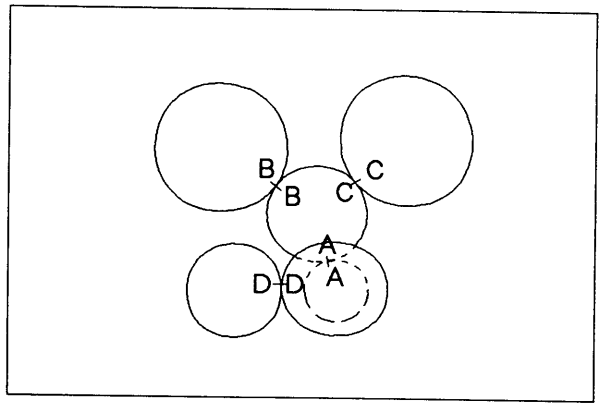
13. Drive gear of oil pump

Install drive gear (1) of oil pump.

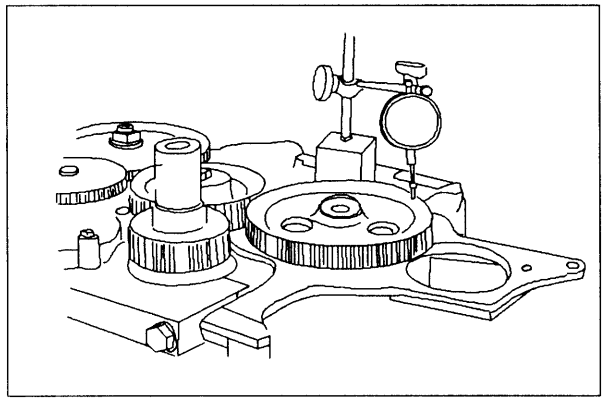


- ★ Check that the match marks of all drive gears and idler gears are correctly aligned.
- ★ Measure the backlash and end play of each gear.
  a) Backlash

Position	Gears	Range (mm)
A	Crankshaft gear and idler gear	0.085 – 0.307
B	Injection pump gear and idler gear	0.054 – 0.380
C	Camshaft gear and idler gear	0.075 – 0.359
D	Oil pump gear and idler gear	0.102 – 0.332

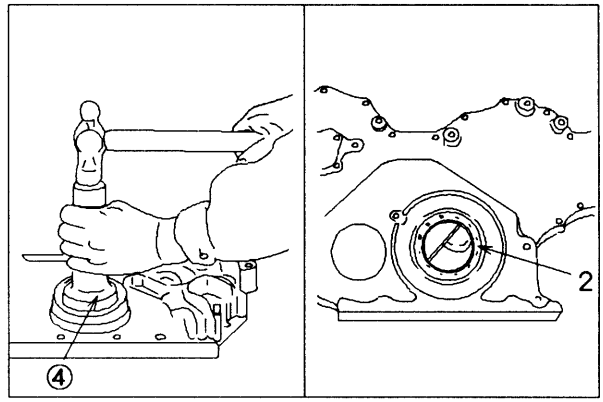


b) End play
★ End play of camshaft : 0.15 to 0.35 mm
★ End play of idler gear : 0.08 to 0.14 mm



14. Gear case cover

1) Using push tool ④ (O.D. 90 mm), press-fit oil seal (2) in case.



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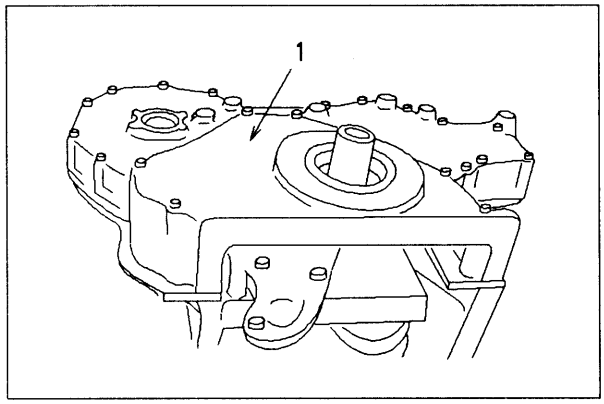
2) Fit gasket and install gear case cover (1).

Coat lip surface of front seal with grease (G2-LI), (about 2 cc).



15. Crankshaft pulley

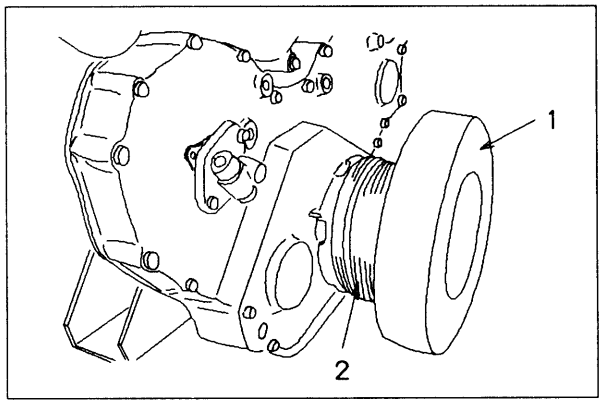
Install crankshaft pulley (2).

kgm Mounting bolt : 43 – 49 kgm

16. Vibration damper

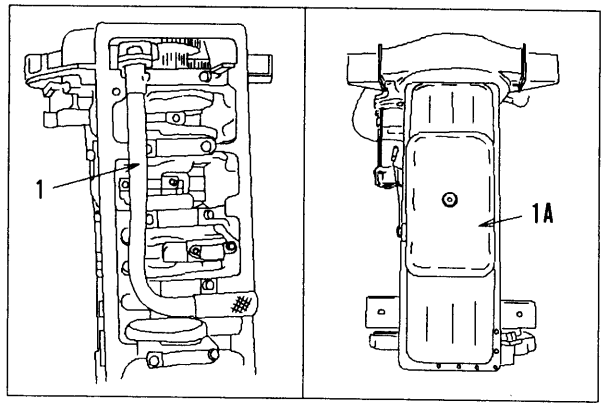
Install vibration damper (1).

kgm Mounting bolt : 6 – 7.5 kgm



17. Suction tube

Install suction tube (1).



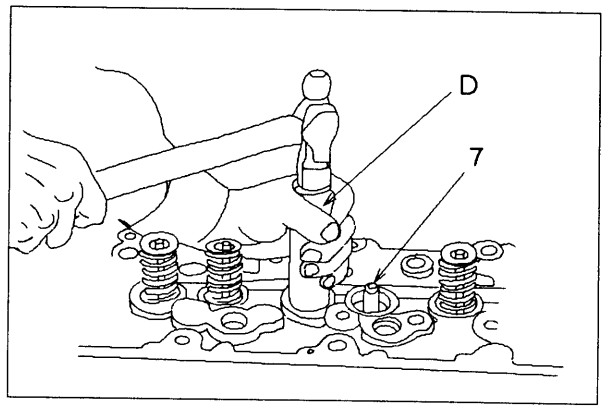
18. Oil pan

Cut gasket so that it is flush with cylinder block, front cover and flywheel housing lower face. Install oil pan (1A).

19. Cylinder head

Assemble cylinder head as follows.

★ If the valve guide has been removed, use push tool **D** to install valve guide (7).



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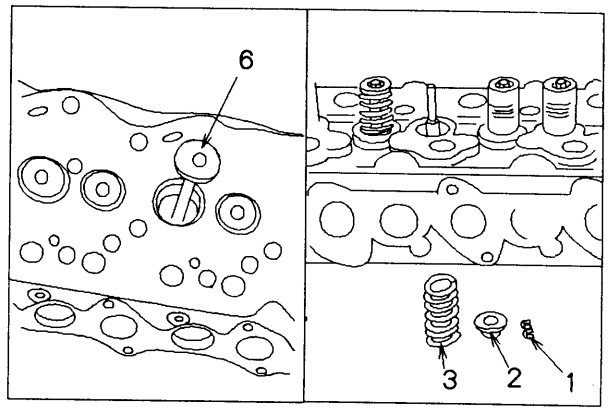
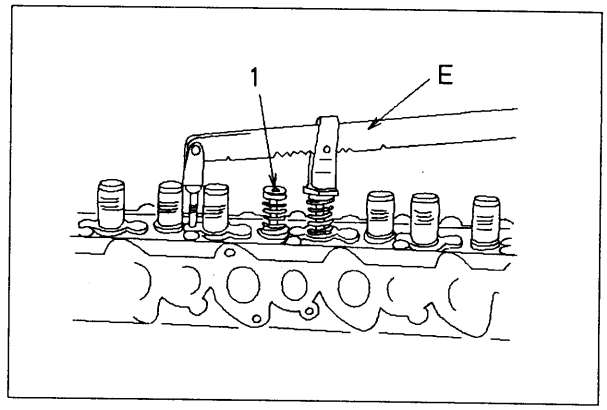
1) Install valve (6).
   ★ Coat the stem of the valve with engine oil (EO30-CD).
2) Install valve spring (3) and valve spring guide (2).

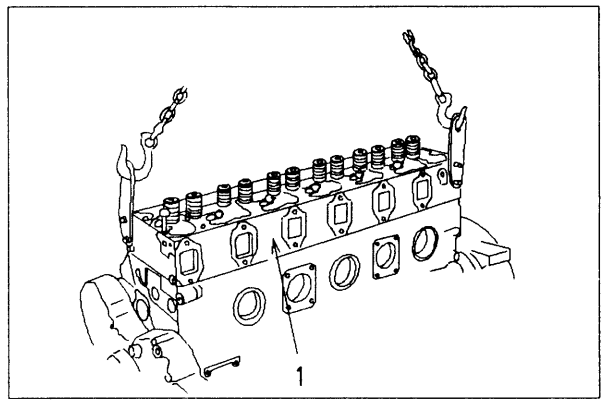


3) Using valve pusher **E**, compress valve spring and fit valve cotter (1) on valve stem.
   ★ Remove tool **E** and tap the valve stem with a plastic hammer to check that the cotter is completely fitted.



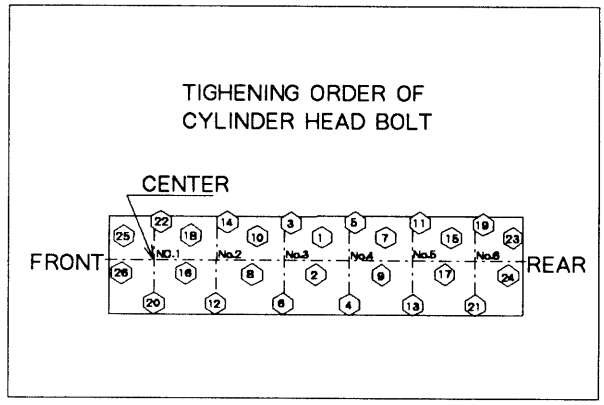
★ Check that the respective mounting surface of the cylinder head and cylinder block are clean and that there is no dirt or foreign material inside the cylinder.

1) Fit cylinder head gasket.
Install cylinder head assembly (1) on the cylinder block.



2) Coat thread of mounting bolts and washer seats with antifriction compound or engine oil. Tighten mounting bolts in order shown in diagram to the following tightening torques.

Mounting bolts : Antifriction compound (LM-P)



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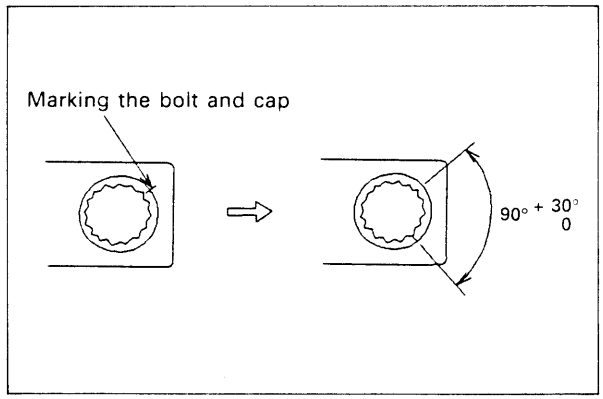
kgm Cylinder head:

Unit : kgm

Order	Target	Range
1st step	10	9 – 11
2nd step	15	14.5 – 15.5
3rd step	more 90° turn	90° – 120°

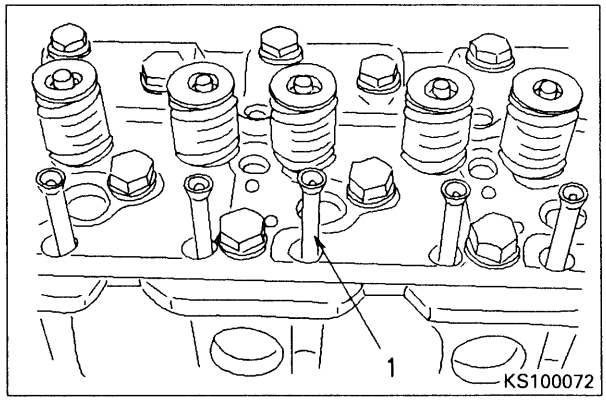


★ After tightening the bolts put one mark on the bolt head with the pointer. If the number of marks exceeds 5, replace with the new bolt.

20. Push rods

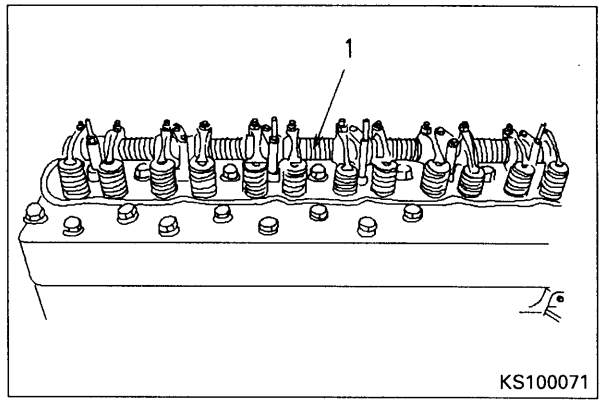
Assemble push rod (1).

★ Check that the push rod is properly fitted into the tappet.



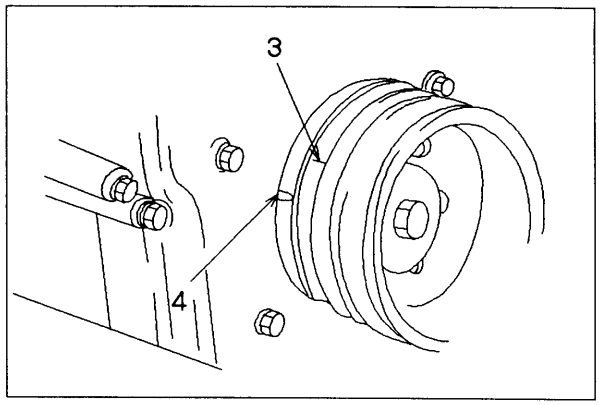
21. Rocker arm assembly

1) Position rocker arm assembly (1).
   - ★ Check that the ball end of the adjustment screw is properly fitted into the socket of the push rod.
   - ★ If the spring is pushing the rocker arm, loosen the adjustment screw.
2) Tighten mounting bolts.
3) When the rocker arm shaft is disassembled, assemble it putting the **V** grooves of the shaft underside.



4) Adjust valve clearance as follows.
   - ★ Adjust the clearance between valve and rocker arm as follows (cold).
     Intake valve : 0.34 mm
     Exhaust valve : 0.66 mm
   - ★ Firing order: 1 – 5 – 3 – 6 – 2 – 4

   a) Rotate the crankshaft in the normal direction to align pointer (4) with the "1.6 TOP" mark on the crankshaft pulley (3). When rotating, check the motion of the valves.
      - ★ When No.1 cylinder is at compression top dead center, adjust the valves marked ●.
      - ★ When No. 6 cylinder is at compression top dead center, adjust the valves marked ○.



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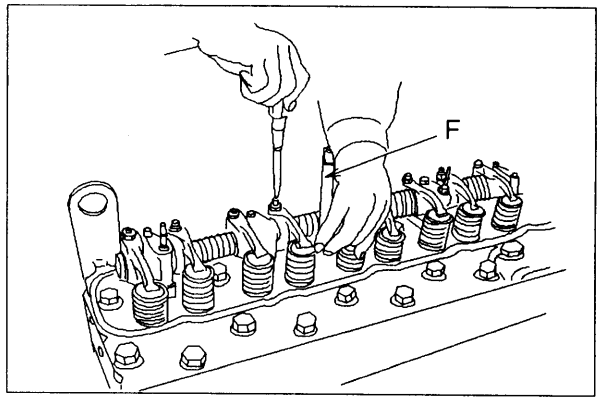
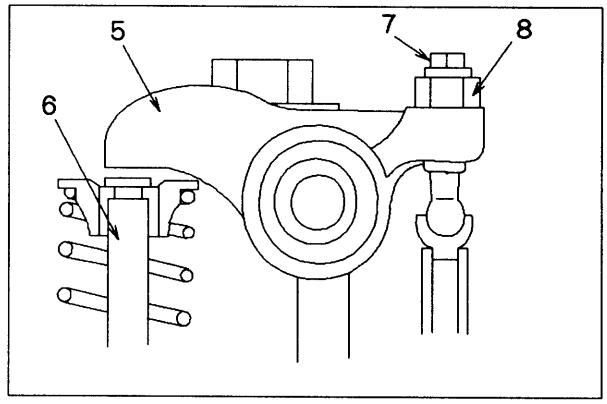
Cylinder No.	1	2	3	4	5	6
Intake valve	●	●	○	●	○	○
Exhaust valve	●	○	●	○	●	○

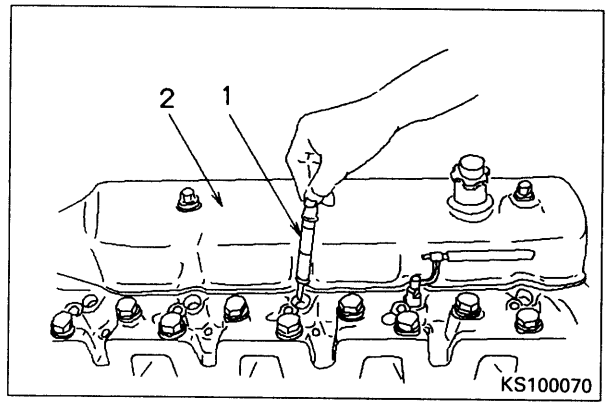
b) To adjust clearance, insert feeler gauge **F** between rocker arm (5) and valve stem (6) and turn adjustment screw (7) to the degree that the gauge moves narrowly.



c) Tighten lock nut (8) to hold adjustment screw in position.
kgm Lock nut : 4 – 5 kgm
★ After tightening the lock nut, check the clearance again.



22. Cylinder head cover
Fit O-ring and install cylinder head cover (2).
kgm Head cover mounting bolt : 0.8 – 1.0 kgm



23. Nozzle holder
★ Check that there is no dirt or damage inside the holder sleeve or on the contact surface of the nozzle holder. Install nozzle holder (1) in cylinder head.
kgm Mounting bolt : 4.0 – 5.0 kgm

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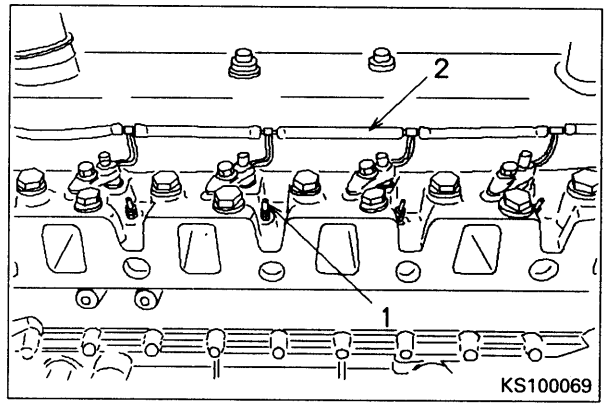
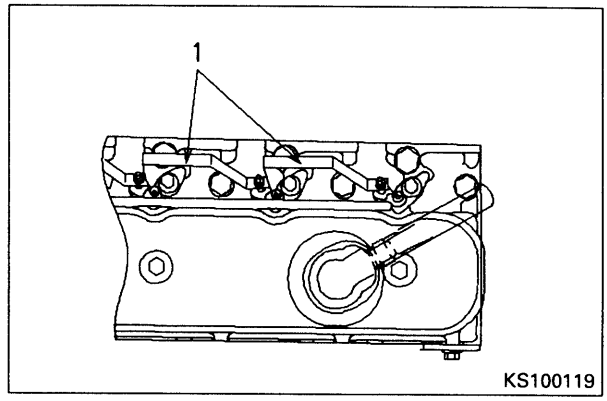
24. Spill pipe
Install spill pipe (2).

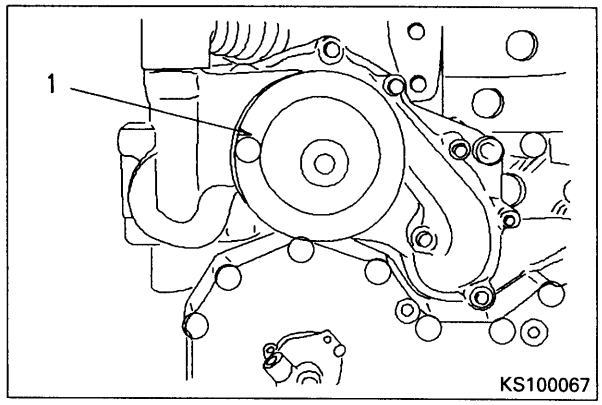
25. Glow plug
Install glow plug (1).



26. Lead
Install lead (1).
kgm Nut : 0.1 – 0.2 kgm

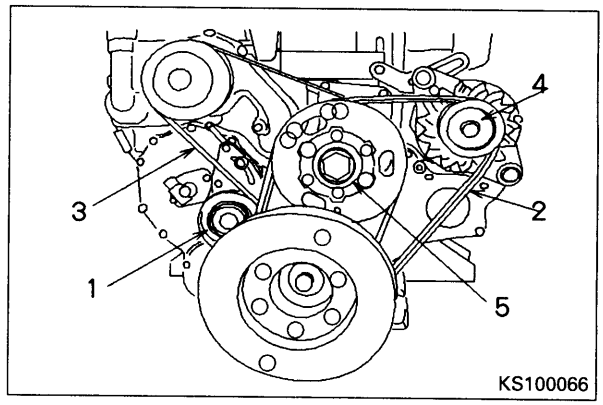


27. Water pump
Fit gasket and install water pump (1).



28. Fan pulley drive assembly
Install fan pulley drive assembly (5).
kgm Mounting nut : 22 – 26 kgm

29. Alternator
Temporarily install alternator (4).



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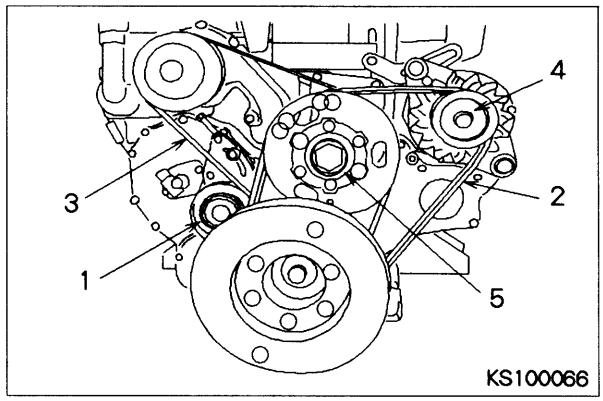
30. Fan belt, water pump belt (PC300-5)

1) Install water pump belt (3).
2) Install fan belt (2).
3) Adjust fan belt tension as follows.
   i) Watch fan belt tension and move alternator to outside. Tighten alternator mounting bolts and plate mounting bolts temporarily so that belt tension is not loose.
   ii) After adjusting, tighten all bolts fully.
   iii) After adjusting, check deflection of belt when point midway between crankshaft pulley and alternator pulley is pressed with a finger force of approx. 6 kg.
   ★ Standard belt deflection (a), (b)
   a: 3 mm (PC300-5)
   b: 6 mm (PC300-5)



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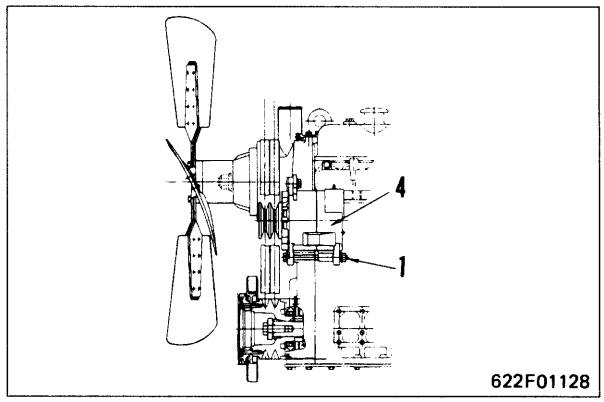

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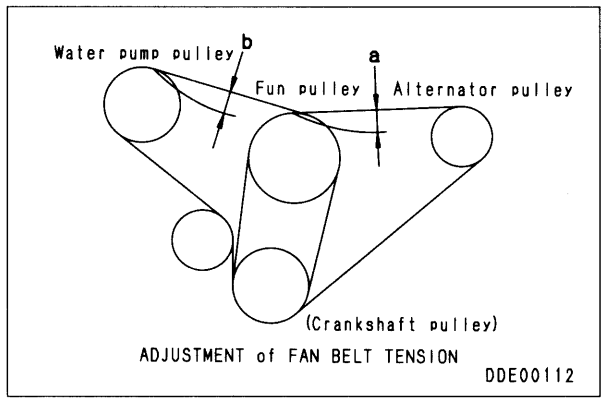
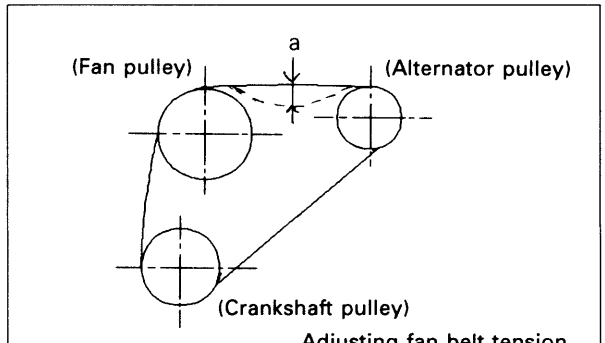
30-1. Fan belt (water pump belt)
(WA320, 380-3, WA420-3) (AUSTOFT)

1) Install fan belt (water pump belt).
2) Insert bar between alternator and cylinder block, then watch fan belt tension and move alternator to outside to adjust belt tension.
   ⚠ Be careful not to get your fingers caught.
   Adjust deflection of belt when point midway between fan pulley (water pump pulley) and alternator pulley is pressed with a finger force of approx. 6 kg.
   ★ Fan belt deflection (a): 7.5 mm
3) After adjusting, tighten all bolts fully.



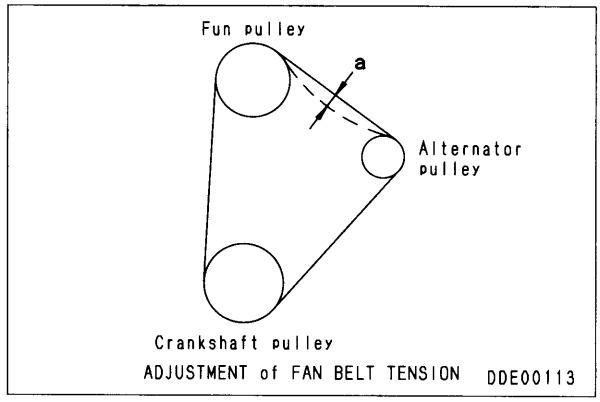
ADJUSTMENT of FAN BELT TENSION
DDE00112



Adjusting fan belt tension
KS100230

30-2. Fan belt (D57S-1B)

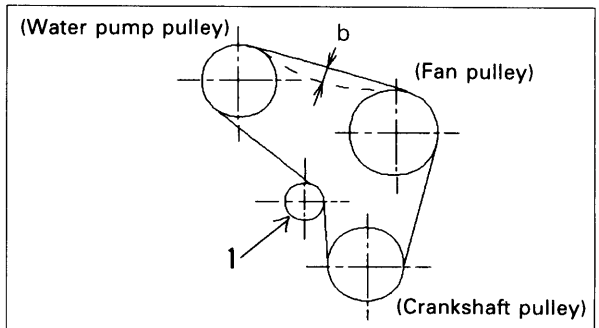
1) Install water pump belt (3).
2) Install fan belt (2).
3) Adjust fan belt tension as follows.
   i) Watch fan belt tension and move alternator to outside. Tighten alternator mounting bolts and plate mounting bolts temporarily so that belt tension is not loose.
   ii) After adjusting, tighten all bolts fully.
   iii) After adjusting, check deflection of belt when point midway between crankshaft pulley and alternator pulley is pressed with a finger force of approx. 6 kg.
   ★ Standard belt deflection (a): 6 mm



ADJUSTMENT of FAN BELT TENSION DDE00113

31. Tension pulley (PC300-5) (AUSTOFT)

1) Install tension pulley (1).
2) Adjust water pump belt tension as follows.
   i) Watch water pump belt tension and tighten adjustment screw to inside. Tighten lock bolt temporarily so that belt tension is not loose.
   ii) After adjusting, tighten all bolts fully.
   iii) After adjusting, check deflection of belt when point midway between fan pulley and water pump pulley is pressed with a finger force of approx. 6 kg.
   ★ Standard belt deflection (b):
   6 mm (PC300-5)
   5 – 10 mm (AUSTOFT)

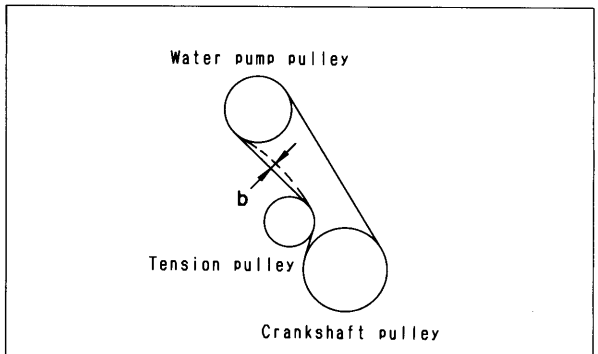


Adjusting water pump belt tension KS100231

622101

31-1. Tension pulley (D57S-1B)

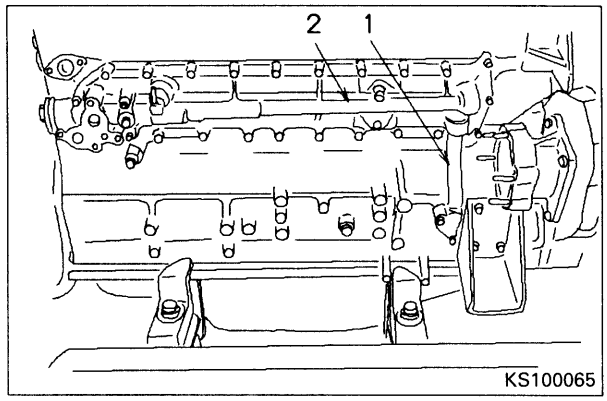
1) Install tension pulley (1).
2) Adjust water pump belt tension as follows.
   i) Watch water pump belt tension and tighten adjustment screw to inside. Tighten lock bolt temporarily so that belt tension is not loose.
   ii) After adjusting, tighten all bolts fully.
   iii) After adjusting, check deflection of belt when point midway between fan pulley and water pump pulley is pressed with a finger force of approx. 6 kg.
   ★ Standard belt deflection (b): 6 mm



DDE00114

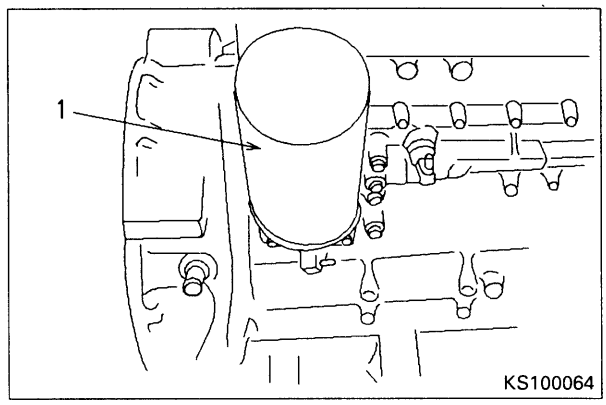
32. Oil cooler

1) Fit gasket and install oil cooler (2).
2) Fit O-ring and install oil cooler inlet tube (1).



33. Oil filter

Fit O-ring and install oil filter (1) together with bracket.



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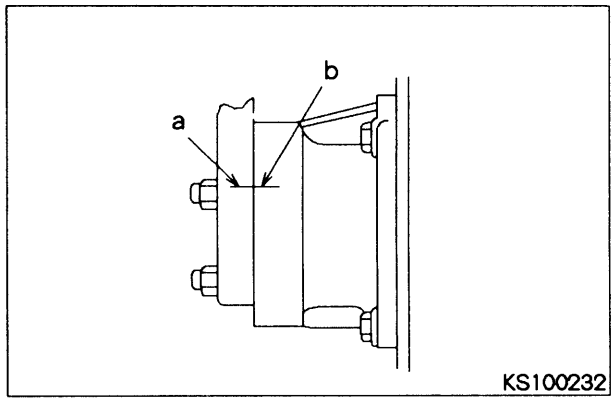
34. Fuel injection pump

Install fuel injection pump (1) to the drive case.

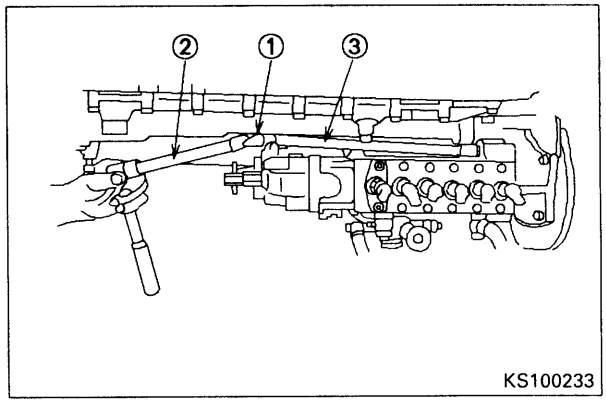
★ When installing the injection pump, align line (a) of the injection pump flange and line (b) of the injection pump drive case.



★ Tighten these two nuts from pump rear using socket wrench, universal joint ①, and extensions ② and ③ .

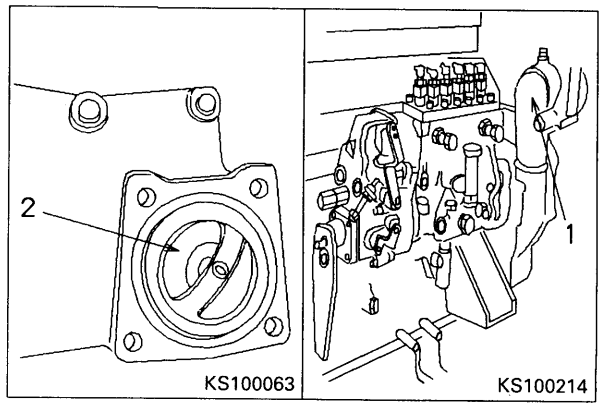
- Extension ② : 300 mm
- Extension ③ : 100 mm

kgm Nut : 6 – 7.5 kgm



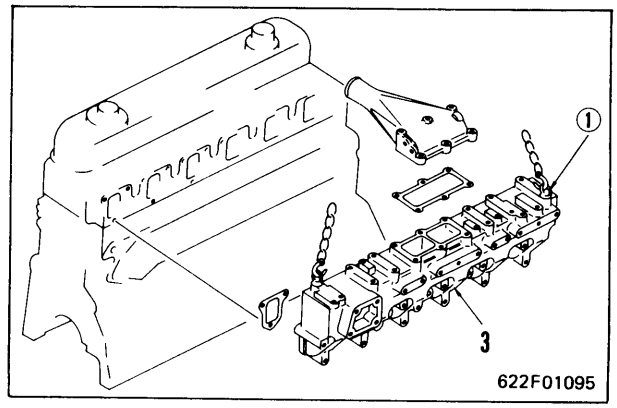
35. Thermostat

1) Fit gasket and install thermostat (2).
2) Install connector (1).



36. Intake manifold (S6D108)

1) Install cover.
2) Usinig eyebolts ① (Thread dia. = 8 mm, Pitch = 1.25 mm), sling intake manifold (3).
3) Fit gasket and install intake manifold (3).
   kgm Mounting bolt : 1.5 – 3.5 kgm



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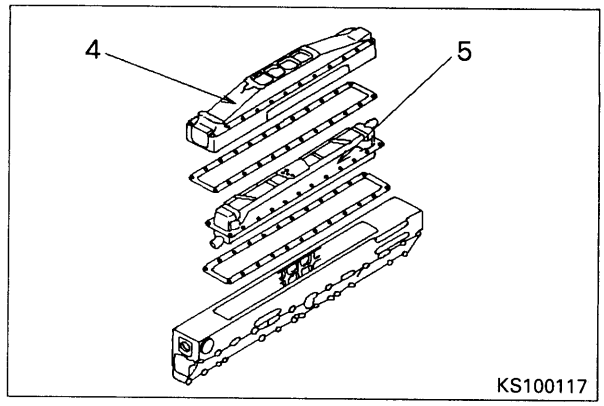
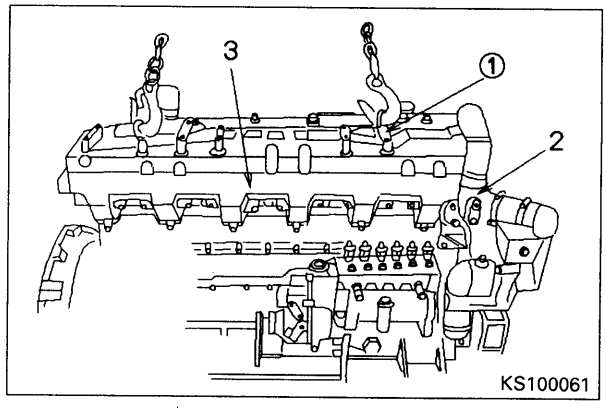
36-1.Aftercooler, intake manifold (SA6D108)

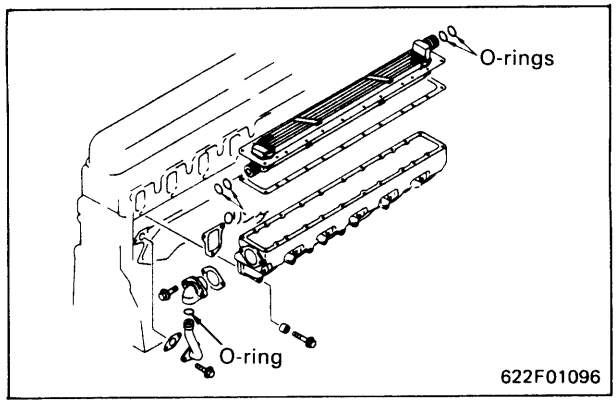
1) Fit gasket and assemble aftercooler (5) to intake manifold.
2) Install cover (4).



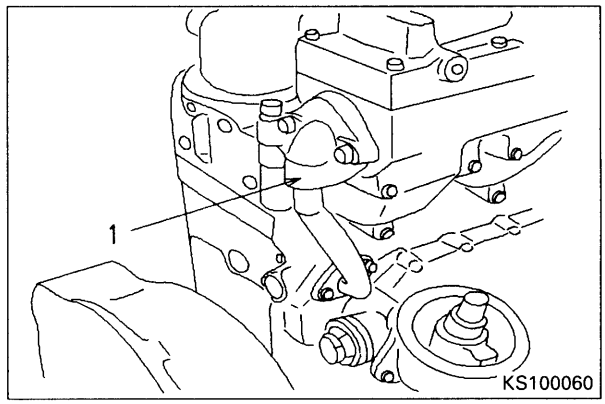
3) Using eyebolts ① (Thread dia. = 8 mm, Pitch = 1.25 mm), sling intake manifold.
4) Fit gasket and install intake manifold (3).
   kgm Mounting bolt : 1.5 – 3.5 kgm
5) Fit O-ring and install aftercooler outlet tube (2).



★ Coat the O-ring and O-ring groove with soapy water or vegetable oil.
Never use mineral oil (engine oil) as this will cause swelling and deterioration.



6) Fit O-ring and install aftercooler inlet tube (1).



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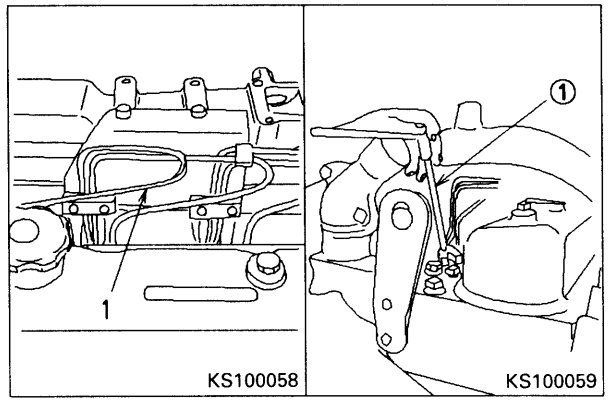
37. Fuel injection pipe

Install fuel injection pipe (1).

★ Using tool ①, install sleeve nut for nozzle holder.

kgm Sleeve nut : 2.0 – 2.5 kgm (flat width 17 mm)

kgm Injection pump side sleeve nut : 2.5 – 3.5 kgm



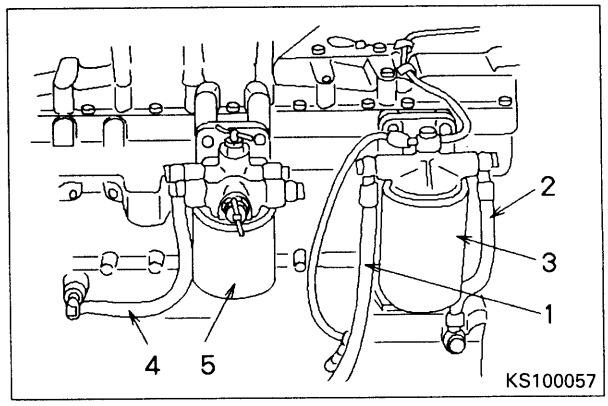
38. Corrosion resistor (When equipped)

Install corrosion resistor (5) and connect hose (4).

39. Fuel filter

1) Install fuel filter (3).
2) Connect fuel filter inlet hose (1).
3) connect fuel outlet hose (2).

40. Resetting engine in engine stand

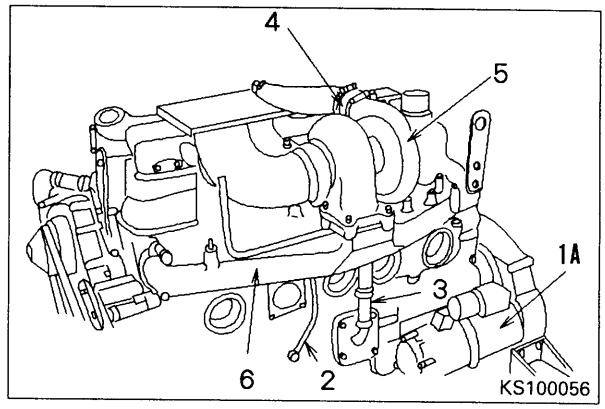


41. Turbocharger and exhaust manifold assembly

1) Install turbocharger (5) and exhaust manifold assembly.
2) Connect intermediate connector (4) between turbocharger and aftercooler. (SA6D108)

2A) Connect intermediate connector (4) of intake manifold. (S6D108)

3) Connect inlet tube (2) and outlet tube (3) between turbocharger and cylinder block.

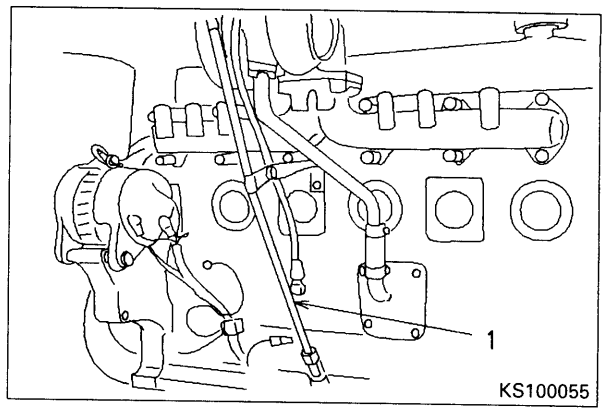


42. Starting motor

Instal starting motor (1A).

43. Oil dipstick guide

Install oil dipstick guide (1).



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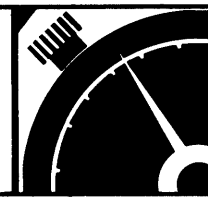
ENGINE
14 MAINTENANCE STANDARD



INTAKE AND EXHAUST SYSTEM
Turbocharger 14-002

ENGINE BODY
Cylinder head 14-004
Valve and valve guide 14-006
Rocker arm, push rod and tappet 14-008
Cylinder liner 14-009
Cylinder block 14-010
Crankshaft 14-012
Camshaft 14-013
Piston, piston ring and piston pin 14-014
Connecting rod 14-015
Timing gear 14-016
Flywheel and flywheel housing 14-017

LUBRICATION SYSTEM
Oil pump 14-018
Regulator valve 14-019
Safety valve 14-019

COOLING SYSTEM
Water pump and thermostat 14-020

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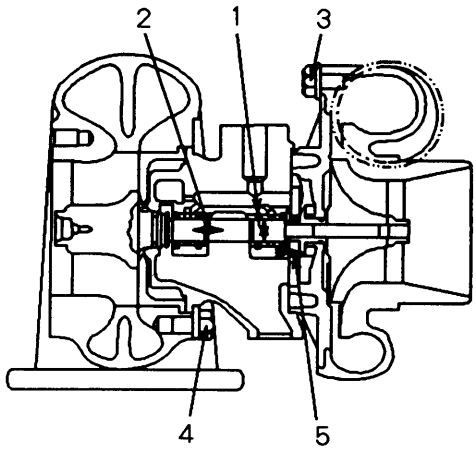
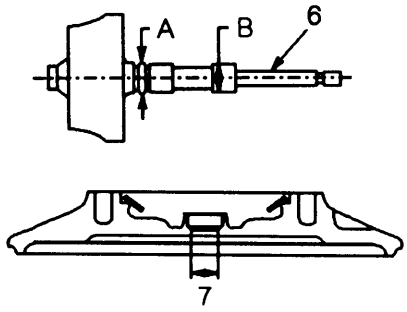
TURBOCHARGER

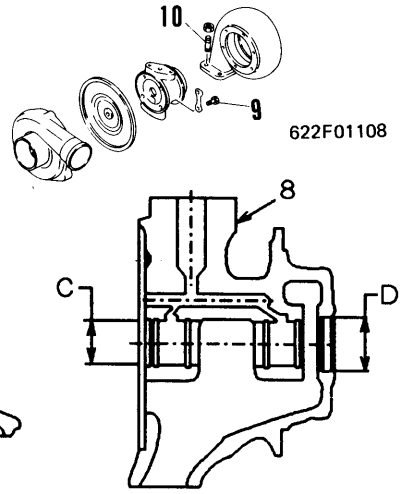
TO4E (GARRET)



14F036A



14F036-1A



14F036-2A

Unit: mm

No.	Check item	Criteria				Remedy
1	Play of rotor in side direction	Standard value: 0.076 – 0.150		Repair limit: 0.15		Correct or replace
2	Play of rotor in axial direction	0.026 – 0.076		0.076		
3	Tightening torque of blower housing bolt	Target: 16.7 Nm (1.7 kgm)		Range: 15.3 – 18.6 Nm (1.56 – 1.9 kgm)		Tighten
4	Tightening torque of turbine housing mounting bolt	19.6 Nm (2.0 kgm)		17.7 – 21.6 Nm (1.8 – 2.2 kgm)		
5	Thickness of thrust bearing	Standard size: 4.36		Repair limit: 4.35		Replace
6	Outside diameter, curvature of wheel shaft		Position	Standard size	Repair limit	
		Outside diameter	A	17.31	17.25	
			B	10.155	10.15	
		Curvature	Repair limit: 0.010 (TIR)			
7	Inside diameter of back plate	12.70		12.71		
8	Inside diameter of center housing	Position	Standard size	Repair limit		
		C	15.80	15.81		
		D	18.03	18.06		
9	Tightening torque of back plate mounting bolt	13.2 Nm (1.35 kgm)		12.1 – 14.0 Nm (1.27 – 1.43 kgm)		
10	Tightening torque of turbocharger mounting bolt (stud)	29.4 – 44.1 Nm (3.0 – 4.5 kgm)				

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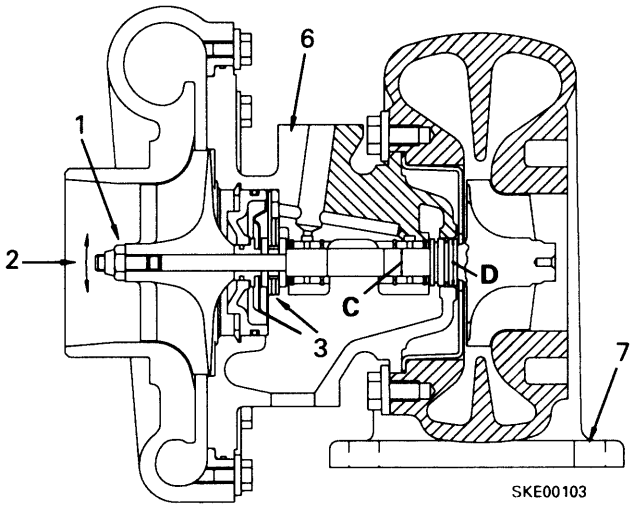
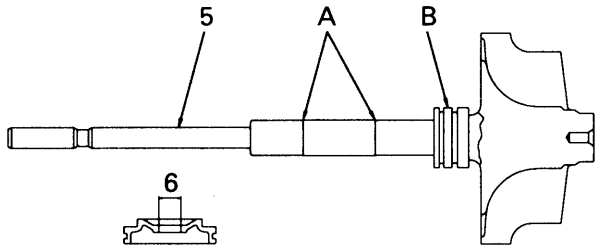
S2B (SCHWITZER)



SKE00103



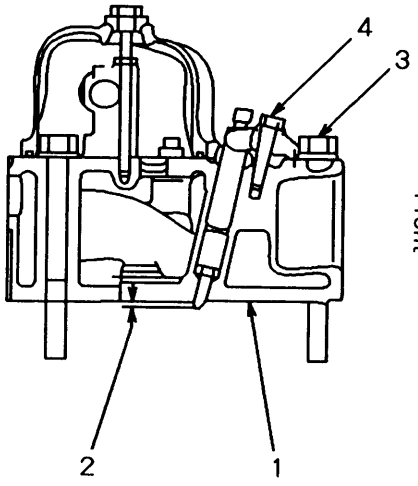
SKE00104

Unit:mm

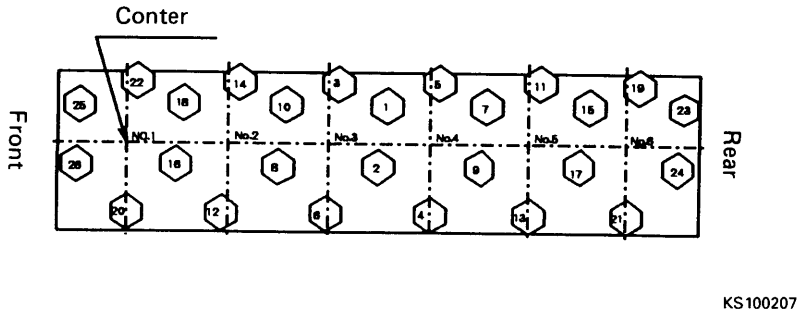
No.	Check item	Criteria			Remedy
1	Play of rotor in radial direction	Standard size		Repair limit	Correct or replace
		0.400 – 0.565		0.840	
2	Play of rotor in axial direction	0.051 – 0.090		0.142	
3	Thickness of thrust bearing	4.35		4.30	
4	Outside diameter, curvature of wheel shaft	Outside diameter	Position	Standard size	Repair limit	Replace
			A	10.152	10.130	
			B	17.32	17.25	
		Curvature	Repair limit: 0.0076 (total runout of indicator)			
5	Inside diameter of insert	Standard size		Repair limit	
		12.71		12.71	
6	Inside diameter of center housing	Position	Standard size	Repair limit	
		C	15.80	15.82	
		D	18.06	18.06	
7	Tightening torque of turbocharger mounting bolt (stud)	29.4 – 44.1Nm (3.0 – 4.5 kgm)			

622101

CYLINDER HEAD



KS100094



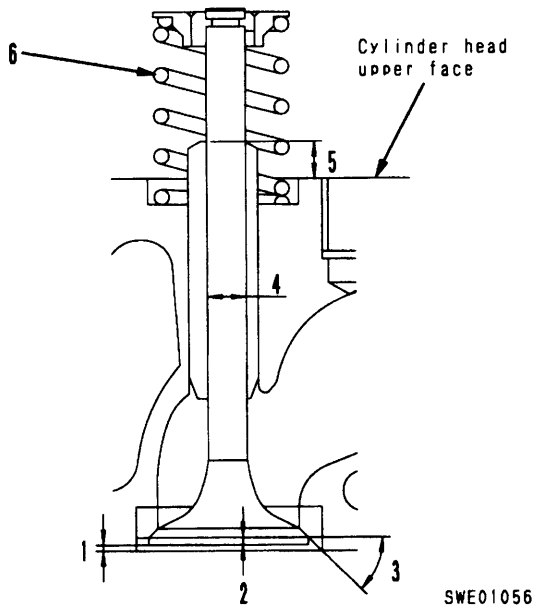
KS100207

622101

Unit:mm

No.	Check item	Criteria			Remedy
1	Distortion of cylinder head mounting surface	Standard size		Repair limit	Correct by grinding or replace
		0 – 0.09		0.12	
2	Protrusion of nozzle	Engine No		Standard	Replace nozzle or gasket
		10001–		3.12 ± 0.39	
3	Tightening torque of cylinder head mounting bolt (Coat thread with molybdenum disulphide.) (Plastic range turning angle tightening method)	Order	Coat with molybdenum disulphide		Tighten in order in diagram above. If any bolt has 5 punch marks, replace with new bolt.
			Target	Range	
		1st pass	98.1Nm (10kgm)	88.3 – 107.9 Nm (9 – 11kgm)	
		2nd pass	147.1Nm (15kgm)	142.2 – 152.0Nm (14.5 – 15.5 kgm)	
		3rd pass	105°	90° – 120°	
4	Tightening torque of nozzle holder mounting bolt	Target		Range	Tighten
		44.1 Nm (4.5 kgm)		39.2 – 49 Nm (4 – 5 kgm)	

VALVE AND VALVE GUIDE



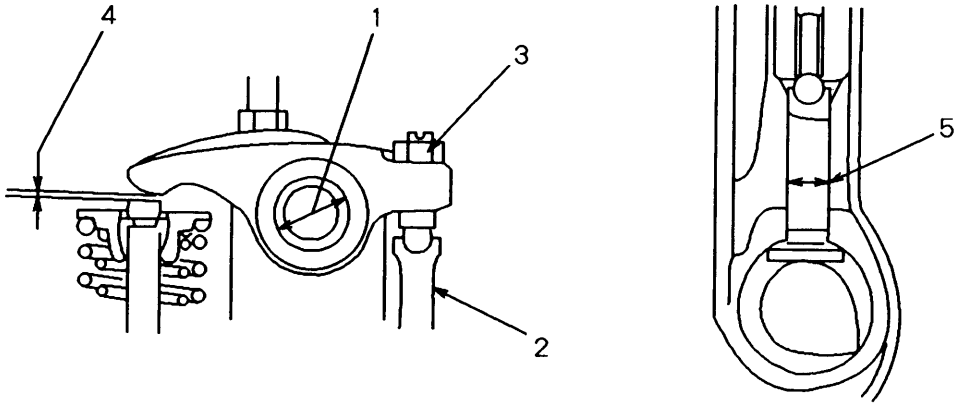
622101

Unit : mm

No.	Check item	Criteria				Remedy
1	Sinking of valve	Valve	Standard size	Tolerance	Repair limit	Replace valve or valve seat
		Intake, exhaust valves	0.0	± 0.1	1.1	
2	Thickness of valve lip	Valve	Standard size		Repair limit	Replace valve
		Intake valve	2.0		1.7	
		Exhaust valve	1.50		1.2	
3	Angle of valve seat		Intake valve		Exhaust valve	Repair or replace valve or valve seat
		Standard	30°		45°	
4	O.D. of valve stem	Valve	Standard size		Tolerance	Replace valve
		Intake valve	9		-0.030 -0.045	
		Exhaust valve	9		-0.060 -0.075	
	I. D. of valve guide	Intake, exhaust valves	9		+0.025 -0.010	Replace valve guide
	Clearance between valve guide and stem	Valves	Standard clearrance		Clearance limit	Replace valve or valve guide
		Intake valve	0.040 – 0.070		0.22	
		Exhaust valve	0.070 – 0.100		0.25	
	Curvature of valve stem	Repair limit : 0.02 (total variation of indicator, per 100mm)				Replace
5	Height of valve guide when knocked in	Standard		Tolerance		Repair
		14		± 0.2		
6	Free length of valve spring	Standard size		Repair limit		Replace valve spring
		62.69		61.2		
	Installed length of valve spring	Installed length	Standard load		Repair limit	
		51.1	254 ±12.8N (25.76 ± 1.3kg)		227.5N (23.2kg)	
	Out-of straight of valve spring	Repair limit 2°(at both ends)				

622101

ROCKER ARM, PUSH ROD AND TAPPET



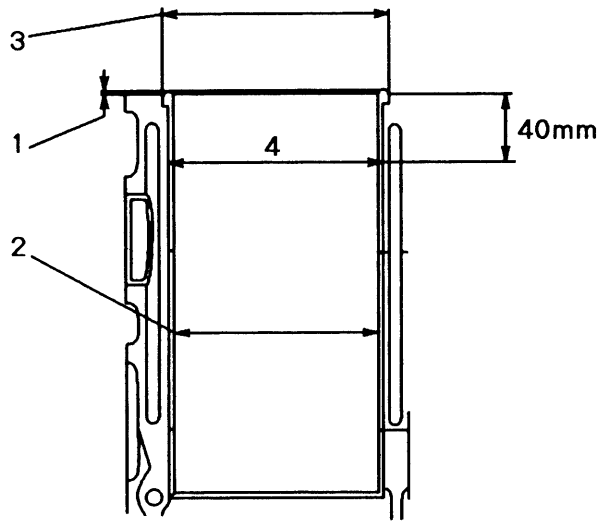
KS100098

Unit:mm

No.	Check item	Criteria			Remedy
1	O.D. of rocker arm shaft	Standard size	Repair limit		Replace rocker arm shaft
		19	0 –0.020		
	I.D. of rocker arm shaft hole	Standard clearance	Clearance limit		Replace rocker arm
		19	+ 0.030 + 0.010		
	Clearrance between rocker arm shaft and rocker arm shaft hole	Standard clearance	Clearance limit		Replace rocker arm or rocker arm shaft
		0.010 – 0.050	0.13		
	Curvature of rocker arm shaft	Repair limit : 0.20 (total variation of indicator)			Replace rocker arm shaft
2	Curvature of push rod	Repair limit : 0.30 (total variation of indicator)			Replace push rod
3	Tightening torque or loke nut for rocker arm adjustment screw	Target	Range		Tighten
		44.1 Nm (4.5kgm)	39.2 – 49.0 Nm (4 –5 kgm)		
4	Valve clearance (when cold)	Valve	Standard	Tolerance	Adjust
		Intake side	0.34	± 0.02	
		Exhaust side	0.66		
5	O.D. of tappet	Standard size	Tolerance		Replace tappet
		18	– 0.020 – 0.038		
	I.D. of tappet hole	18	+ 0.018 0		Replace cylinder head
	Clearance between tappet and tappet hole	Standard clearance	Clearance limit		Replace tappet or cylinder head
		0.020 – 0.056	0.20		

622101

CYLINDER LINER



KS100209

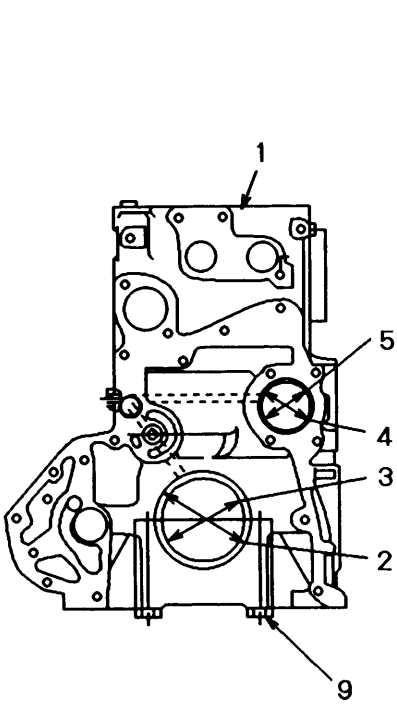
622101

Unit:mm

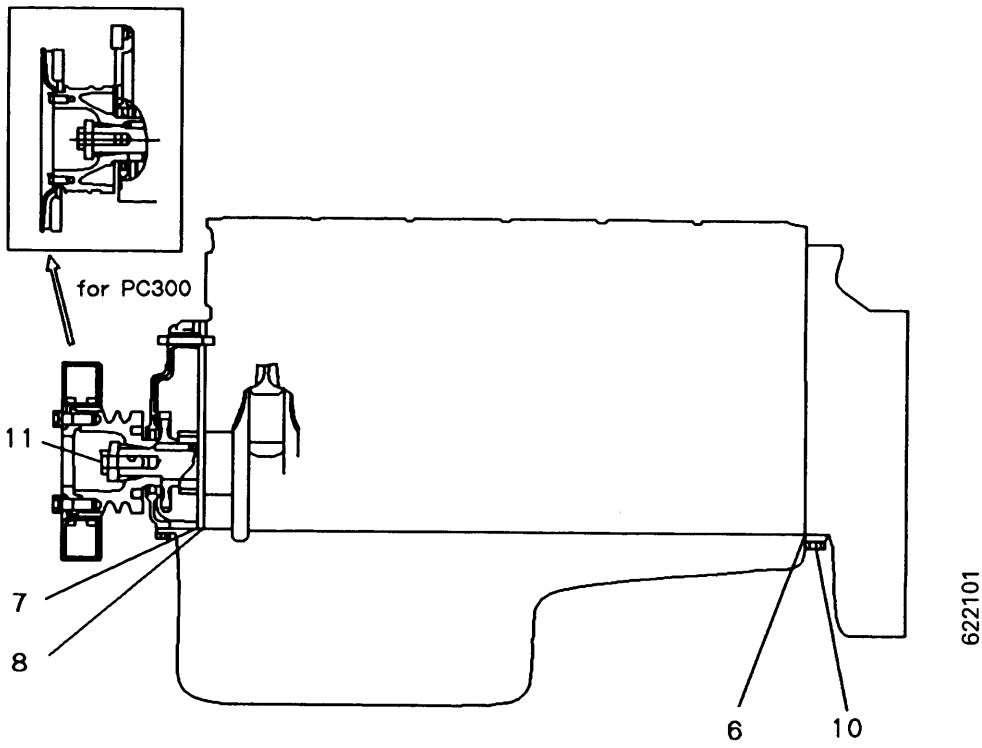
No.	Check item	Criteria			Remedy
1	Protrusion of cylinder liner	Permissible range : 0.05 – 0.13			Replace cylinder linner or cylinder block
2	Inside diameter of cylinder liner	Standard size	Tolerance	Repair limit	Replace cylinder linner
		108	+ 0.032 0	108.20	
	Roundness of cylinder liner	Repair limit : 0.15			
	Cylinder of cylinder liner	Repair limit : 0.08			
3	Outside diameter of cylinder liner (Counter bore)	Standard size	Tolerance		
		120	0 -0.08		
	Clearance between cylinder block and cylinder liner (Counter bore)	Standard clearance : 0.10 – 0.28			Replace cylinder liner or cylinder block
4	Interference between cylinder liner and cylinder block (The average value in the front-rear and left-right dirsctions at a point 40mm from the top surface)	Standard size	Mark	Tolerance: Liner O.D. / Block I.D.	Standard interference
		111.4	S	+ 0.029 + 0.017 / + 0.012 + 0.006	0.005 – 0.030
			M	+ 0.042 + 0.029 / + 0.024 + 0.012	
			L	+ 0.053 + 0.042 / + 0.030 + 0.04	

Replace cylinder liner or cylinder block (Selection of size) (Assemble a part of the same mark)

CYLINDER BLOCK



KS100210



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KS100211

Unit:mm

No.	Check item	Criteria			Remedy
1	Distortion of cylinder head mounting surface	Standard size	Repair limit		Repair by grinding or replace
		0 – 0.080	0.12		
2	Inside diameter of main bearing mounting hole	Standard size	Tolerance		Replace main bearing cap
		101	+ 0.022 0		
	Straightness of main bearing mountig hole	Repair limit : 0.010			
	Roundness of main bearing mounting hole	Repair limit : 0.005			
3	Inside diameter of main bearing	Standard size	Tolerance	Repair limit	Replace main bearing
		95	+ 0.050 + 0.006	95.15	
4	Inside diameter of bushing mounting hole	Standard size	Tolerance		Replair or replace
		62	+ 0.030 0		
5	Inside diameter of camshaft bushing	Standard size	Tolerance	Repair limit	Replace camshaft bearing
		59	+ 0.088 + 0.009	59.3	
6	Difference between cylinder block lower face and flywheel housing	Repair limit : 0.13			Repair by reassembling
7	Difference between cylinder block lower face and front cover	Repair limit : 0.11			
8	Difference between cylinder block lower face and front plate	Repair limit	Plate protrusion : 0.04 Plate inset : 0.22		
9	Tightening torque of main bearing cap mounting bolt (Coat bolt thread with engine oil) (Tightening using plastic range turning angle)	Order	Target	Range	Tighten
		1st step	78.5 Nm (8 kgm)	68.6 – 88.3 Nm (7 – 9 kgm)	
		2nd step	156.9 Nm (16 kgm)	152.0 – 161.8 Nm (15.5 – 16.5 kgm)	
		3rd step	105°	90° – 120°	
10	Tightening torque of oil pan mounting bolt		18.6 Nm (1.9 kgm)	13.7 – 23.5 Nm (1.4 – 2.4 kgm)	
11	Tightening torque of crankshaft pulley mounting bolt		451 Nm (46 kgm)	421.4 – 480.2 Nm (43 – 49 kgm)	

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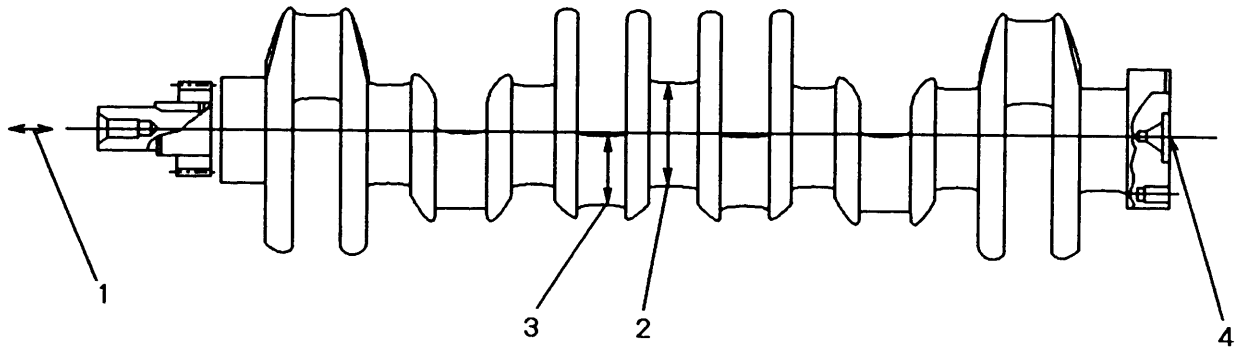
CRANKSHAFT



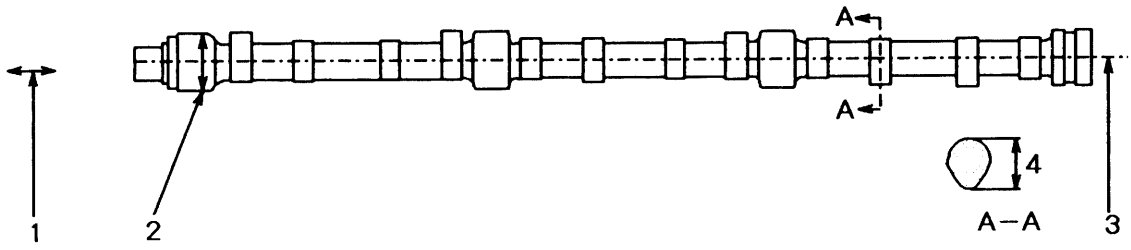
KS100103

Unit:mm

No.	Check item	Criteria				Remedy
1	End play	Standard size		Repair limit		Replace thrust bearing or correct oversize
		0.140 – 0.315		0.40		
2	O.D. of main journal		Standard size	Tolerance	Repair limit	Correct under size or replace
		S.T.D	95	- 0.050 - 0.065	94.87	
		0.25 U.S	94.75		94.62	
		0.50 U.S	94.50		94.37	
		0.75 U.S	94.25		94.12	
		1.00 U.S	94.00		93.87	
	Out-of roundness of main journal	Repair limit : 0.020				
	Clearance at main journal	Standard clearance		Clearance limit		Replace main bearing
		0.056 – 0.115		0.28		
3	O.D. of crank pin journal		Standard size	Tolerance	Repair limit	Correct under size or replace
		S.T.D	70	- 0.050 - 0.065	69.87	
		0.25 U.S	69.75		69.62	
		0.50 U.S	69.50		69.37	
		0.75 U.S	69.25		69.12	
		1.00 U.S	69.00		68.87	
	Out-of roundness of crank pin journal	Repair limit : 0.020				
	Clearance at crank pin journal	Standard		Clearance limit		Replace connecting rod bearing
		0.040		0.28		
4	Bend of crankshaft	Repair limit : 0.2 (total variation of indicator)				Correct under-size or replace

622101

CAMSHAFT



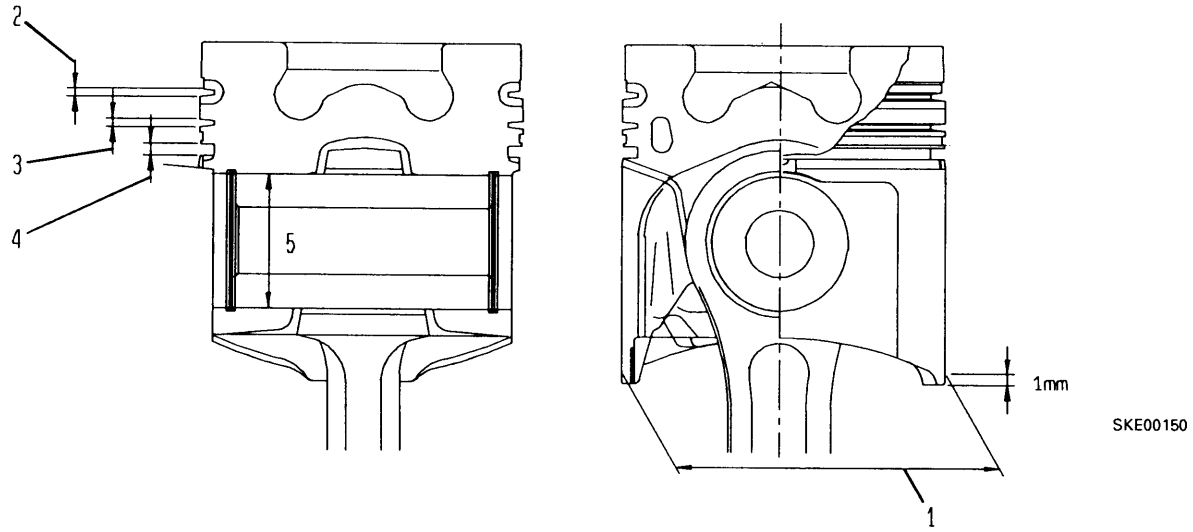
KS100212

622101

Unit:mm

No.	Check item	Criteria				Remedy
1	End play	Standard size		Repair limit		Replace thrust plate
		0.15 – 0.35		0.50		
2	O.D. of camshaft journal	Standard size		Tolerance		Replace
		59		- 0.03 - 0.06		
	Clearance at camshaft journal	Standard clearance		Clearance limit		Replace bushing
		0.039 – 0.148		0.28		
3	Curvature of camshaft	Repair limit : 0.03 (total variation of indicator)				
4	Cam height	Cam	Standard size	Tolerance	Repair limit	Replace
		Intake	50.76235	± 0.10	50.26	
		Exhaust	49.87052	± 0.10	49.37	

PISTON, PISTON RING AND PISTON PIN

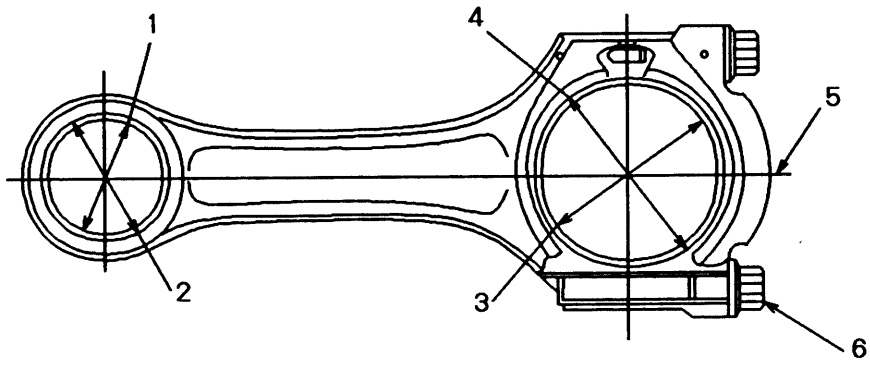


Unit:mm

No.	Check item	Criteria				Remedy
1	Outside diameter of piston	Standard size		Tolerance	Repair limit	Replace piston
		107.830		± 0.015		
2 ~ 4	Thickness of piston ring	No.	Measuring point	Standard size	Tolerance	Replace piston ring
		2	Top ring	2.5	- 0.08 / - 0.10	
		3	Second ring	2.5	- 0.01	
		4	Oil ring	4	- 0.03	
	Width of piston ring groove	2	Top ring	Judge using groove wear gauge		Replace piston
		3	Second ring			
		4	Oil ring	4	+ 0.04 / + 0.02	
	Clearance between piston ring and piston ring groove	No.	Measuring point	Standard clearance	Clearance limit	Replace piston or piston ring
		2	Top ring	Judge using groove wear gauge		
		3	Second ring			
		4	Oil ring	0.03 – 0.07	0.15	
	Piston ring gap	2	Top ring	0.30 – 0.45	2.0	Replace piston ring or cylinder liner
		3	Second ring	0.30 – 0.45	1.5	
		4	Oil ring	0.25 – 0.45	1.0	
5	Outside diameter of piston pin	Standard size		Tolerance		Replace piston pin
		45		0 / - 0.007		
	Inside diameter of piston pin hole	45		+ 0.011 / + 0.004		Replace piston
	Clearance between piston pin and piston	Standard clearance		Clearance limit		Replace piston pin
		0.004 – 0.018		0.05		
6	Weight of piston	Standard weight		Pemissible range		Replace
		1,350 g		± 13 g		

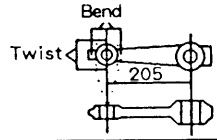
622101

CONNECTING ROD



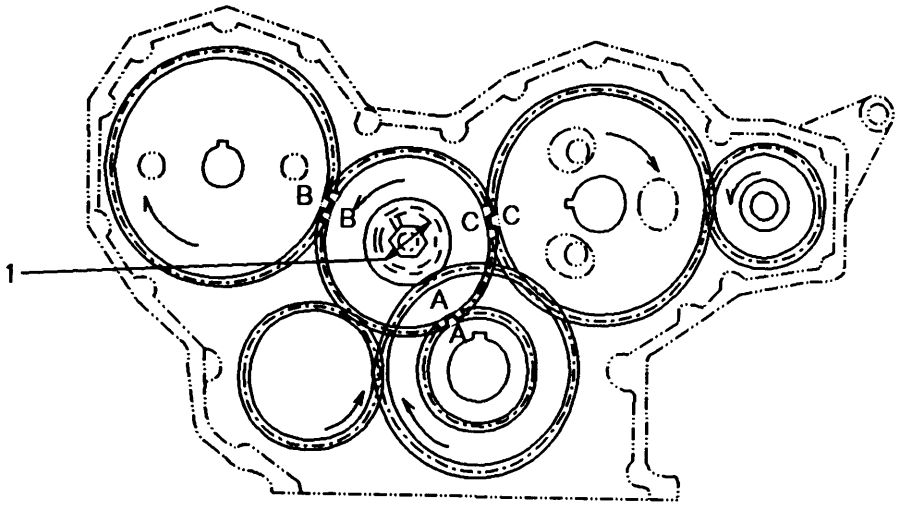
6136F046

Unit:mm

No.	Check item	Criteria			Remedy
1	I.D. of bushing at small end of connecting rod	Standard size	Tolerance		Replace bushing
		45	+ 0.041 + 0.025		
	Clearance between bushing and piston pin at small end of connecting rod	Standard clearance	Clearance limit		Replace bushing or piston rod
		0.025 – 0.048	0.10		
2	I.D. of bushing mounting hole at small end of connecting rod	Standard size	Tolerance		Replace connecting rod
		49	+ 0.025 0		
3	I.D. of bearing at big end of connecting rod (crank pin journal)	Standard size	Tolerance	Repair limit	Replace bearing
		70	+ 0.035 - 0.010	70.15	
4	I.D. of bearing mounting hole at big end of connecting rod	74	+ 0.024 0	74.04	Replace connecting rod
		• Measure after tightening connecting rod cap to specified torque.			
5	Curvature and twist of connecting rod	 Bend Repair limit : 0.25 Twist Repair limit : 0.35			
6	Tightening torque of connecting rod cap mounting bolt (Coat bolt threads and nut seats with engine oil)	Order	Target	Range	Tighten
		1st	73.6 Nm (7.5 kgm)	71.6 – 75.5 Nm (7.3 – 7.7 kgm)	
		2nd	105°	90° – 120°	
7	Weight of connecting rod	Repair limit : 2,437 ± 70 (g)			Replace

622101

TIMING GEAR



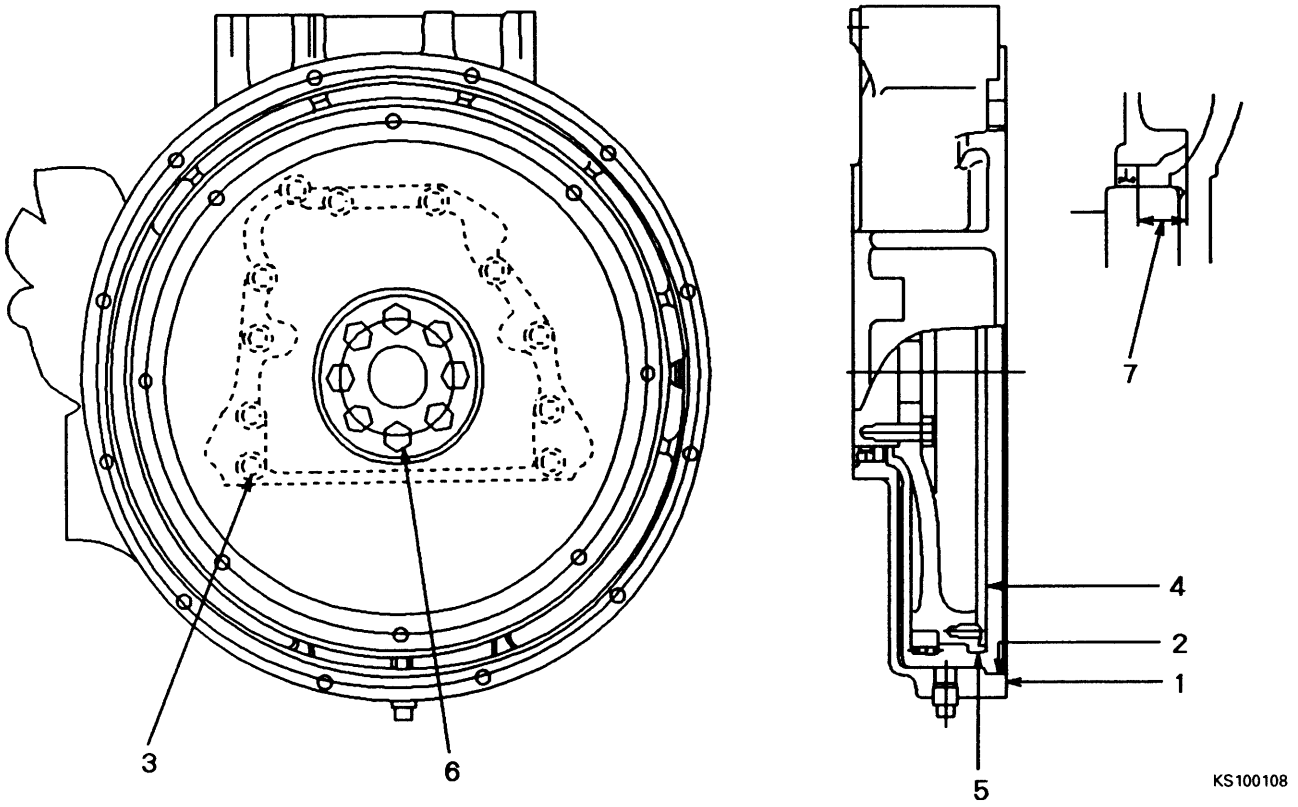
6136F044

622101

Unit:mm

No.	Check item	Criteria				Remedy
		Measurement points		Standard	Repair limit	
A ~ C	Gear back lash	A	Crank gear and idler gear	0.062 – 0.213	0.6	Replace bushing or gear
		B	Idler gear and injection pump gear	0.057 – 0.280		
		C	Idler gear and cam gear	0.063 – 0.214		
1	O.D. of idler gear shaft	Standard size		Tolerance		Replace shaft
		45		0 - 0.016		
	I.D. of idler gear bushing	45		+ 0.115 + 0.027		Replace bushing
	Clearance between idler gear bushing and shaft	Standard clearance		Clearance limit		
		0.027 – 0.131		0.20		
	Idler gear end play	Standard		Repair limit		Replace thrust plate
		0.08 – 0.14		0.3		

FLYWHEEL AND FLYWHEEL HOUSING



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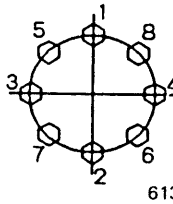
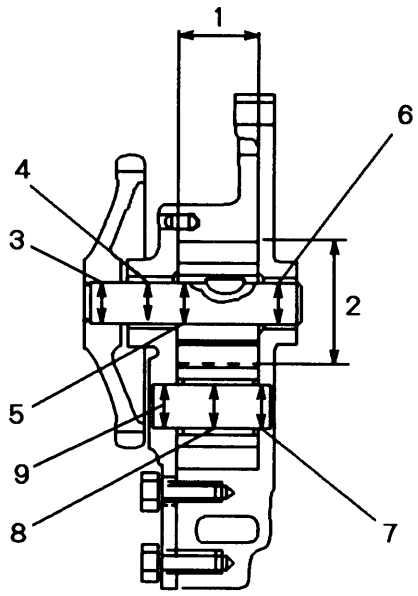
Unit:mm

No.	Check item	Criteria			Remedy
1	Face runout of flywheel housing	Repair limit : 0.35			Correct and reassemble
2	Radial runout of flywheel housing	Repair limit : 0.30			
3	Tightening torque of flywheel housing mounting bolts	Target	Range		Tighten
		107.9Nm (11kgm)	98.1 - 122.6Nm (10 - 12.5kgm)		
4	Face runout of flywheel	Repair limit : 0.20			Correct and reassemble
5	Radial runout of flywheel	Repair limit : 0.15			
6	Tightening torque of flywheel mounting bolts (Coat thread, seat and washer with engine oil.)	Order	Target	Range	Tighten
		 1 st	88.3Nm (9kgm)	58.8 - 111.7Nm (6 - 12kgm)	
		2 nd	186.3Nm (19kgm)	176.5 - 196.1Nm (18 - 20kgm)	
		6138F032			
7	Installation position for rear seal	When replacing the seal on the present crankshaft (Dimension when oil seal is moved to rear)	When installing the seal on a new crankshaft (dimension when oil seal is not moved)		-
	Double lip oil seal	24	27		
	Single lip oil seal	20	23		

LUBRICATION SYSTEM

OIL PUMP



KS100109

Unit:mm

No.	Check item	Criteria					Remedy
1	Axial clearance of pump gear	Standard size	Tolerance: Thickness of gear	Tolerance: Depth of body	Standard clearance (End play)	Clearance limit (End play)	Replace gear
		32	0 - 0.025	+ 0.067 + 0.040	0.04 – 0.092	0.10	
2	Radial clearance of pump gear	Standard size	Tolerance: O.D. of gear	Tolerance: I.D. of body	Standard clearance	Clearance limit	
		51.4	- 0.15 - 0.21	+ 0.06 0	0.033 – 0.088	0.13	
3	Interference between pump drive gear and drive shaft	Standard size	Tolerance: Shaft	Tolerance: Hole	Standard clearance	Clearance limit	Replace
		19	+ 0.027 - 0.003	- 0.033 - 0.058	Interference 0.03 – 0.085	–	
4	Clearance between drive shaft and cover bushing	19	+ 0.027 - 0.003	+ 0.114 + 0.031	0.004 – 0.117	–	Replace bushing
5	Interference between pump gesr and drive shaft	19	+ 0.027 - 0.003	- 0.044 - 0.064	Interference 0.041 – 0.091	–	Replace
6	Clearance between drive shaft and body bushing	19	+ 0.027 - 0.003	+ 0.114 + 0.031	0.004 – 0.117	–	Replace bushing
7	Clearance between driven shaft and body	19	+ 0.027 - 0.003	+ 0.065 + 0.039	0.012 – 0.068	–	Replace
8	Clearance between driven shaft and gear bushing	19	+ 0.027 - 0.003	+ 0.114 + 0.031	0.004 – 0.117	–	Replace bushing
9	Interference between driven shaft and cover	19	+ 0.027 - 0.003	- 0.028 - 0.053	Interference 0.025 – 0.080	–	Replace

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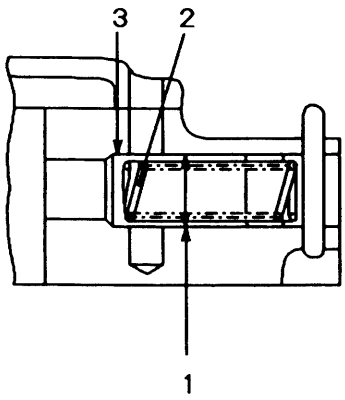
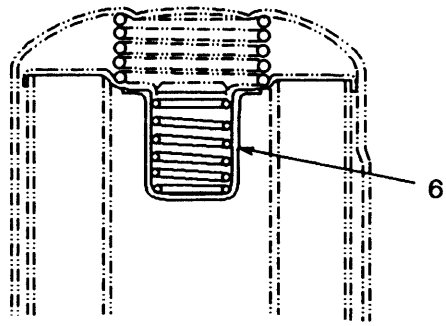
REGULATOR VALVE



KS100110

SAFETY VALVE



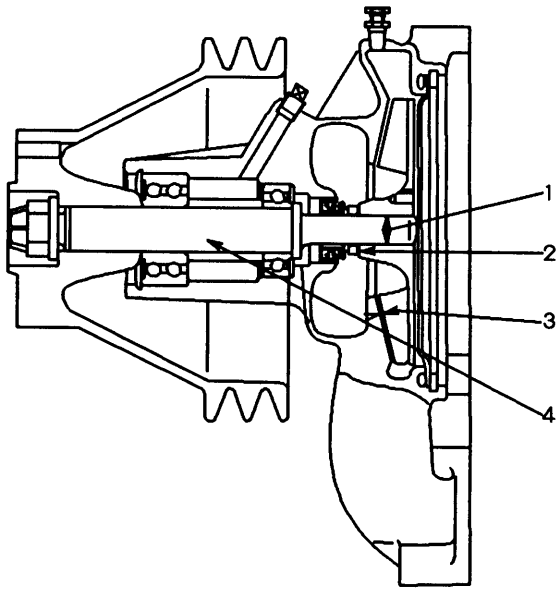
KS100111

622101

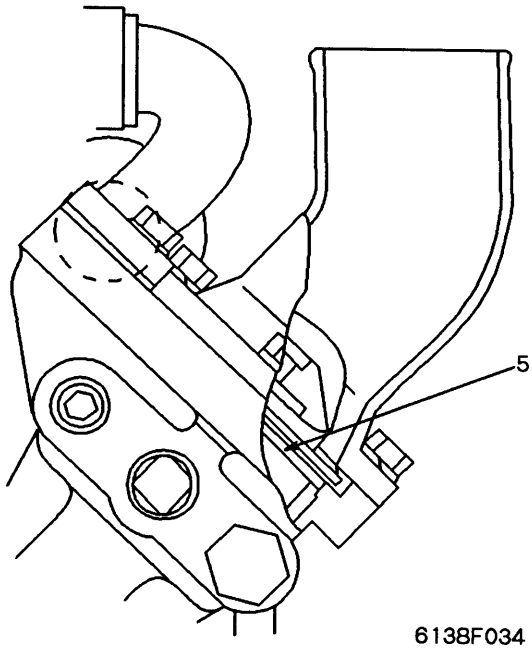
Unit:mm

No.	Check item	Criteria				Remedy
1	Clearance between valve and body	Standard size	Tolerance		Standard clearance	Replace
			Shaft	Hole		
		18	- 0.040 - 0.060	+ 0.043 0	0.040 – 0.103	
2	Regulator valve spring	• Free length Standard size : 44.9 • Installed load				Replace
		Installed length	Standard load		Repair limit	
		38.97	155.9 N (15.9 kg)		273.6 N (27.9 kg)	
5	Operating pressure of regulator valve	1.0 ± 0.05 MPa (10.0 ± 0.5 kg/cm²)				Adjust
6	Operating pressure of relief valve	0.2 ± 0.02 MPa (2 ± 0.2 kg/cm²)				Replace cartridge

COOLING SYSTEM
WATER PUMP AND THERMOSTAT
(AUSTOFT)



6138F033A



6138F034

Unit : mm

No.	Check item	Criteria				Remedy
1	Interference between impeller and shaft	Standard size	Shaft O.D.	Impeller I.D.	Standard interference	Replace (usually replace impeller, shaft O.D. rarely changes)
		15.9	+0.020 +0.005	−0.020 −0.050	0.025−0.070	
2	Abrasion of seal ring in water seal	 14F035 A dimension repair limit : 0				
3	Clearance between body and impeller	Standard clearance : 0.2−0.6				Replace
4	Curvature of shaft	Repair limit : 0.1mm	Total variation of indicator,measure by face run−out at point 40mm from center of fan pulley			
5	Full open lift of thermostat	Permissible range	Min.10	Inspect after immersion for 4−5minutes in water at 90℃		Replace
	Opening and closing of thermostat	Valve should be fully closed after immersion for 4−5min in water from fully open (90℃) to fully closed (71℃).				

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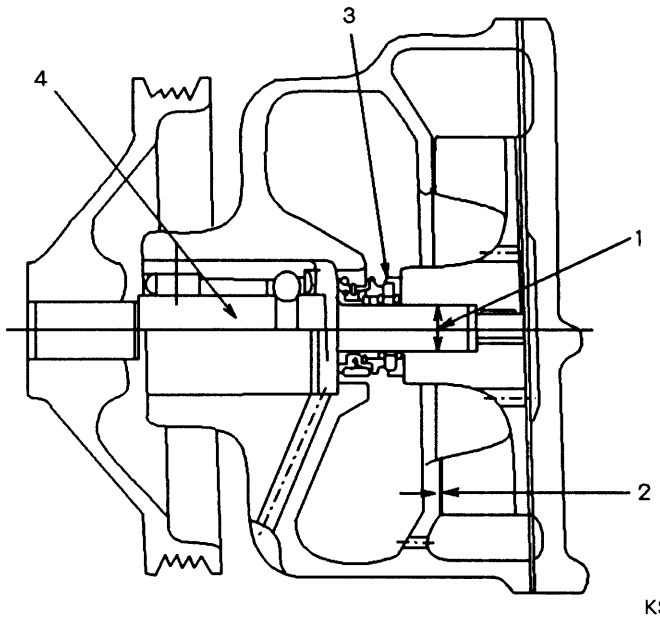
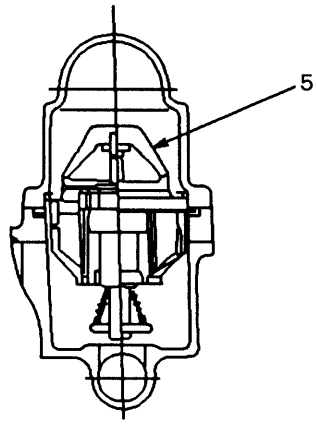
WATER PUMP AND THERMOSTAT

(D75S-1, PC300-5)

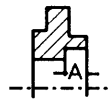


KS100115

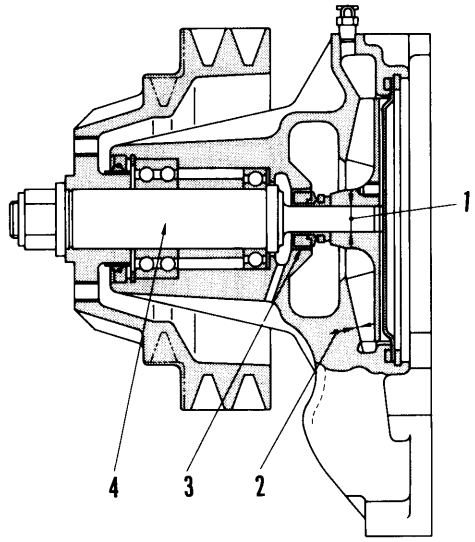


KS100116

Unit : mm

No.	Check item	Criteria				Remedy
1	Interference between impeller and shaft	Standard size	Shaft O.D.	Impeller I.D.	Standard interference	Replace(usual-ly replace impeller,shaft O.D.rarely changes)
		12	0 −0.013	−0.030 −0.055	0.017−0.055	
2	Clearance between body and impeller	Standard clearance : 0.3−1.3				
3	Abrasion of seal ring in water seal	 14F035	A dimension repair limit : 0			Replace
4	Curvature of shaft	Repair limit : 0.1mm	Total variation of indicator,measure by face run−out at point 40mm from center of pulley			
5	Full open lift of thermostat	Permissible range	Min.10	Inspect after immersion for 4−5minutes in water at 85℃		Replace
	Opening and closing of thermostat	Valve should be fully closed after immersion for 4−5min in water from fully open (85℃) to fully closed (65℃).				

622101



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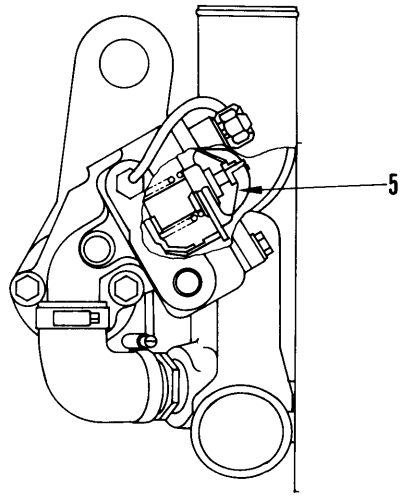
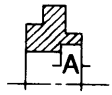


622F01111

622101

Unit: mm

No.	Check item	Criteria				Remedy
1	Interference between impeller and shaft	Standard size	Shaft O.D.	Impeller I.D.	Standard interference	Replace (usually replace impeller shaft O.D. rarely changes)
		15.9	+0.020 +0.005	−0.020 −0.050	0.025 – 0.070	
2	Clearance between body and impeller	Standard clearance: 0.2 – 1.47				
3	Abrasion of seal ring in water seal	 14F035 A dimension repair limit: 0				Replace
4	Curvature of shaft	Repair limit: 0.1 mm (Total variation of indicator, measure by face run-out at point 40 mm from center of pulley)				
5	Full open lift of thermostat	Permissible range	Min. 10 (Inspect after immersion for 4 – 5 minutes in water at 90°C)			Replace
	Opening and closing of thermostat	Valve should be fully closed after immersion for 4 – 5 min. in water from fully open (90°C) to fully closed (71°C).				

ENGINE

15 REPAIR AND REPLACEMENT OF PARTS

Repairing mounting face of cylinder head by grinding 15-002
Replacing valve seat insert 15-003
Pressure test 15-007
Replacing valve guide 15-008
Grinding the valve 15-009
Replacing cam bushing 15-010
Replacing crank gear 15-012
Replacing cam gear 15-012
Replacing flywheel ring gear 15-013
Replacing main bearing cap 15-014
Grinding crankshaft 15-015
Replacing engine rear seal 15-020

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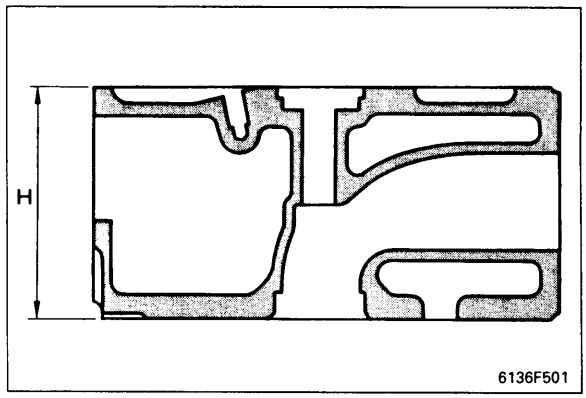
REPAIRING MOUNTING FACE OF CYLINDER HEAD BY GRINDING

1. **Grinding**
   1) Remove the valve seat inserts. For details, see REPLACING VALVE SEAT INSERTS.
   2) When grinding within the repair limit for cylinder head height (H) to remove deformation of corrosion from the cylinder head, stamp an (R) mark on the left side face of the cylinder head.
      - ★ **Repair limit of cylinder head height (H) : 99.5mm**
        (Standard size 99.8 - 100.2 mm)
      - ★ **Amount to remove per grinding : 0.10 to 0.15 mm**
      - ★ **Surface roughness of grinding surface : Within 6S**
      - ★ **Flatness (deformation): 0.05mm max.**
      - ★ **Grinding limit : 0.3mm**
   3) Press-fit the valve seat inserts. For details, see REPLACING VALVE SEAT INSERTS.



2. **Check after grinding**
   Check the amount of sinking of the valve to confirm that it is within the standard value. Carry out further modification and adjustment if necessary.
   - ★ **Standard sinking of valve: 1.12 ± 0.18 mm**
   - ★ **Allowable protrusion of nozzle : 2.73 to 3.51mm**

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REPLACING VALVE SEAT INSERTS

Special tools

		Part No.	Part Name	Q'ty
A		795-100-4800	Puller (Valve seat)	1
B		790-471-1150	Push tool (for intake valve)	1
C		790-470-1160	Push tool (for exhaust valve)	1
D	1	795-100-3003	Seat cutter (kit)	1
		795-100-3100	Body assembly	1
		795-100-3200	Micrometer	1
		795-100-3300	Gauge	1
		795-100-3400	Tool head	1
		795-100-3601	Head support	1
	2	795-100-3710	Cutter	1
	3	795-100-3720	Cutter (for 30°)	1
	4	795-100-3730	Cutter (for 45°)	1
	5	795-100-4110	Pilot (9.00 mm)	1
		795-100-4120	Pilot (9.01 mm)	1
		795-100-4130	Pilot (9.02 mm)	1
		795-100-4140	Pilot (9.03 mm)	1

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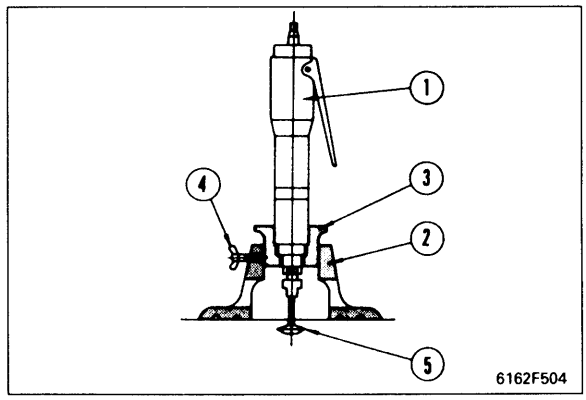
1. Pulling out the valve seat insert

⚠ Before using the grinder, run it for a minute to test it.

- After replacing the grindstone, run the grinder for three minutes to test it.

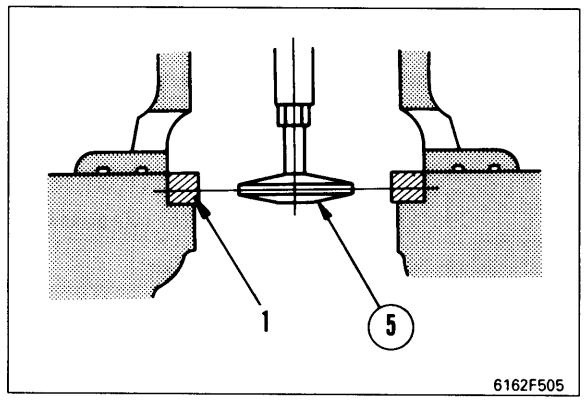
⚠ Confirm that the grindstone is not damaged, then install it to the shaft of the grinder without applying excessive force. Confirm that there is no play between the grindstone and shaft.

⚠ When using the grinder, wear safety goggles.



- When using a valve seat puller to remove the valve seat
  1) Install grindstone ⑤ to grinder ①.
  2) Align the groove of sleeve ③ with holder ②, then insert.
     ★ Adjust the position of the grinder with set screw ④.

3) Adjust the position of the grinder so that the center of grindstone ⑤ will be at the center of seat insert (1), then tighten the set screw to secure the grinder.
4) Rotate the grindstone and move slowly until it contacts insert (1).

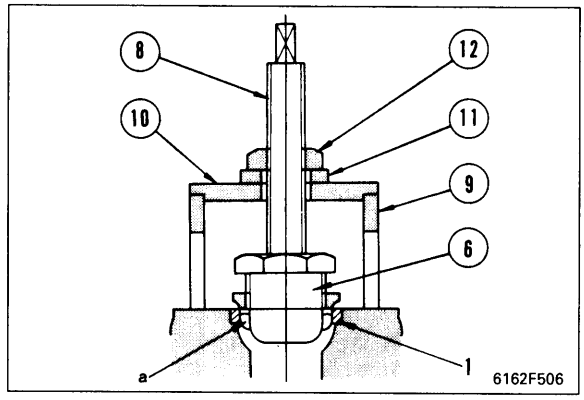


5) Press the grindstone against the inside of the insert, move it in a circular pattern, and make a groove about 1 mm deep.

6) Push in the three claws (a) on puller head ⑥ of tool **A** by hand to insert it inside insert (1).

7) Tighten screw ⑧ to press the three claws against the groove on the inside surface of the insert.
★ When the claws contact the groove completely, stop tightening.

8) Place bridge ⑨ over the puller head, then place plates ⑩ and ⑪ on the bridge. Tighten nut ⑫ to pull out the insert



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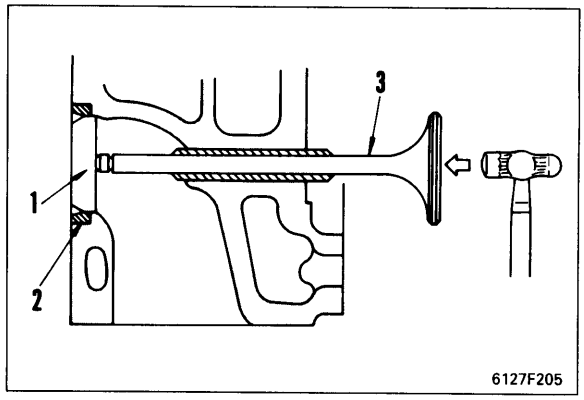
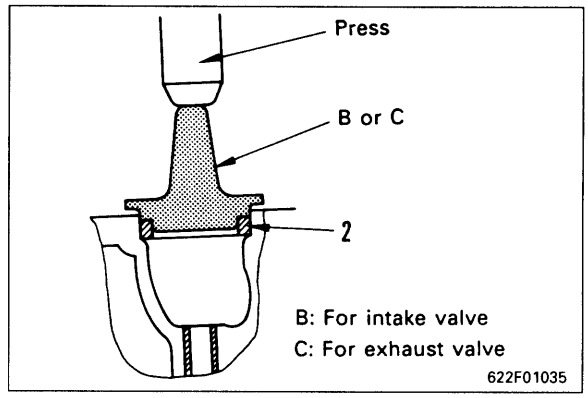
- **When welding a bar to the insert to remove the seat insert**
  1) Weld bar (1) of radius approx. ø 10, that is 0.1 – 0.5mm shorter than the inside diameter to the inside diameter of insert (2).
     ★ Be careful not to let the welding metal stick to the head itself.

  2) when the temperature of the weld goes down to around room temperature, insert an old valve (3) in the reverse direction, and tap the head of the valve with a small hammer to knock out the insert.
     ★ if the valve is hit too hard, the weld may break.



2. Press fitting the valve seat insert

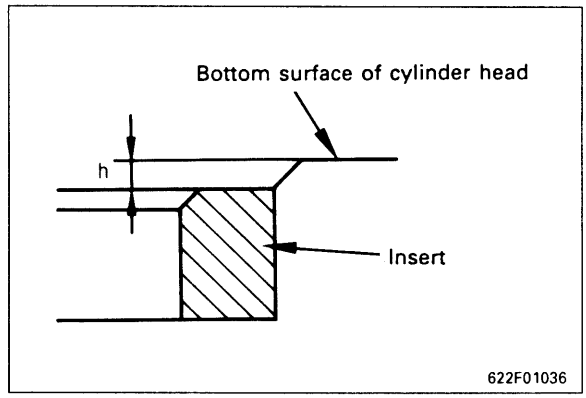
- When not grinding and correcting the press fitting surface for the valve seat insert
  1) Using tool **B** or **C** press fit standard valve seat insert (2).
     ★ Do not use a hammer to press fit.
     ★ Press-fitting force for valve seat (intake, exhaust sides): **Approx. 9.8KN (1 ton)**



2) Check the depth of the insert from the bottom surface of the cylinder head.
   ★ Depth of the insert h

   Intake side : $3.12^{+0.2}_{-0.1}$ mm

   Exhaust side : $2.62^{+0.2}_{-0.1}$ mm



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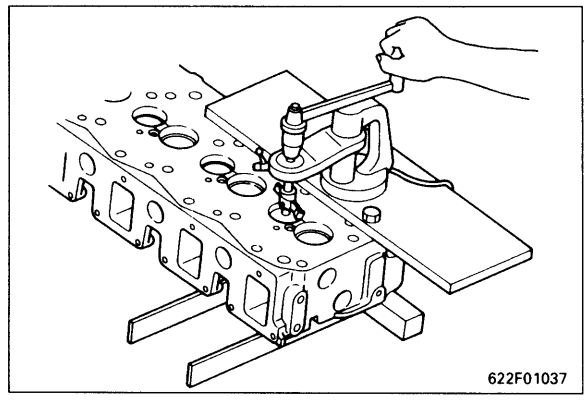
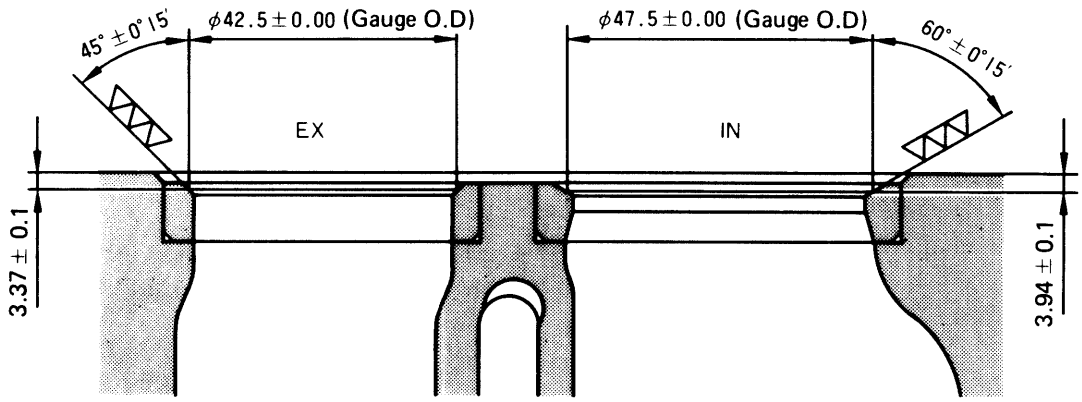
3. Finishing insert seat surface

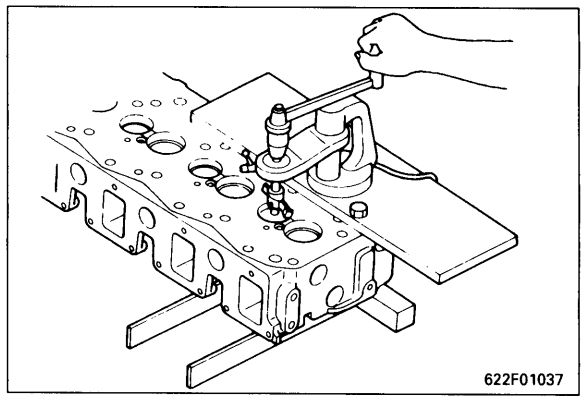
1) Using tools D_1, D_3, and D_4, finish the insert seat surface to the dimensions shown in the diagram.
   ★ When inserting the pilot D_5 into the valve guide, select a pilot that will enter and leave no clearance.





4. Machining valve seat insert mounting hole to oversize

1) Using tools D_1 and D_2, grind the hole to a one size larger oversize.
   ★ Machine within a range of 1.0 mm oversize.
   If it is more than 1.0mm, replace the cylinder head.



• Dimensions of insert and mounting hole

Unit : mm

Insert	Valve	Insert		Mounting hole for valve seat insert		
		d	h	D_1	D2	H
STD	Intake	51.5 $^{+0.105}_{+0.095}$	8.5 $^{0}_{-0.1}$	51.50 $^{+0.020}_{0}$	57.39 ± 0.2	11.62 ± 0.1
	Exhaust	45.5 $^{+0.080}_{+0.070}$	9.0 $^{0}_{-0.1}$	45.50 $^{+0.020}_{0}$	48.50 ± 0.2	11.62 ± 0.1
0.25 O.S	Intake	51.75 $^{+0.105}_{+0.095}$	8.5 $^{0}_{-0.1}$	51.75 $^{+0.020}_{0}$	57.64 ± 0.2	11.62 ± 0.1
	Exhaust	45.75 $^{+0.080}_{+0.070}$	9.0 $^{0}_{-0.1}$	45.75 $^{+0.020}_{0}$	48.75 ± 0.2	11.62 ± 0.1
0.50 O.S	Intake	52.0 $^{+0.105}_{+0.095}$	8.62 $^{0}_{-0.1}$	52.00 $^{+0.020}_{0}$	57.89 ± 0.2	11.74 ± 0.1
	Exhaust	46.0 $^{+0.080}_{+0.070}$	9.12 $^{0}_{-0.1}$	46.00 $^{+0.020}_{0}$	49.00 ± 0.2	11.74 ± 0.1
0.75 O.S	Intake	52.25 $^{+0.105}_{+0.095}$	8.75 $^{0}_{-0.1}$	52.25 $^{+0.020}_{0}$	58.14 ± 0.2	11.87 ± 0.1
	Exhaust	46.25 $^{+0.080}_{+0.070}$	9.25 $^{0}_{-0.1}$	46.25 $^{+0.020}_{0}$	49.25 ± 0.2	11.87 ± 0.1
1.00 O.S	Intake	52.25 $^{+0.105}_{+0.095}$	8.88 $^{0}_{-0.1}$	52.50 $^{+0.020}_{0}$	58.39 ± 0.2	12.00 ± 0.1
	Exhaust	46.5 $^{+0.080}_{+0.070}$	9.38 $^{0}_{-0.1}$	46.50 $^{+0.020}_{0}$	49.50 ± 0.2	12.00 ± 0.1

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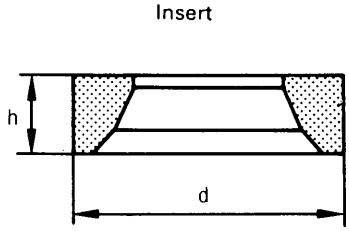

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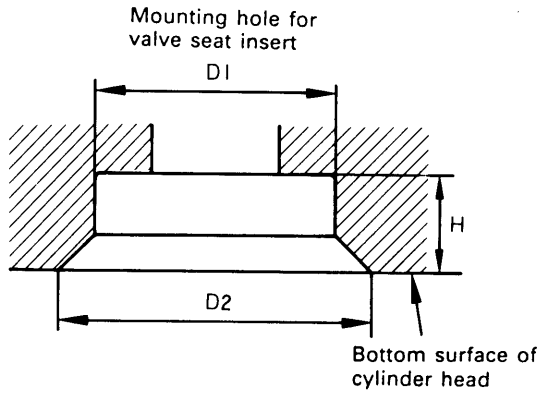

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★ Inside surface roughness : 6.3S max.
★ Mounting hole bottom roughness : 12.5S max.
★ Concentricity of valve guide hole and insert : 0.05 mm (T.I.R) max.

PRESSURE TEST

- If the area round the head has been corrected, test as follows.

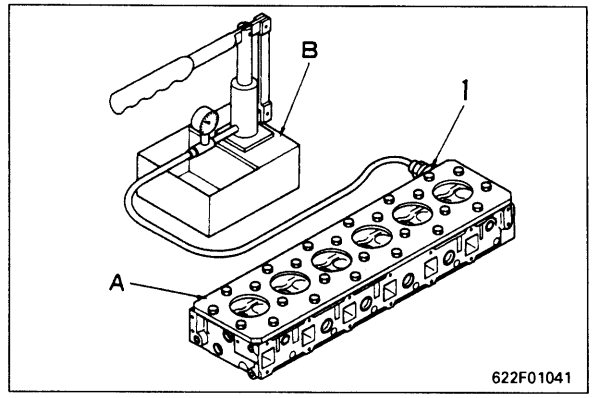
Special tools

	Part No.	Part Name	Q'ty
A	790-553-1800	Coolant tester kit	1
B	79A-471-1050	Pump ass'y	1

1. Water pressure test

1) Tighten the nozzle holder assembly to the specified torque.
2) Assemble tool **A** and tool **B**, and connect a hose to flange (1).
3) Apply water pressure [0.34 - 0.4Mpa (3.5 - 4.0 kg/cm²)] for approx. 10 minutes, and check for any leakage from around the head.

★ It is preferable to warm the whole cylinder head and carry out the test with hot water (82 - 93°C).



2. Air pressure test

1) Tighten the nozzle holder assembly to the specified torque.
2) Connect the pump hose to flange (1).
3) place the head in a water bath, apply air pressure 0.3 - 0.34 Mpa (3.0 - 3.5 kg/cm²) for approx. 30 seconds, and check for any air leakage in the water.

★ If the above test shows that there are cracks around the nozzle holder and plugs, replace the cylinder head.

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REPLACING VALVE GUIDE

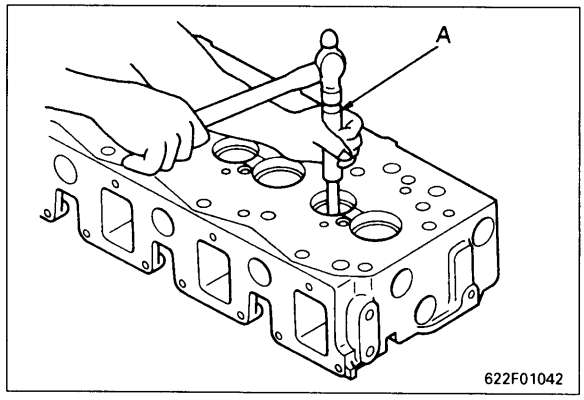
Special tools

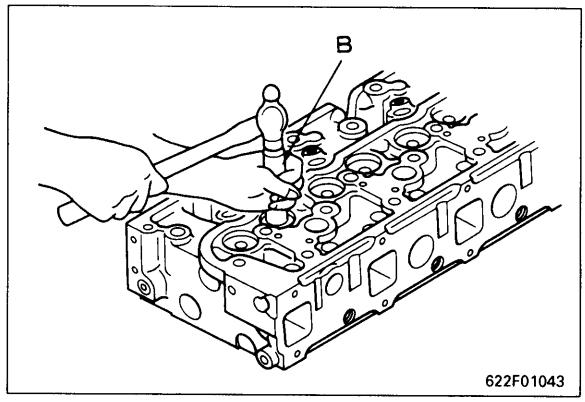
	Part No.	Part Name	Q'ty
A	790-100-1531	Valve guide remover	1
B	790-472-1361	Valve guide driver	1

1. **Removing valve guide**
   Put tool **A** in contact with the valve guide from the bottom of the cylinder head, and knock it out with a hammer.

2. **Press fitting valve guide**
   1) Press fit the valve guide until the tip of tool **B** contacts the cylinder head.
      ★ After press fitting, insert the valve. If the valve dose not enter smoothly, modify with a reamer ($\phi 90^{+0.025}_{+0.010}$)

   2) Confirm that the protrusion of the valve guide is within specification.
      ★ Protrusion of valve guide:
      14.0 ± 0.2 mm





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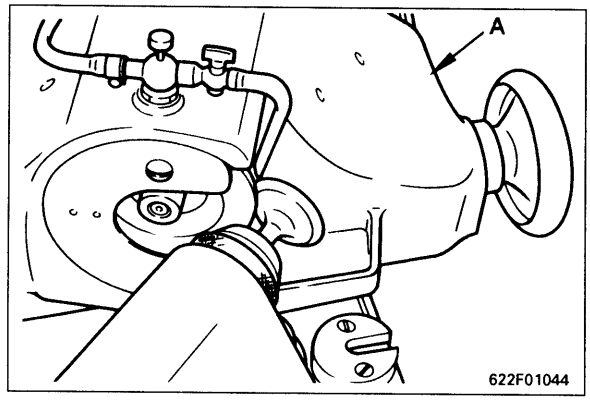
GRINDING THE VALVE

Special tools

	Part No.	Part Name	Q'ty
A	– (Purchase)	Valve refacer	1

1. **Grinding the seat surface**
   Grind the seat surface with valve refacer **A**.
   ★ Angle of valve seat
   - Intake valve : 30°
   - Exhaust valve : 45°



2. **Checking after grinding**
   Confirm that the thickness of the valve head, protrusion of the valve, and the contact surface of the valve seat are within specification.
   ★ Allowable thickness of valve head
   - Intake valve : 2 ± 0.1 mm
   - Exhaust valve : 1.5 ± 0.1 mm

   ★ Sinking distance of valve : 1.12 ± 0.18 mm
   ★ Contact width of valve seat
   - Intake valve : 3.20 mm
   - Exhaust valve : 2.01 mm

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REPLACING CAM BUSHING

Special tools

		Part No.	Part Name	Q'ty
A		790-472-1100	Push tool assembly	1
A	1	790-472-1170	Push tool	1
	2	790-472-1180	Collar	1
	3	790-472-1110	Guide	1
	4	795-102-2610	Push bar	1
	5	792-103-0400	Grip	1

1. Removing cam bushing

★ After removing the bushing, remove any burrs and clean any dirt or dust from the busing mounting hole.

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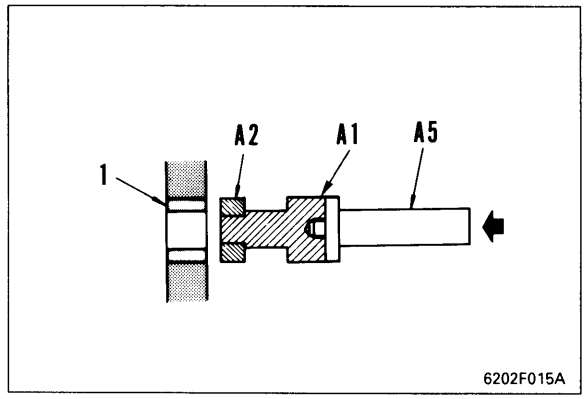
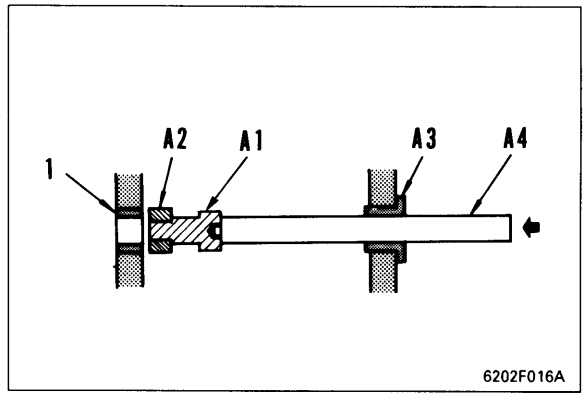
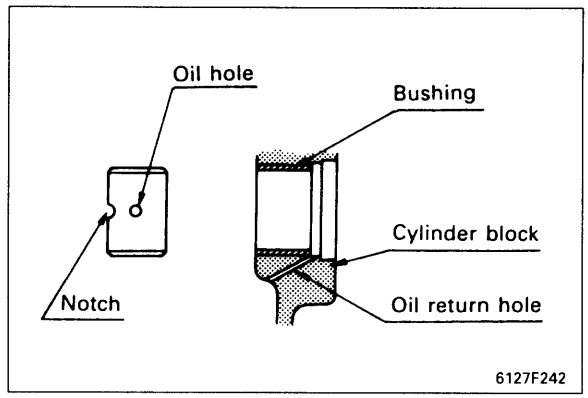
1) Removing front and rear bushings
Assemble push tool **A1**, **A2**, and grip **A5**, then hit with a hammer to remove bushing (1).



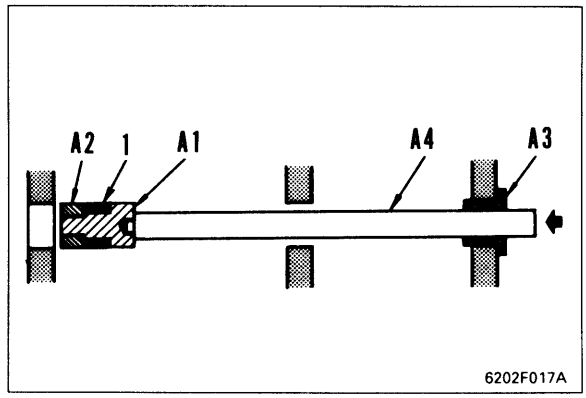
2) Removing center bushing
Assemble push tool **A1**, **A2**, guide **A3**, and push bar **A4**, then hit with a hammer to remove bushing (1).



2. **Press fitting cam bushing**
   ★ Align the oil hole in the bushing with the oil hole in the cylinder block, and press fit the bushing.



1) Press fitting center bushing
   - Assemble push tool **A1**, guide **A3**, push bar **A4**, bushing (1), and collar **A2**, then hit with a hammer to press fit bushing (1) to a point where the oil hole in the cylinder block is aligned with the oil hole in the bushing.



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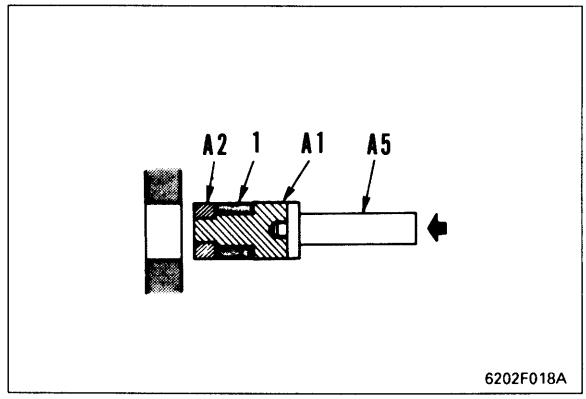
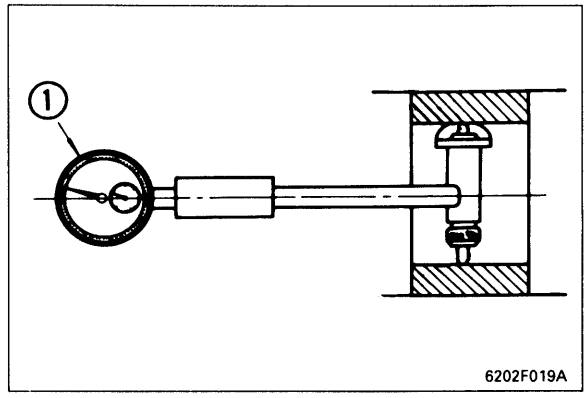
2) Press fitting front and rear bushings
   - Assemble push tool **A1**, grip **A5**, bushing (1), and collar **A2**, then hit with a hammer to press fit bushing (1) to a point where the oil hole in the bushing is aligned with the oil hole in the cylinder block.



3) After press fitting bushing
   - Using inside gauge ①, measure the inside diameter of the bushing.
   - Check the clearance between the bushing and shaft. If the clearance is not within the permissible range, or the shaft does not pass through smoothly, correct the inside diameter of the bushing with a reamer.
     ★ After correcting the inside diameter of the bushing with a reamer, clean out all metal particles from the oil hole and oil groove.
     ★ Inside diameter of cam bushing:
     $\phi 59\ ^{+0.088}_{+0.009}$
   - Camshaft journal clearance :
     0.039 - 0.148



REPLACING CRANK GEAR

1. **Removal of gear**
   - Grind a line in the surface of the gear tooth root with a grinder, then break it with a chisel and remove the gear.
   - ★ Be careful not to damage the shaft.

2. **Press fitting gear**
   1) Check the gear mounting face, key groove, and flange surface, and if there are any scratches, correct with an oil-stone.
   2) Knock the key into the key groove of the shaft.
   3) Heat the gear to the specified shrink-fitting temperature for the specifid period of time.
      - ★ Heating temperature for crank gear : 230 - 250°C
      - Heating time : within 60 minutes
   4) Set the timing mark on the outside, then use a driving tool to press fit until the outside surface of the the gear is in tight contact with the shaft flange.
      - ★ Drive the gear in quickly before it cools.

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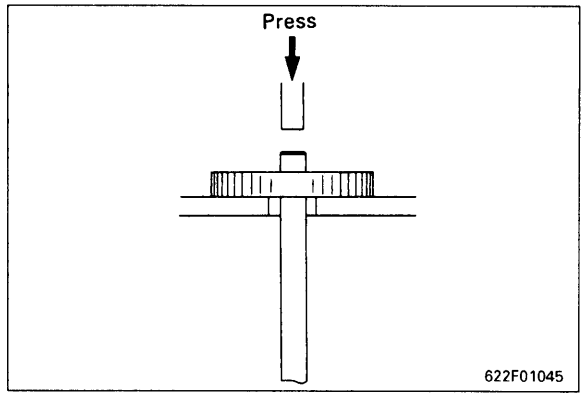
REPLACING CAM GEAR

1. **Removal of cam gear**
   Set the camshaft assembly on a press stand, then push the camshaft out with press.

2. **Press fitting cam gear**
   - ★ Use the same procedure as when shrink fitting the crank gear.
   - ★ Heating temperature for cam gear : 220 - 240°C
   - Heating time within 60 minutes



REPLACING FLYWHEEL RING GEAR

⚠ Take care not to let the flywheel fall.

1. **Removal of ring gear**
   1) Prepare a flywheel support stand, then set on the stand with the ring gear surface facing down.
   2) Heat around the ring gear with a torch lamp, then hit with a hammer to remove.

2. **Press-fitting the ring gear**
   1) Check the fitting surface of the ring gear. If any flaw is found, repair it with an oilstone.
   2) Heat the ring gear at the specified temperature for the specified time for shrinkage fitting.
   ★ Heating temperature for ring gear : 200°C max.
   Heating time : 50 minutes.
   3) With the chamferred side of ring gear facing the flywheel, fit it until its side contacts the flywheel.

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REPLACING MAIN BEARING CAP

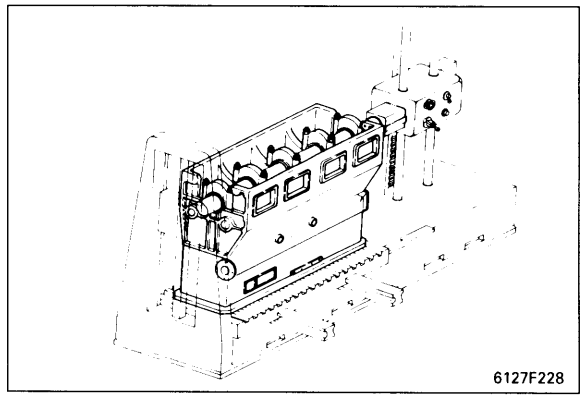
★ When replacing the main bearing cap, machine the semi-finished product as follows, then install.

1. Machining inside diameter of main bearing cap

1) Remove the cylinder liner.
2) Install the replacement main bearing cap to the cylinder block, and tighten to the specified torque.
   ★ Align the cylinder block and the notch in the cap.
3) Set a cylinder block mounting jig on the table of a horizontal boring machine, fit the cylinder liner mounting hole of the cylinder block to the standard line on the jig, and install the block.
4) Of the main bearing caps to be used again, take the one with the longest pitch and put a dial gauge in contact with the inside diameter at two places to align the center of the boring machine arbor.

kgm Main bearing cap mounting bolt : Unit:Nm(kgm)

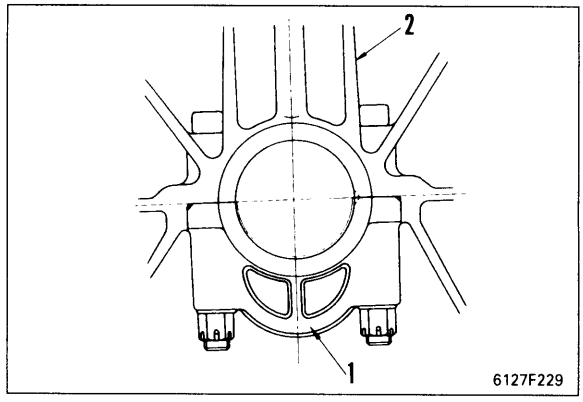
Order	Target	Range
1st step	78.4(8)	± 9.8(± 1)
2nd step	156.8(16)	± 4.9(± 0.5)
3rd step	90°	$^{+30°}_{0°}$



5) Check the machined inside diameter of bearing cap (1) and grind a little at a time.
   ★ Grind until the bit touches the inside surface of cylinder block (2).
   ★ Inside diameter of main bearing cap

   Tolerance: $\phi 101^{+0.022}_{0}$ mm

   ★ Finishing roughness: Within 12.5 S
   ★ Do not grind the inside face of the cylinder block.



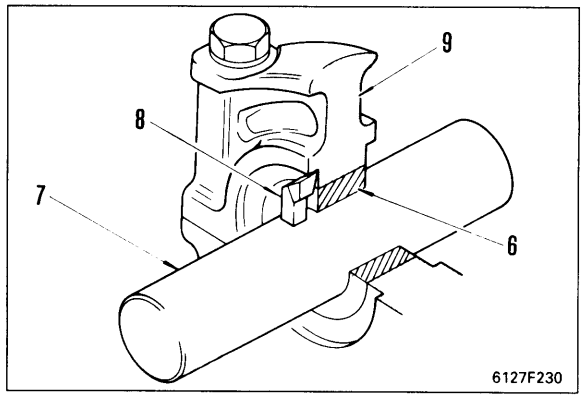
2. Machining width of main bearing cap

1) Insert cast iron bushing (6), then pass arbor (7) through.
2) Install facing bit (8) to the arbor.
3) Grind cap (9) until the bit touches the cylinder block face.
4) Grind the opposite side in the same way.

★ Width of main bearing cap Tolerance:

$$35^{\ 0}_{-0.025}\ \text{mm}$$

★ Roughness of thrust bearing mounting surface: Within 12.5 S
★ Do not grind the cylinder block.



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GRINDING CRANKSHAFT

- When grinding the crankshaft to correct wear, light seizure or damage, grind to any of the following undersize dimensions.
  Undersize: 0.25, 0.50, 0.75, 1.00 mm

- If there is curvature or uneven wear of the crankshaft, it is preferable to replace the crankshaft and not to repair it. (A high level of skill is required.)

- When correcting the plating of a damaged surface, correct only the following surfaces.
  1. Rear seal journal portion
  2. Crankshaft gear mount

- Be particularly careful when finishing the crankshaft fillet portion **R**, shoulder **r**, and **R** around the hole.
  ★ Necessary equipment and jigs for grinding
  1) Magnet flaw detector
  2) Shore hardness gauge
  3) Etching kit
  4) Crankshaft mill
  5) Crankshaft polisher
  6) Roughness gauge
  7) Fillet R measurement ball gauge
     For minimum value : 795-500-1140
     For maximum value : 795-500-1150

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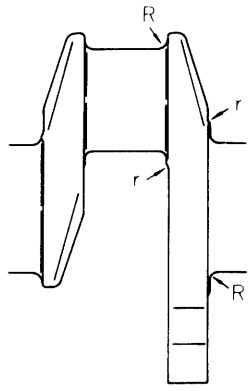
- Finishing dimension for fillet



R : $4^{+0.5}_{0}$ mm

r : 6.4mm

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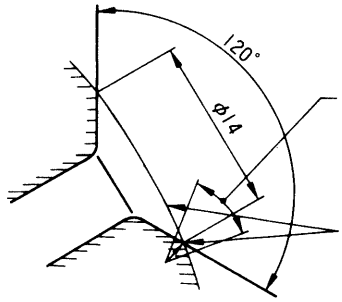
- Finishing dimensions for oil holes in main journal



Edge around oil hole shall be within 1.6S

Intersecting portion shall be less than 1.6S and shall change smoothly

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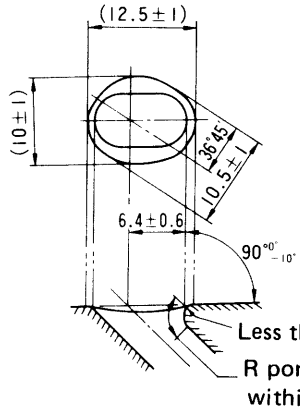
- Finishing dimensions for oil holes in pin journal



Less than 1.0–1.5 R portion shall be within 1.6S

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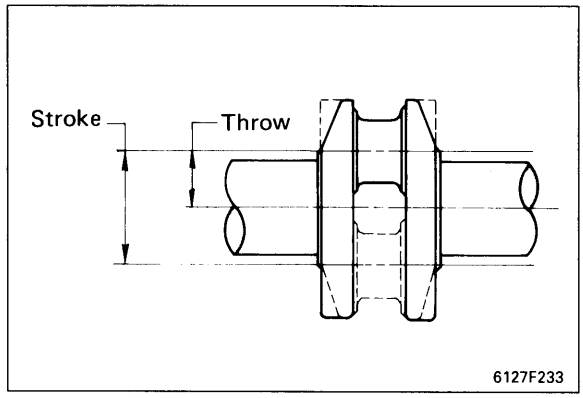
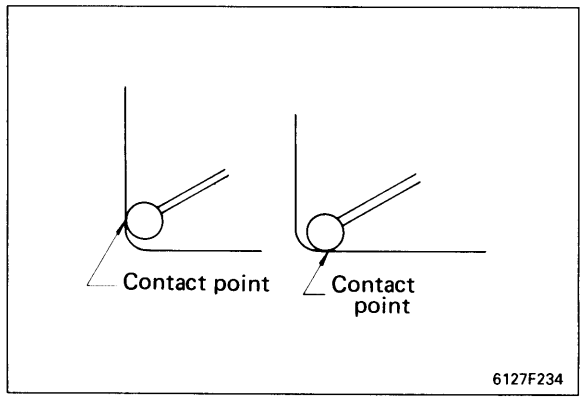
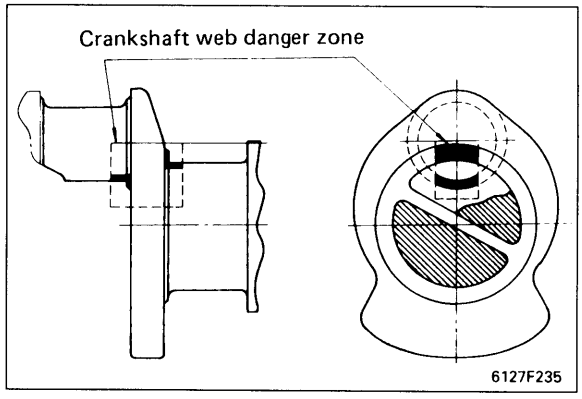
1. **Inspecting before grinding**
   1) Visual inspection
      Check for cracks, damage, discoloration caused by seizure, and wear, and judge if it is possible to correct by grinding.
   2) Inspecting hardness of journal surface
      Hardness of journal surface (Shore hardness)
      Standard range: 60 - 67 Hs
      Repair limit: 60 Hs
      If it is below the repair limit, discard the part.
   3) Inspection for twisting
      Throw tolerance: ± 0.05 mm
      Horizontal displacement (difference between throw of No.1 cylinder and rearmost cylinder) repair limit: 0.94 mm
      Variation in throw between cylinders: Less than 0.20 mm
      If it is outside the repair limit, discard the part.



2. **Inspection during grinding and after grinding**
   1) Inspecting fillet **R**
      i) Check that the fillet **R** is connected smoothly to the shoulder of the journal.
      ii) Use a fillet **R** measurement ball gauge to check that the **R** dimension is between the dimension for the minimum value gauge and the dimension for the maximum value gauge.
   2) Checking for traces of seizure using etching
   - After grinding, carry out an etching test to confirm that there is no grinding seizure.
   - If any traces of seizure are found, grind approx. 0.02 mm and correct again to the next undersize dimension.
   - After inspection, neutralize and wash the inspection surface, then coat with rust prevention oil.
   3) Magnetic flaw detection
   - Carry out a magnetic flaw detection of the corrected crankshaft before use and check that there are no cracks.
   - Be particularly careful when checking the journal fillet portion entering each web danger zone of the crankshaft.



Fillet R Min. radius : 4.00 mm
Max. radius : 4.50 mm



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4) Measuring curvature (measuring alignment)

- Measure the curvature of the crankshaft after grinding and check that it is within the standard value.
- Check the curvature (alignment) at the following four places.
  - i) Total length alignment Tolerance: Within 0.09 mm
  - ii) Neighboring alignment Tolerance: Within 0.05 mm
  - iii) Tip alignment Tolerance: Within 0.04 mm
  - iv) Rear end alignment Tolerance: Within 0.03 mm

3. Grinding main journal

★ Grind each main journal to the same undersize dimension.

★ When grinding, leave a tolerance of 0.007 - 0.008 mm for finishing.

- Roundness, cylindricity (TIR) of main journal
  Tolerance: Max. 0.010 mm
  Repair limit: 0.015 mm

• Main journal undersize dimension Unit: mm

Size	Standard size	Tolerance
S.T.D	ø 95.00	- 0.050 - 0.065
0.25US	ø 95.25	- 0.050 - 0.065
0.50US	ø 95.50	- 0.050 - 0.065
0.75US	ø 95.75	- 0.050 - 0.065
1.00US	ø 96.00	- 0.050 - 0.065

4. Grinding thrust surface

★ There is no particular need to grind the front and rear thrust surface to the same undersize dimension.

★ If the thrust surface has been ground, check that the end play of the crankshaft is within the permitted range. (For details, see the overall assembly.)

- Squareness of thrust surface (TIR)
  Tolerance: 0.04 mm
  Repair limit: Within 0.035 mm

• Thrust surface oversize dimension Unit: mm

			Rear thrust surface	
			S.T.D	0.25 OS
Front thrust surface	S.T.D	Standard size	40 $^{+0.050}_{0}$	40.25 $^{+0.050}_{0}$
		Repair limit	47.060	40.310
	0.25 O.S	Standard size	40 $^{+0.050}_{0}$	40.50 $^{+0.050}_{0}$
		Repair limit	40.310	40.560

5. Grinding pin journal

★ Grind each pin journal to the same undersize dimension.

★ When grinding, leave a tolerance of 0.007 - 0.008 mm for finishing.

★ Roundness, cylindricity (TIR) of pin journal
  Tolerance: Within 0.010 mm
  Repair limit: 0.015 mm

• Pin journal undersize dimension Unit: mm

Size	Standard size	Tolerance
S.T.D	ø 70.00	- 0.050 - 0.065
0.25US	ø 70.25	- 0.050 - 0.065
0.50US	ø 70.50	- 0.050 - 0.065
0.75US	ø 70.75	- 0.050 - 0.065
1.00US	ø 71.00	- 0.050 - 0.065

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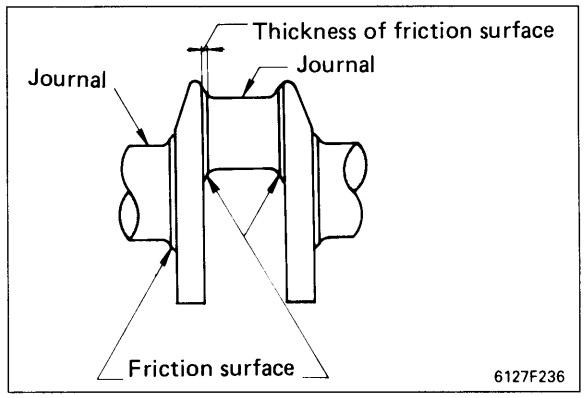
6. Grinding main journal width and pin journal width

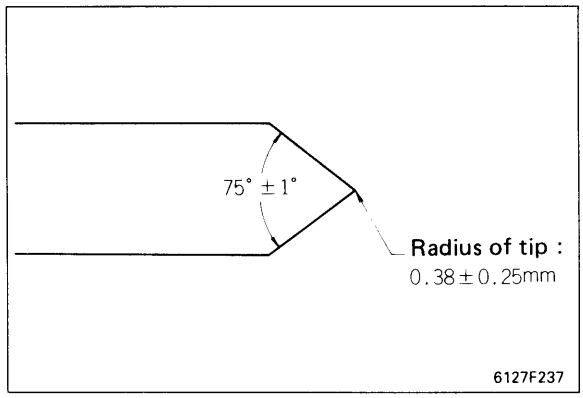
- When correcting the wear surface of the main journal and pin journal, correct using the minimum amount of grinding.
- Crankshaft pin journal width
  When grinding one side only
  Standard: $42\ ^{+0.28}_{+0.21}$ mm
  Repair limit:

  Squareness (TIR) of thrust surface
  Repair limit: 0.04 mm



7. Correcting grindstone

- Carry out dressing for the grindstone for each journal.
- Grindstone dresser
  Bevel angle : 75° ±1°
  Radius of tip : 0.38±0.25 mm
  Use a grindstone dresser with an industrial diamond embedded in the tip of the cone.
- Adjust the grindstone correction device and correct the grindstone to a dimension matching the claws of the fillet.
- When checking and correcting the grindstone edge, grind a wooden test piece and check with a ball gauge.



8. Prevention of grinding seizure

1) Use the plunge grind method when grinding
2) Use the whole width of the grindstone
   Avoid grinding the boss surface as far as possible. .pa
3) Direct an ample supply of cooling oil on the grinding surface.
4) When the crankshaft speed is 50 rpm, make the standard grinding speed at the circumference of the grindstone 2000 m/min.

9. Finishing surface

- Surface roughness standard
  Journal face: Within 0.8 S
  Thrust surface: Within 1.6 S
  Tip taper portion, pin, main journal boss portion
  Fillet portion: Within 3.2 S
- Allowance for polish finishing:
  0.007 - 0.008 mm

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10. Action after grinding

- Check again that each dimension is as specified.
- Wash each part thoroughly and coat it with rust prevention oil.
- When storing for a long period, support at three points or fit a lifting tool and stand upright.

11. Balancing (reference)

(As far as possible, do not carry out repairs that will affect the balance of the crankshaft.)

- Service limit for imbalance: 100 g.cm
- Limitations for accurate reading of balance
  Crankshaft curvature: 0.05 mm (TIR)
  Crankshaft rotation speed: Max. 325 rpm
- Carry out balancing with the crankshaft gear installed, or fit a weight equivalent to the gear mounting key to the key groove.

- To correct the balance, make a drill hole in the counterweight or carry out grinding.
  Limit to amount of correction of counterweight:
  No. of holes: Max. 5
  Hole diameter: 10 or 12 mm
  Hole depth: Max. 35 mm
  Clearance between hole and side face: Min. 3 mm
  Clearance between holes: Min. 5 mm

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REPLACING ENGINE REAR SEAL

Special tools required

No.	Part No.	Part Name	Q'ty
A	795-931-1100	Seal puller assembly	1
B	795-931-1310	Sleeve jig (for assembly)	1

• Remove the flywheel. (See DISASSEMBLY AND ASSEMBLY)

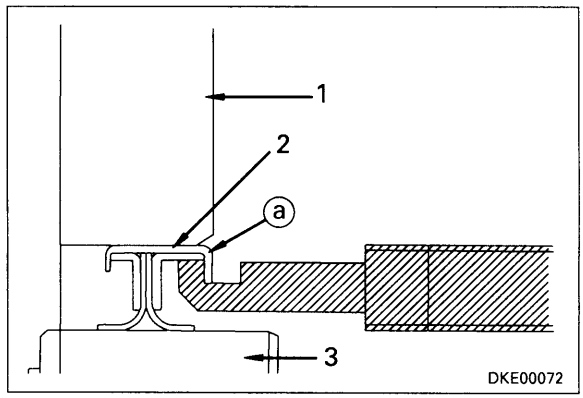
1. Removing seal

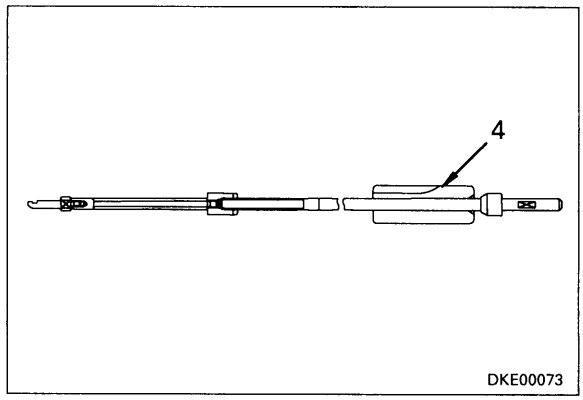
1) Hook tip (a) of tool A under metal ring (a) of seal ②, then remove it with the impact force of slide hammer (4).

★ Before pulling out, knock seal ② in slightly to free it from flywheel housing ② and make it easy to remove.

★ Be careful not to scratch or damage crankshaft (3).

★ Do not use a drill. If a drill is used, metal particles will get inside the engine.





2. Checking wear of shaft

2) If the wear is only seen as luster (when touched with the flat of the finger, the wear cannot be detected; wear depth: approx. 10 μm or less) and there are no scratches or other damage, the part can be used again.

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3. Installing seal

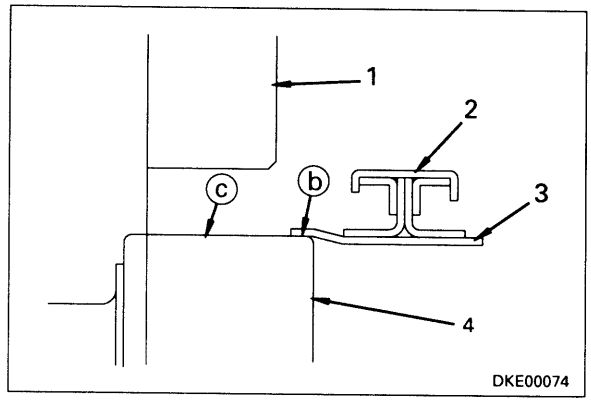
1) Put large inside diameter end (b) of plastic inner tube (3) in contact with crankshaft (4).

★ Be careful not to mistake the direction.

★ Before assembling the seal, remove all scratches, burrs, flashes, and rust from flywheel housing (1), the end face corner of clutch shaft (4), and sliding face (c) of the lip.

★ Wipe off all the oil from the shaft.

★ Do not coat the shaft and seal lip (2) with oil or grease.



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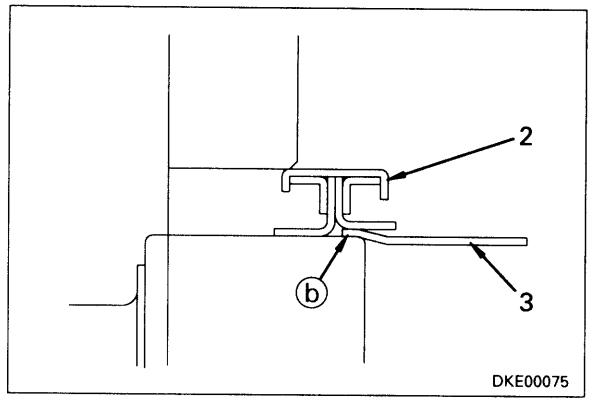
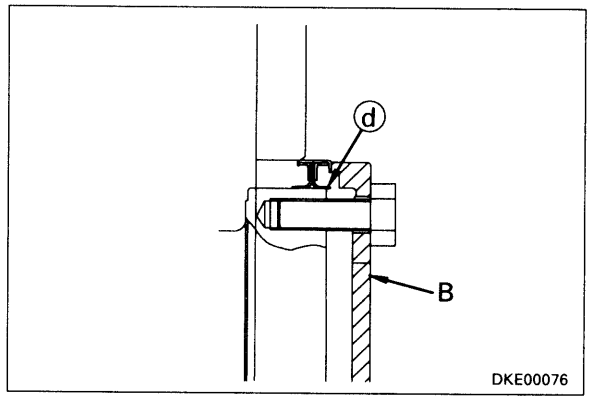
2) Push in metal ring (2) of the seal uniformly with both hands until it feels that it has passed inside large diameter end (b) of plastic tube (3).
3) Remove plastic tube (3), taking care not to damage the lip.



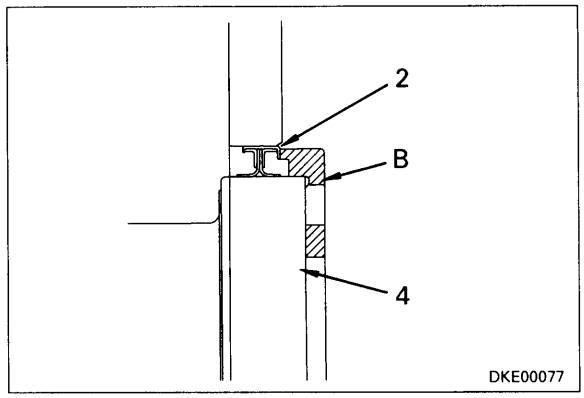
4 Put tool **B** in contact as shown in the diagram on the right, then tighten with the bolts.

★ Be careful not to damage the tip of lip (d).



5) Press fit until tool **B** contacts crankshaft (4).

★ Wipe off all the gasket sealant that is squeezed out from the outside circumference.



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