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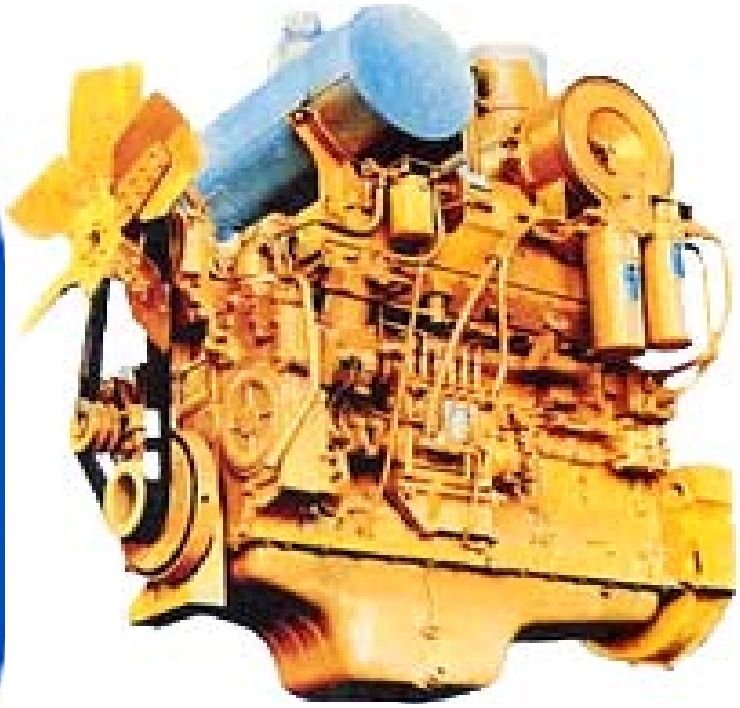
SHOP MANUAL



B(S)(A)6D140-1 SERIES DIESEL ENGINE

BEML LIMITED

MYSORE, INDIA.

CONTENTS

IMPORTANT SAFETY NOTICE

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

To prevent injury to workers, the symbols ⚠ and ⚠ are 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.

⚠ SAFETY

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, glasses, 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 REAIR 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, part 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, 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 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 oi1 drips on to 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

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 chapters for each main group of components; these chapters are further divided into the following sections.

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 adjust ments 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. Contact your **beml** Regional Office for the latest information.

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 : } Each issued as one volume to
Attachments volume : } cover all models

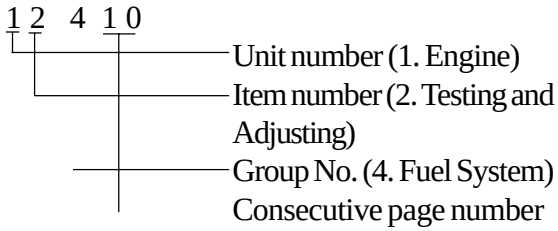
These various volumes are designed to avoid duplicating the same information. Therefore to deal with all repairs for any model, it is necessary that chassis, engine, electrical and attachment volumes are ready.

DISTRIBUTION AND UPDATING

Any additions, amendments or other changes will be sent to Regional office. Get the most upto-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.

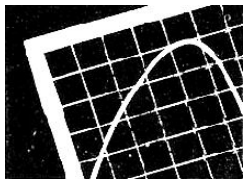


3. Additional pages: Additional pages are indicated by a hyphen (-) and number after the page number. File as in the example.
   Example:

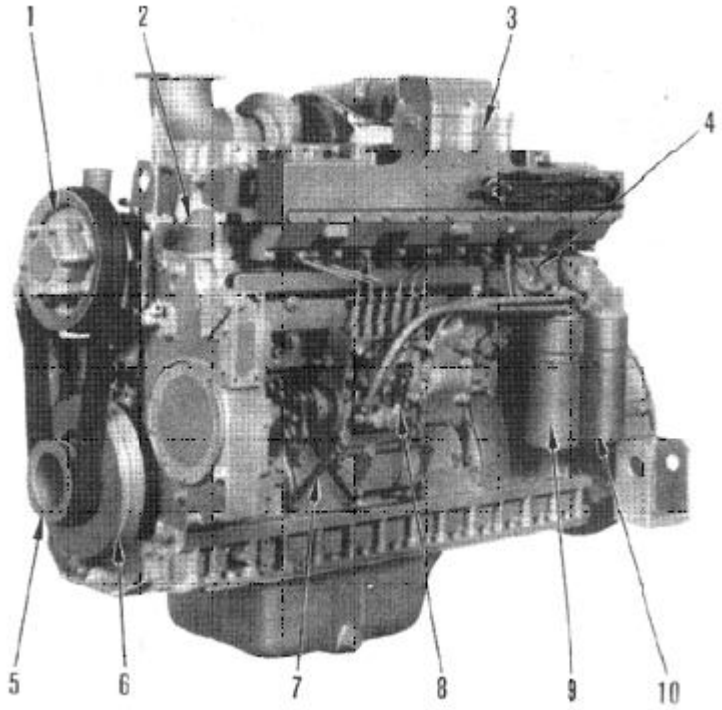
Symbol	Item	Remarks
	Safety	Special safety precautions are necessary when performing the work.
		Extra special safety precautions are necessary when performing the work because it is under internal pressure.
	Caution	Special technical precautions or other precautions for preserving standards are necessary when performing the work.
	Weight	Weight of parts or systems. Caution necessary when selecting hoisting wire, or when working posture is important, etc.
	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.

ENGINE

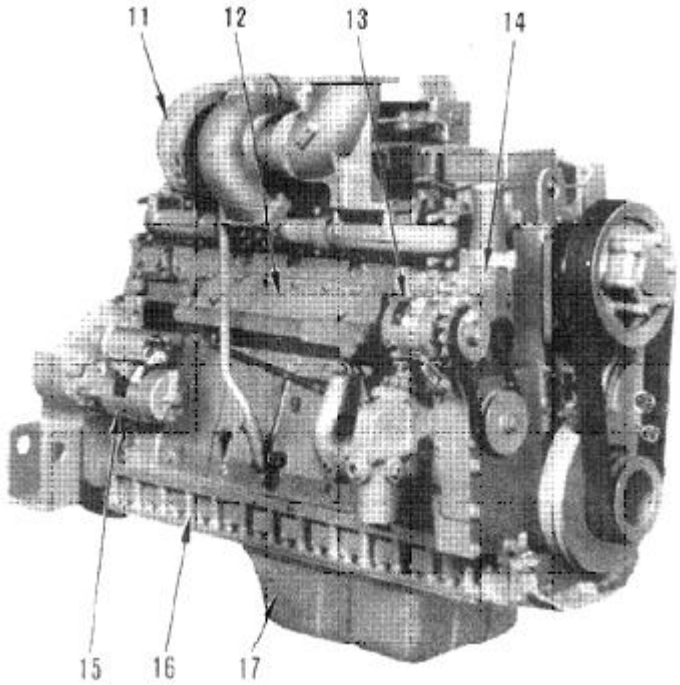
11 GENRAL



GENERAL VIEW

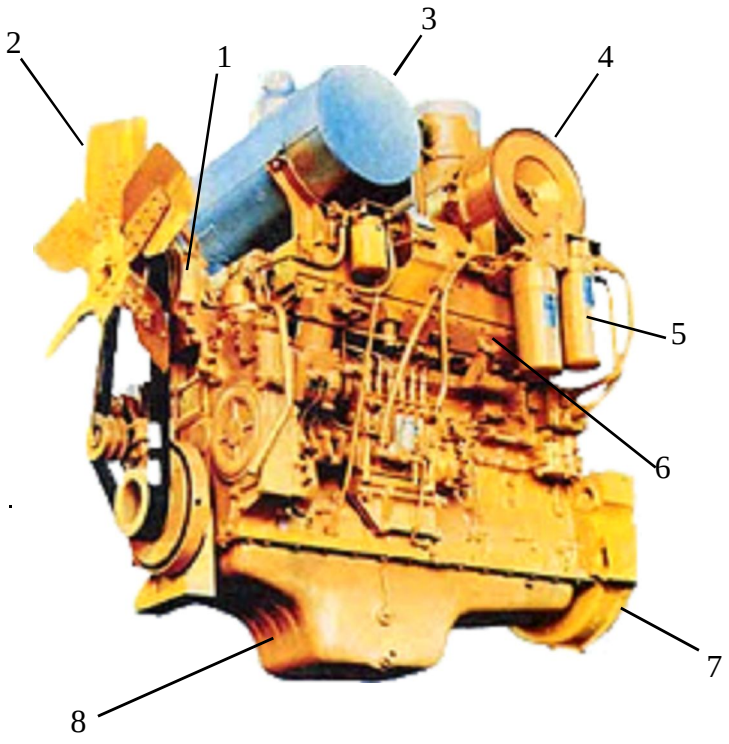


1. Fan pulley
2. Breather
3. Electrical intake air heater
4. Oil filter
5. Crankshaft pulley
6. Vibration damper
7. Dipstick
8. Fuel injection pump
9. Fuel filter
10. Oil filter



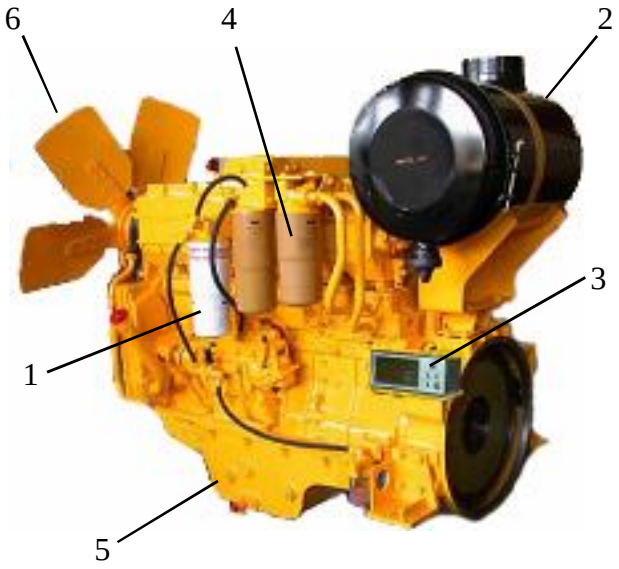
11. Turbocharger
12. Oil filter
13. Alternator
14. Thermosatat housing
15. Oil pan

BG825 ; BH40 ; BL40 ; CM20H ; BD30W-1 ENGINE



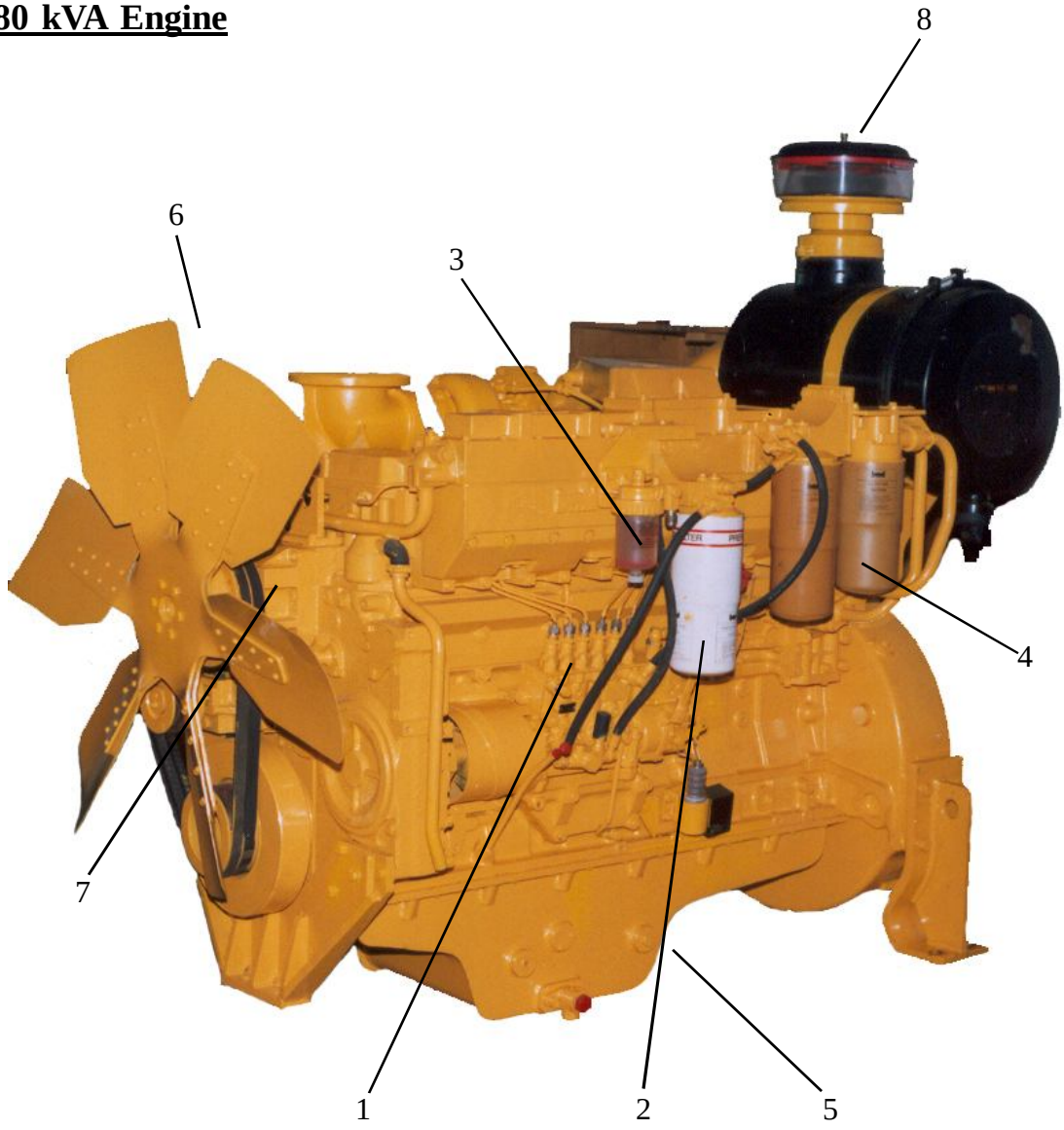
1. Fan pulley
2. Fan
3. Muffler
4. Air cleaner
5. OIl Filter
6. Manifold
7. Flywheel
8. Oil pan

BE650 ; BL54 ENGINE



1. Fuel filter
2. Muffler
3. Engine safety system
4. Oil filter
5. Oil pan
6. Fan

BDG360 / 380 kVA Engine



1. Fuel injection pump
2. Fuel filter
3. water seperator
4. Oil filter
5. Oil pan
6. Fan
7. Fan pulley

SPECIFICATION OF BG825 & BL40

Engine model			BS6D140-1	
Applicable machine			BG825	BL40
Number of cylinder - Bore x Stroke		(mm*mm)	6 - 140 x 165	
Total piston displacement		(cc)	15.24	
Firing order			1 - 5 - 3 - 6 - 2 - 4	
Dimensions	Overall length	(mm)	1593	1674
	Overall width	(mm)	895	1066
	Overall height	(mm)	2060	1671
Performance	Flywheel horsepower			
		Kw/r/min	280/2,100	300/2100
		hp(Metric)/r/min	126/1,400	131/1500
	Maximum torque	(Kgm/r/min)	2300-2400	2300/2400
		(nm/r/min)	650-700	700-750
	High idling Speed	(r/min)		
	Low idling Speed	(r/min)	148	148
	Minimum fuel consumption ratio	(r/min)		
Dry weight		(kg)	1360	1380
Fuel pump			Bosch PE-P type	
Governor			Bosch RSV Centrifugal all speed type	
Lubricating oil amount (refill capacity)		(1)	40(36)	38(34)
Coolant amount		(1)	78.5	119
Aternator			24V, 50A	24V, 50A
Starting motor			24V, 7.5 kw	24V, 7.5 kw
Battery			12V,200Ah x 2	12V,200Ah x 2
Turbocharger			KKK	KKK
Air compressor			Made by Diesel KIKI	Made by Zexel

SPECIFICATION OF BD155X

Engine model			BS6D140-1	
Applicable machine			BD155X	
Number of cylinder - Bore x Stroke		(mm*mm)	6 - 140 x 165	
Total piston displacement		(cc)	15.24	
Firing order			1 - 5 - 3 - 6 - 2 - 4	
Dimensions	Overall length	(mm)	1,747	
	Overall width	(mm)	1,066	
	Overall height	(mm)	1,669	
Performance	Flywheel horsepower	Kw/r/min	320/2,000	
		(kgm/r/min)	144/1,400	
	Maximum torque	(Kgm/r/min)	2150-2250	
		(Nm/r/min)	700-750	
	High idling Speed	(r/min)		
	Low idling Speed	(r/min)	152	
	Minimum fuel consumption ratio	(g/hp.h)		
Dry weight		(kg)	1550	
Fuel pump			Bosch PE-P type	
Governor			Bosch RSV Centrifugal all speed type	
Lubricating oil amount (refill capacity)		(1)	38(34)	
Coolant amount		(1)	141	
Aternator			24V, 50A	
Starting motor			24V, 9.0 kW	
Battery			12V,200Ah x 2	
Turbocharger			KKK	
Air compressor			Made by Diesel KIKI	

SPECIFICATION OF VVL 10 x 8 & VTI 8 x 8

Engine model			BS6D140-1	
Applicable machine			VVL 10 x 8	VTI 8 x 8
Number of cylinder - Bore x Stroke		(mm)	6 - 140 x 165	
Total piston displacement		(cc)	15.24	
Firing order			1 - 5 - 3 - 6 - 2 - 4	
Dimensions	Overall length	(mm)	1,590	1,590
	Overall width	(mm)	780	780
	Overall height (Excluding exhaust pipe)	(mm)	1,099	956
	Overall height (Including exhaust pipe)	(mm)		-
Performance	Flywheel horsepower	(kW/r/min)	285/2100	285/2,100
	Maximum torque	(N-m/r/min)	1,521/1,400±100	1,521/1,400±100
	High idling Speed	(r/min)	2,350±50	2,350±50
	Low idling Speed	(r/min)	650-700	650-700
	Minimum fuel consumption ratio	(g/HP.h)	214	214
Dry weight		kg	1,360	1,360
Fuel pump			Bosch PE-P type inline	
Governor			Bosch RSUV centrifugal, all-speed type	
Lubricating oil amount (refill capacity)		Litre	38	38
Coolant amount		Litre	--	--
Aternator			24V, 45A Lucas	24V, 45A Lucas
Starting motor			24V, 7.5 kW Lucas	24V,7.5kW ucas
Battery			200 Amph	200 Amph
Turbocharger			3K	3K
Air compressor			Sundaram claton (Wabco)	Sundaram calyton (Wabco)
Others			----	---

SPECIFICATION OF BH35-2 & CM20H C-CRANE

Engine model			BS6D140-1	
Applicable machine			BH35-2	CM20H C-Crane
Number of cylinder - Bore x Stroke		(mm)	6 - 140 x 165	
Total piston displacement		(cc)	15,240	
Firing order			1 - 5 - 3 - 6 - 2 - 4	
Dimensions	Overall length	(mm)	1,650	
	Overall width	(mm)	1,010	
	Overall height (Excluding exhaust pipe)	(mm)	1,370	
	Overall height (Including exhaust pipe)	(mm)	-	-
Performance	Flywheel horsepower	(kW/r/min)	280/2,100	261 kW/2,100
	Maximum torque	(Nm/r/min)	1,628@1,400	1,313 Nm/1,450
	High idling Speed	(r/min)	2,260/2,360	
	Low idling Speed	(r/min)	675-725	
	Minimum fuel consumption ratio	(g/HP.h)	195	
Dry weight		kg	1,350	
Fuel pump			Bosch PE-P type inline	
Governor			Bosch RSUV centrifugal, all-speed type	
Lubricating oil amount (refill capacity)		litre	38(34)	
Coolant amount		litre	30	
Aternator			24V, 45A	
Starting motor			24V, 7.5 kW	24V, 7.5kW
Battery			12V, 200Ah x 2	12V, 200Ah x 2
Turbocharger			TEL (KKK)	KTR / KKK
Air compressor			Wabco	---
Others			---	---

SPECIFICATION OF BH35-2 / WS28-2 WATER SPRINKLER

Engine model			BS(A)6D140-1	
Applicable machine			BH35-2	WS28-2
Number of cylinder - Bore x Stroke		(mm)	6 - 140 x 165	
Total piston displacement		(cc)	15,240	
Firing order			1 - 5 - 3 - 6 - 2 - 4	
Dimensions	Overall length	(mm)	1,650	1,650
	Overall width	(mm)	1,010	1,010
	Overall height (Excluding exhaust pipe)	(mm)	1,370	1,370
	Overall height (Including exhaust pipe)	(mm)	-	-
Performance	Flywheel horsepower	(kW/r/min)	280/2,100	280/2,100
	Maximum torque	(Nm/r/min)	1,628@1,400	1,628@/1,400
	High idling Speed	(r/min)	2,260/2,360	2,260/2,360
	Low idling Speed	(r/min)	675-725	675-725
	Minimum fuel consumption ratio	(g/HP.h)	195	195
Dry weight		kg	1,350	1,350
Fuel pump			Bosch PE-P type inline	
Governor			Bosch RSUV centrifugal, all-speed type	
Lubricating oil amount (refill capacity)		Litre	38(34)	38(34)
Coolant amount		Litre	30	30
Aternator			24V, 45A	24V,45A
Starting motor			24V, 7.5 kW	24V, 7.5kW
Battery			12V, 200Ah x 2	12V, 200Ah x 2
Turbocharger			TEL (KKK)	KTR / KKK
Air compressor			Wabco	Wabco
Others			---	---

SPECIFICATION OF BE650-3 & BL54

Engine model			BSA6D140-1	
Applicable machine			BE650-3	BL54
Number of cylinder - Bore x Stroke		(mm)	6 - 140 x 165	
Total piston displacement		(cc)	15.24	
Firing order			1 - 5 - 3 - 6 - 2 - 4	
Dimensions	Overall length	(mm)	1,655	1,719
	Overall width	(mm)	1,185	1,220
	Overall height (Excluding exhaust pipe)	(mm)	1,684	1,741
	Overall height (Including exhaust pipe)	(mm)	-	-
Performance	Flywheel horsepower	(kW/r/min)	410/1,800	309/2,100
	Maximum torque	(Nm/r/min)	184/1,400	1,750/1,400
	High idling Speed	(r/min)	1,930-2,030	2,260/2,360
	Low idling Speed	(r/min)	675-725	675-700
	Minimum fuel consumption ratio	(g/HP.h)	149	212
Dry weight		kg	1,475	1,426
Fuel pump			Bosch PE-P type inline	
Governor			Bosch RSUV centrifugal, all-speed type	
Lubricating oil amount (refill capacity)		Litre	38(33.5)	38(34)
Coolant amount		Litre	147	30
Aternator			24V, 50A	24V, 45A
Starting motor			24V, 7.5 kW	24V, 7.5kW
Battery			12V, 170Ah x 2	12V, 200Ah x 2
Turbocharger			KTR110/KKK	KTR / KKK
Air compressor			Made by DIESEL KIKI	---
Others			With after cooler	---

SPECIFICATION OF BH40 & EUCLID R35

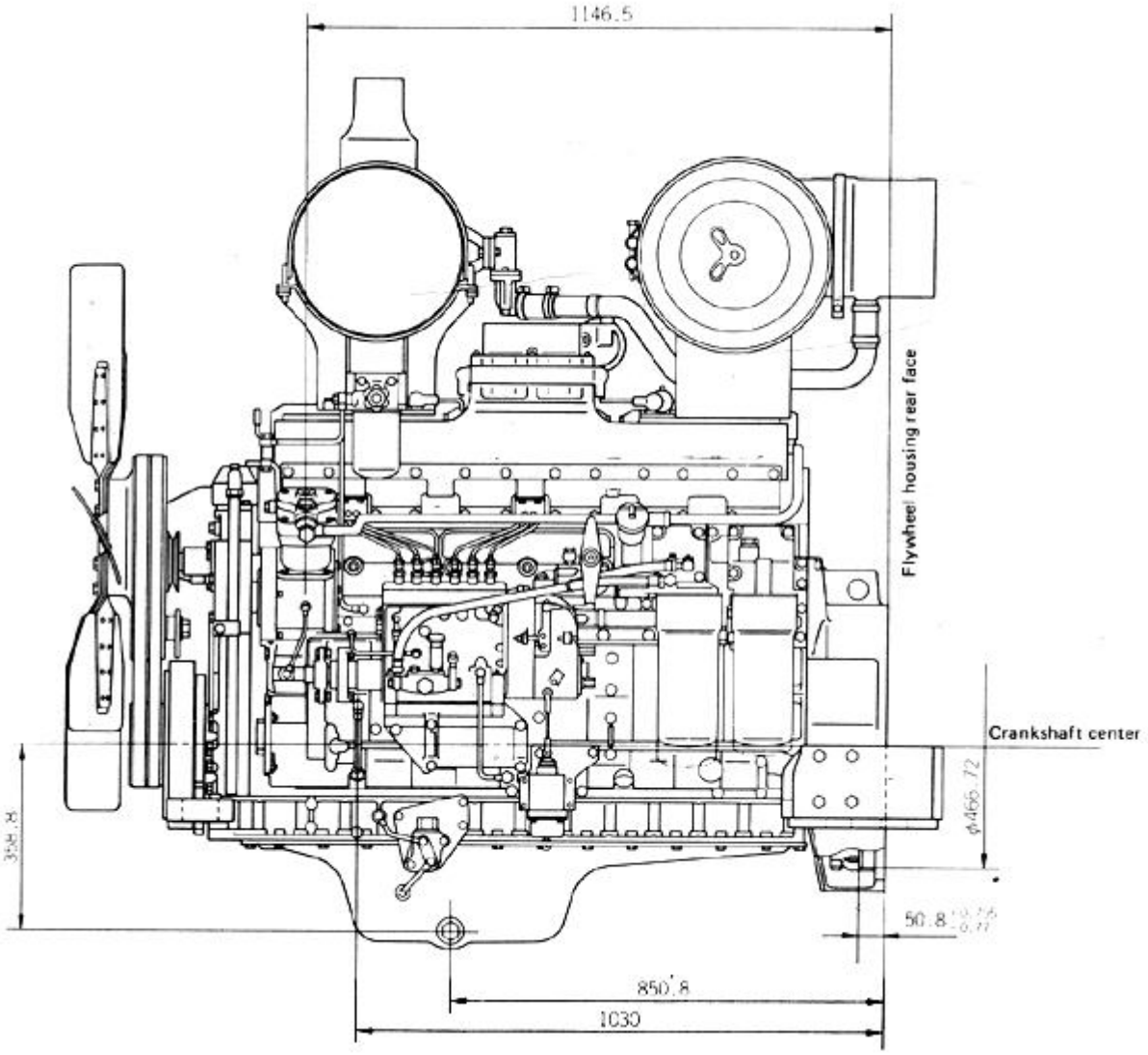
Engine model			BSA6D140-1	
Applicable machine			BH40	EUCLID R35
Number of cylinder - Bore x Stroke		(mm)	6 - 140 x 165	
Total piston displacement		(cc)	15.24	
Firing order			1 - 5 - 3 - 6 - 2 - 4	
Dimensions	Overall length	(mm)	1,567	
	Overall width	(mm)	937	
	Overall height (Excluding exhaust pipe)	(mm)	1,227	
	Overall height (Including exhaust pipe)	(mm)		
Performance	Flywheel horsepower	(hp/r/min)	462/2100	
	Maximum torque	(kgm/r/min)	189/1,400	
	High idling All speed governor	(r/min)	2,260~2,360	
	Max-Min goveror	(r/min)	2,350~2,450	
	Low idling Speed	(r/min)	650-700	
	Minimum fuel consumption ratio	(g/HP.h)	145	
Dry weight		kg	1,390	
Fuel pump			Bosch PE-P type inline	
Governor			Bosch RSUV centrifugal, all-speed type	
Lubricating oil amount (refill capacity)		Litre	38(34)	
Coolant amount		Litre	141	
Aternator			24V, 50A	
Starting motor			24V, 7.5 kW	
Battery			12V, 200 Ah x 2	
Turbocharger			**3K**	
Air compressor			Made by XEXEL	
Others			----	

SPECIFICATION OF BDG360 kVA

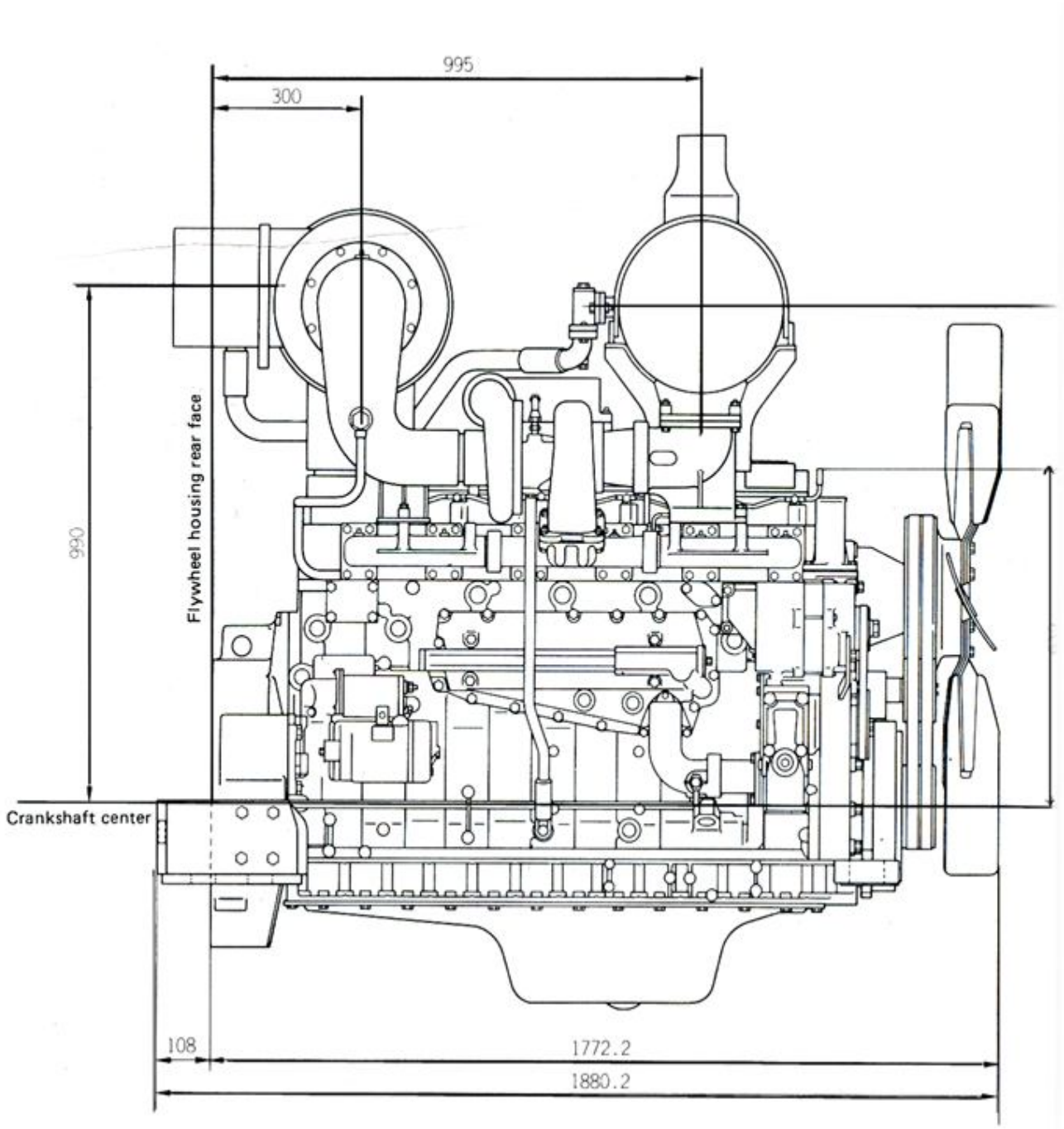
Engine model			BS6AD140G	
Applicable machine			BDG360kVA	
Number of cylinder - Bore x Stroke		(mm*mm)	6 - 140 x 165	
Total piston displacement		(cc)	15.24	
Firing order			1 - 5 - 3 - 6 - 2 - 4	
Dimensions	Overall length	(mm)	1,878	
	Overall width	(mm)	1,000	
	Overall height	(mm)	1,521	
Performance	Flywheel horsepower	kW/r/min	309@ 1 ,500	
		hp(Metric)/r/min	420@,1,500	
	Maximum torque	(Kgm/r/min)	1,555~1,560	
		(nm/r/min)	975~1,025	
	High idling Speed	(r/min)		
	Low idling Speed	(r/min)	205	
	Minimum fuel consumption ratio	(r/min)		
Dry weight		(kg)	1,450±40	
Fuel pump			Bosch PE-P type	
Governor			Bosch RSV Centrifugal all speed type	
Lubricating oil amount (refill capacity)		(1)	38(34)	
Coolant amount		(1)	27	
Aternator			24V, 30A	
Starting motor			24V, 7.5 kw	
Battery			12V,200Ah x 2	
Turbocharger			KKK-K36	
Air compressor			---	

General Assembly Drawing

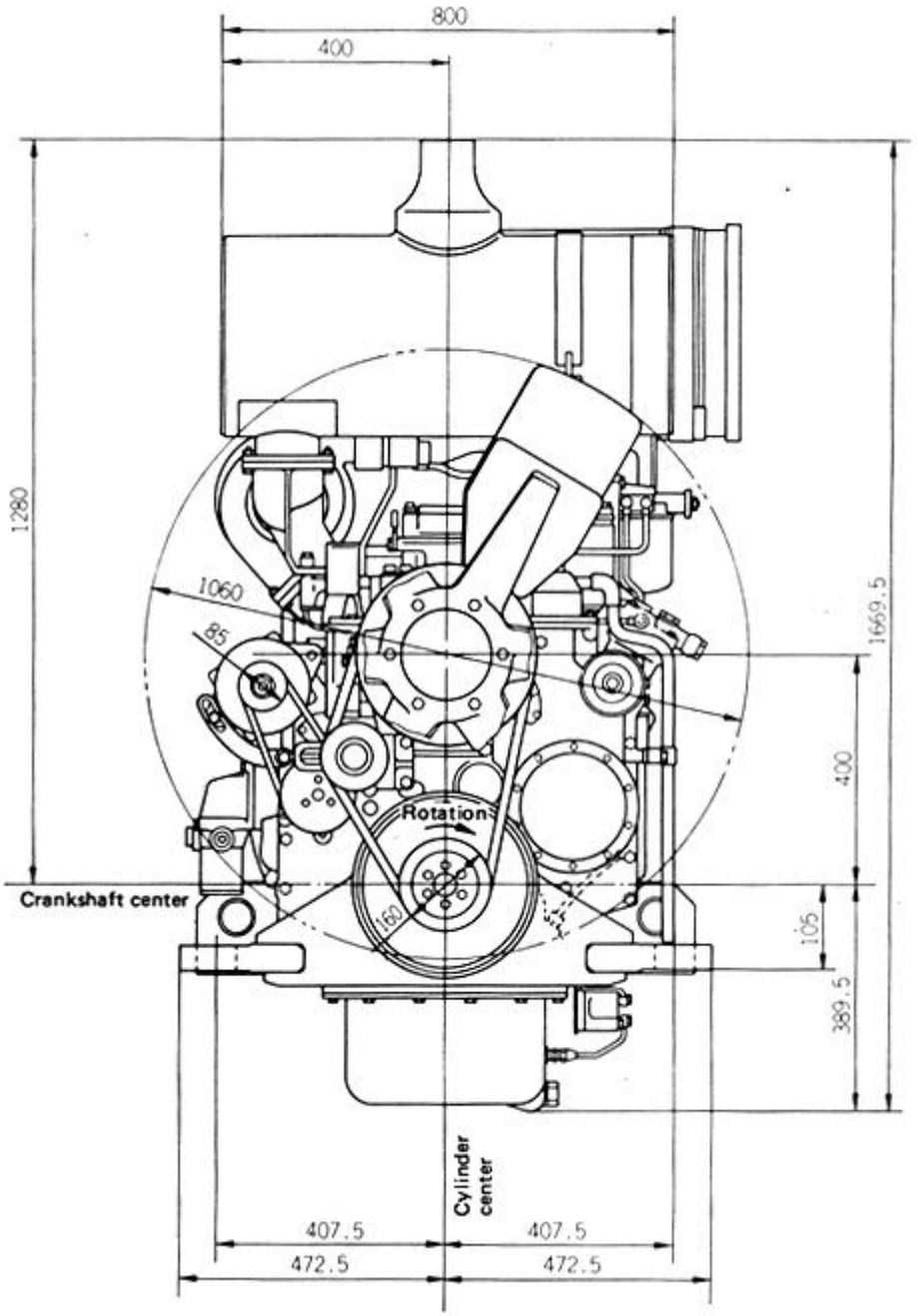
(BS6D140-1 LEFT SIDE VIEW (BG825; BL40; BH35-2; BD155X; CM20H C- CRANE ; VTI 8x8; VVL 10x8)



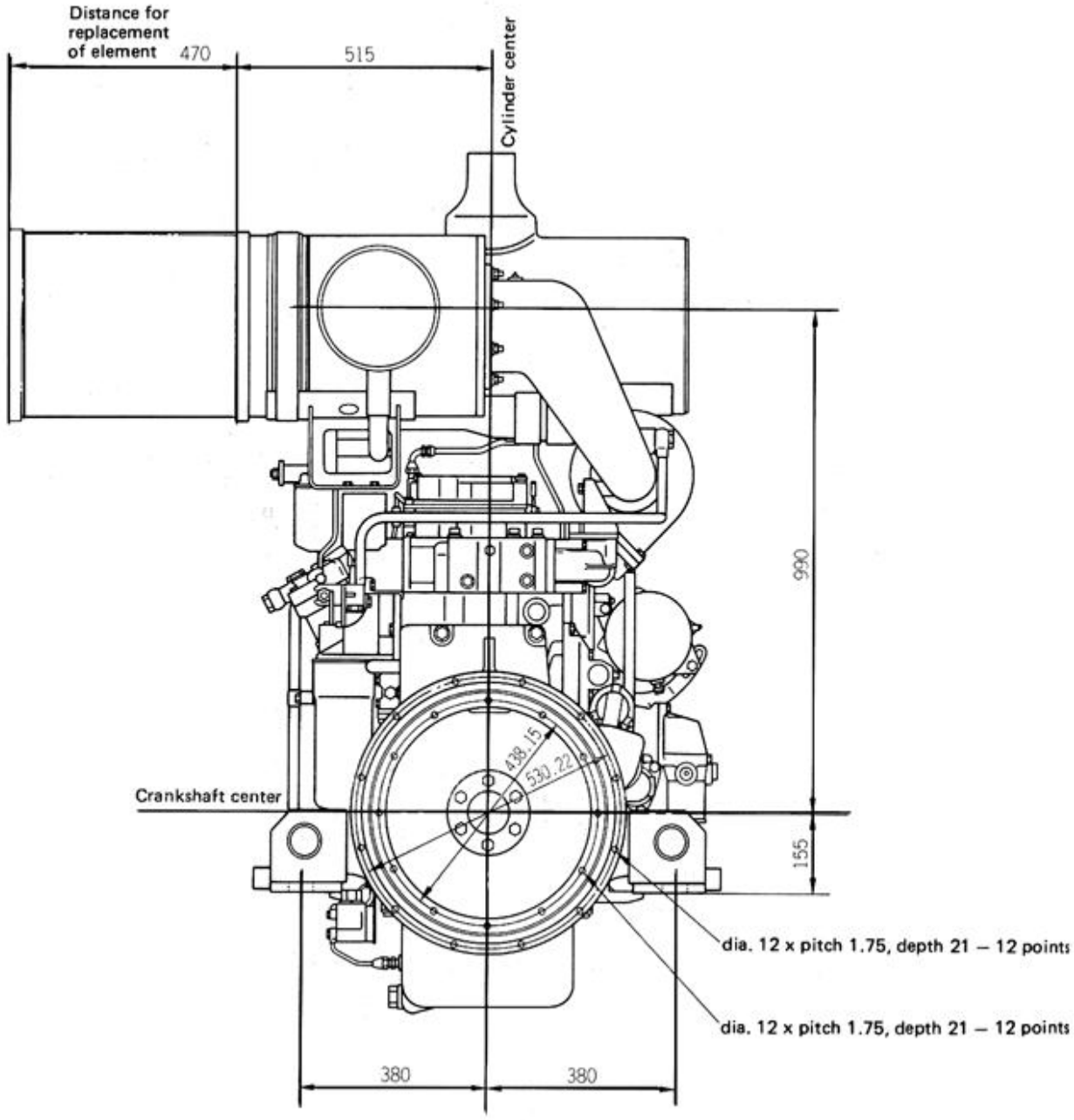
BS6D140-1 RIGHT SIDE VIEW



BS6D140-1 FRONT VIEW

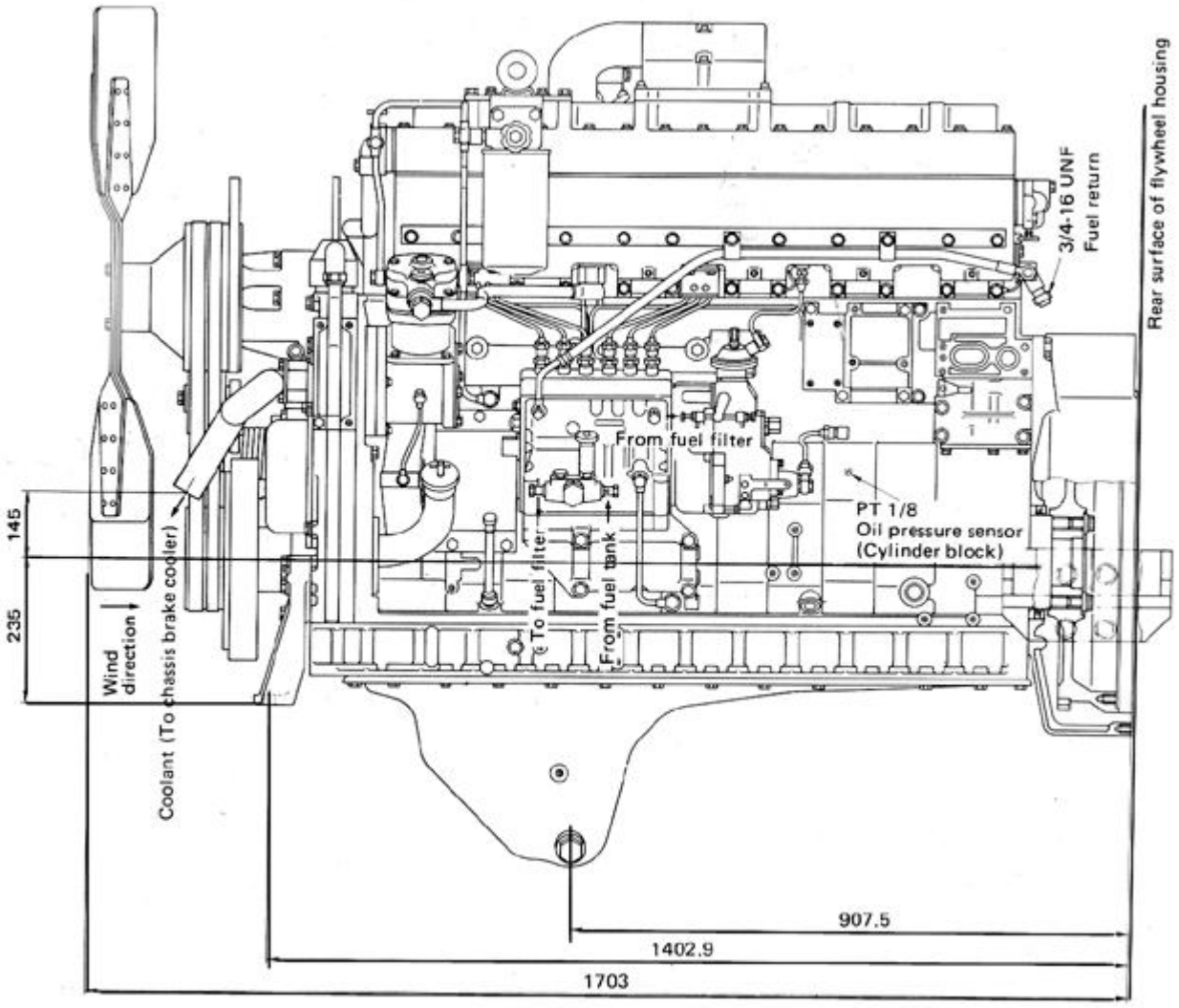


BS6D140-1 REAR VIEW

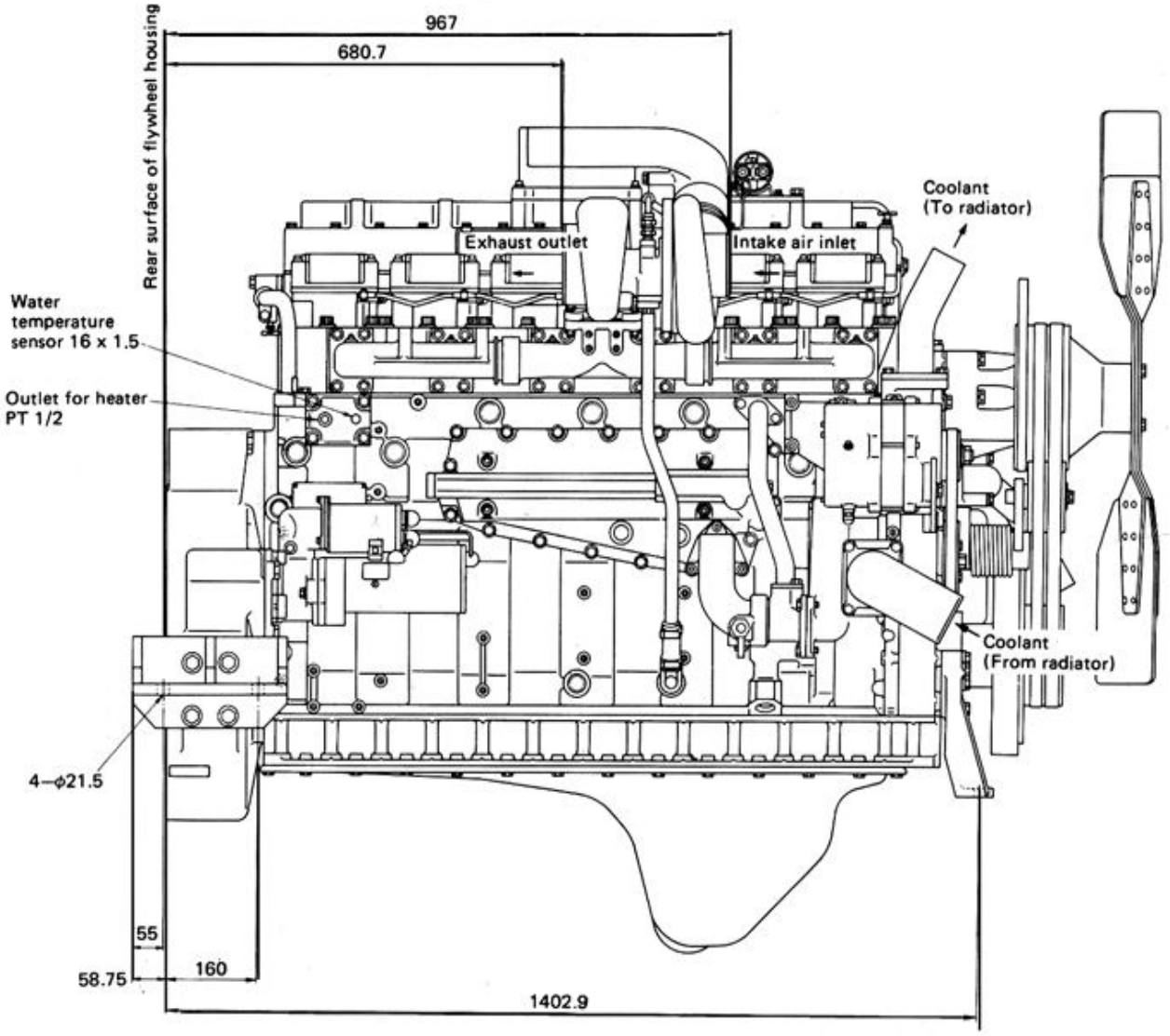


BSA6D140-1 LEFT SIDE VIEW

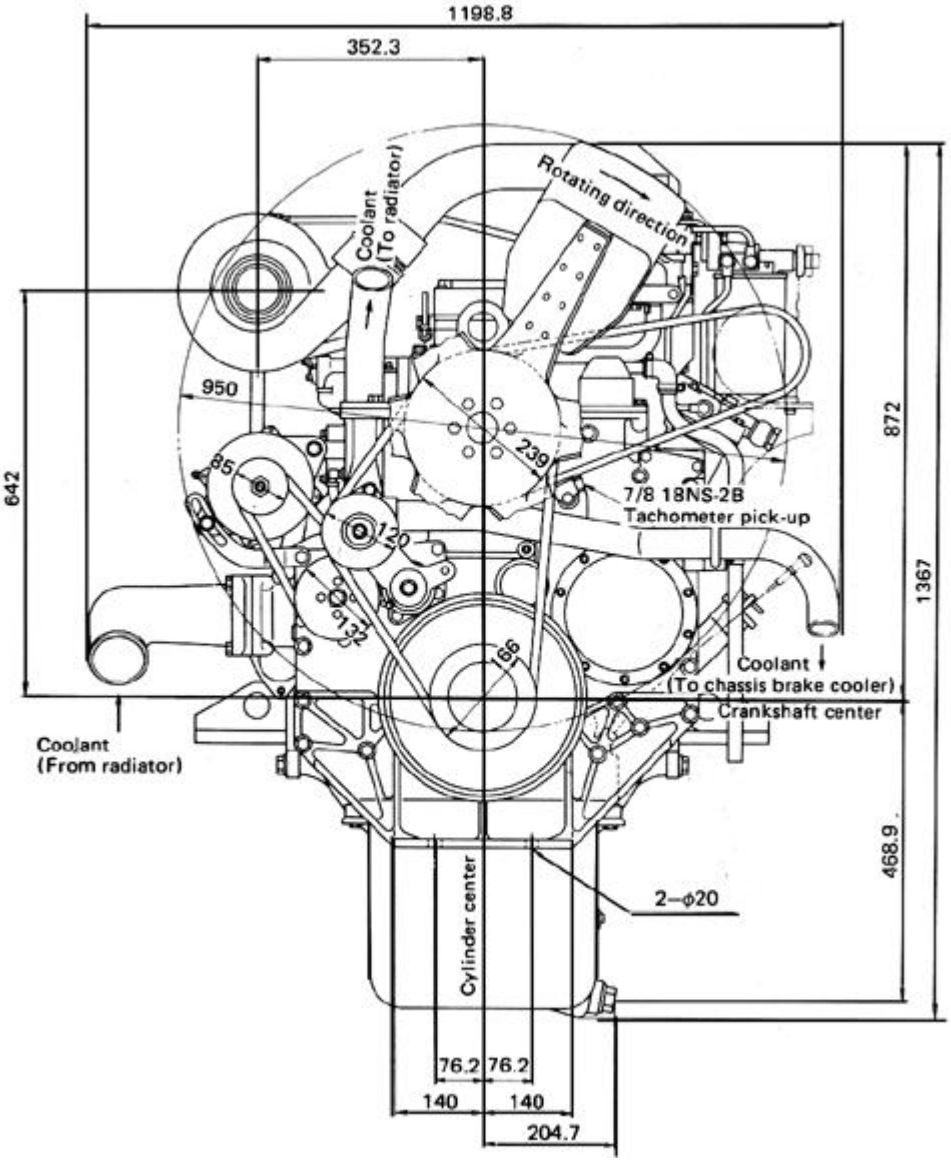
(BH35-2; WS28-2; BH40; BL54; EUCLID R35)



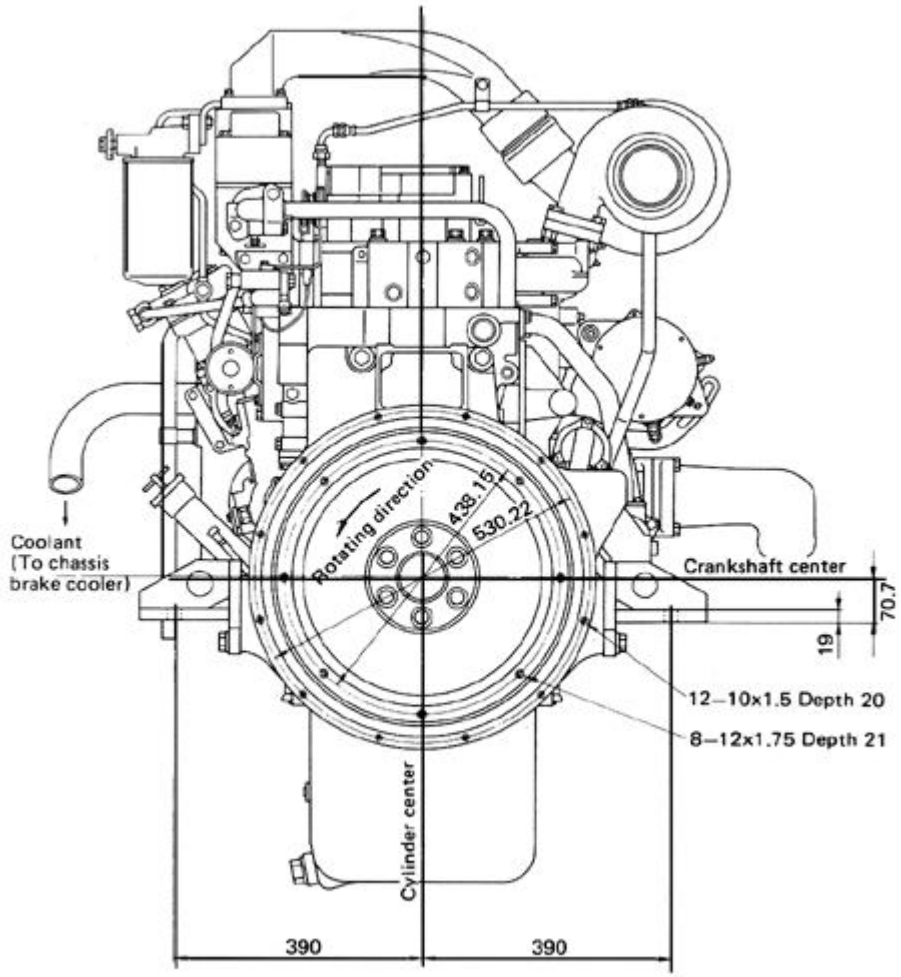
BSA6D140-1 RIGHT SIDE VIEW



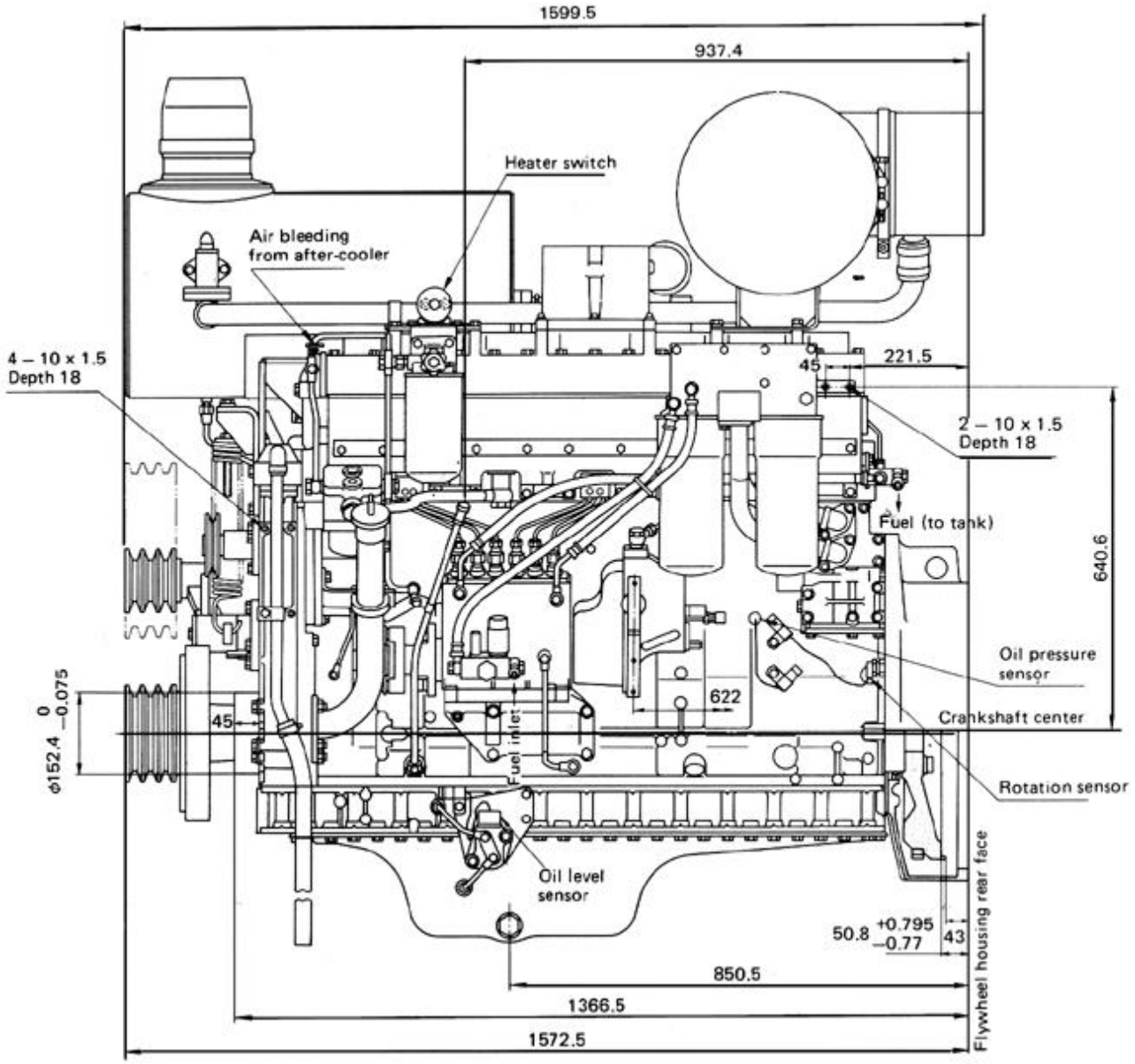
BSA6D140-1 FRONT VIEW



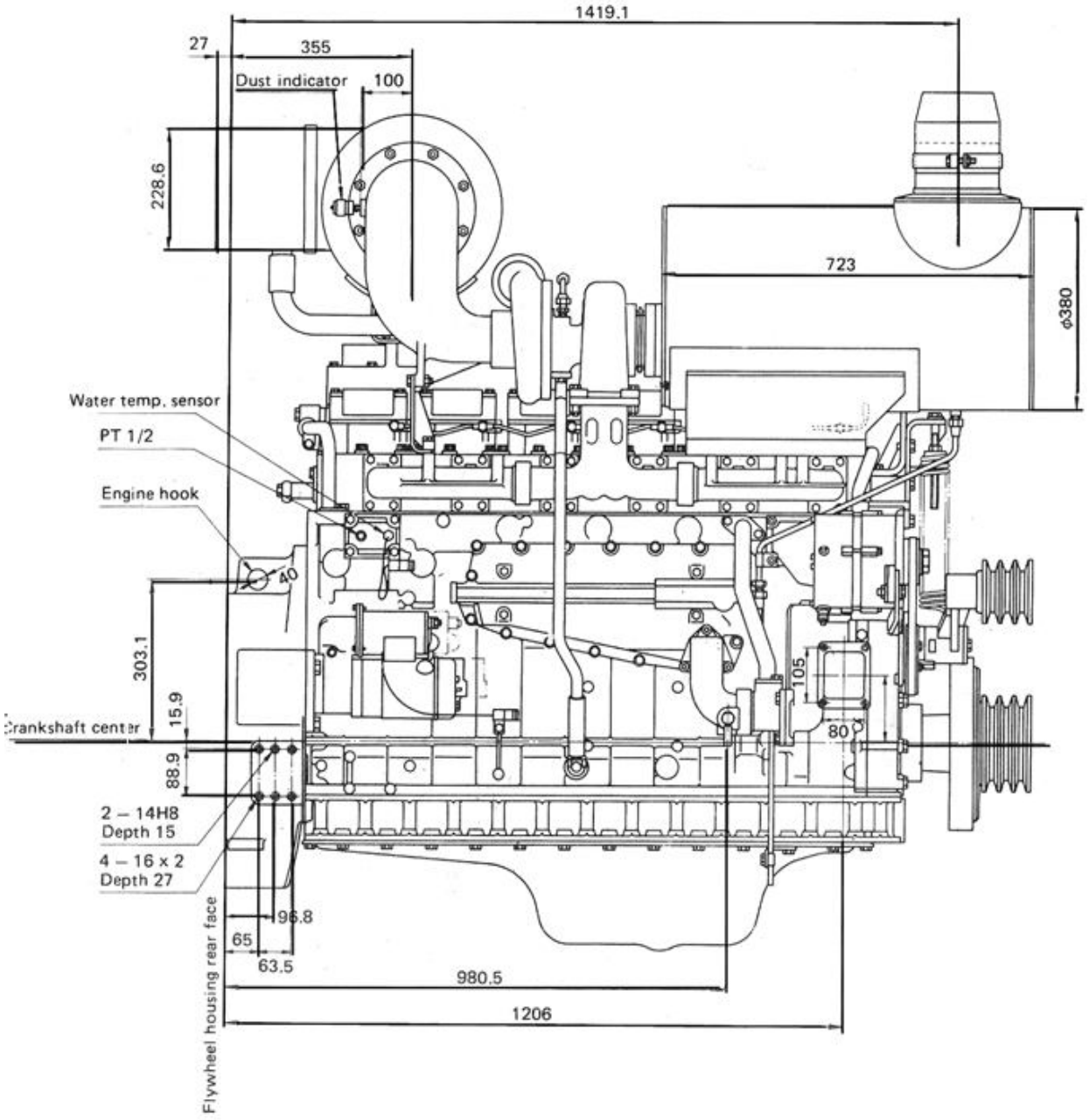
BSA6D140-1 REAR VIEW



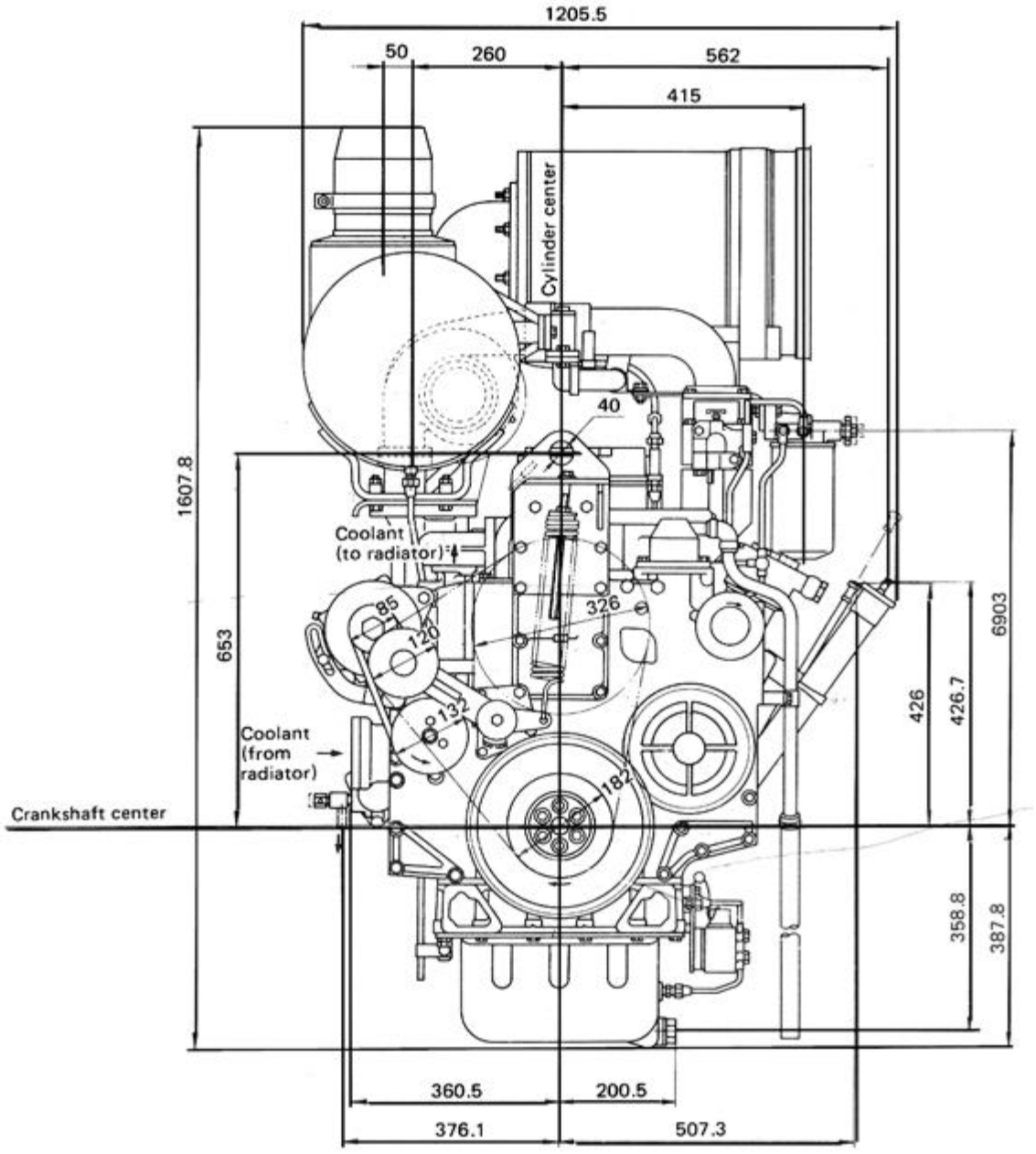
BSA6D140-1 LEFT SIDE VIEW (FOR BE650-3 & BE1600-1)



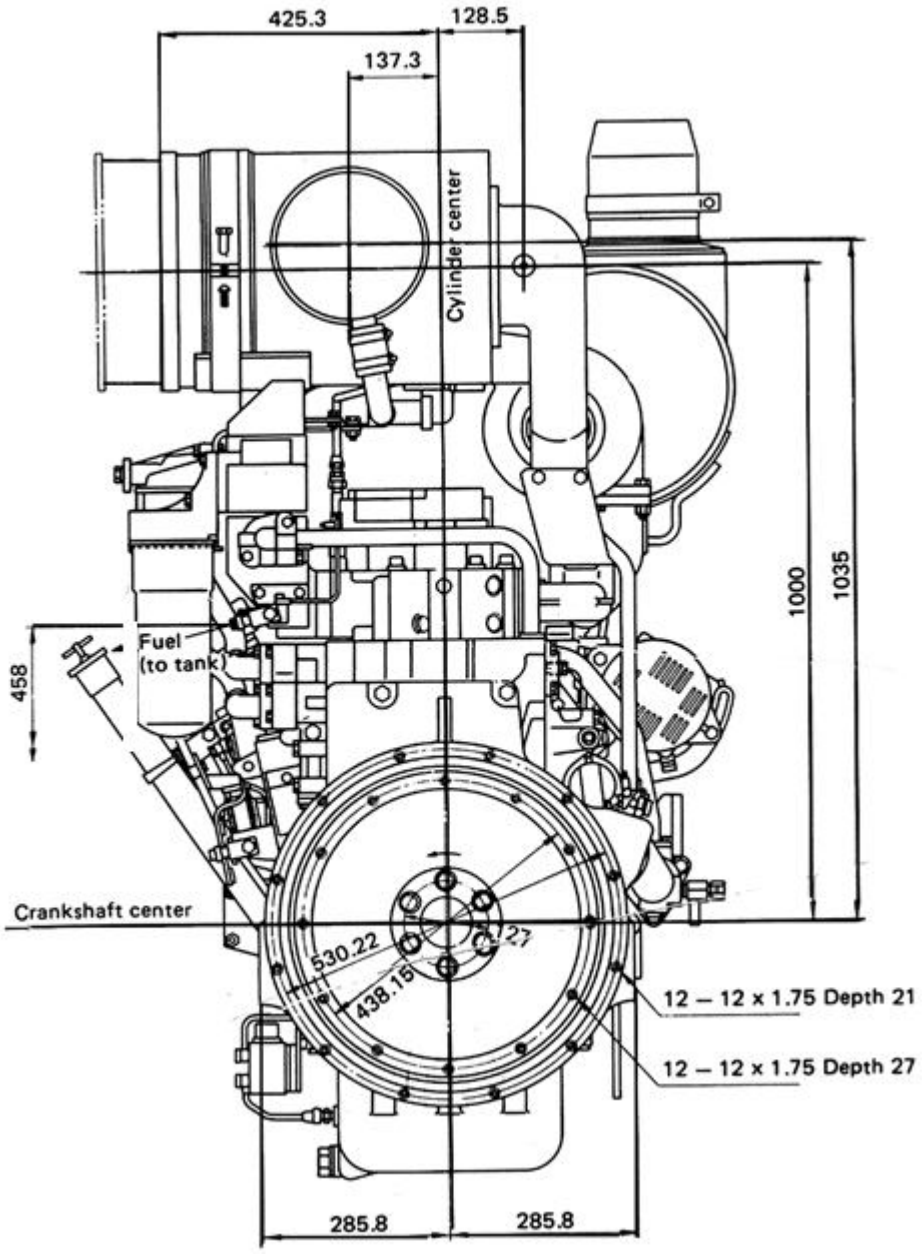
BSA6D140-1 RIGHT SIDE VIEW



BSA6D140-1 FRONT SIDE VIEW

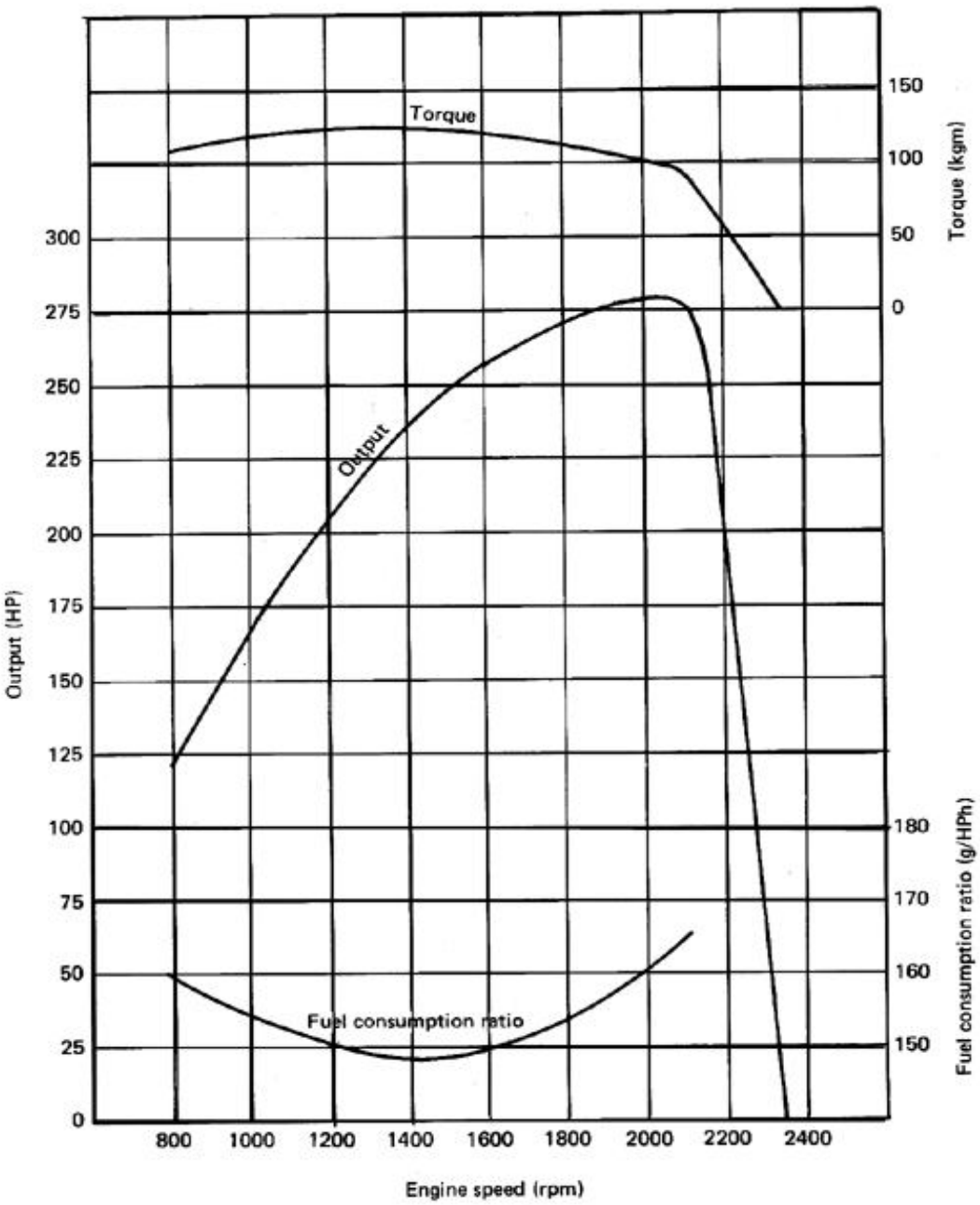


BSA6D140-1 REAR VIEW



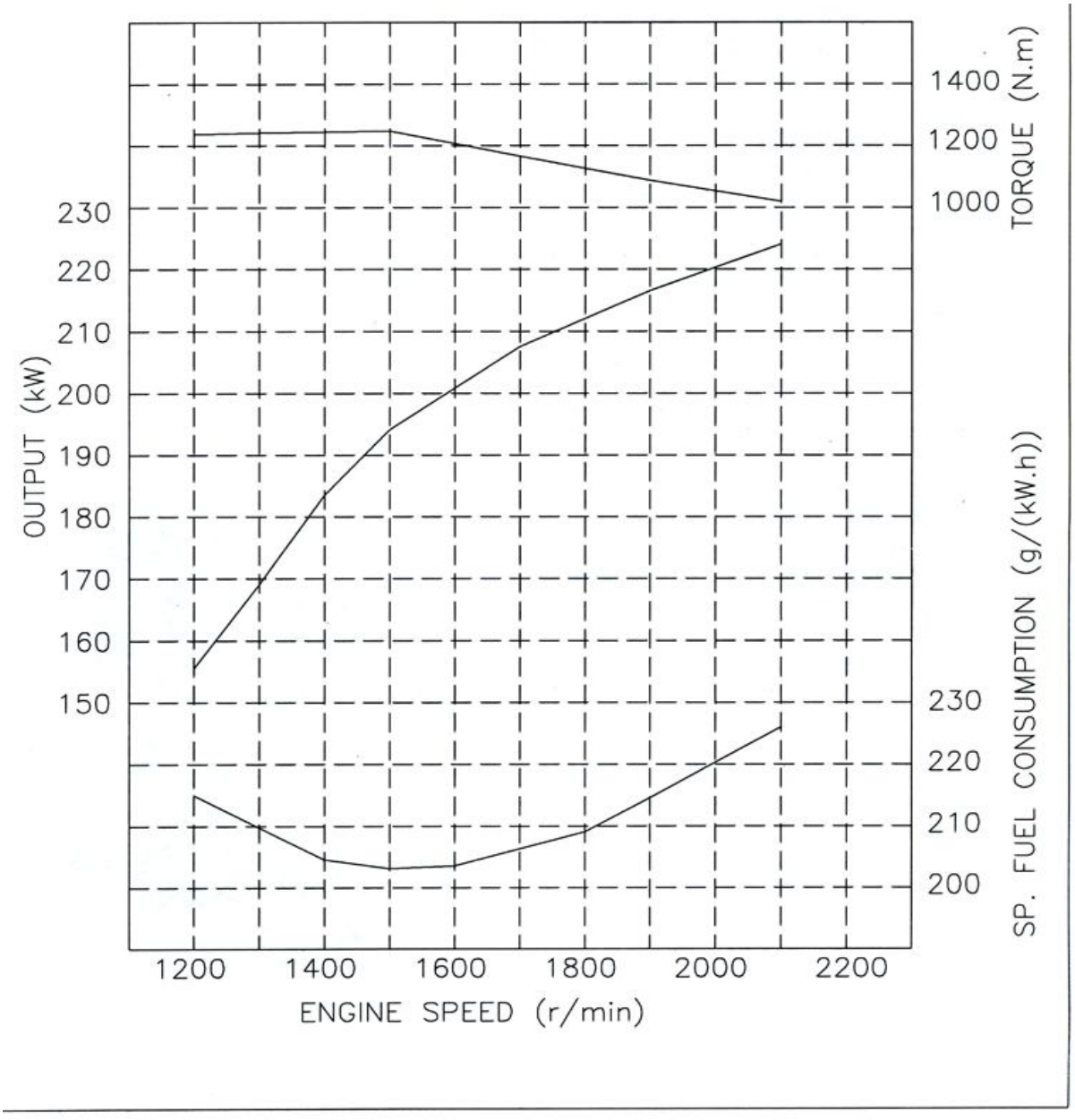
ENGINE PERFORMANCE CURVE
BS6D140-1 FOR BG825A-1

Flywheel horsepower : 280 HP/2,100 rpm
Maximum torque : 126 kgm/1,400 rpm
Minimum fuel consumprtion : 148 g/HPh



BS6D140-1 (FOR BL40)

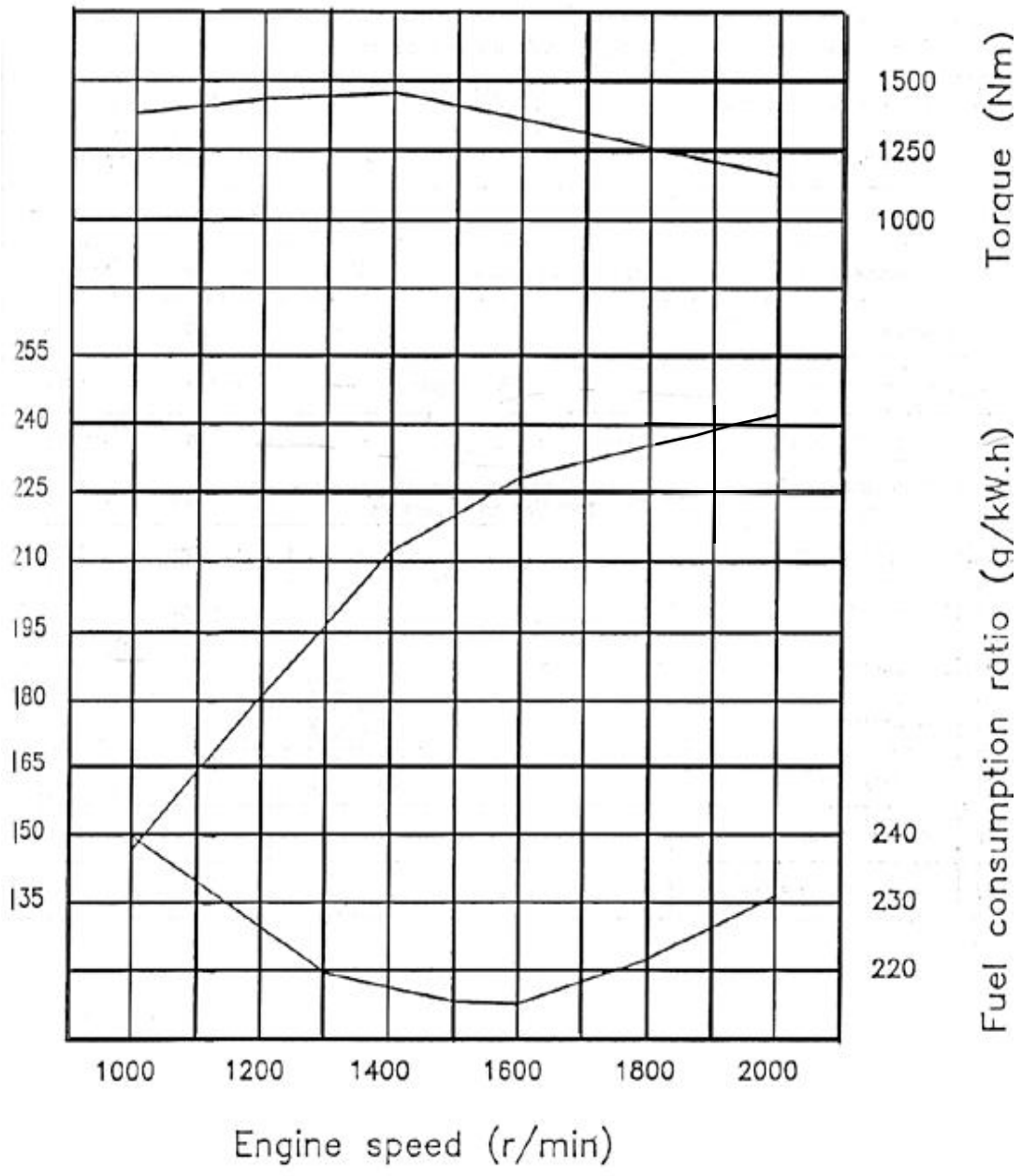
Flywheel horsepower	:	224 kW @ 2100 r/min
Mximum torque	:	1248 N.m @ 1500 r/min
Mnimum fuel consumption ratio	:	203 g/kW.h
Corrected in accordance with	:	IS 13116 /ISO 9249



ENGINE PERFORMANCE CURVE

BS6D140-1 (FOR BD155X)

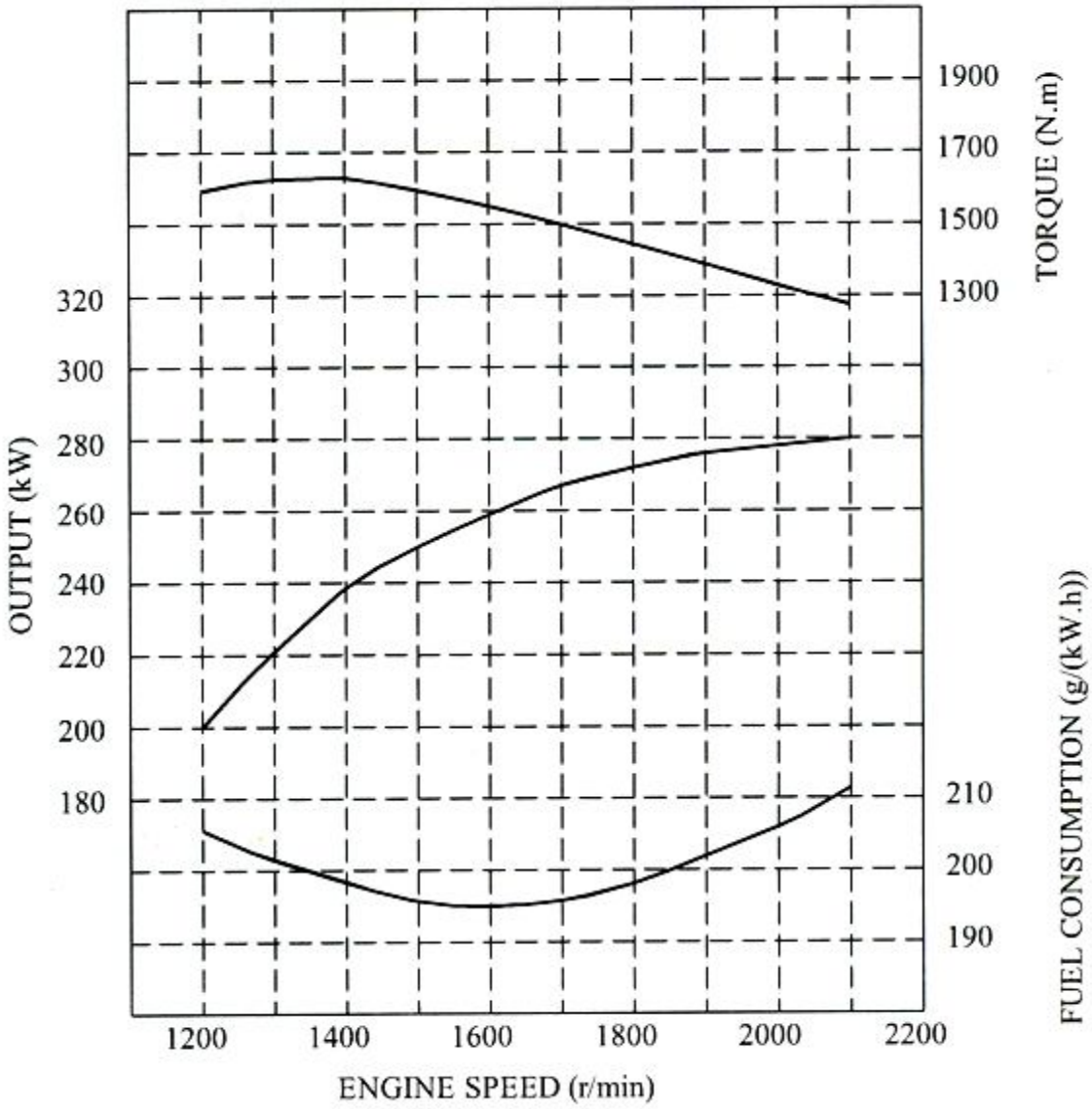
Flywheel horsepower	:	242 kw @ 2000 r/min
Mximum torque	:	1456 Nm @ 1400 r/min
Mnimum fuel consumption ratio	:	216 g/kW.h



ENGINE PERFORMANCE CURVE

BS6D140-1 (FOR BH35-2)

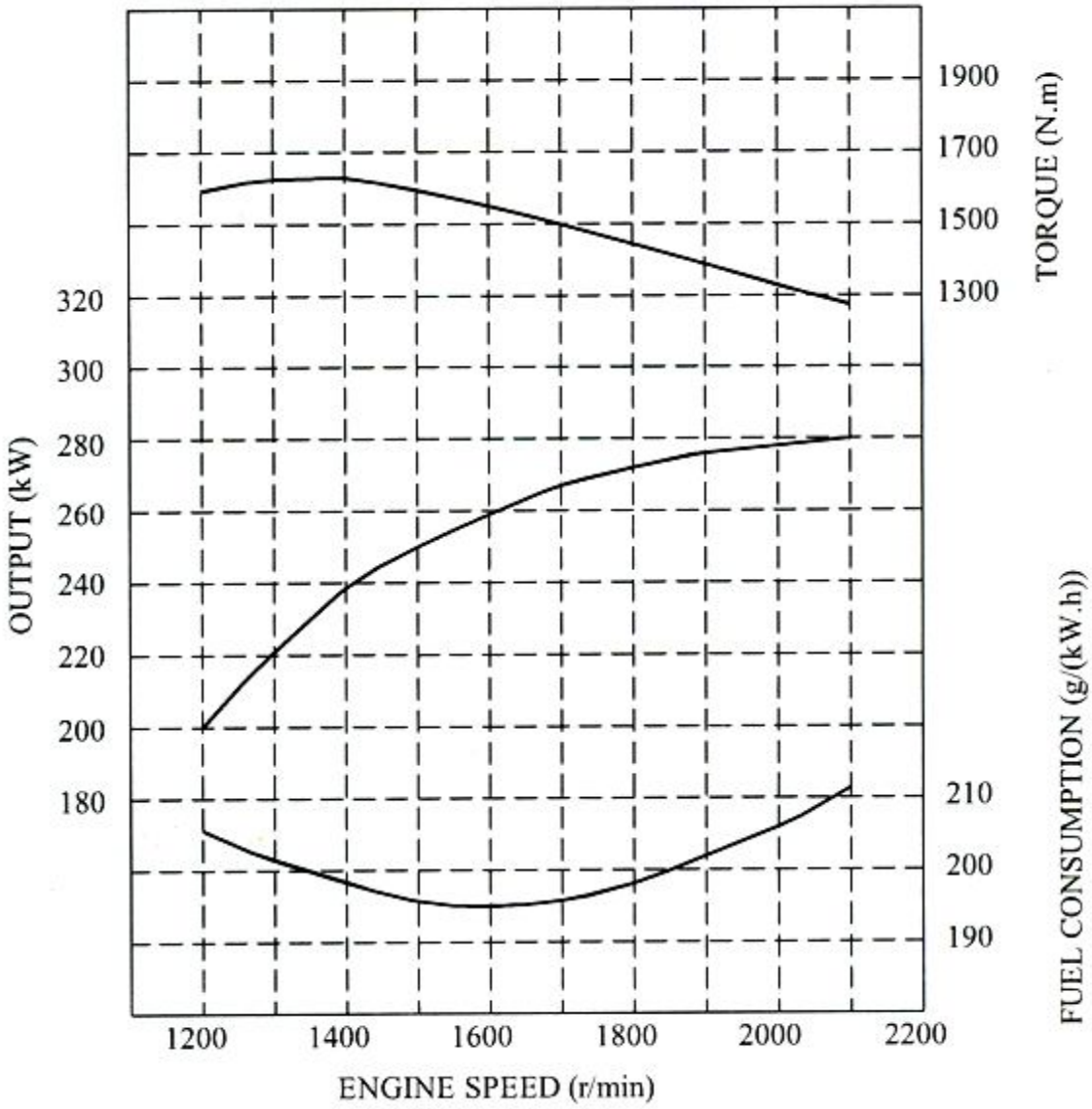
Flywheel horsepower	:	280 kW @ 2100 r/min
	:	(375 hp@ 2100 r/min)
Mximum torque	:	1628 N.m @ 1400 r/min
Mnimum fuel consumption ratio	:	195 g/kW.h
Corrected in accordance with	:	IS 13116 /ISO 9249



ENGINE PERFORMANCE CURVE

BS(A)6D140-1 (FOR BH35-2/WS28-2)

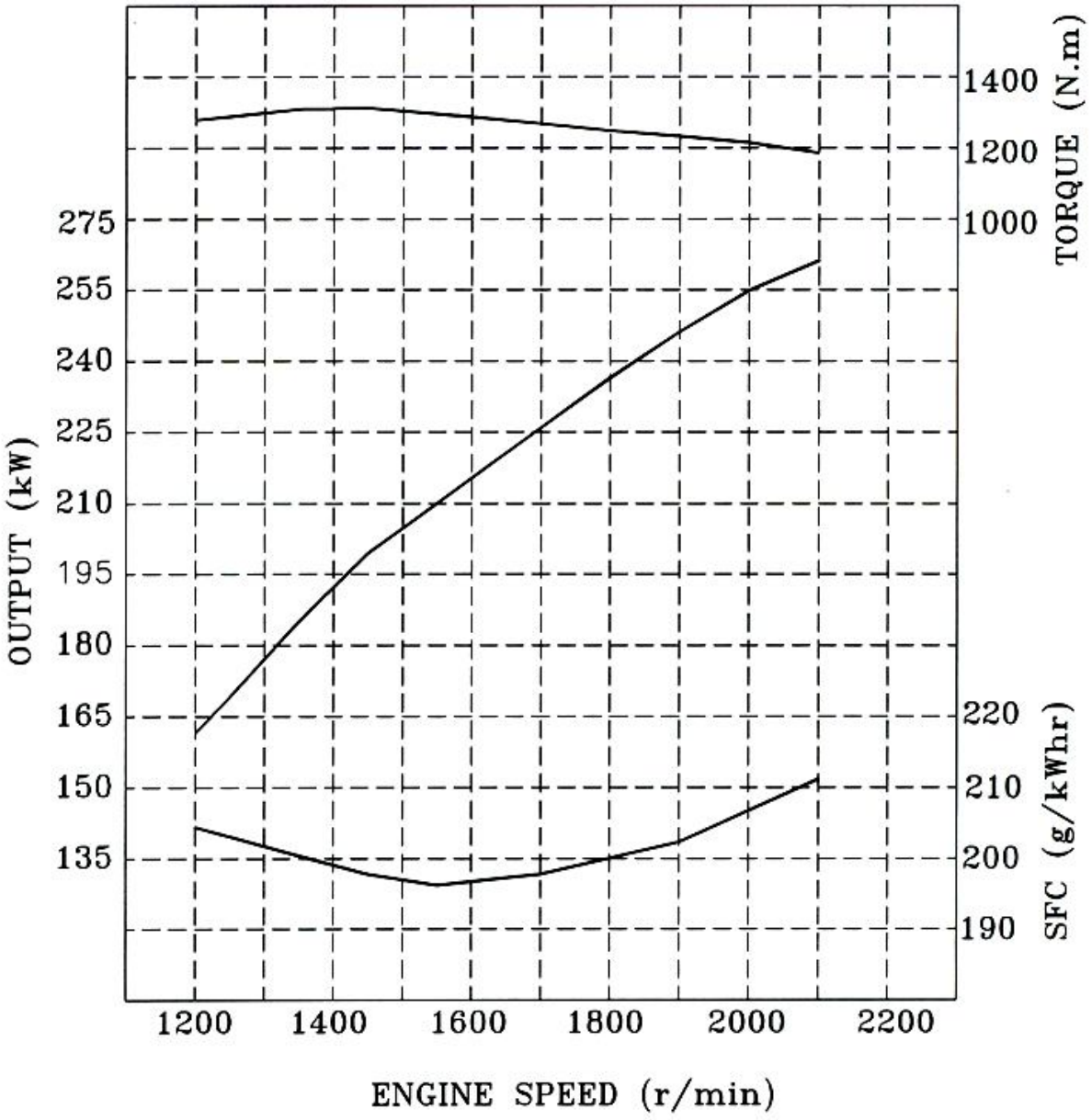
Flywheel horsepower	:	280 kW @ 2100 r/min
	:	(375 hp@ 2100 r/min)
Mximum torque	:	1628 N.m @ 1400 r/min
Mnimum fuel consumption ratio	:	195 g/kW.h
Corrected in accordance with	:	IS 13116 /ISO 9249



ENGINE PERFORMANCE CURVE

BS6D140-1 (FOR CM20H C-CRANE)

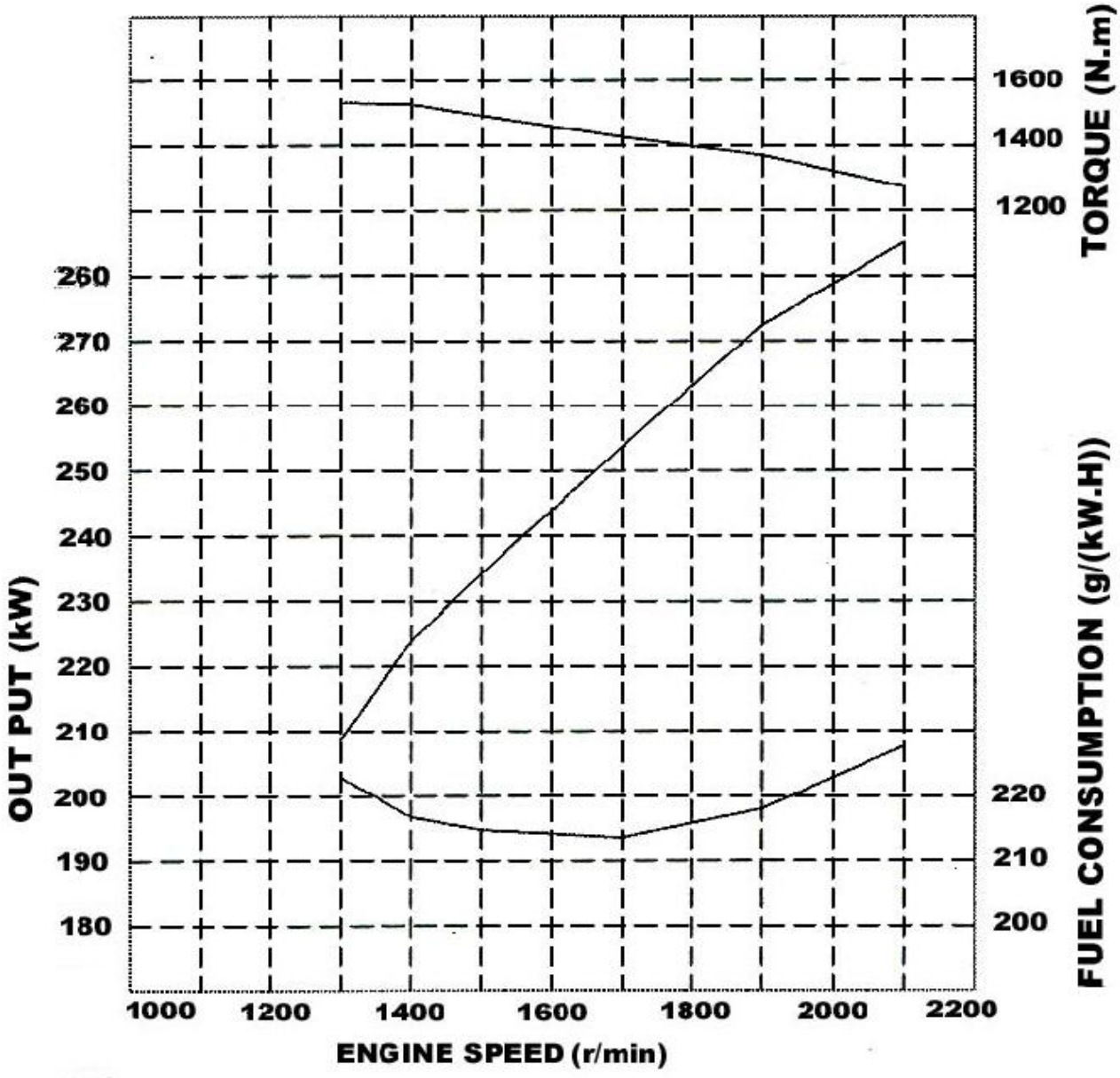
Flywheel horsepower	:	261 kW @ 2100 r/min
Mximum torque	:	1313 N.m @ 1450 r/min
Mnimum fuel consumption ratio	:	211 g/kW.hr @ 2100 r/min
Corrected in accordance with	:	IS 13116 / ISO 9249



ENGINE PERFORMANCE CURVE

BS6D140-1 (FOR VVL 10 x 8)

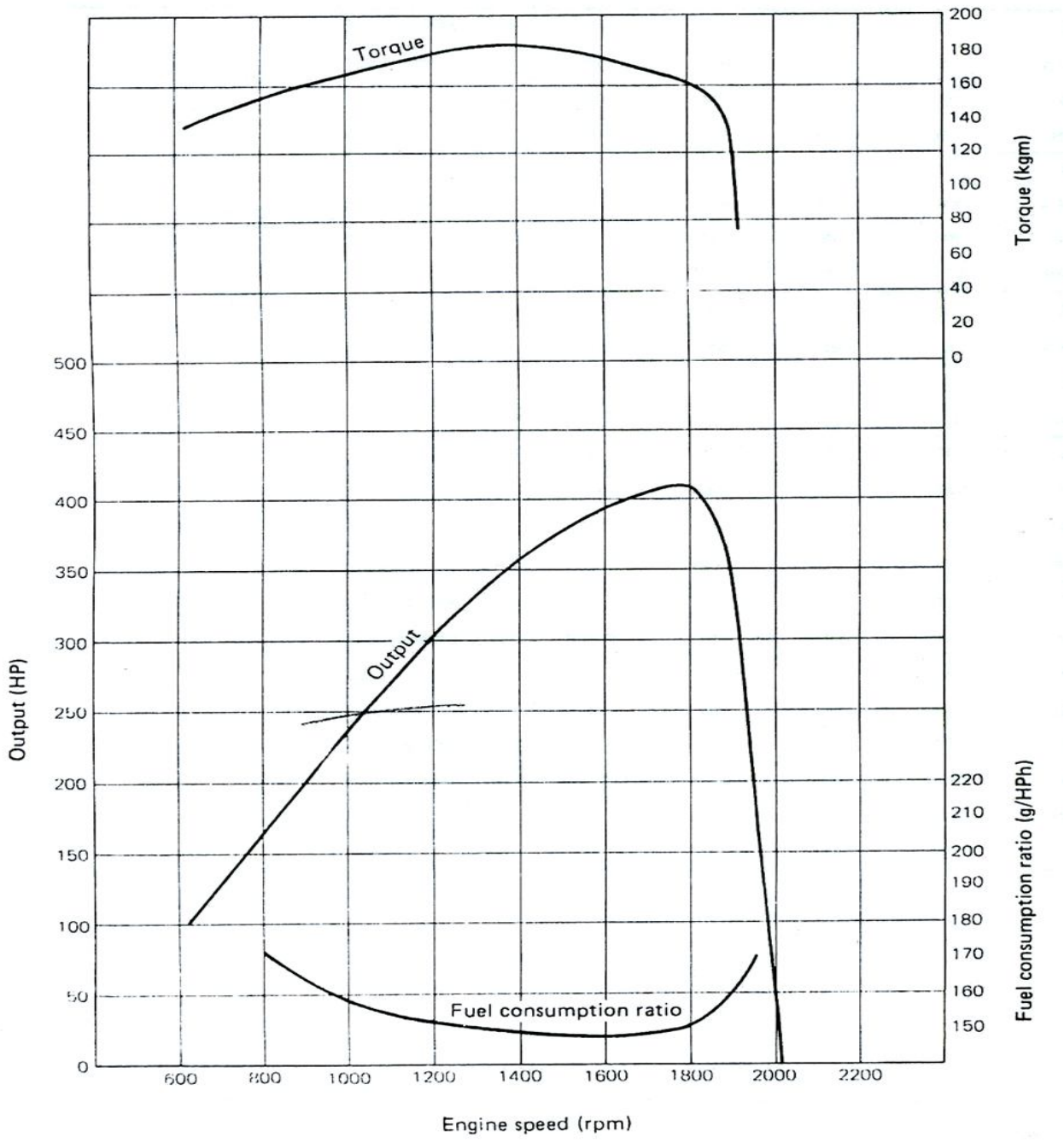
Flywheel horsepower	:	285 kW @ 2100 r/min
Mximum torque	:	1521 N.m @ 1400 r/min
Mnimum fuel consumption ratio	:	215 g (kW.hr)
Corrected in accordance with	:	IS 13116 / ISO 9249



ENGINE PERFORMANCE CURVE

BSA6D140-1 (FOR BE650-3 & BE1600-1)

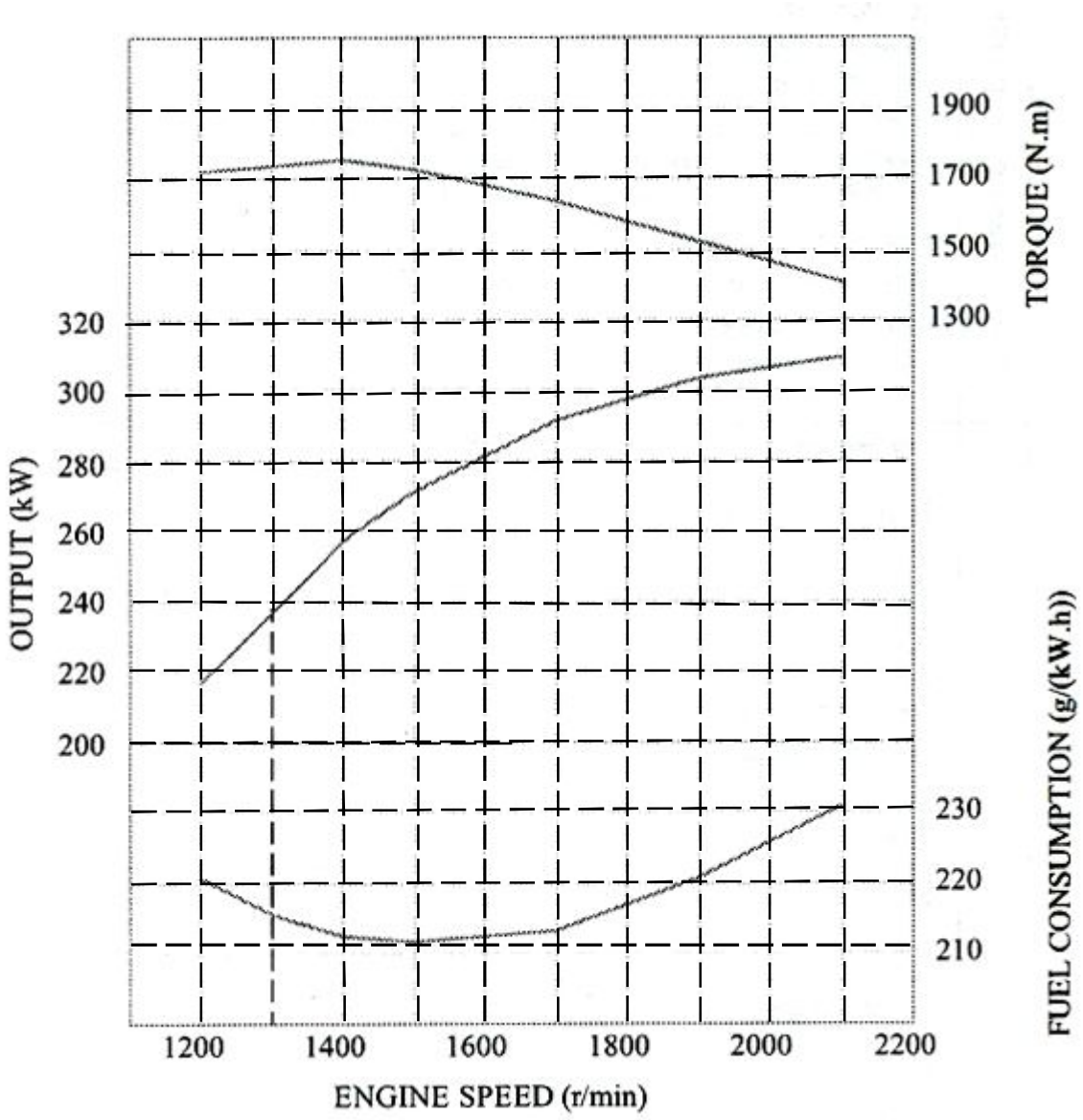
Flywheel horsepower	:	41O HP @ 1800 r/min
Mximum torque	:	184 kgm @ 1400 r/min
Mnimum fuel consumption ratio	:	149 g/HPh



ENGINE PERFORMANCE CURVE

BSA6D140-1 (FOR BL54)

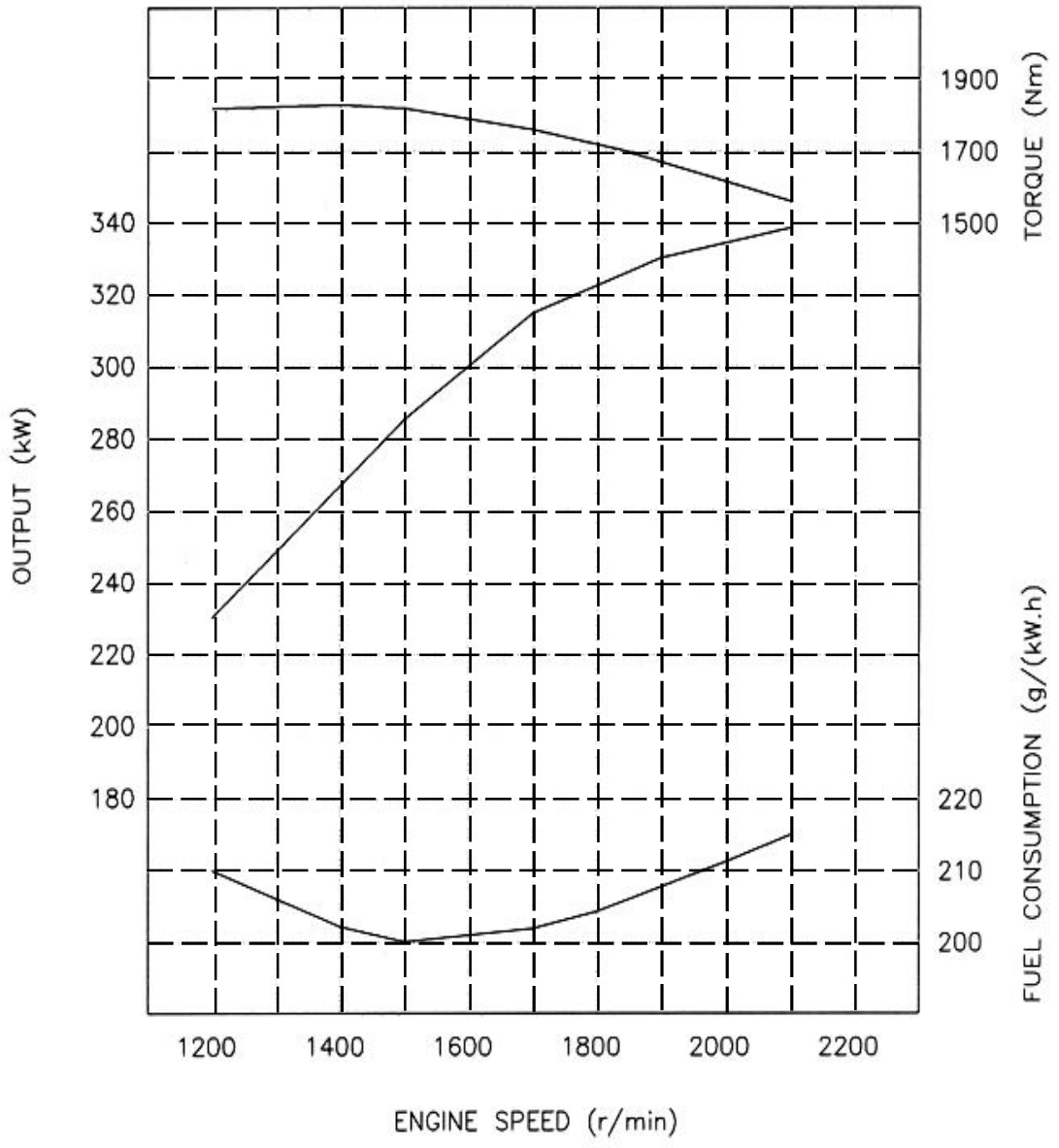
Flywheel horsepower	:	309 kW @ 2100 r/min
	:	(420 Ps @ 2100 r/min
Mximum torque	:	1750 N.m @ 1400 r/min
Mnimum fuel consumption ratio	:	212 g (kW.hr)
Corrected in accordance with	:	IS 13116 / ISO 9249



ENGINE PERFORMANCE CURVE

BSA6D140-1 (FOR EUCLID R35)

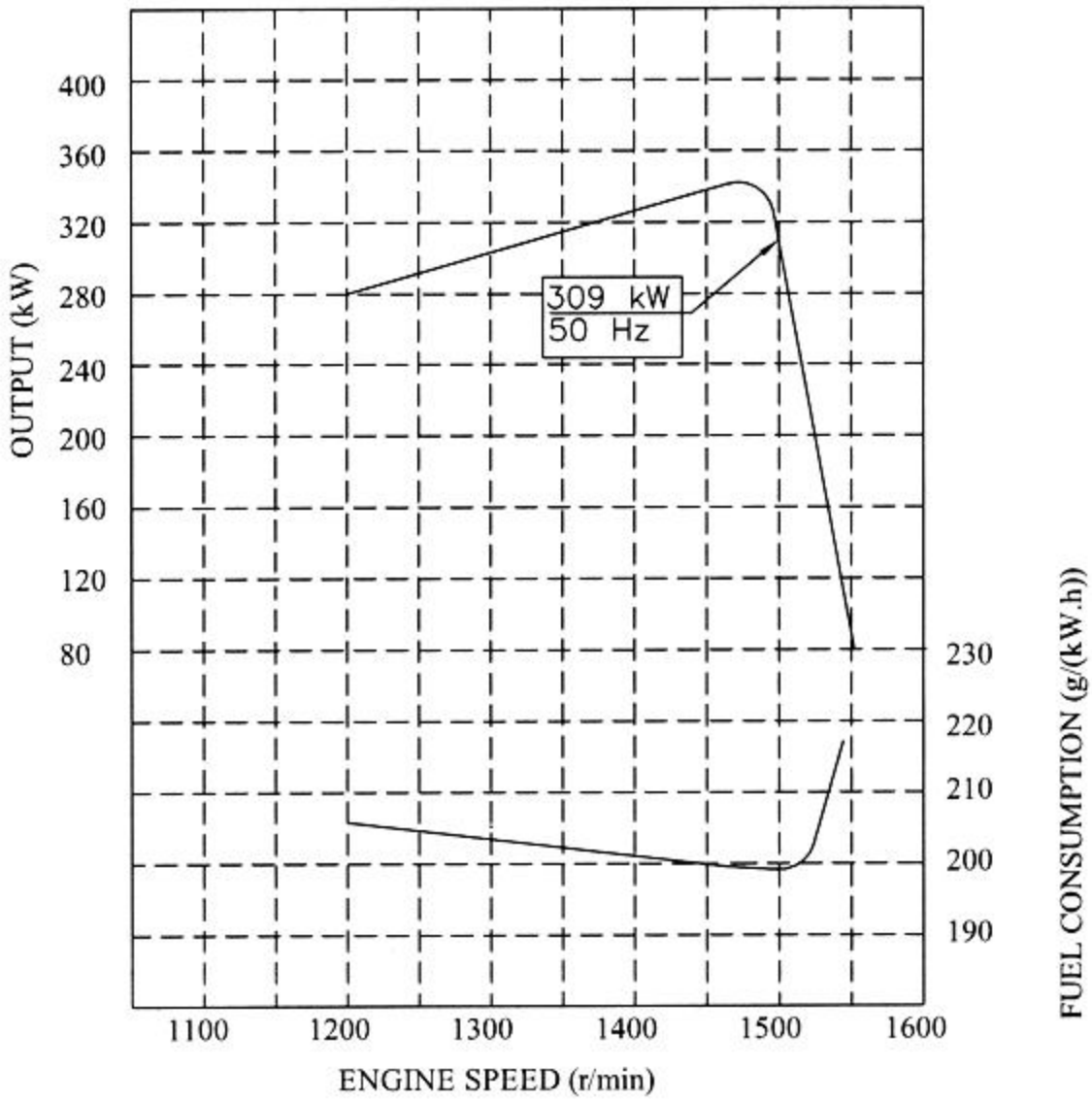
Flywheel horsepower	:	339 kW @ 2100 r/min
	:	(461 Ps @ 2100 r/min
Mximum torque	:	1840 N.m @ 1400 r/min
Mnimum fuel consumption ratio	:	200 g (kW.hr) @ 1500 r/min
	:	(147 g (Ps.h) @ 1500 r/min)
Corrected in accordance with	:	IS 13116 / ISO 9249



ENGINE PERFORMANCE CURVE

BSA6D140G1 (FOR BDG360)

Flywheel horsepower	:	309 kW @ 1500 r/min (420 Ps @ 1500 r/min)
Mnimum fuel consumption ratio	:	205 g (kW.h)
Corrected in accordance with	:	IS 13116 / ISO 9249

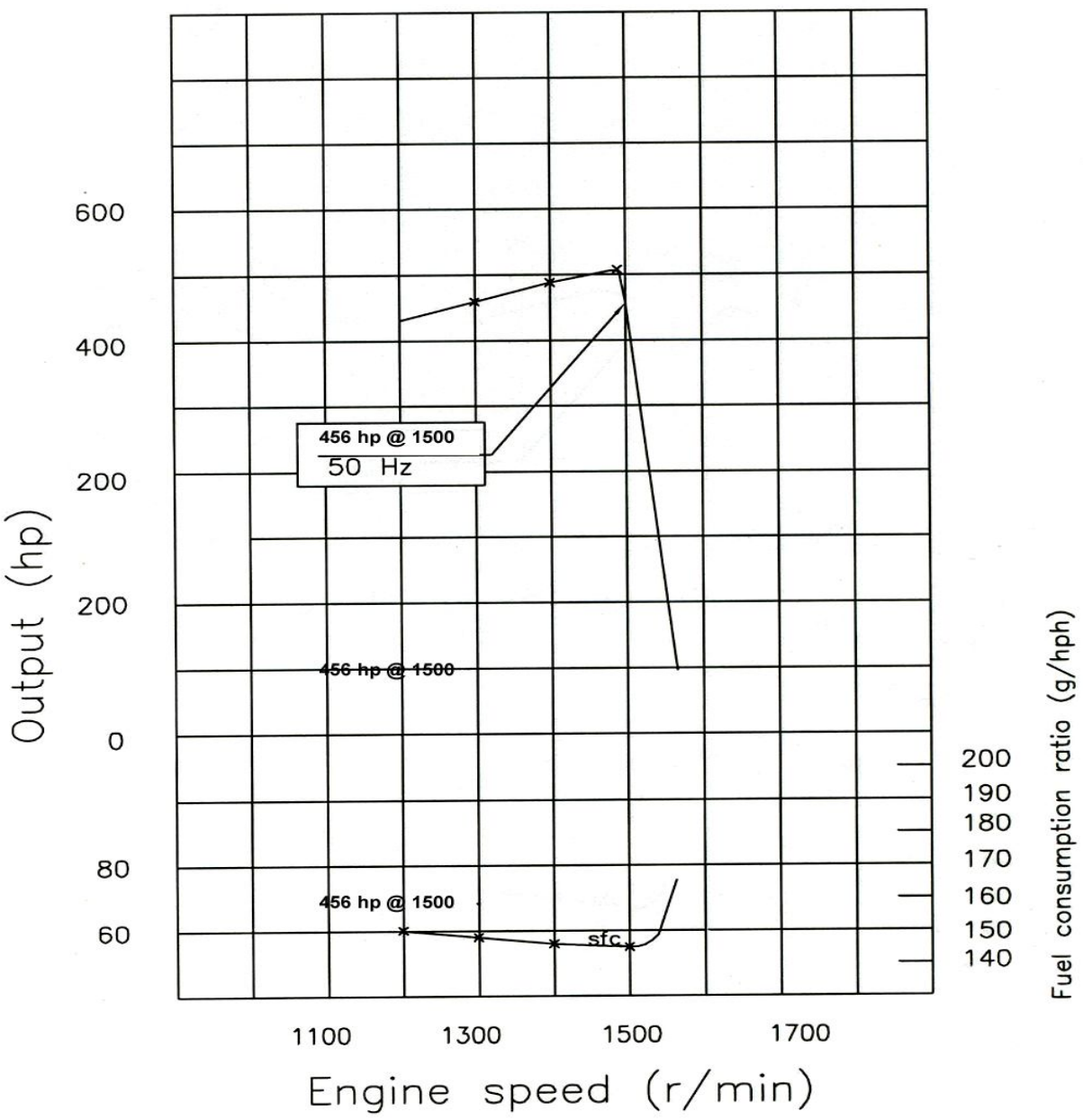


ENGINE PERFORMANCE CURVE

BSA6D140G1 (FOR BDG380)

Flywheel horsepower : 456 hp @ 1500 r/min

Mnimum fuel consumption ratio : 146 g (hph)



WEIGHT TABLE

! The weight table is a guide for use when transporting or handling components.

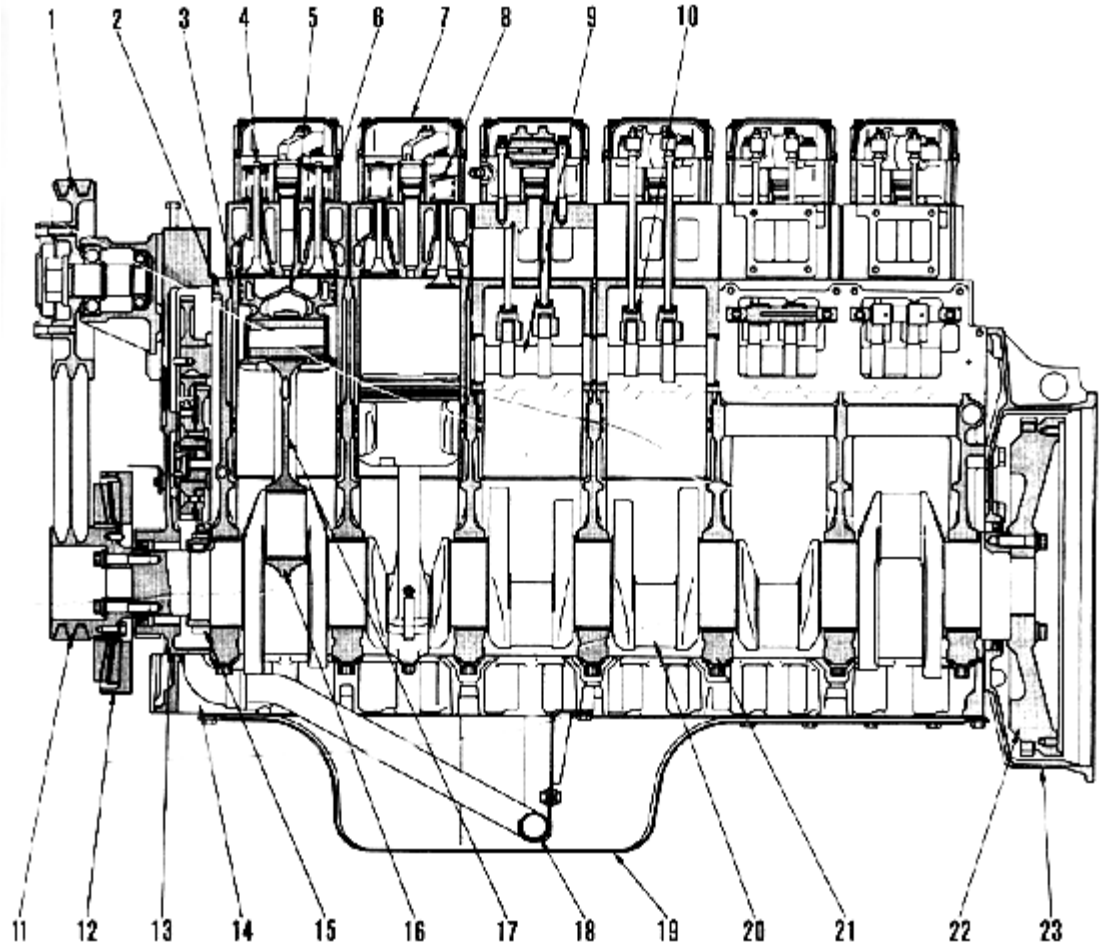
No.	ITEM	COMPONENT	BS6D140-1	BSA6D140-1
1	Turbocharger	KTR -110	22	22
2	Cylinder head assembly	Cylinder head, vlaue and Valve spring	18.3	18.3
3	Cylinder block assembly	Cylinder block, cylinder liner, main bearing cap,bearing	340	340
4	Front cover		37	37
5	Flywheel housing		BG825	BE650
6	Flywheel assembly	Flywheel , Ring gear	BG825	BE650
7	Oil pan		30	30
8	Crankshaft assembly	Crankshaft,Crank gear	132	132
9	Camshaft assembly	Camshaft, cam gear	19	19
10	Piston and connecting rod assembly	Piston, piston ring, piston pin and connecting rod cap,bearing	10.5	10.5
11	Fuel injection pump		20	21:HD325, WS23 S 31:BE650
12	Water pump		12	17
13	Oil pump		5.5	5.5
14	Alternator	24V,35A	9.5	9.5
		24V,50A	12	12
16	Starting motor	24V,7.5kW	18	18
		24V,11kW	20	20
17	Air compressor		15	15
18	After cooler assembly		-	43

ENGINE

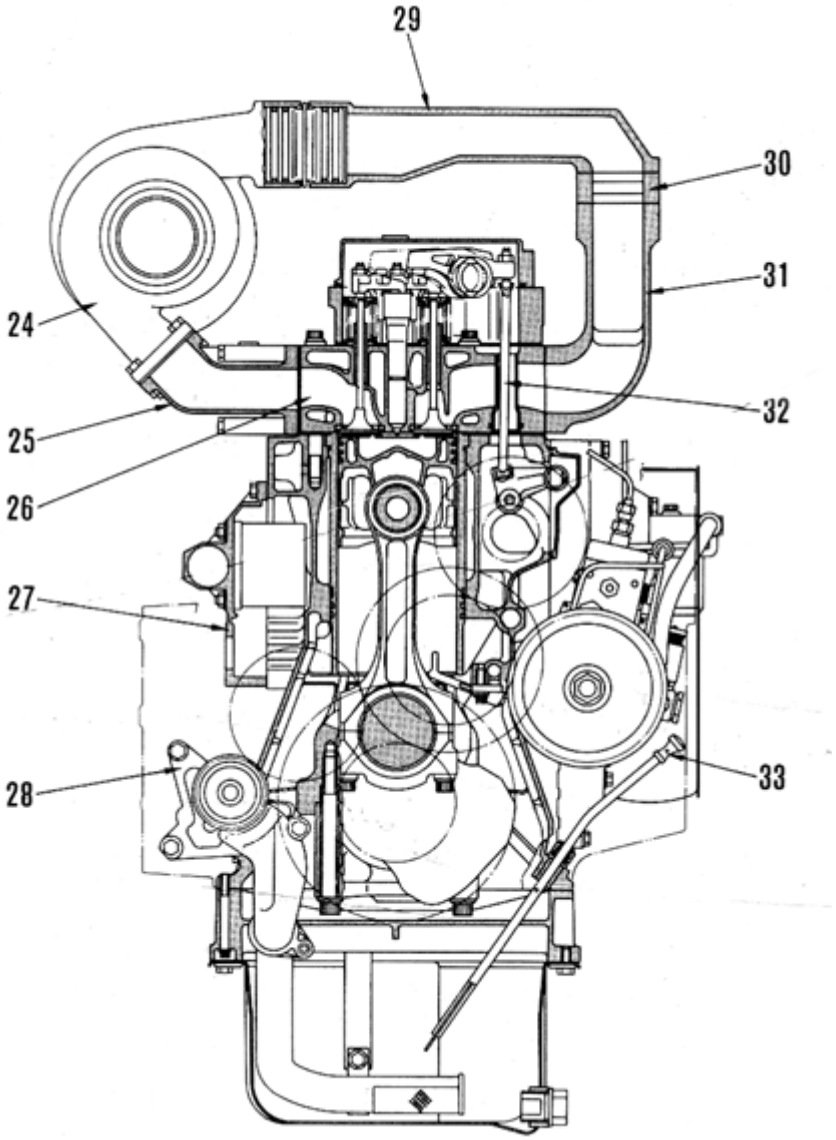
12 STUCTURE AND FUNCTION

GENERAL STRUCTURE

BS6D140-1



1. Fan pulley
2. Cylinder block
3. Cylinder liner
4. Exhaust valve
5. Piston
6. Rocker arm housing
7. Rocker arm housing cover
8. Intake valve
9. Camshaft
10. Camfollower
11. Crankshaft pulley
12. Vibration damper
13. Front cover
14. Under frame
15. Crankshaft gear
16. Connecting rod cap
17. Connecting rod
18. Oil strainer
19. Oil pan
20. Crankshaft
21. Main bearing cap
22. Flywheel
23. Flywheel housing
24. Turbocharger



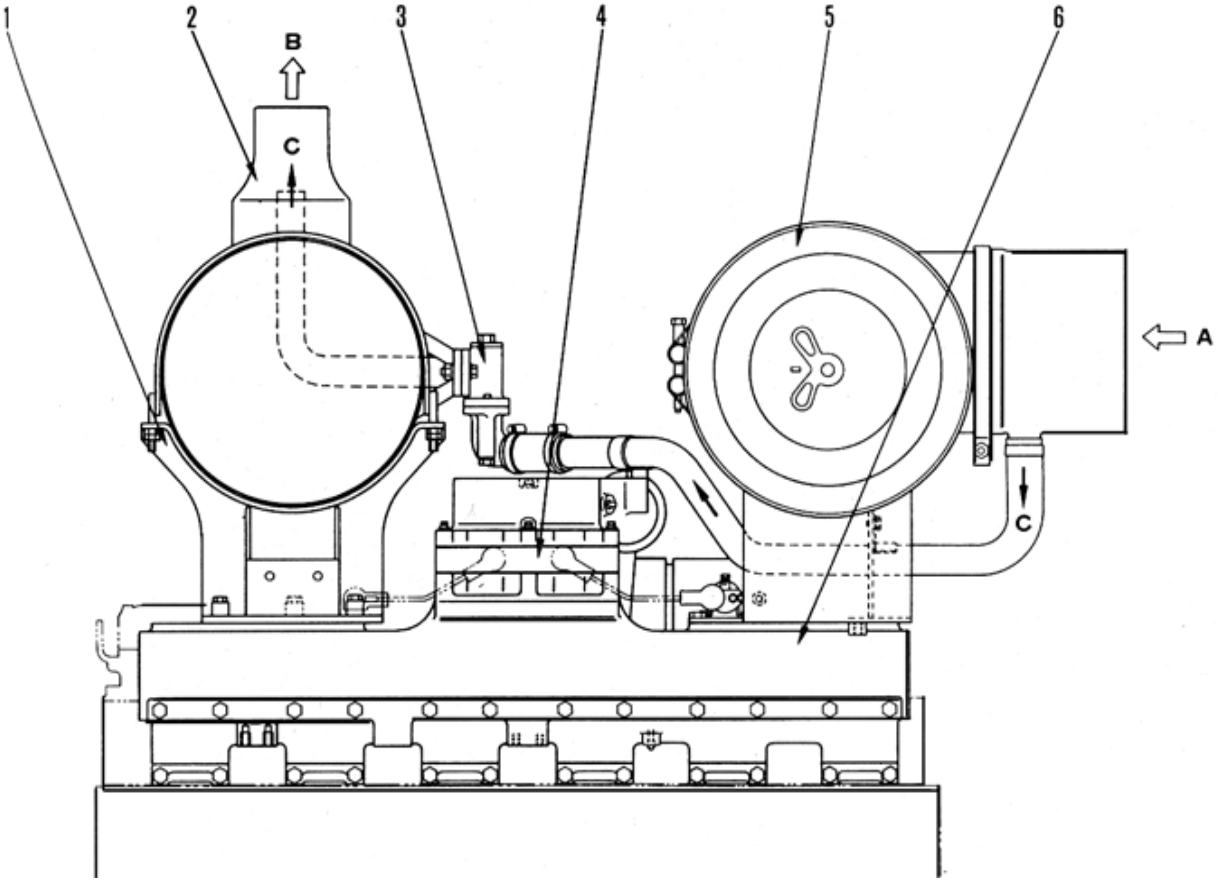
25. Exhaust manifold
26. Cylinder head
27. Oil cooler
28. Oil pump
29. Intake connector pipe
30. Electrical intake air heater
31. Intake manifold
32. Push rod
33. Dipstick

Engine: BS6D140-1 (with turbocharger)
BSA6D140-1 (with turbocharger and after cooler)

Type: In-line,6-cylinder,water-cooled,direct fuel injection, 4-cycle diesel engine

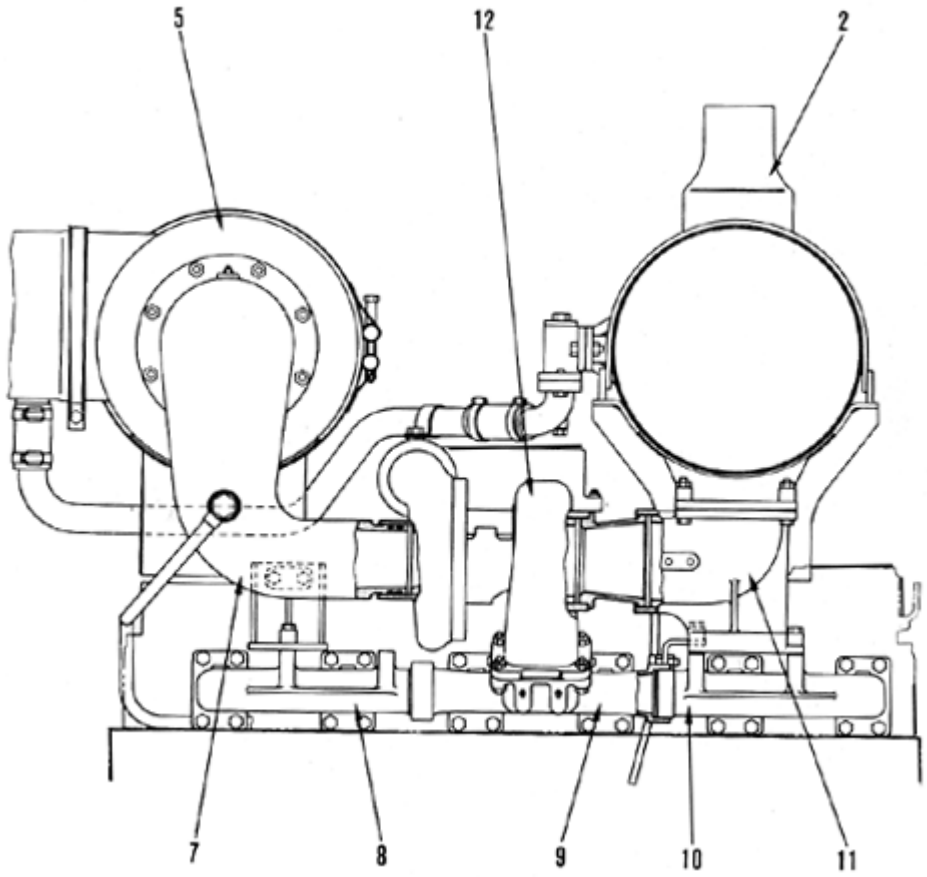
INTAKE AND EXHAUST SYSTEM

BSA6D140-1



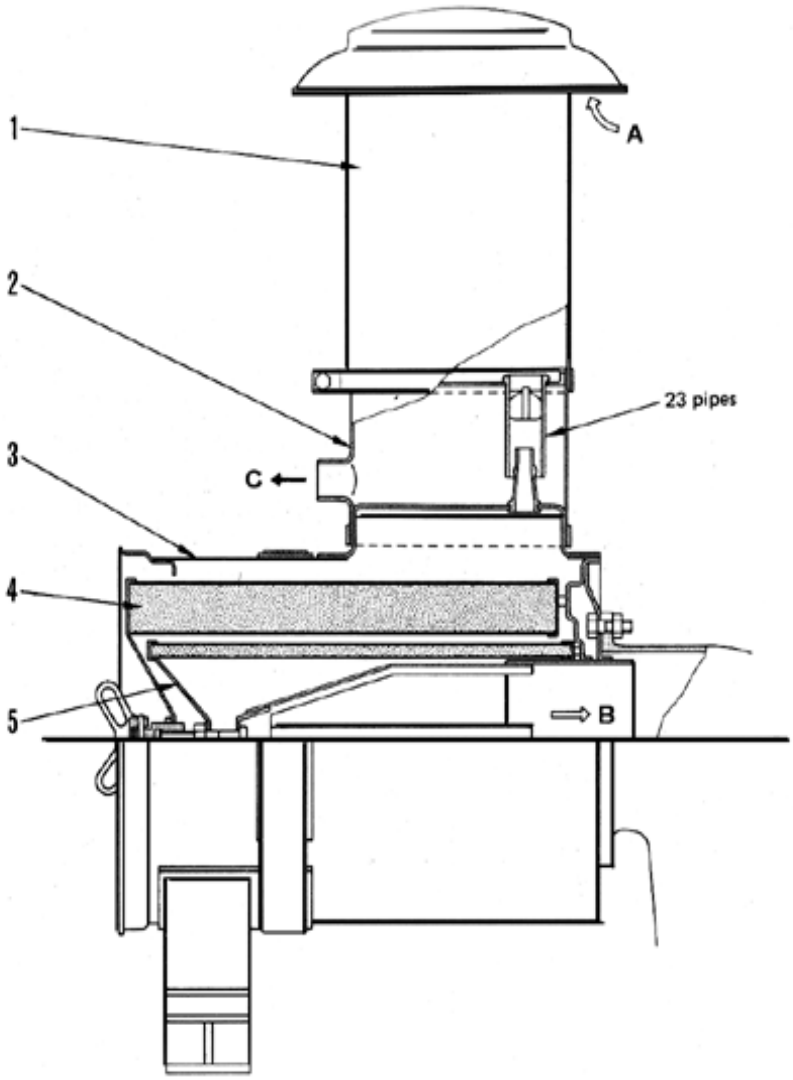
1. Bracket
2. Muffler
3. Check valve
4. Electrical intake air heater
5. Air cleaner
6. Intake manifold
7. Intake connector
8. Exhaust manifold (Rear)
9. Exhaust manifold (Center)
10. Exhaust manifold (Front)
11. Elbow
12. Turbocharger

A. Intake
B. Exhaust
C. Dust(together with exhaust gas)


5
12
2
7
8
9
10
11

AIR CLEANER

BEML clone (automatic discharge multicyclone)type BS6D140-1

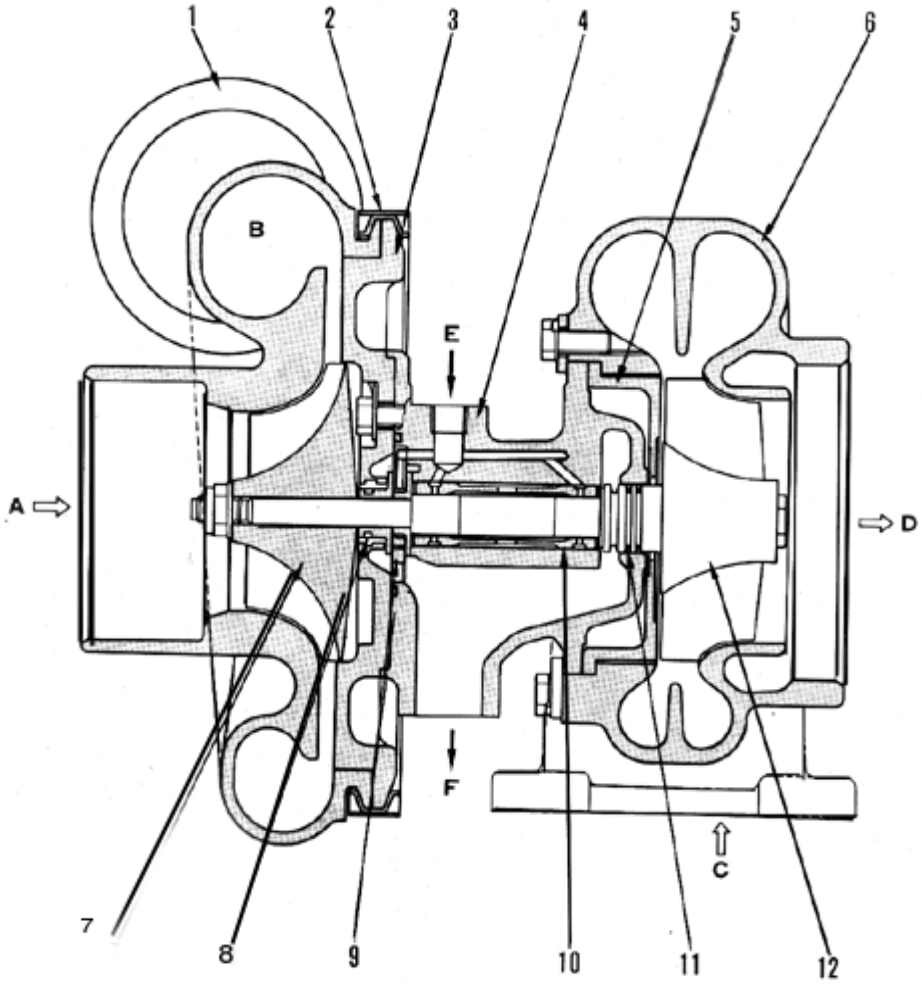


1. Hood
2. Precleaner
3. Air cleaner body
4. Outer element
5. Inner element

A. Air inlet
B. To turbocharger (Air)
C. To muffler (Dust)

TURBOCHARGER

KTR110



1. Blower housing
2. V-band
3. Plate
4. Center housing
5. Shroud
6. Turbine housing
7. Blower impeller
8. Seal ring
9. Thrust bearing
10. Journal bearing
11. Seal ring
12. Turbine impeller

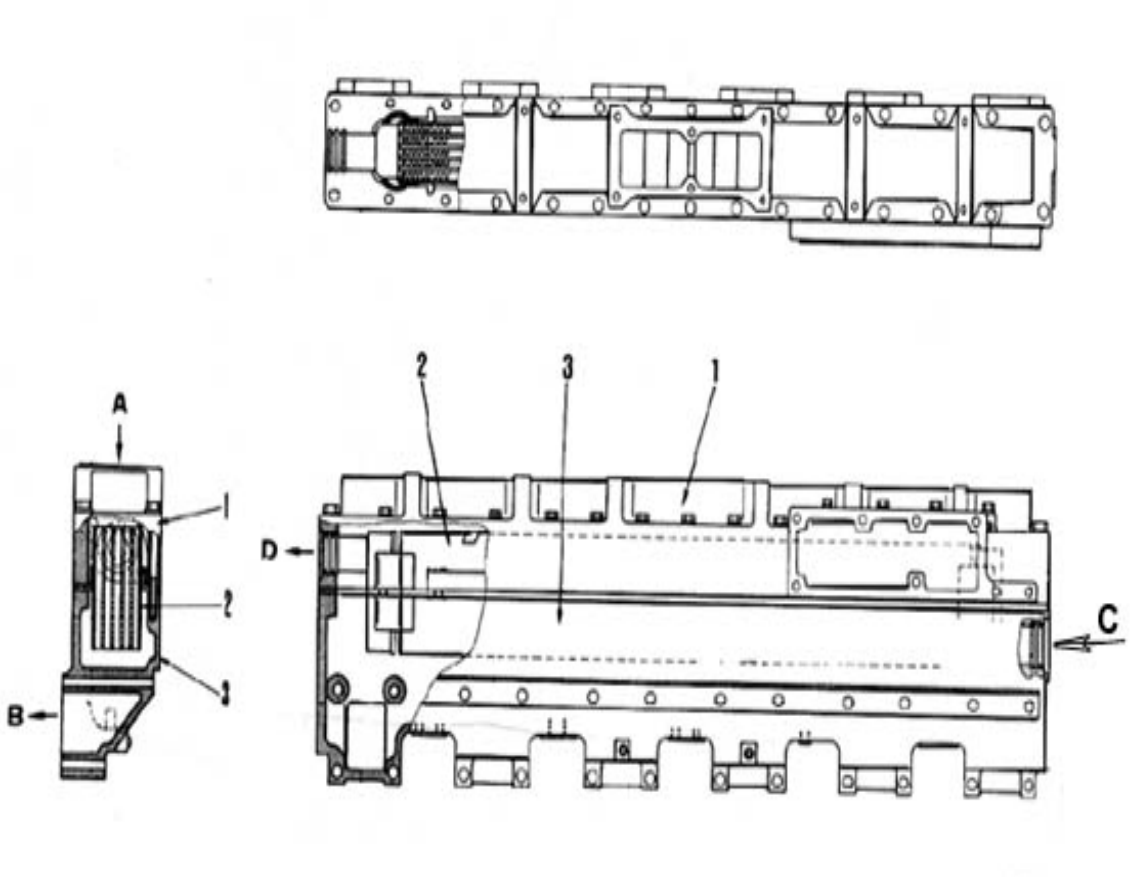
A. Intake inlet
B. Intake outlet
C. Exhaust inlet
D. Exhaust outlat
E. Oil inlet
F. Oil outlet

TURBOCHARGER

Type	: KTR110
Overall lenght	: 290mm
Overall width	: 305 mm
Overall height	: 267 mm
Weight	: 19kg
Maximum allowable rotation	: 94,000 rpm
Maximum charging	: 46 kg/min
Maxium allowable temperature(inlet)	: 750°c max.
Directionn of rotation (View from blower side)	: Right
Lubrication method	: Forced lubrication with engine oil

AFTER-COOLER

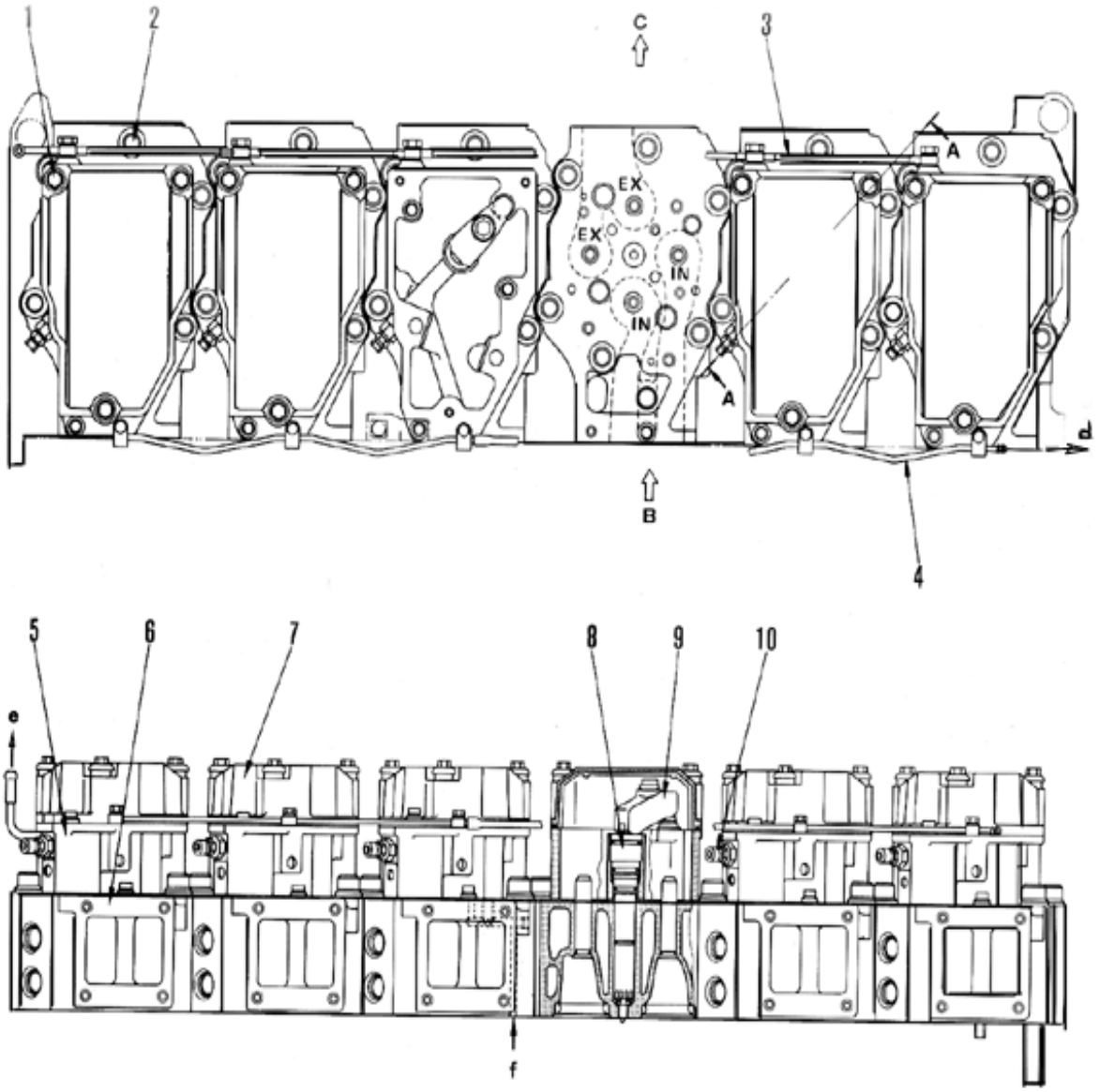
BSA6D140-1



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

A. Intake air inlet (from turbocharger)
B. Intake air outlet (to cylinder head)
C. Water inlet (from cylinder block)
D. Water outlet (to thermosatat)

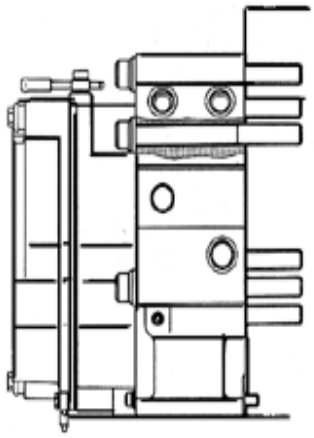
CYLINDER HEAD



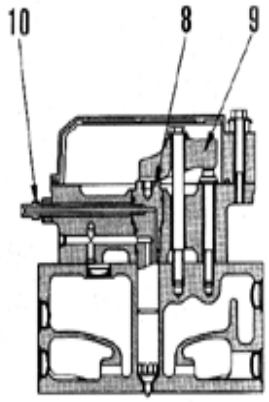
1. Rocker arm housing mounting bolt
2. Cylinder head mounting bolt
3. Air vent tube
4. Fuel spill pipe
5. Rocker arm housing
6. Cylinder head
7. Rocker arm housing cover
8. Fuel injectionn nozzle
9. Nozzle mounting bracket
10. Fuel inlet connector

B. Intake
C. Exhaust

d. To fuel tank (Fuel)
e. To radiator (Air)
f. To rocker arm (Oil)



View Z



Section A-A

F621201011

CYLINDER HEAD

- **Divided type (one cylinder head for one cylinder)**
- **4-valve**
- **Direct fuel injection type**
- **Injection nozzleand fuel inlet connector assembled**
- **In rocker arm housing and cylinder head**

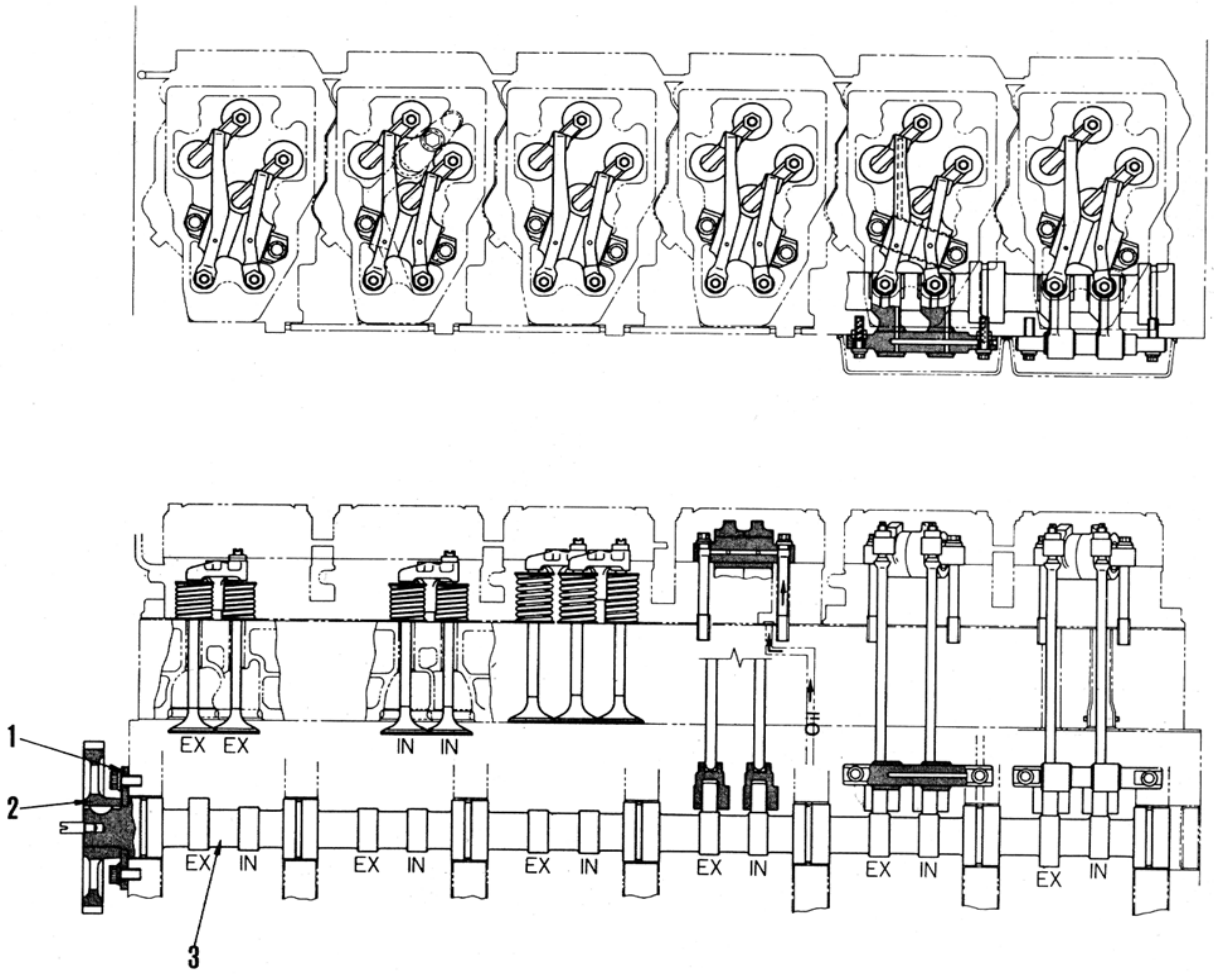
VALVE SEAT INSERT

- **Press-fitted insert for intake and exhaust**

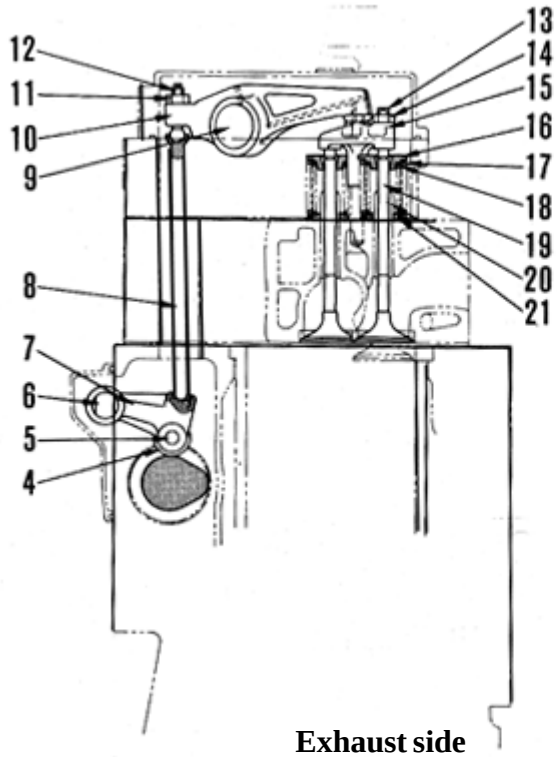
ROCKER ARM HOUSING COVER

- **Floating type seal**

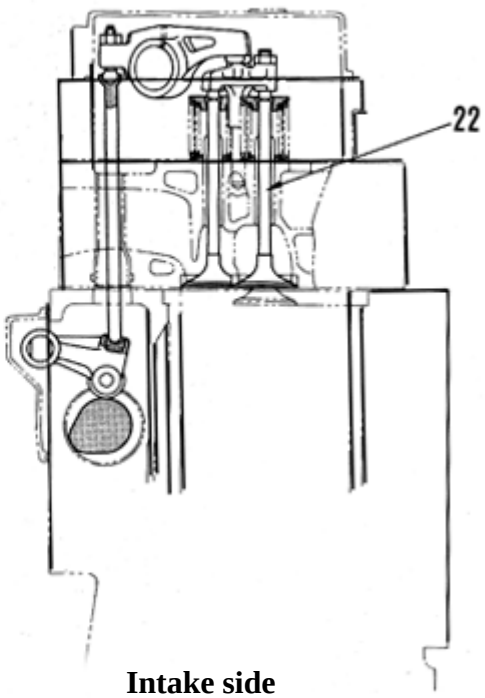
VALVE SYSTEM



1. Thrust plate
2. Camshaft gear
3. Camshaftt
4. Cam roller
5. Cam roller pin
6. Cam Follower shaft
7. Cam Follower
8. Push rod
9. Rocker arm shaft
10. Rocker arm
11. Lock nut
12. Rocker arm adjustment screw
13. Crosshead adjustment screw
14. Lock nut
15. Crosshead
16. Upper spring seat
17. Outer valve spring
18. Inner valve spring
19. Exhaust valve
20. Valve guide
21. Lower spring seat
22. Intake valve



Exhaust side

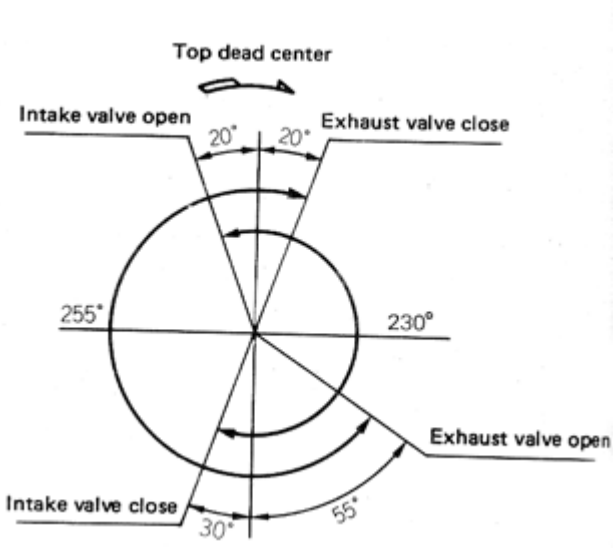


Intake side

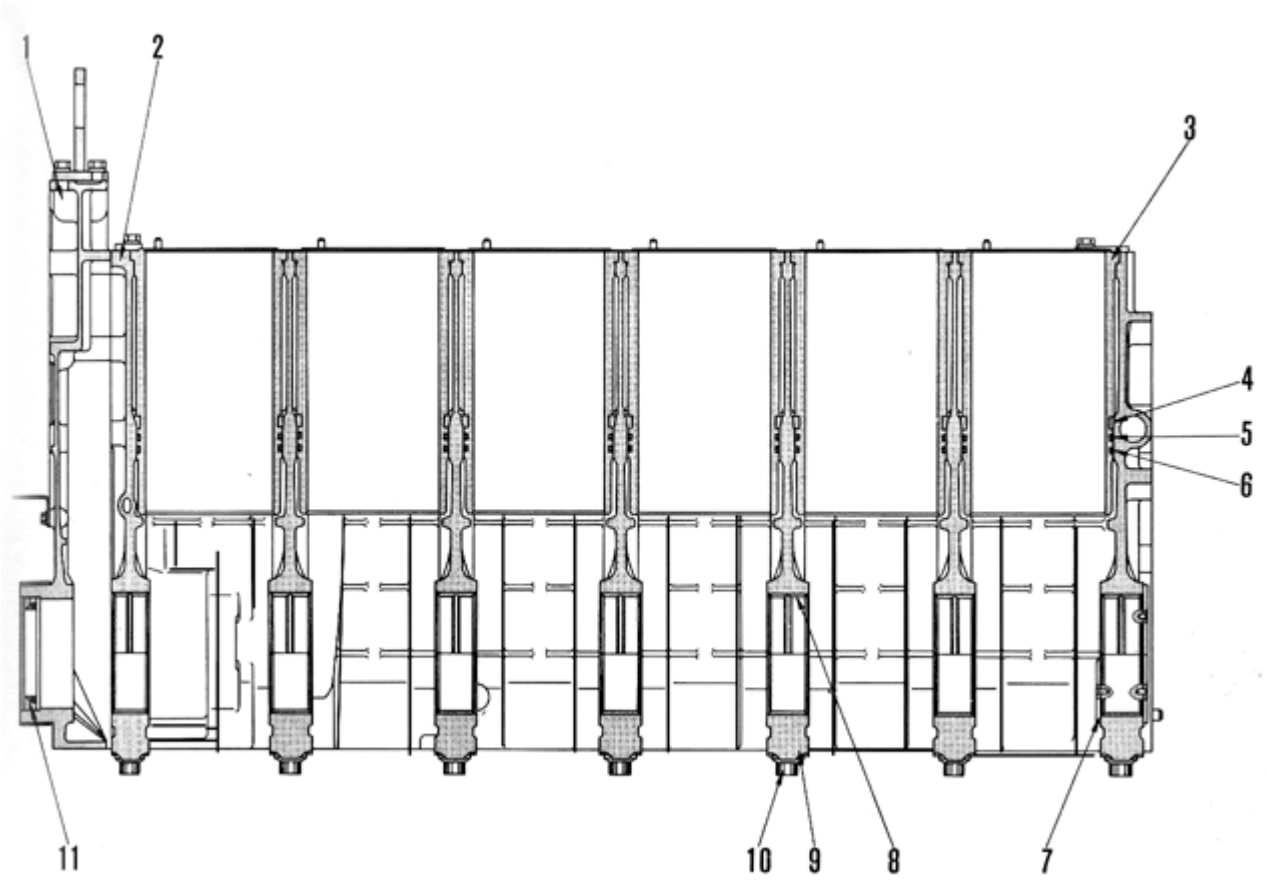
CAMSHAFT

- Stamp forging
- Journal and cam portion : Induction hardening

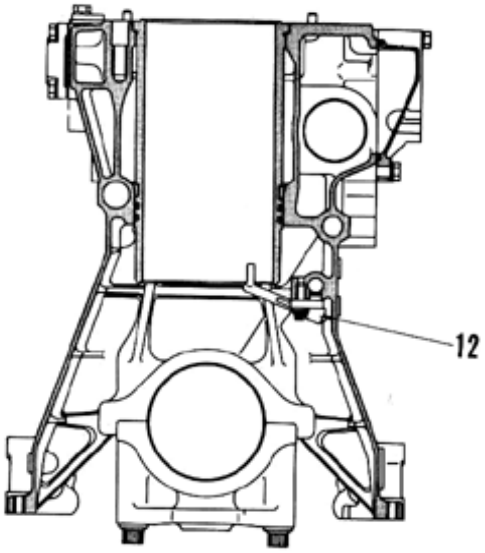
VALVE TIMING



CYLINDER BLOCK



1. Front cover
2. Cylinder block
3. Cylimder liner
4. Crevice seal
5. Liner seal
6. Liner seal
7. Thrust bearing
8. Main bearing
9. Main bearing cap
10. Main bearing cap mouting bolt
11. Front oil seal
12. Piston cooling nozzle



CYLINDER BLOCK

- Crankshaft : 7 bearings
- Camshaft : 7 bushings

FRONT OIL SEAL

- Single lip with dust seal

PISTON COOLING

- With cooling nozzle

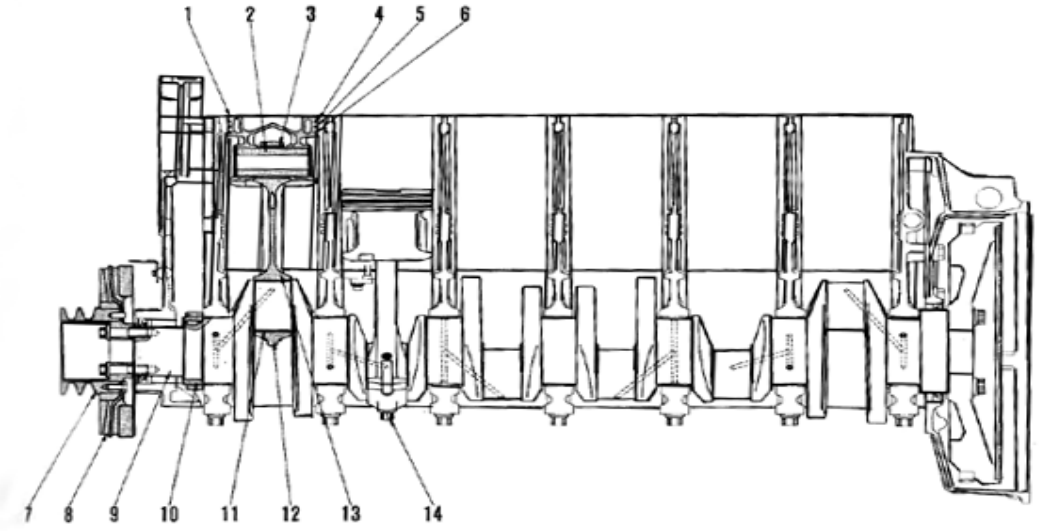
CYLINDER LINER

- Wet type

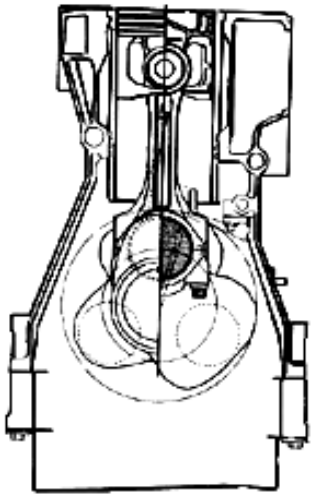
LINER SEAL

- Top : Crevice seal (Ethylene propylene rubber)
- Middle : O-ring (Ethylene propylene rubber)
- Bottom : O-ring (Silicon rubber)

MAIN CIRCULATION SYSTEM



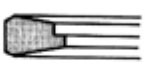
1. Piston
2. Piston pin
3. Connecting rod,bushing
4. Top ring
5. Second ring
6. Oil ring
7. Crankshaft pulley
8. Vibration damper
9. Crankshaft
10. Crankshaft gear
11. Connecting rod bearing
12. Connecting rod cap
13. Connecting rod
14. Connecting rod cap mounting bolt



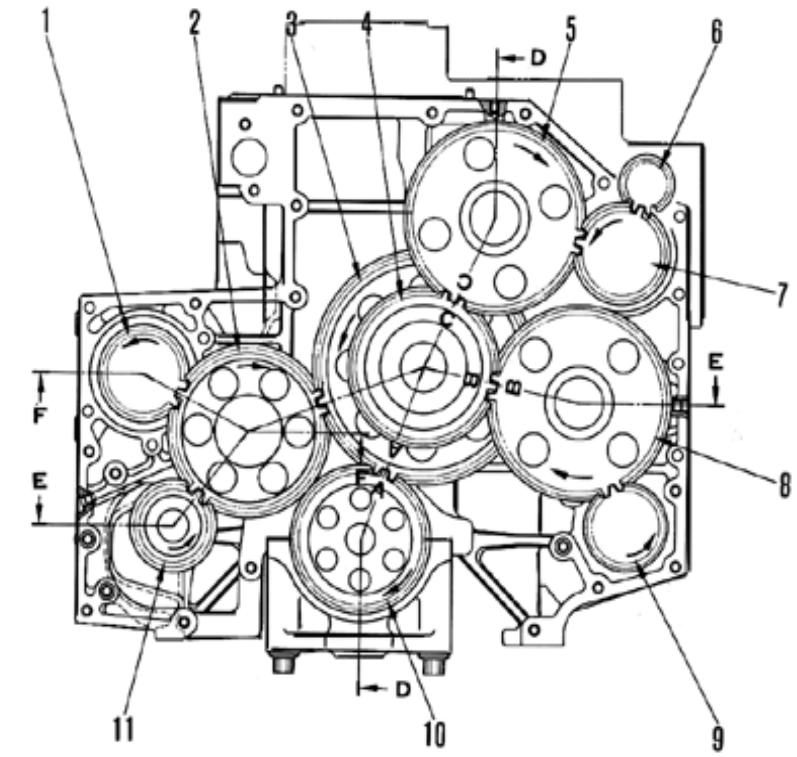
PISTON RING

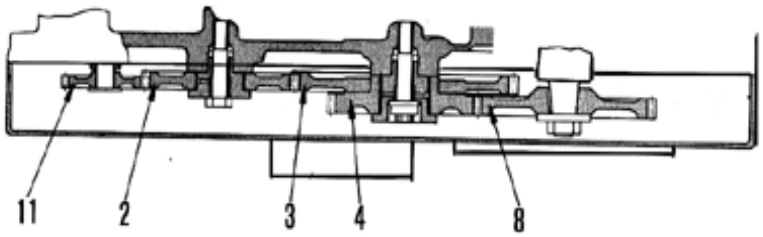
CAMSHAFT
- Stamp forging
- Journal and fillet portion :
  Indction hardening

PISTON
- Ductile cast iron

Top ring	Second ring	Oil ring
		
Both faces keystone Barrel face Hard chrome plating	Keystone inner cut tapered face Hard chrome plating	M-shape steeel Hard chrome plat--ting with coil expander

TIMING GEAR

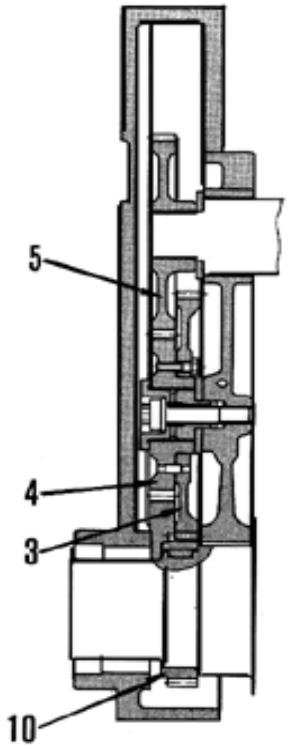




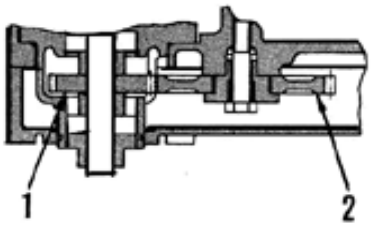
Section E-E

1. Water pump drive gear (No.of teeth: 23)
2. Sub idler gear (No.of teeth: 42)
3. Main idler gear(Large) (No.of teeth: 60)
4. Main idler gear (Small) (No.of teeth: 40)
5. Camshaft gear (No.of teeth: 48)
6. PTO gear (OPTION) (No.of teeth: 14)
7. Compressor drive gear (No.of teeth: 24)
8. Fuel injection pump drive gear (No.of teeth: 48)
9. PTO gear (OPTION) (No.of teeth: 22)
10. Crankshaft gear (No.of teeth: 36)
11. Oil pump drive gear (No.of teeth: 22)

A,B,C : Match marks



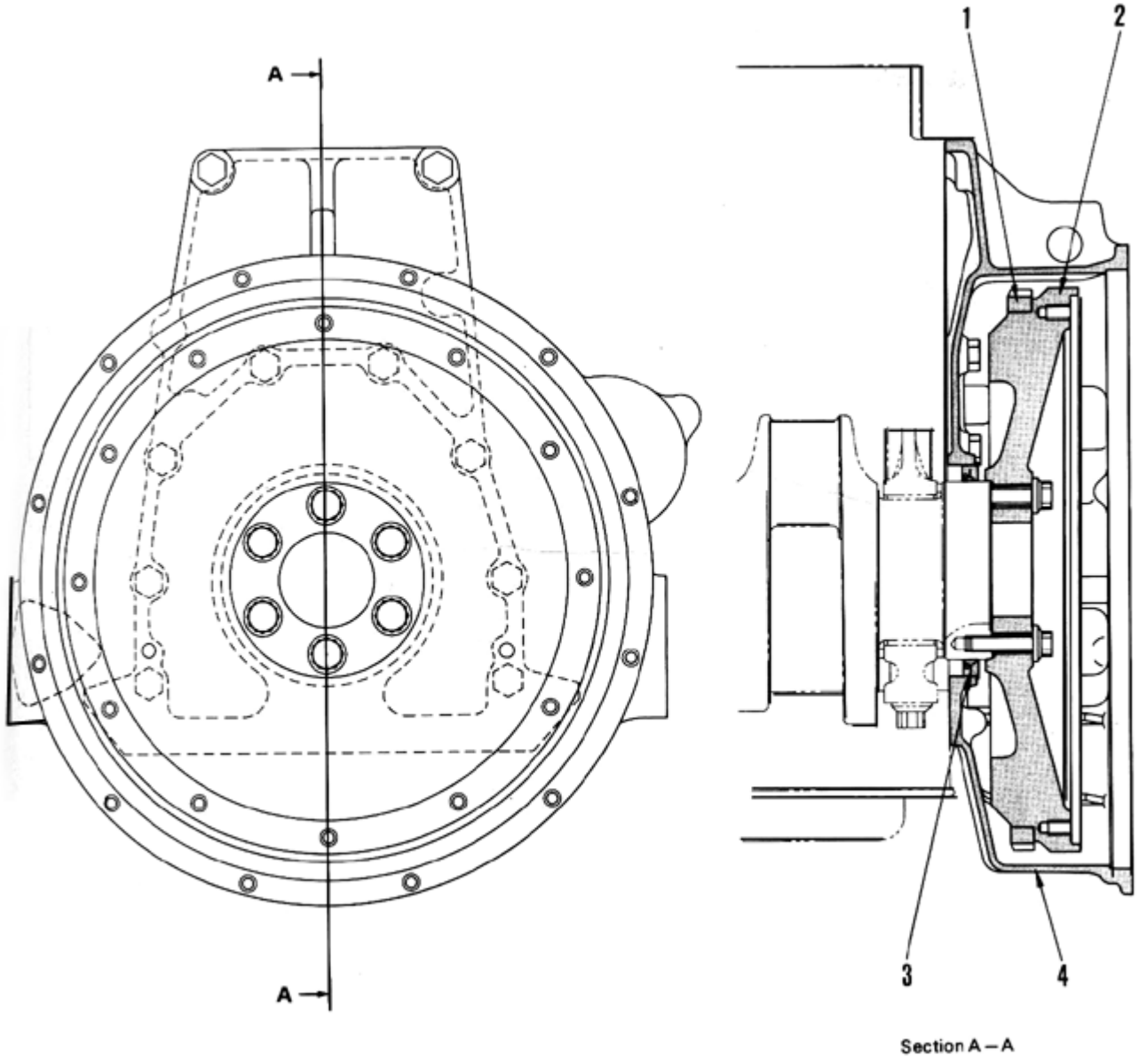
Section D-D



Section F-F

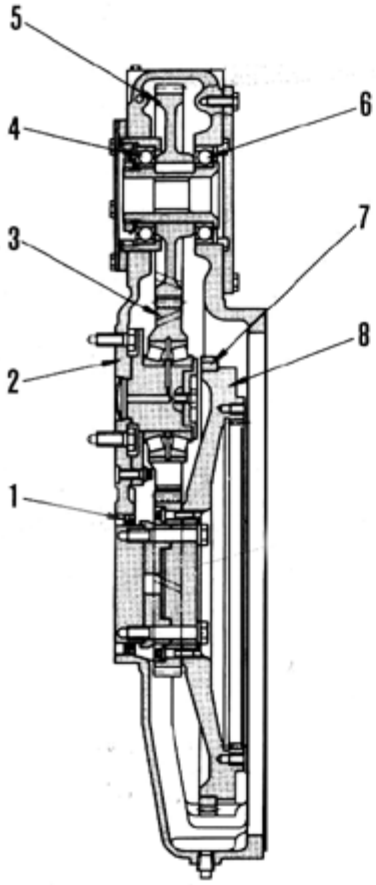
FLYWHEEL AND FLYWHEEL HOUSING

With out PTO type

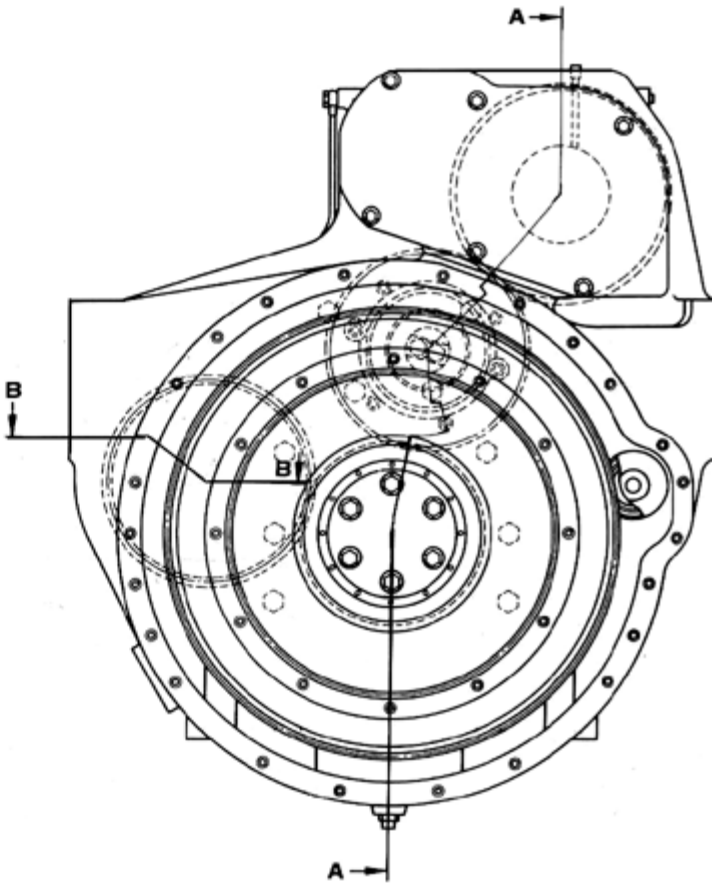


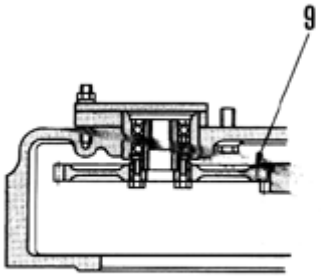
1. Ring gear (No. of teeth: 148)
2. Flywheel
3. Rear oil seal
4. Flywheel housing

with PTO type



Section A – A

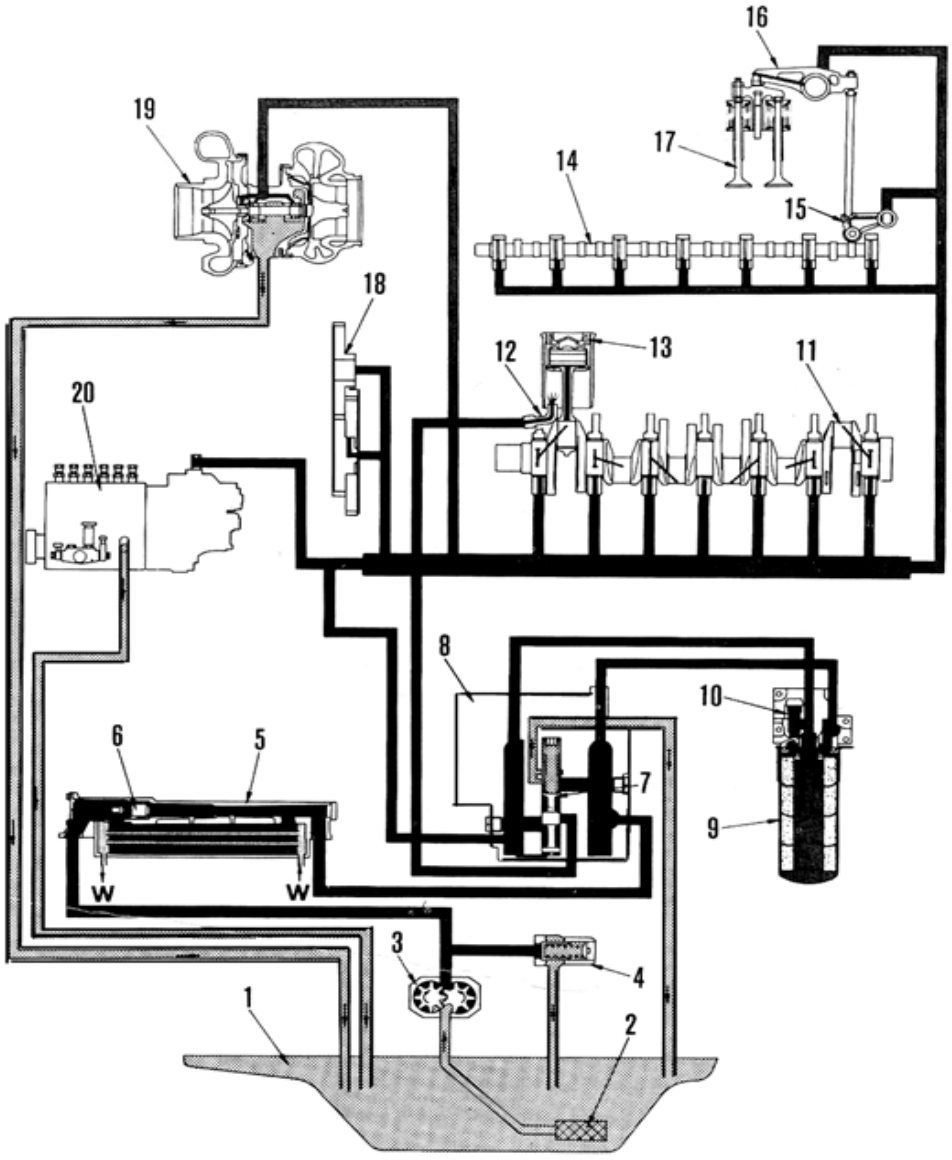




Section B – B

1. Rear oil seal
2. Flywheel housing
3. Idler gear (No. of teeth: 43)
4. Ball bearing
5. PTO drive gear (No. of teeth: 43)
6. Ball bearing
7. Ring gear (No. of teeth: 138)
8. Flywheel
9. Steering pump drive geat (No. of teeth: 46)

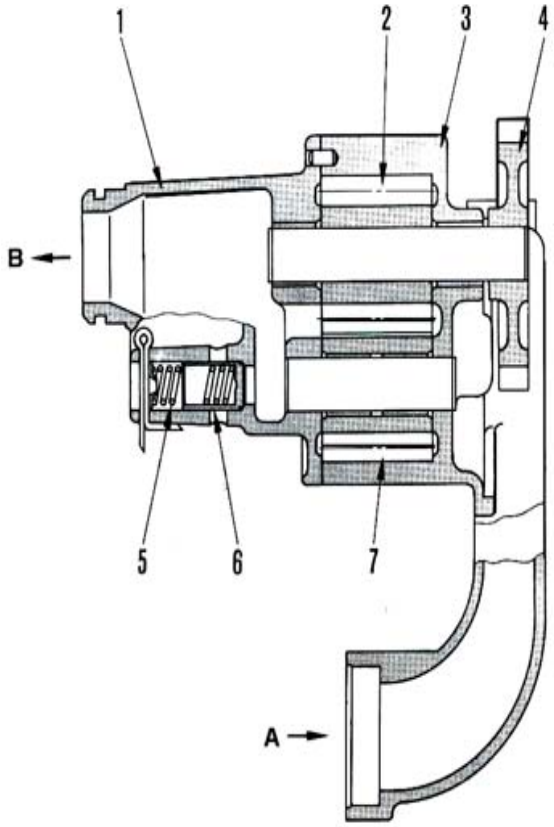
LUBRICATION SYSTEM CHART

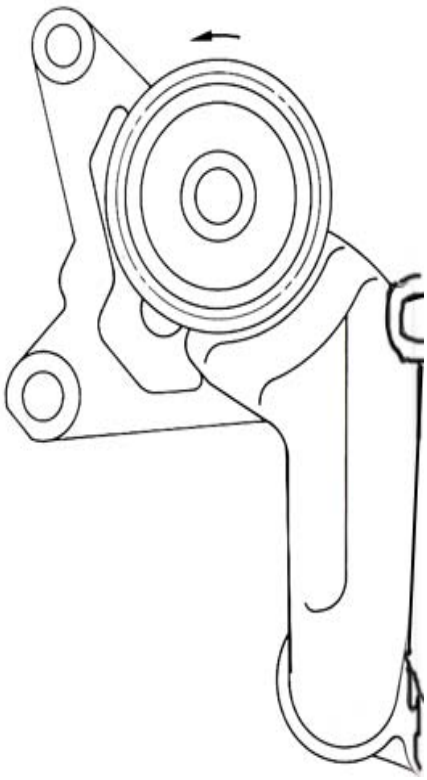


1. Oil pan
2. Oil strainer
3. Oil pump
4. Main relief valve
5. Oil cooler
6. Thermostat
7. Regulator valve
8. Valve adapter
9. Oil filter
10. Safety valve
11. Crankshaft
12. Piston cooling nozzzle
13. Piston
14. Camshaft
15. Cam follower
16. Rocker arm
17. Intake and exhaust valve
18. Timing gears
19. Turbocharger
20. Fuel injection pump

W: Cooling water

OIL PUMP

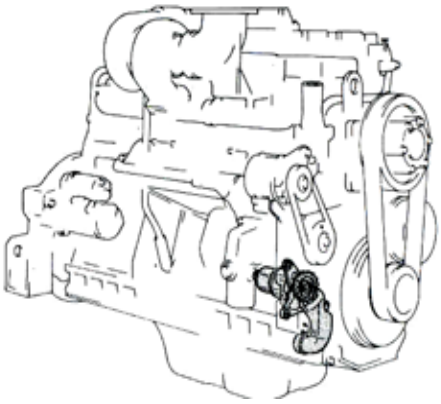




1. Pump cover
2. Drive gear
3. Pump body
4. Pump drive gear (No. of teeth: 22)
5. Valve spring
6. Main relief valve
7. Driven gear

A. Suction (From oil pan)
B. Discharge (From Oil cooler)

oil pump

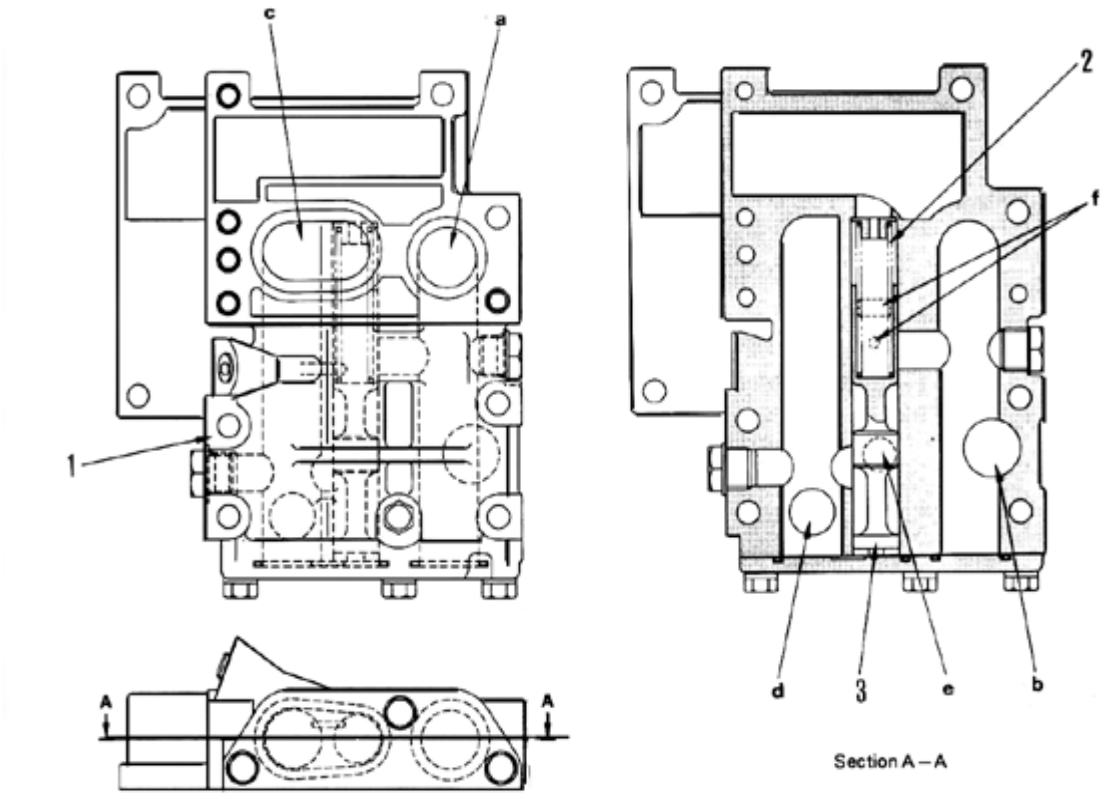


- Type : Gear pump
- Pump speed : Engine speed x1.64

MAIN RELIEF VALVE

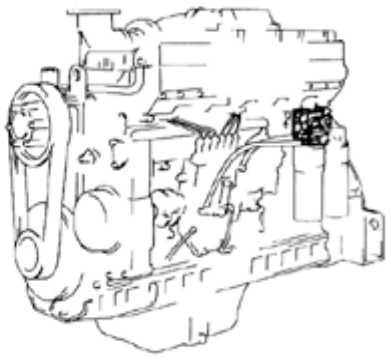
- Set pressure : 8.0±0.5 kg/cm²

REGULATOR VALVE AND PISTON COOLIONG VALVE



1.Valve body
2.Valve spring
3.Valve

a. From oil cooler
b. To oil filter
c. From oil filter
d. To main gallery
e. To piston cooling nozzle
f. To oil pan (drain)



REGULATOR VALVE

- Valve opening pressure : 3.2±0.2 kg/cm²

PISTON COOLING VALVE

- Valve opening pressure : 1.4±0.2 kg/cm²

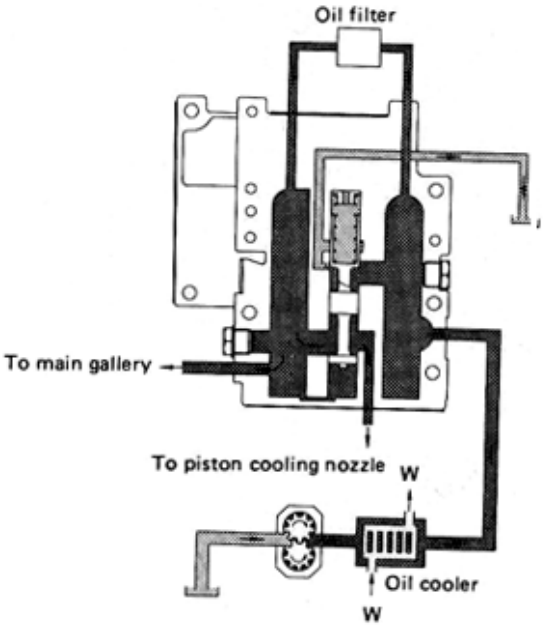
FUNCTION

- The regulator valve keeps the oil pressure in the main gallery at the proper value.
- The oil pressure in the main galllery and piston cooling gallery is controlled by the one spool built into the regulator valve.
- The drain port is split into two parts to handle any sharp rise in the oil pressure which may occur if the engine is mistakenly caused to over run.
- The regulator valve spool is activated by the oil pressure in the main gallery, but the pressure oil is relieved before the filter so that the quantity of oil flowing through the filter is small,thus reducing the load imposed on the oil pump.
- At low speeds,the quantity of oil in the piston cooling gallery is somewhat reduced through the regulator valve,thus the oil pressure in the main gallery is maintained at the specified value.

OPERATION

- **At a normal engine speed:**

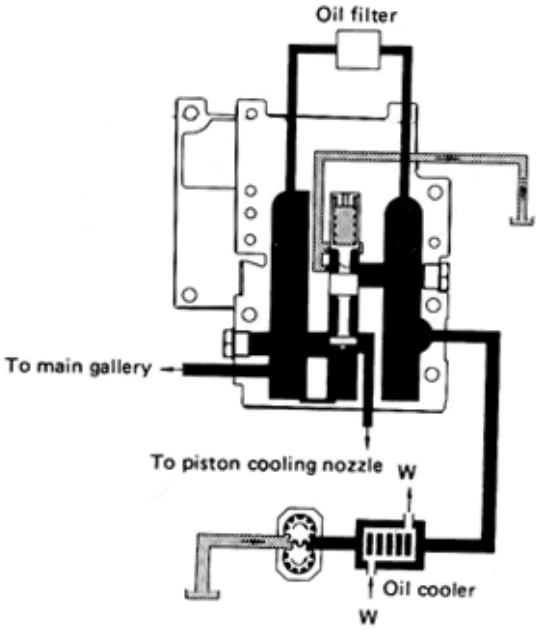
When the oil pressure in the main gallery reaches the specified pressure (regulator valve cracking pressure) As the engine speed increases after the engine has been started,the spool will be pushed up by the pilot pressure from the main gallery,allowing the oil to be relieved through the smaller hole before entering the oil filter.



F621201025

- **When the engine overruns:**

When the engine overruns,the oil pressure in the main gallery sharply increases,causing the spool to be forced up further,which in turn causes a lot of oil to be relieved through the larger hole.Thus, the oil pressure in the main gallery is maintained at the specified level.



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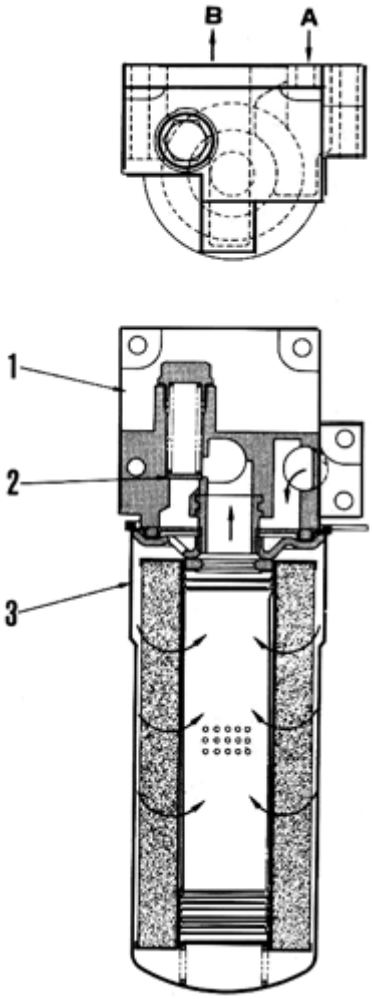
OIL FILTER

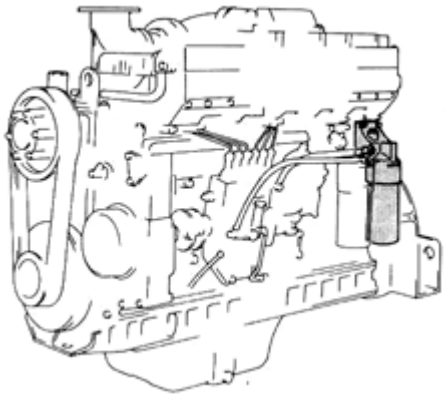


1. Filter bracket
2. Safty valve
3. Cartridge

A. Oil inlet
B. Oil outlet

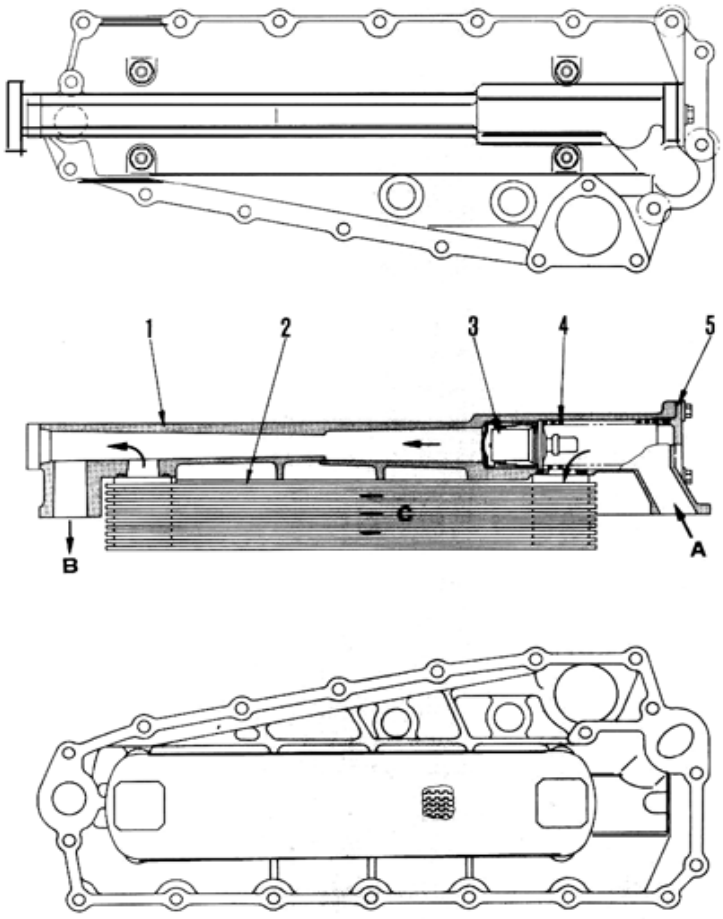
SAFETY VALVE
- Set pressure : 2.0 ± 0.2 kg/cm²

OIL FILTER



Filteration area : 0.85 m²

OIL COOLER



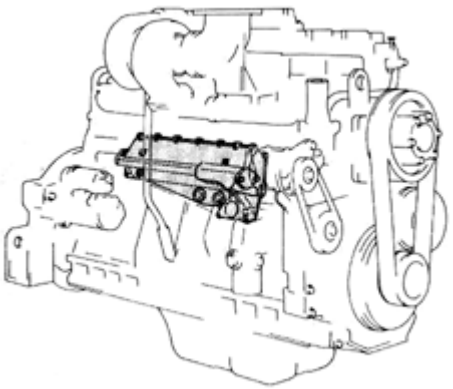
1. Cooler cover
2. Cooler element
   - BS6D140-1 10 Cores
   - BSA6D140-1 12 Cores
3. Thermostat
4. Spring
5. Thernosatat cover

A. Oil inlet (From oil pump)
B. Oil outlet (To regulator valve)
C. Cooler water

THERMOSTAT FUNCTION

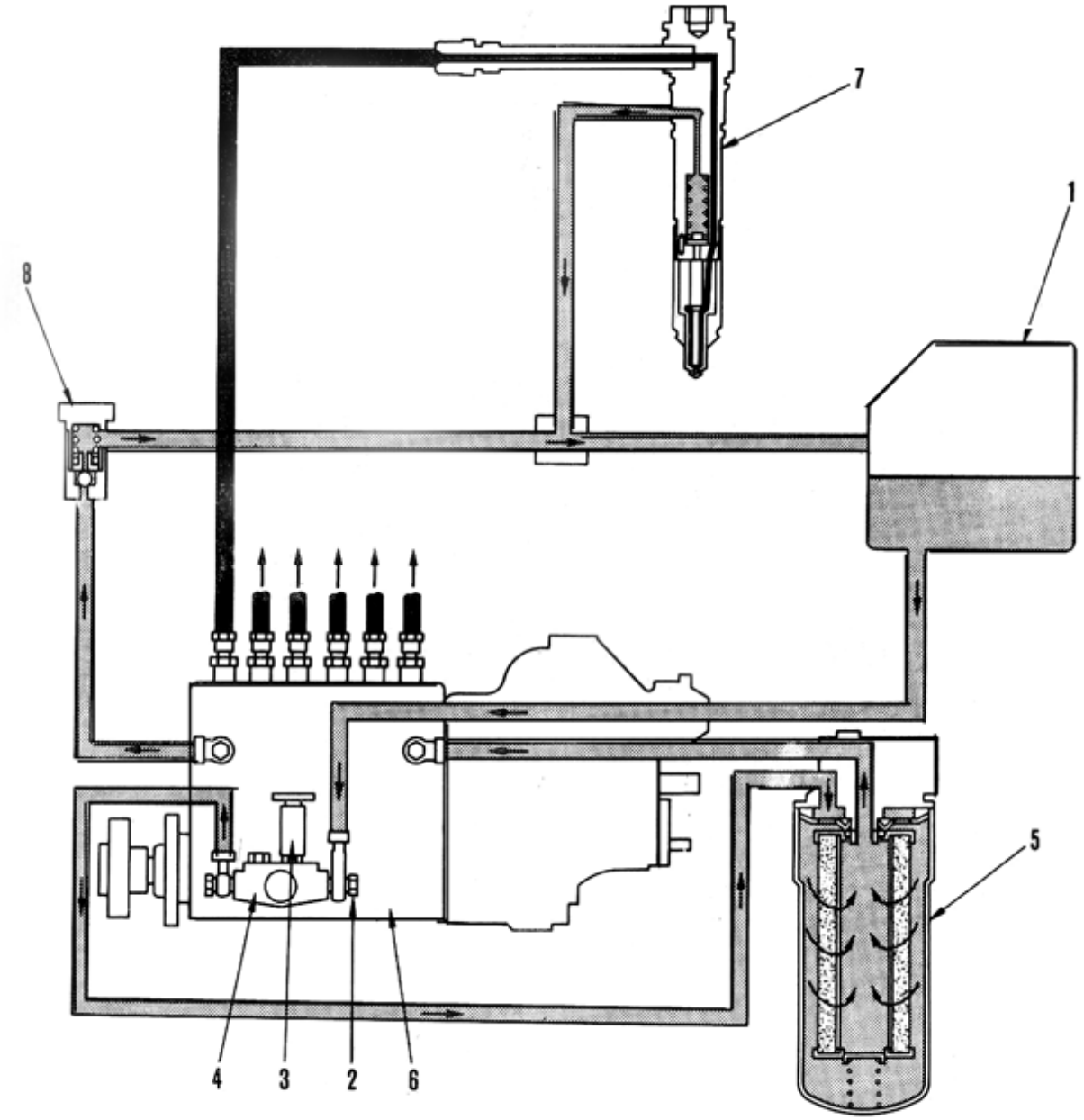
- Valve cracking temperature : 110°c
- Full opening temperature : 116°c
- Full opening lift : Min.8 mm

OIL COOLER



Effective area : BS6D140-1 0.822 m²
BSA6D140-1 : 0.986 m²

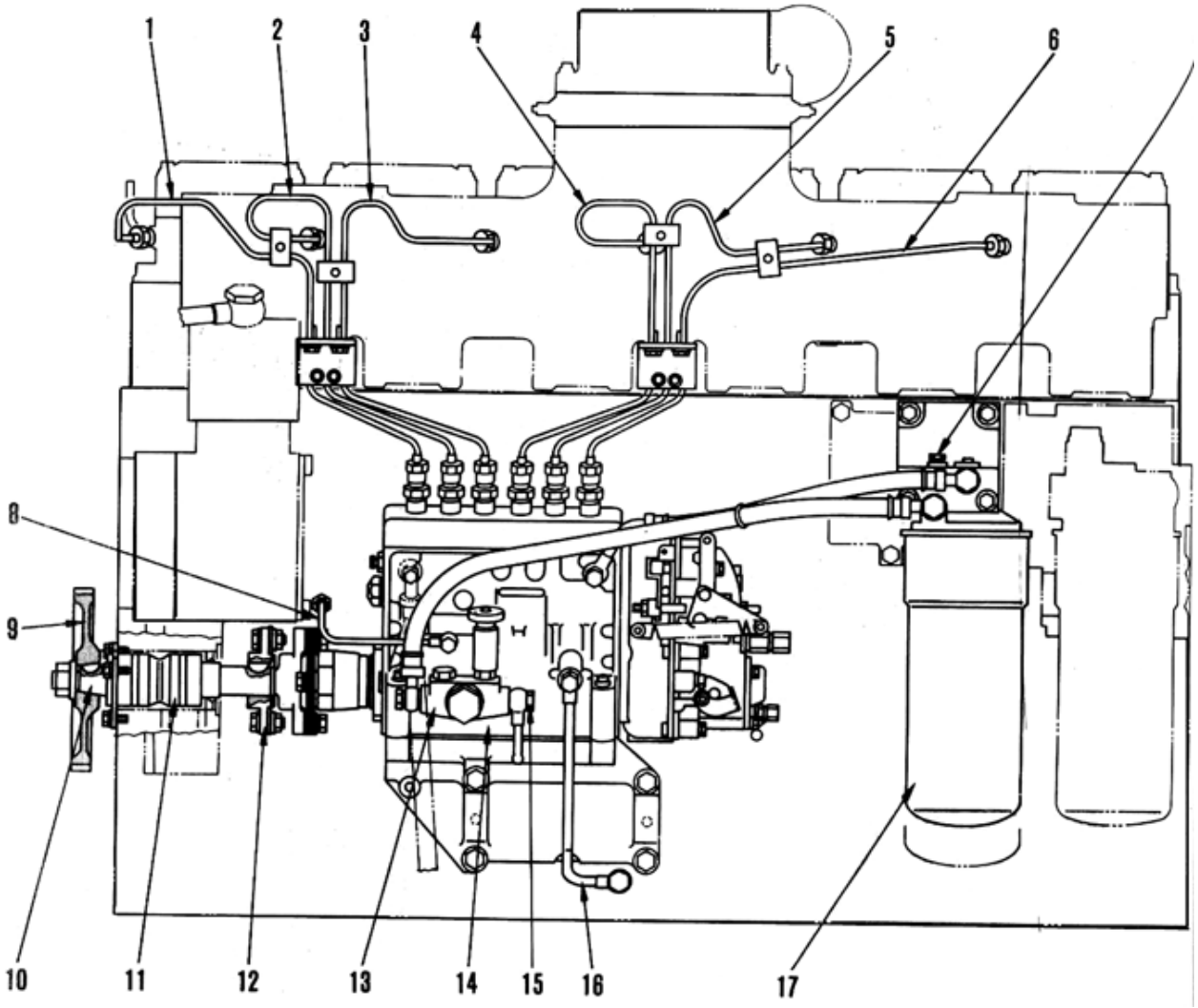
FUEL SYSTEM CHART



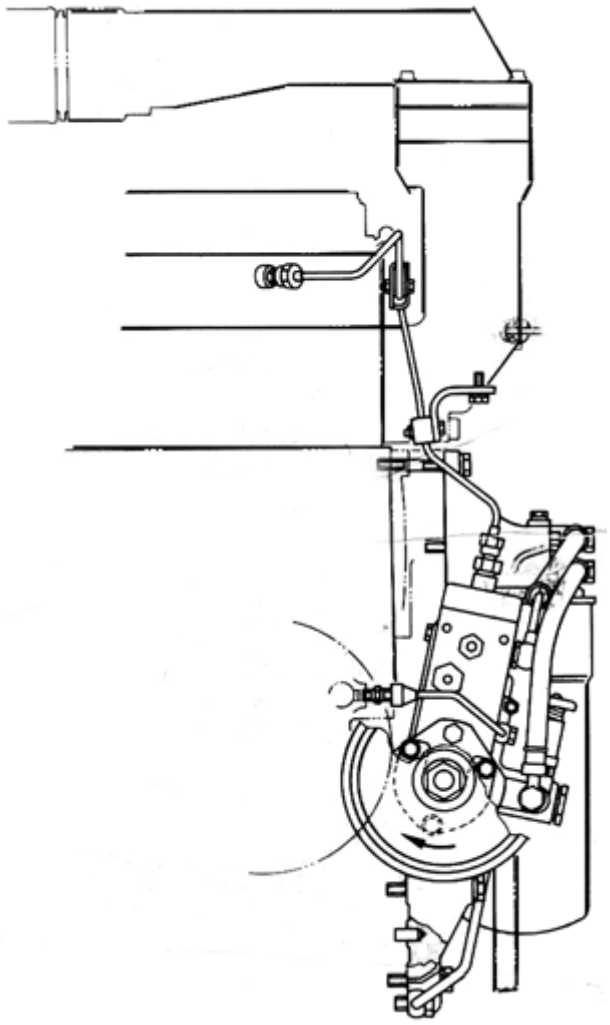
1. Fuel tank
2. Gauze filter
3. Priming pump
4. Feed pump
5. Fuel filter
6. Fuel injection pump
7. Fuel injection nozzle
8. Over-flow valve

FUEL INJECTION PUMP

BS6D140-1 (BG825A-1)



1. Fuel injection pipe (No. 1)
2. Fuel injection pipe (No. 2)
3. Fuel injection pipe (No. 3)
4. Fuel injection pipe (No. 4)
5. Fuel injection pipe (No. 5)
6. Fuel injection pipe (No. 6)
7. Air bleeder plug
8. Oil tube (inlet)
9. Fuel injection pump drive gear (No. of teeth 48)
10. Fuel injection pump drive shaft
11. Bearing box
12. Coupling
13. Feed pump
14. Fuel injection pump
15. Gauze filter
16. Oil filter
17. Fuel filter

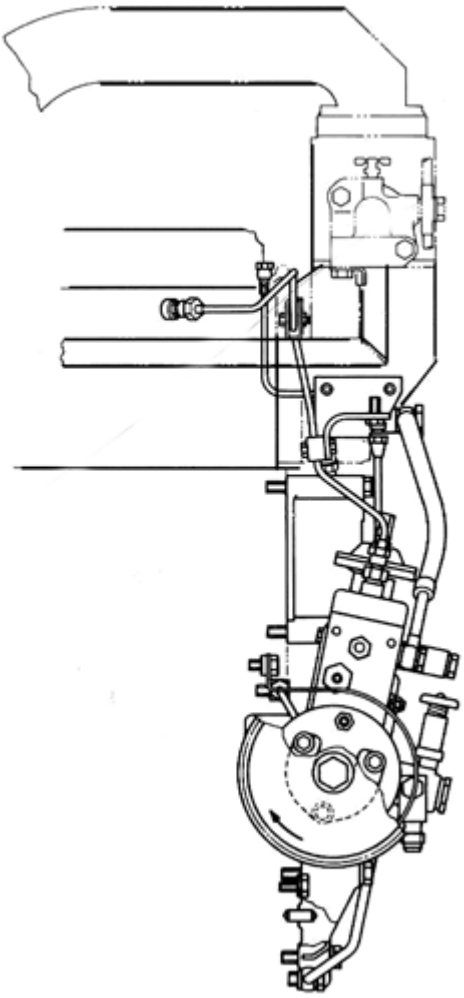


FUEL INJECTION PUMP

- Maker : DIESEL KIKI
- Type : Bosch PE-P
- Lubrication method : Forced lubrication with engine oil

GOVERNOR

- Type : Bosch RSV Centrifugal, all speed type



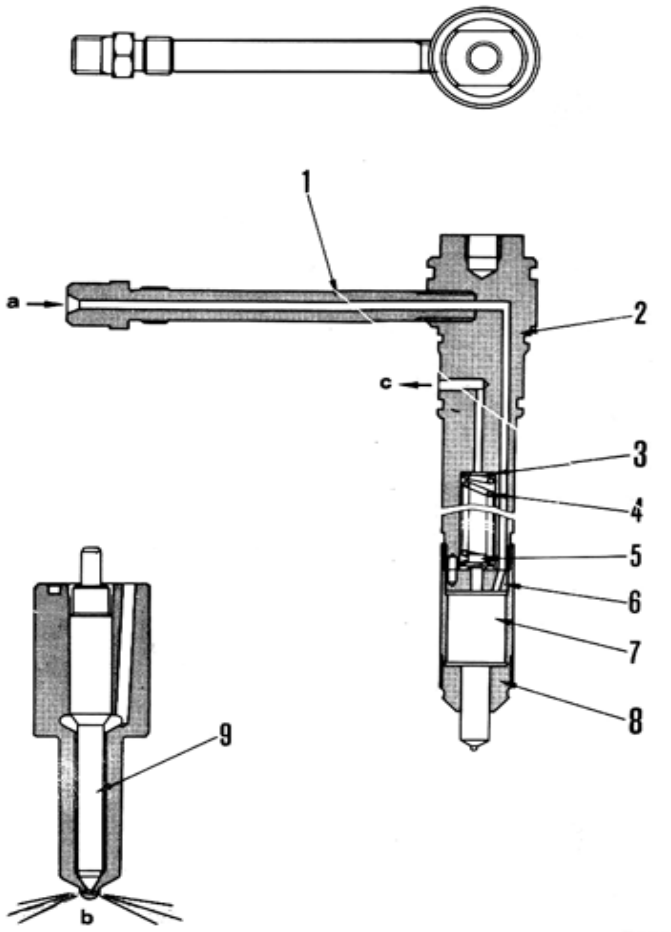
FUEL INJECTION PUMP

- Maker : NIPPON DENSO
- Type : Bosch PE-NE
- Lubrication method : Forced lubrication with engine oil

GOVERNOR

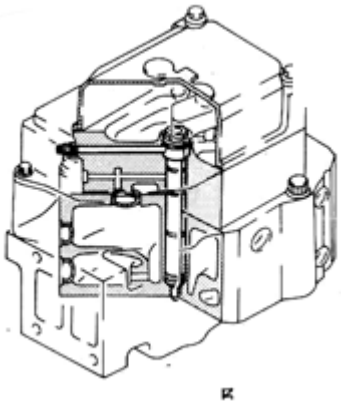
- Type: Bosch Centrifugal,max.and min. speed control type

FUEL INJECTION NOZZLE



FUEL INJECTION NOZZLE

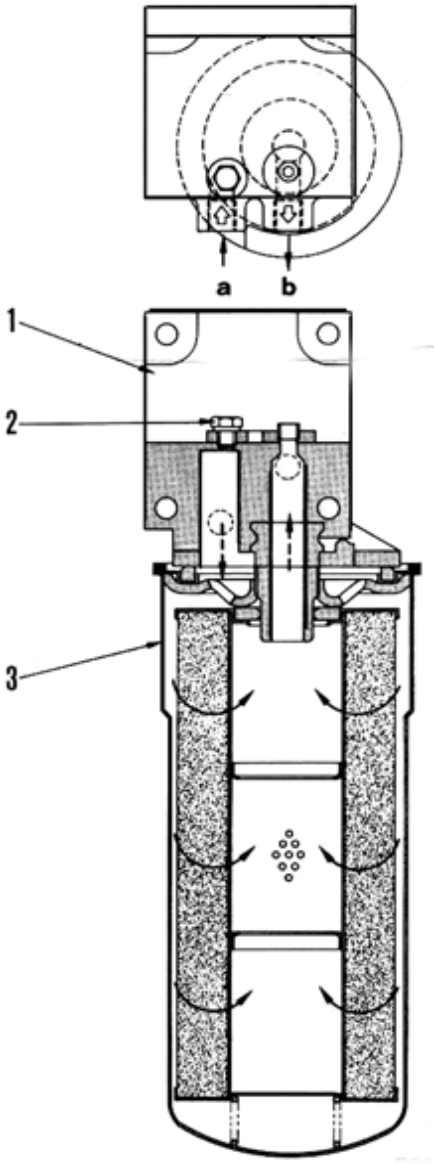
1. Fuel inlet connecotor
2. Nozzle holder
3. Adjustment shim
4. Spring
5. Seat
6. Spacer
7. Nozzle
8. Retaining cap
9. Needle valve



BS6D140-1: Made by DIESEL KIKI
(Diameter of nozzle hole 0.35 x 7 hole)
BSA6D140-1: Made by DIESEL KIKI
Made by NIPPON DENSO
(Diameter of nozzle hole 0.36 x 6 hole)

- Maker : DIESEL KIKI (BS6D140-1)
  NIPPON DENSO(BSA6D140-1)
- Type : Multi-hole type
- Injection pressure : 250 kg/cm²
- Adjusting injection pressure : Shim adjusting type

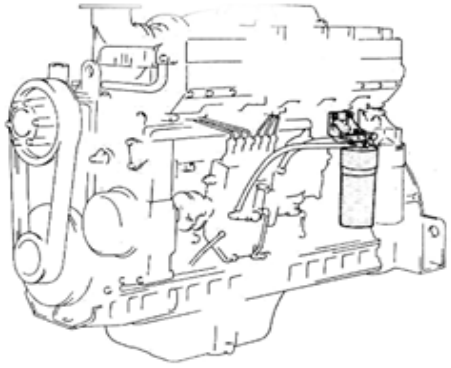
FUEL FILTER



FUEL FILTER

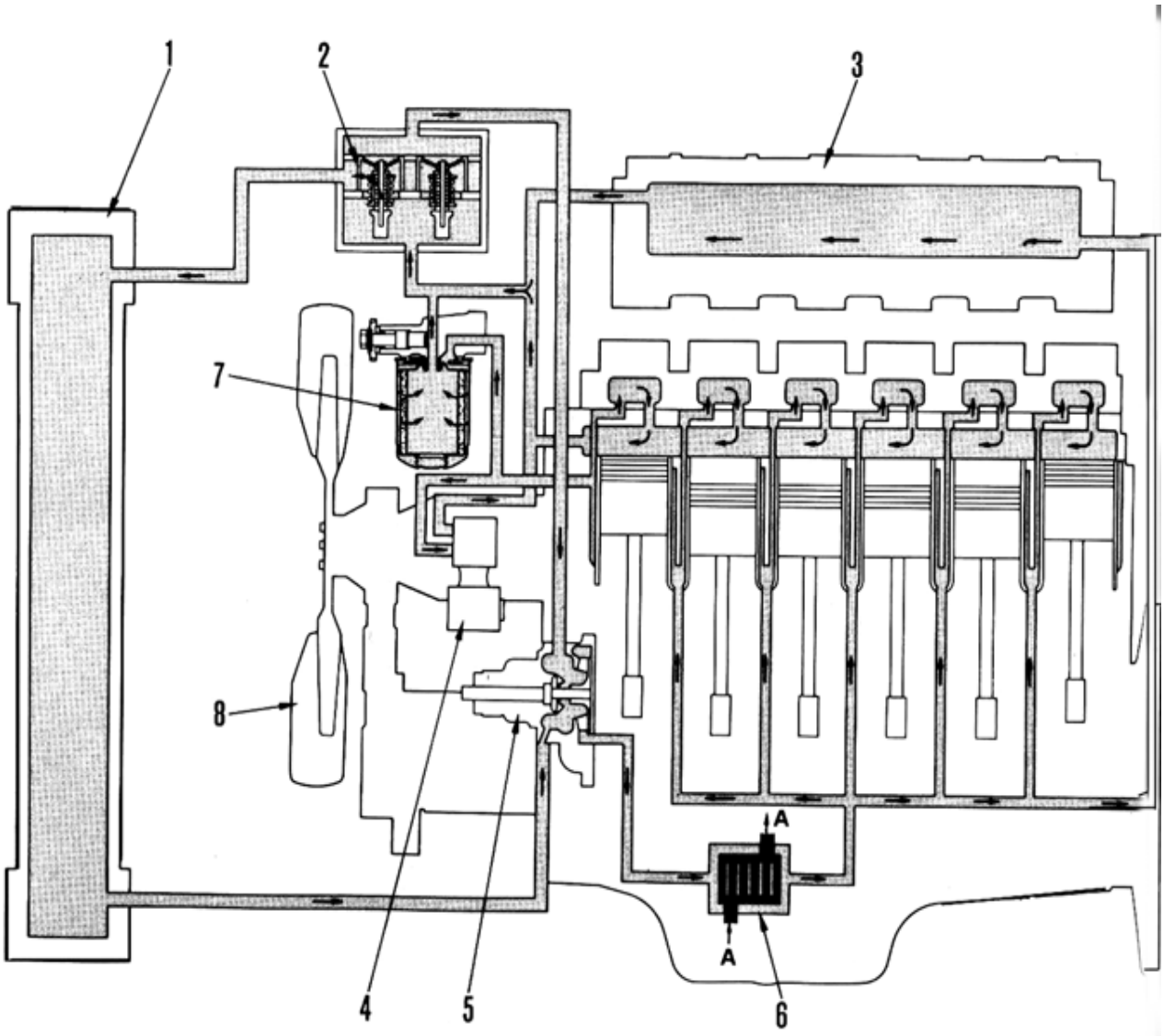
1. Filter bracket
2. Air bleed plug
3. Cartridge

a. Fuel inlet (From feed pump)
b. Fuel outlet (To injection pump)



Filteration area: 1.0 m²

COOLING SYSTEM CHART

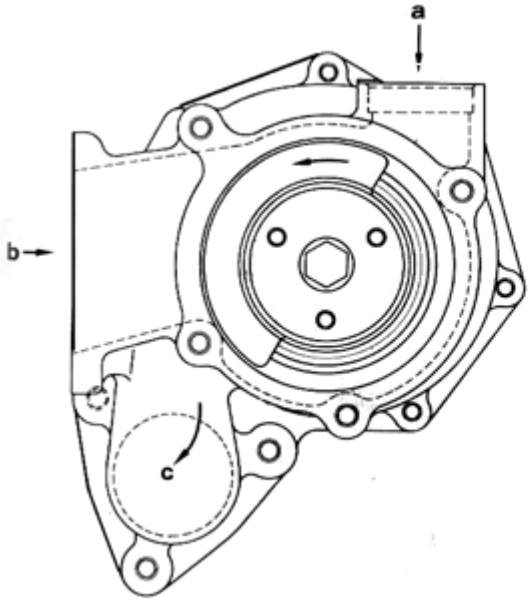


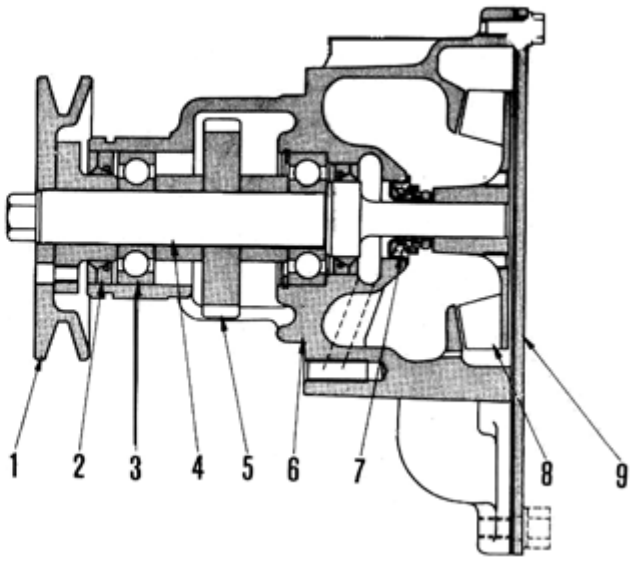
1. Radiator
2. Thernostat
3. After-cooler (BSA6D140-1)
4. Air compressor (if equipped)
5. Water pump
6. Oil cooler
7. Corrosion resistor
8. Cooling fan

A. Lubrication on oil

WATER PUMP

BS6D140-1 (BG825A-1)



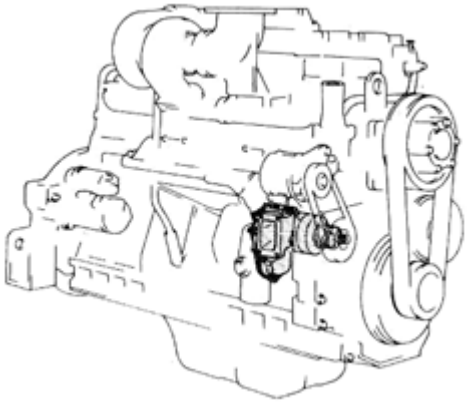


1. Alternator drive pulley
2. Oil seal
3. Ball bearing
4. Pump shaft
5. Water pump drive gear (No. of teeth:23)
6. Pump body
7. Water seal
8. Impeller
9. Pump cover

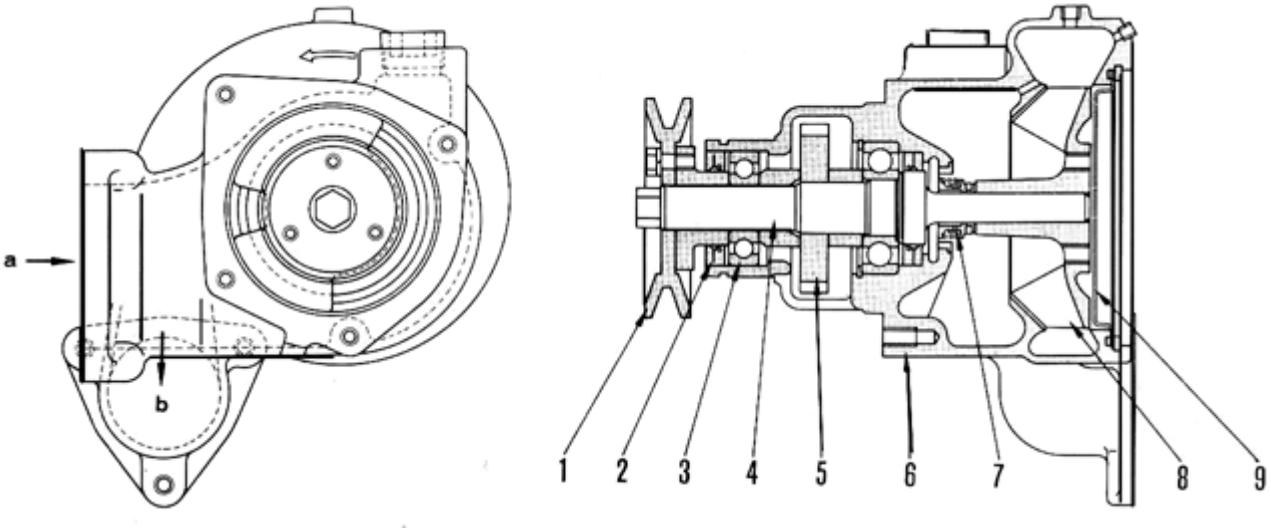
a. Water inlet (From thermostat)
b. Water inlet (From radiator)
c. Water outlet (To oil cooler)

WATER PUMP

- Waterpumpspeed=Engine speed*1.56
- Flow capacity : 400 l/min



BSA6D140-1 (BHD325-5)



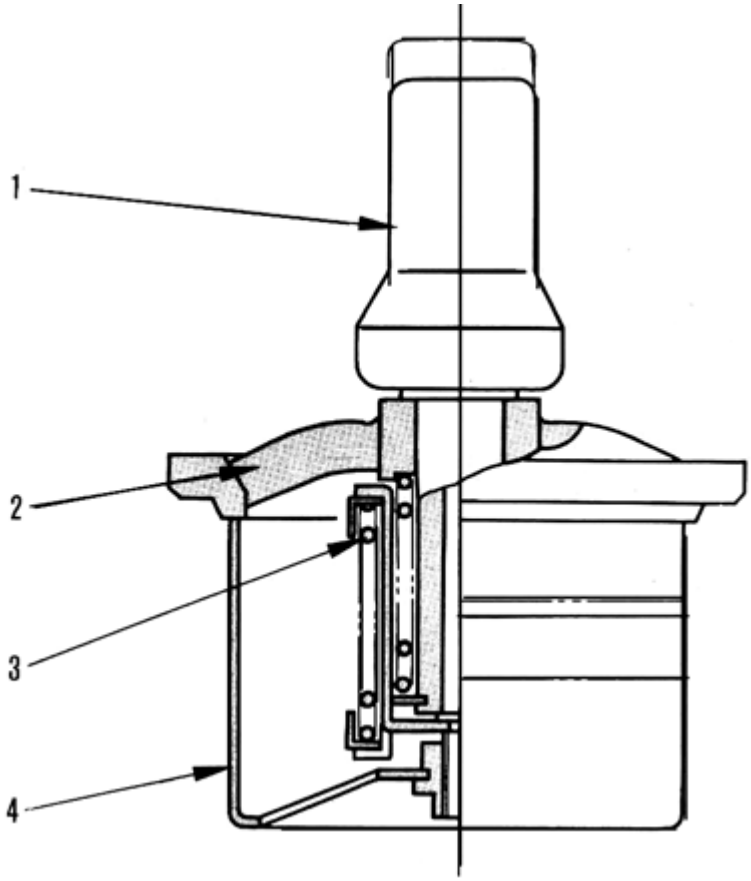
1. Alternator drive pulley
2. Oil seal
3. Ball bearing
4. Pump shaft
5. Water pump drive gear (No. of teeth:23)
6. Pump body
7. Water seal
8. Impeller
9. Pump cover

WATER PUMP

- Waterpumpspeed=Engine speed*1.56
- Flow capacity : 800 l/min

a. Water inlet (From radiator)
b. Water outlet (To oil cooler)

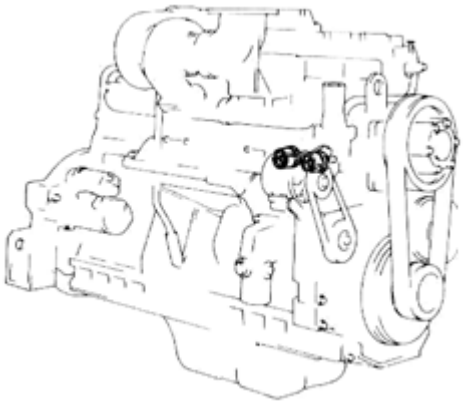
THERMOSTAT



1. Wax case
2. Valve
3. Spring
4. Thermostat

THERMOSTAT

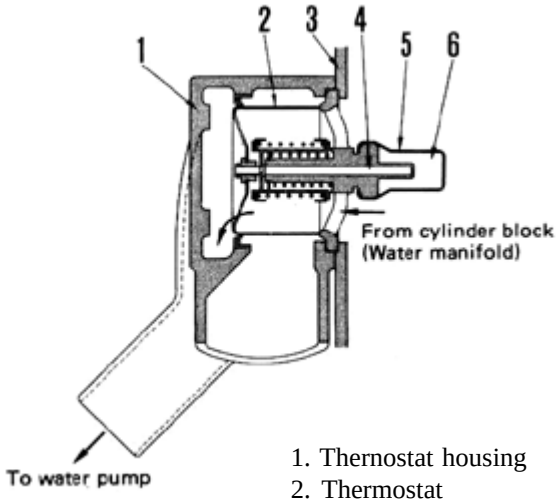
- Opening temperature: 76.5±2°C
- Full opening temperature: 90°C
- Valve lift : 10± 0.5mm



FUNCTION

- The thermostat keeps the engine cooling water at the proper temperature by automatically controlling the amount of cooling water flowing to the radiator. The thermostat opens or closes depending on the temperature of the cooling water.

- A wax case (the heat sensing element) is set in the thermostat.The thermostat opens or closes depending on the amount of swelling of the wax.

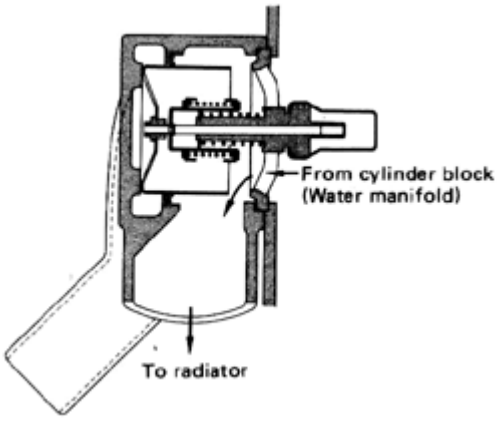


1. Thernostat housing
2. Thermostat
3. Cylinder block
4. Piston
5. Wax case
6. Wax

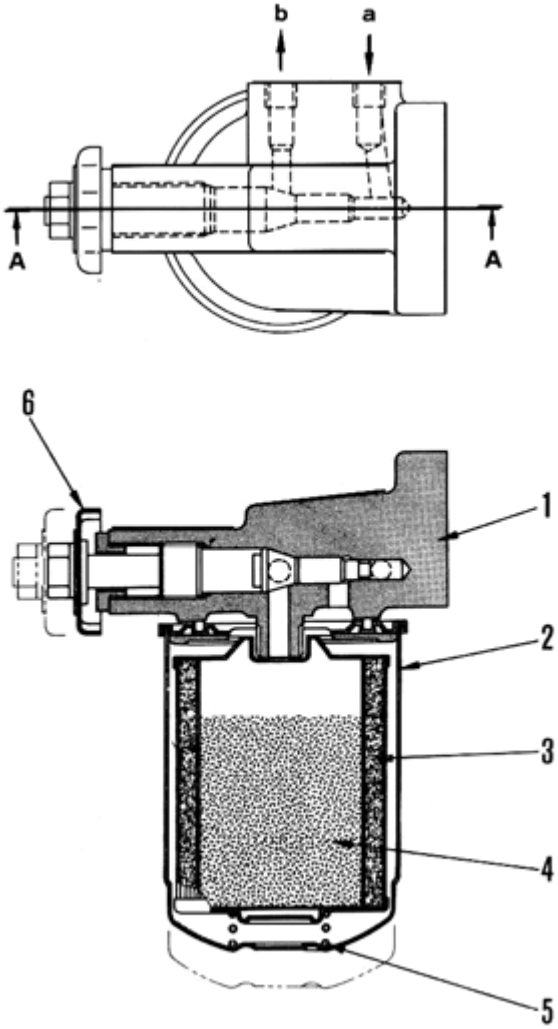
OPERATION

- **When the cooling water temperature is low :**
  Most of the cooling water entering from the water manifold flows to the water pump.

- **When the cooling water temperature is high** :
  As the cooling water temperature goes up, the wax in the wax case expands to push the case upward. Thereby, the amount of water flowing to the water pump and the radiator is restricted, keeping the water at the proper temperature.



CORROSION RESISTOR (BS6D140-1)

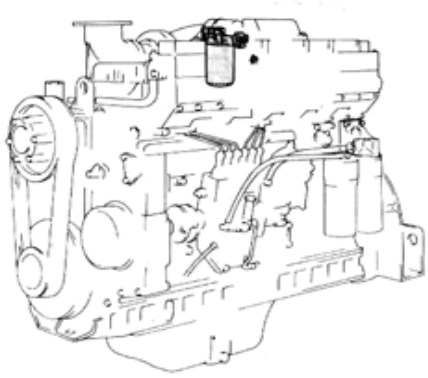


Section A-A

1. Bracket
2. Catridge
3. Element (paper)
4. Element (Chemicals)
5. Spring
6. Valve

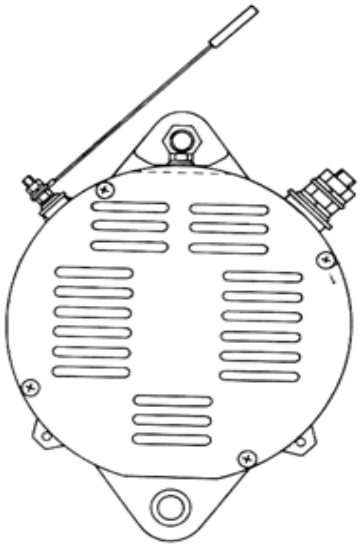
a. Water inlet
b. Water outlet

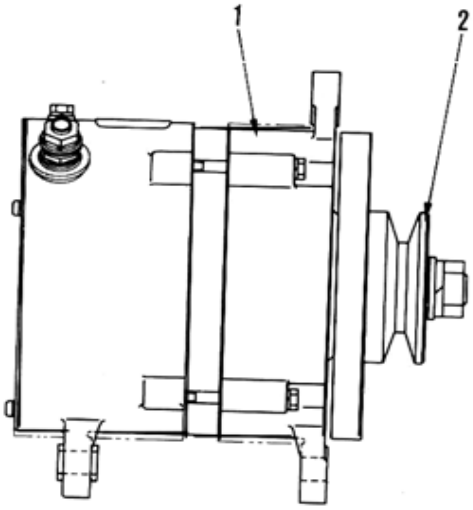
CORROSION RESISTOR

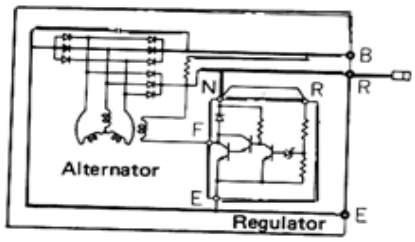


Filteration area:
BS6D140-1 : 0.13 m²
BSA6D140-1 : 0.373 m²

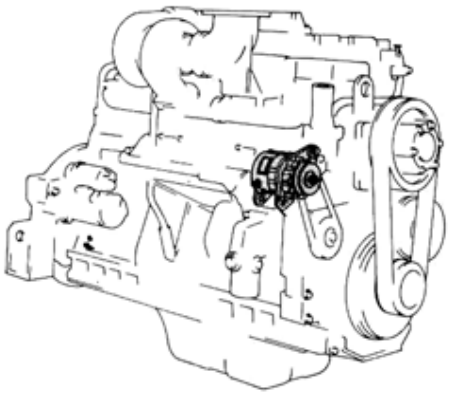
ALTERNATOR
(BS6D140-1;BSA6D140-1& BSA6D140G1)







ALTERNATOR

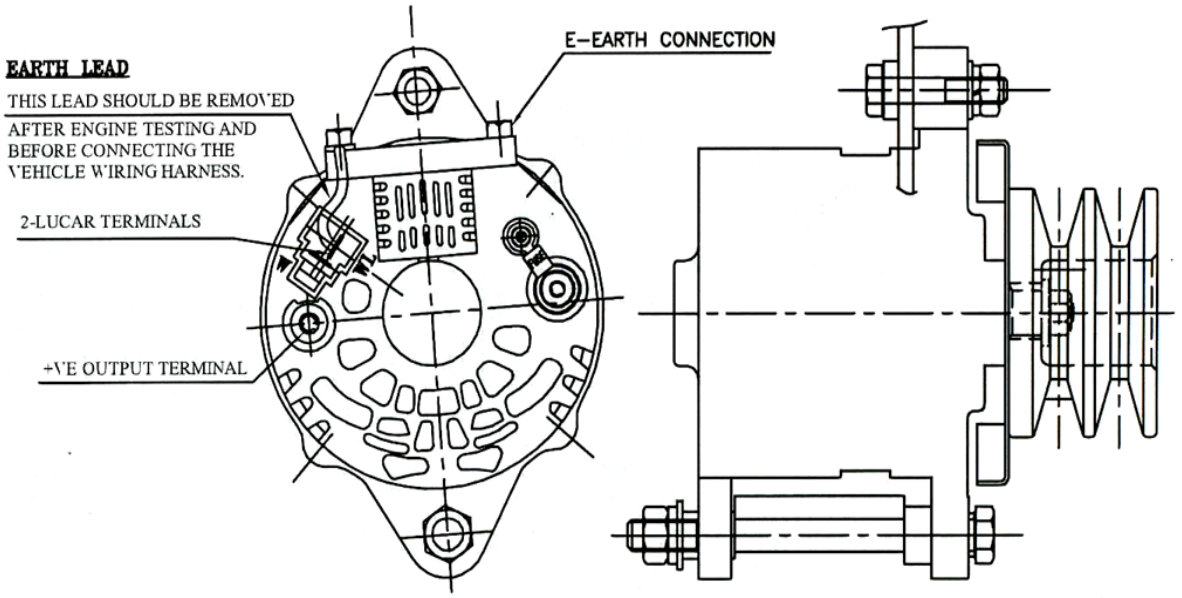


1. Alternator
2. Alternator pulley

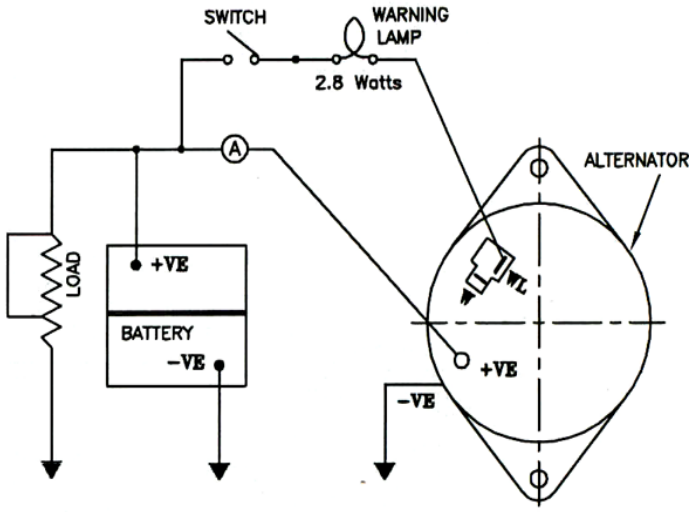
B,E,F,N,R : Terminals

Engine Model	Applicable Machie Model	TYPE	Specification	Pulley O.D) (mm)	Weight (Kgs)
BS6D140-1	BG825,BL40,BD155X BH35-2, CM20H	MAKE: LUCAS TVS	24V, 45A	85	6.3
	VTI 8 x 8,VVL 10 x 8	MAKE: KEL MAKE: SAWAFUJI	24V, 50A 24V, 50A	85 85	18 12
BSA6D140-1	BE650-3, BE1600, BH40, EUCLID R35	MAKE : KEL MAKE: SAWAFUJI	24V, 50A 24V, 50A	85 85	18 12
	BL54	MAKE : LUCAS TVS	24V, 45A	85	6.3
BSA6D14G1	BDG360, BDG380	MAKE: LUCAS TVS	24V, 30A	85	10

ALTERNATOR (BSA6D140-1 ;BSA6D140G1)
(BL54 : BDG360 & 380 kVA)



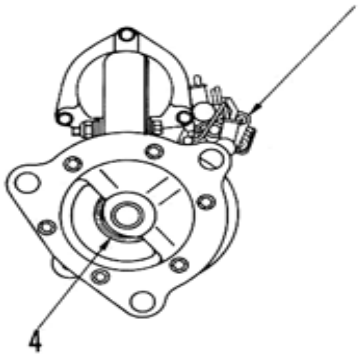
TERMINAL	SIZE	TIGHTENING TORQUE
+VE	M8x1.25	45kg.cm~55kg.cm
-VE	M6x1	25kg.cm~30kg.cm
WL	LUCAR 6.35x0.8t	—
W	—"—	—
W= A.C PHASE TAP TERMINAL (UNREGULATED VOLTAGE TERMINAL)		

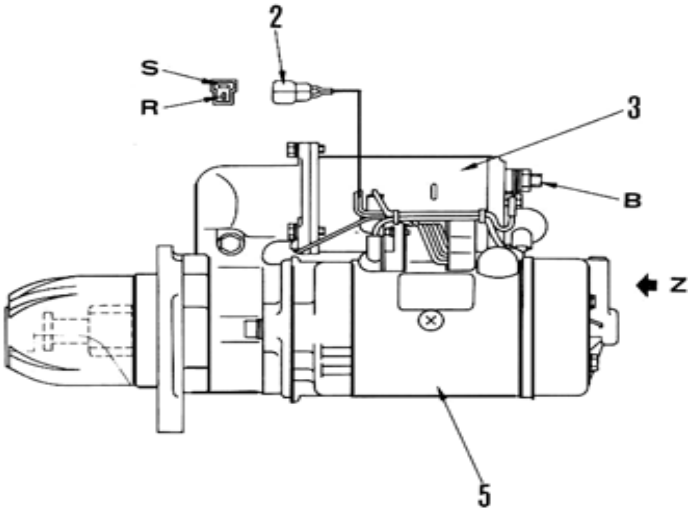


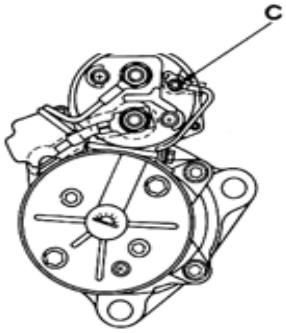
ALTERNATOR TERMINAL IDENTIFICATION & SIZE

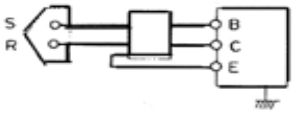
MAKE	MODEL	TERMINAL IDENT / SIZE				Pulley O.D (mm)	Weight (kg)
		POSITIVE	NEGATIVE/ EARTH	WARNING LAMP	A.C.PHASE TAP (UNREGULATED)		
L-TVS (30A)	360 kVA DGSET	B M8x1.25	E M6x1	WL 6.35x0.8t	---	95	10
L-TVS(45A)	BL54	B M8X1.25	E M6x1	WL 6.35x0.8t	W 6.35x0.8t	95	6.3

STARTING MOTOR







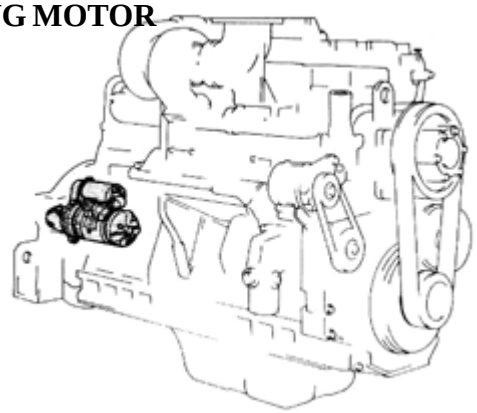


View Z

1. Safety relay
2. Connector
3. Magnetic switch
4. Pinion gear
5. Starting motor

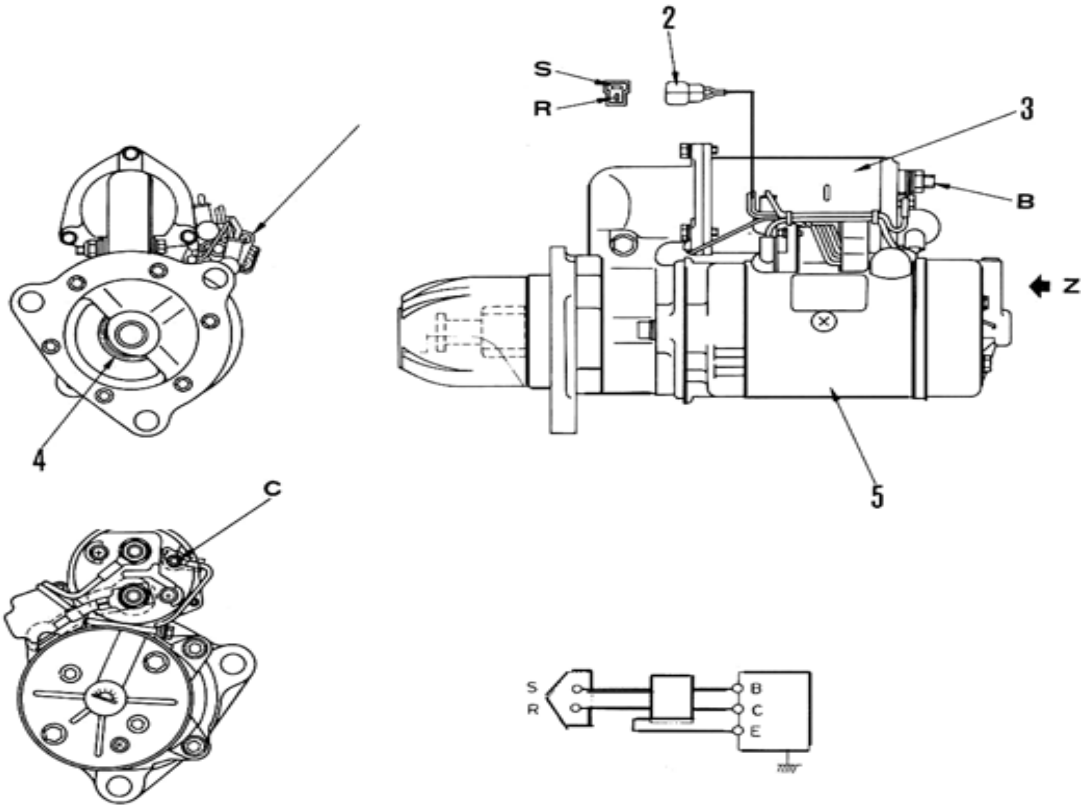
B,C,E,R,S : Terminals

STARTING MOTOR



Engine Model	Applicable machine model	Type	Specification	Number of penion teeth	Weight(kg)
BS6D140-1	BG825A-1(S.T.D)	Maker: NIKKO DINKI Type: Sealed	24V, 7.5kW	12	18
	BG825A-1(Option)	Maker: SAWAFUJI Type: Sealed	24V, 11kW	12	20
BSA6D140-1	BE650-3	Maker: NIKKO DINKI Type: Sealed	24V,7.5kW	12	18
	BHD325-5	Maker: SAWAFUJI Type: Sealed	24V,11kW	12	20

STARTING MOTOR (BS6D140-1 & BSA6D140-1) (BG825;BL40; BD155X;CM20H; VTI 8x8; VVL 10x8)

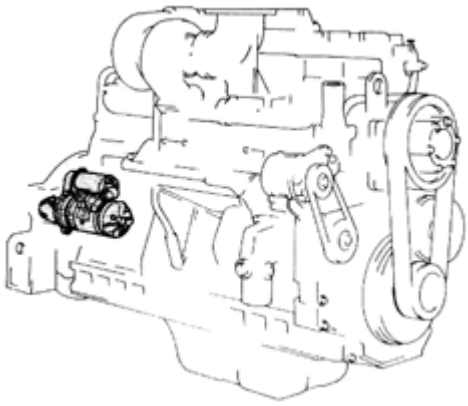


View Z

STARTING MOTOR

1. Safety relay
2. Connector
3. Magnetic switch
4. Pinion gear
5. Starting motor

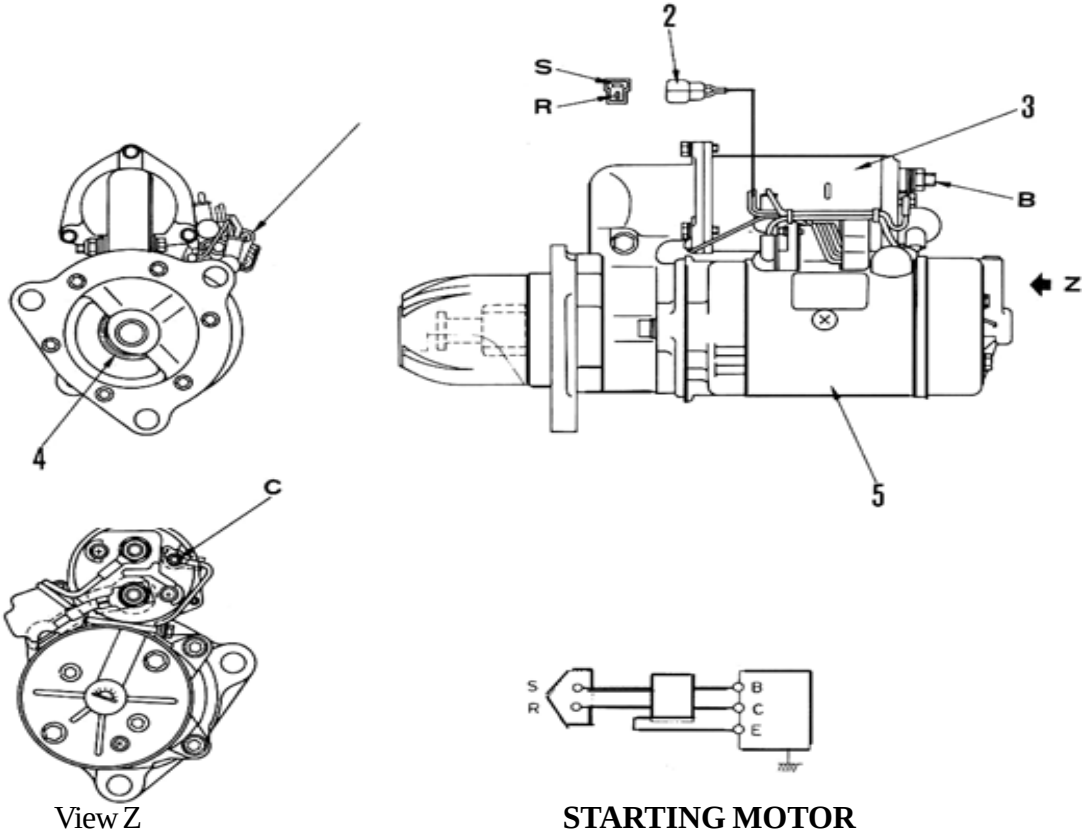
B,C,E,R,S : Terminals



Engine Model	Applicable machine model	Type	Specification	Number of penion teeth	Weight(kg)
BS6D140-1	BG825A;BL40;CM20H; BD155X, VTI 8x8 VVL 10x8	Maker: LUCAS TVS (SM 130 PE)	24V, 7.5 kW	12	32
		Maker: DELCOREMY 50MT-TYPE 400	24V, 9.0kW	11	40
BSA6D140-1	BE650-3, BE1600	Maker: LUCAS TVS (SM130 PE)	24V,7.5kW	12	32
	BH40	Maker: SAWAFUJI Type: Sealed	24V,11kW	12	20

STARTING MOTOR：(BSA6D140-1)

(BE650-3; BE1600-1; BH40)

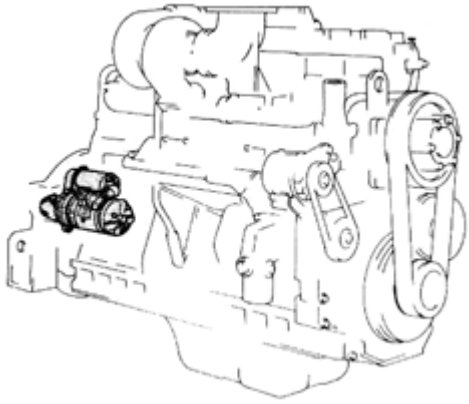


View Z

STARTING MOTOR

1. Safety relay
2. Connector
3. Magnetic switch
4. Pinion gear
5. Starting motor

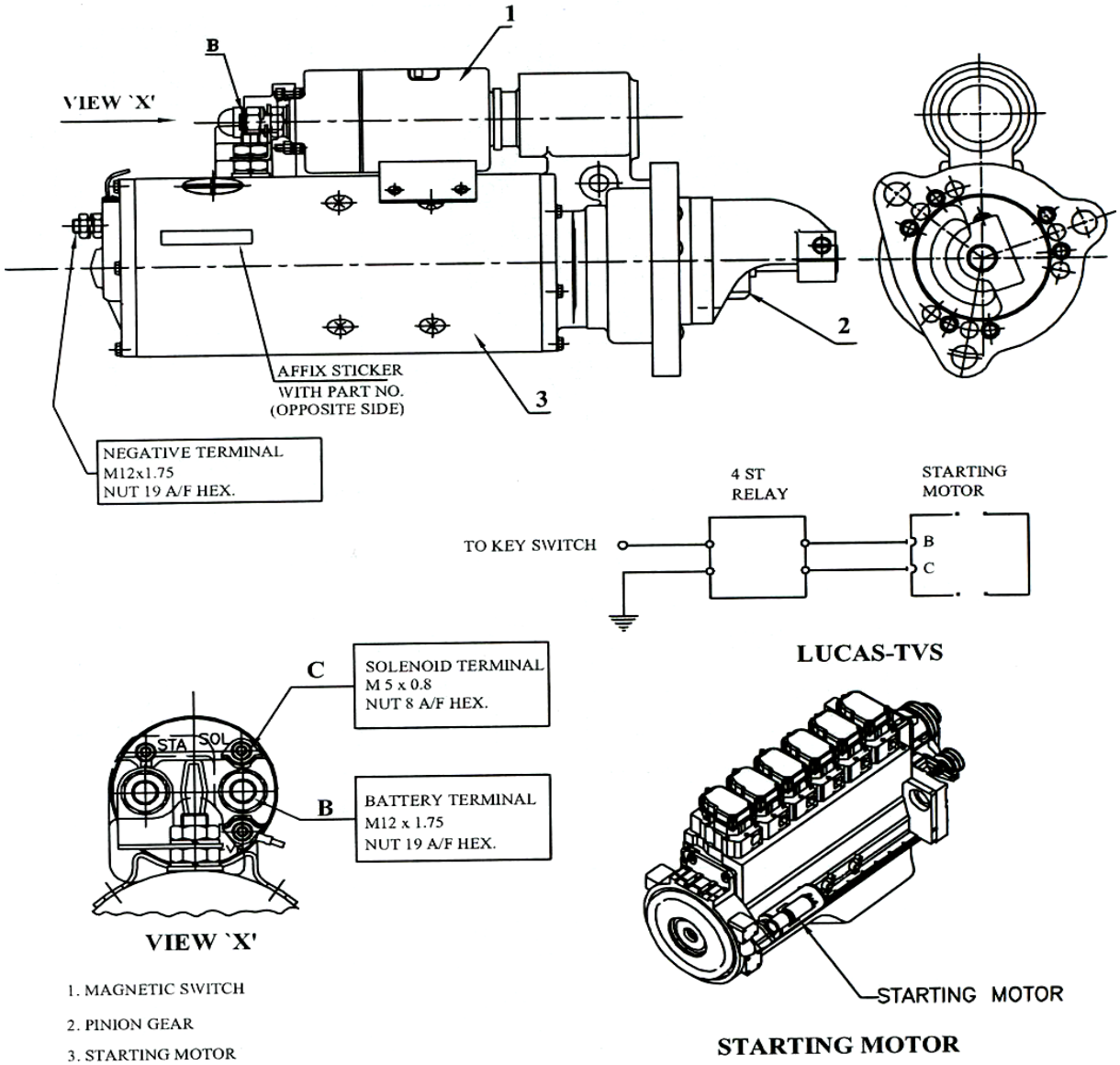
B,C,E,R,S : Terminals



Engine Model	Applicable machine model	Type	Specification	Pulley O.D. (mm)	Weight(kg)
BSA6D140-1	BE650; BE1600; BH40	Maker: LUCAS TVS Type: (SM 130 PE)	24V, 7.5kW	12	32
		Maker: SAWAFUJI Type: Sealed	24V, 11kW	12	20

STARTING MOTOR： BSA6D140-1 & BSA6D140G1

(BL54 ; EUCLID R35; BDG360kVA)

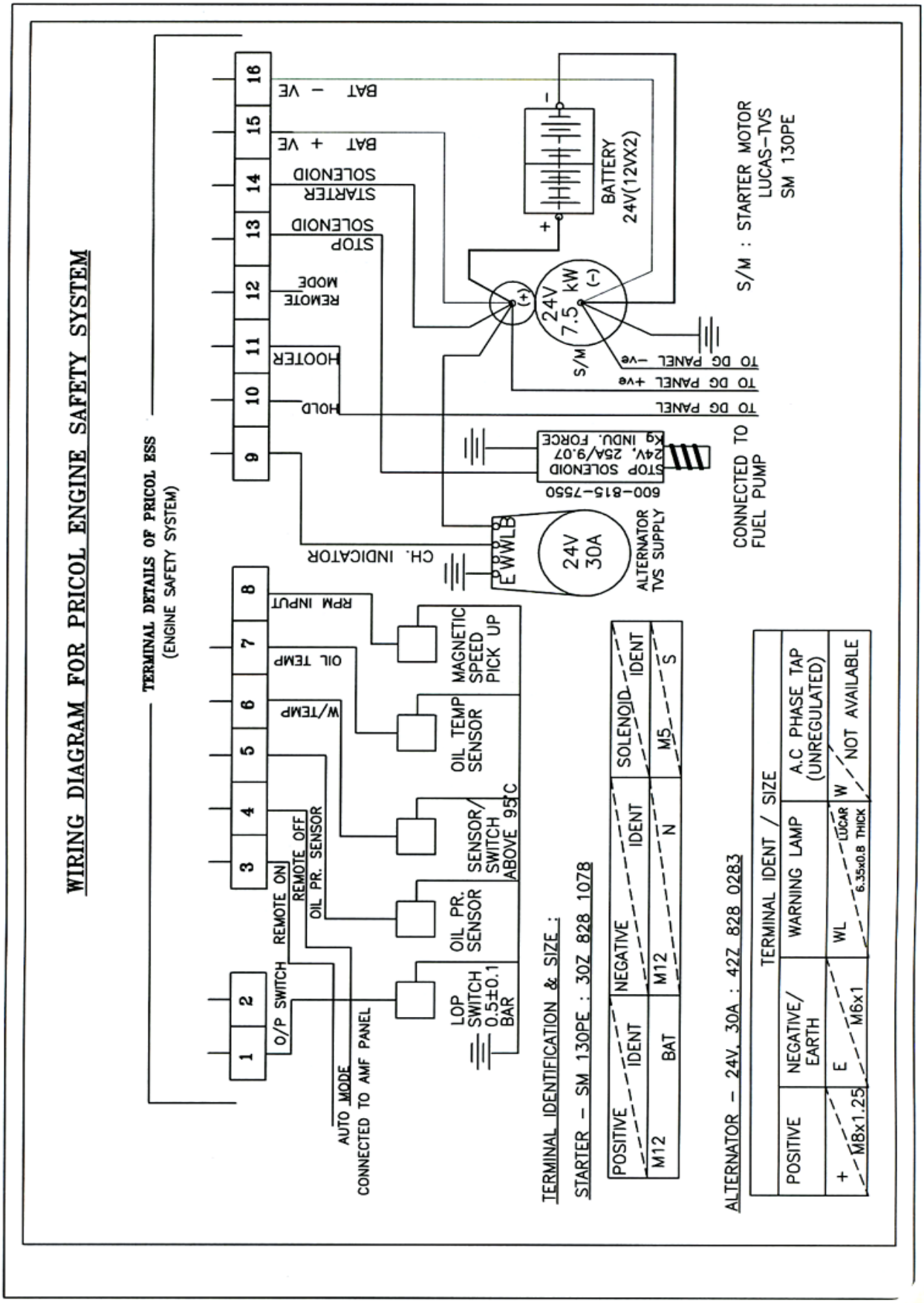


1. MAGNETIC SWITCH
2. PINION GEAR
3. STARTING MOTOR

STARTING MOTOR

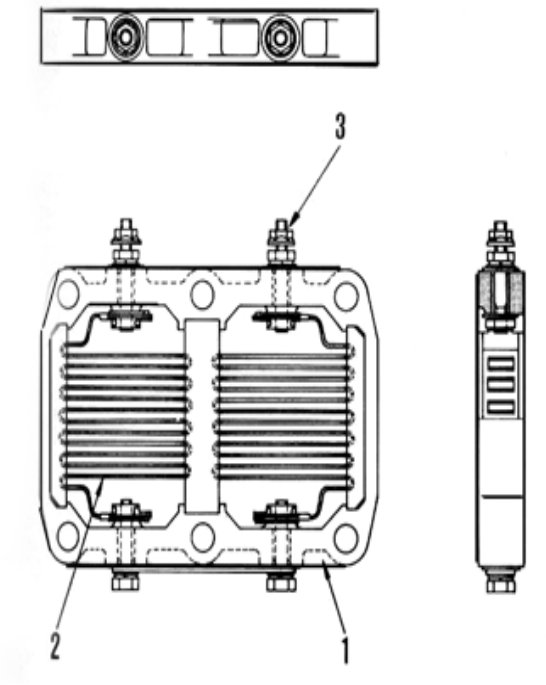
Engine Model	Applicable machine model	Type	Specification	Number of pinion teeth	Weight(kg)
BSA6D140-1	BL54	Maker: LUCAS TVS (SM 130 PE)	24V, 7.5kW	12	32
BSA6D140G1	BDG360 KVA EUCLID R35	Maker: LUCAS TVS (SM 130 PE)	24V, 7.5kW	12	32
		Maker: SAWAFUJI Type: Sealed	24V,11kW	12	20

WIRING DIAGRAM



ELECTRICAL INTAKE AIR HEATER

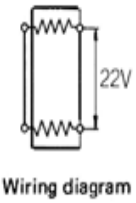
BS6D140-1



1. Heater body
2. Heater coil
3. Terminal

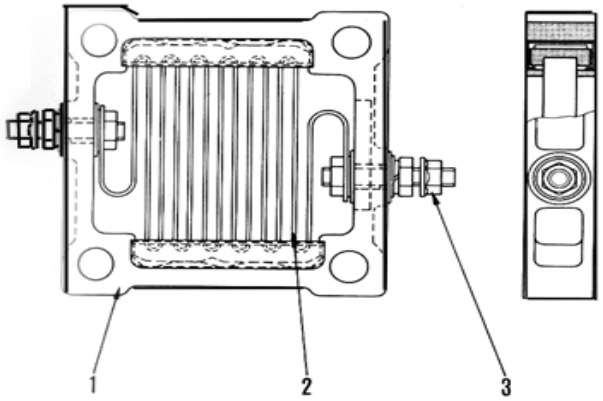
ELECTRICAL INTAKE AIR HEATER

- Rated voltage : DC22V
- Rated current : 175A



Wiring diagram

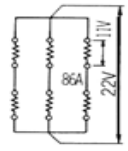
BSA6D140-1



1. Heater body
2. Heater coil
3. Terminal

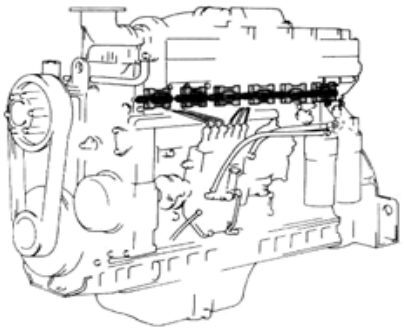
ELECTRICAL INTAKE AIR HEATER

- Rated voltage : DC11V
- Rated current : 86A

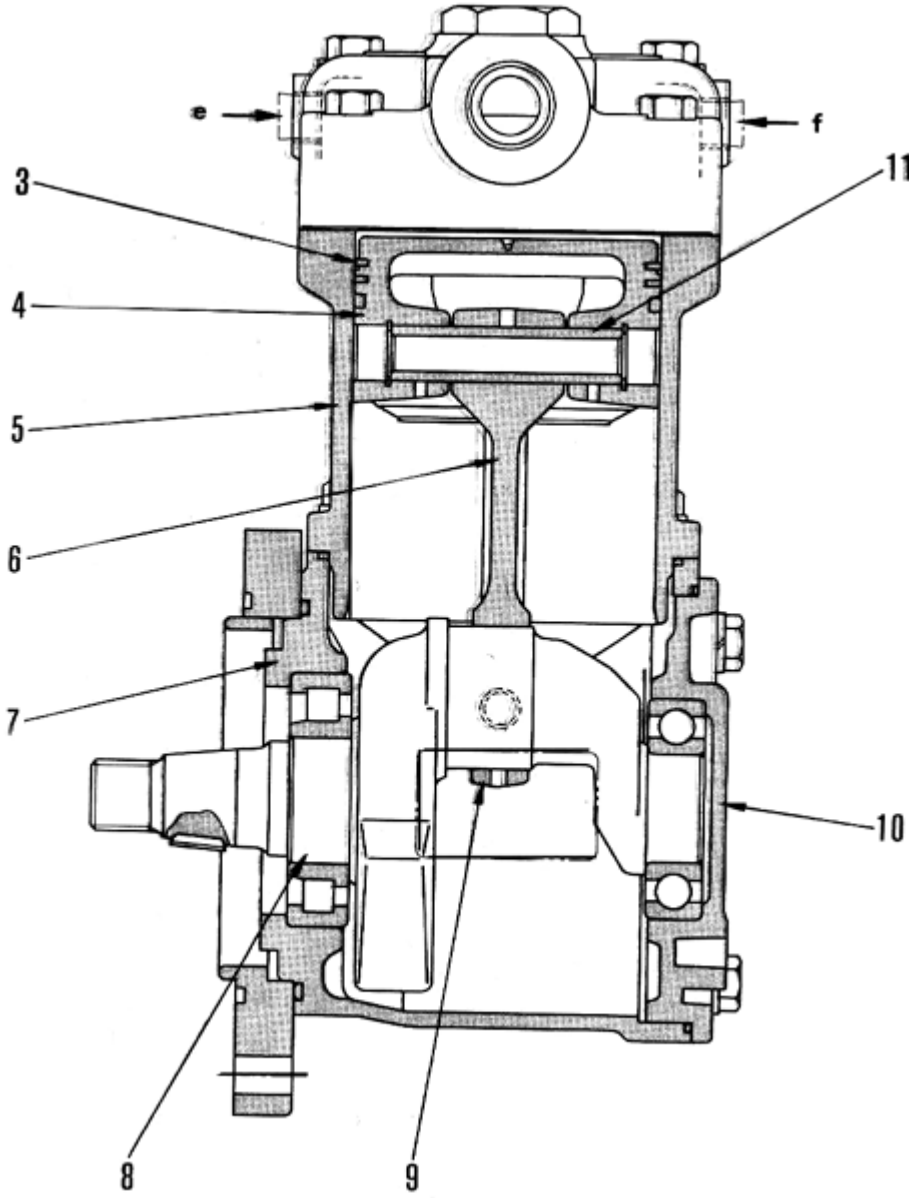


Wiring diagram

ELECTRICAL INTAKE AIR HEATER

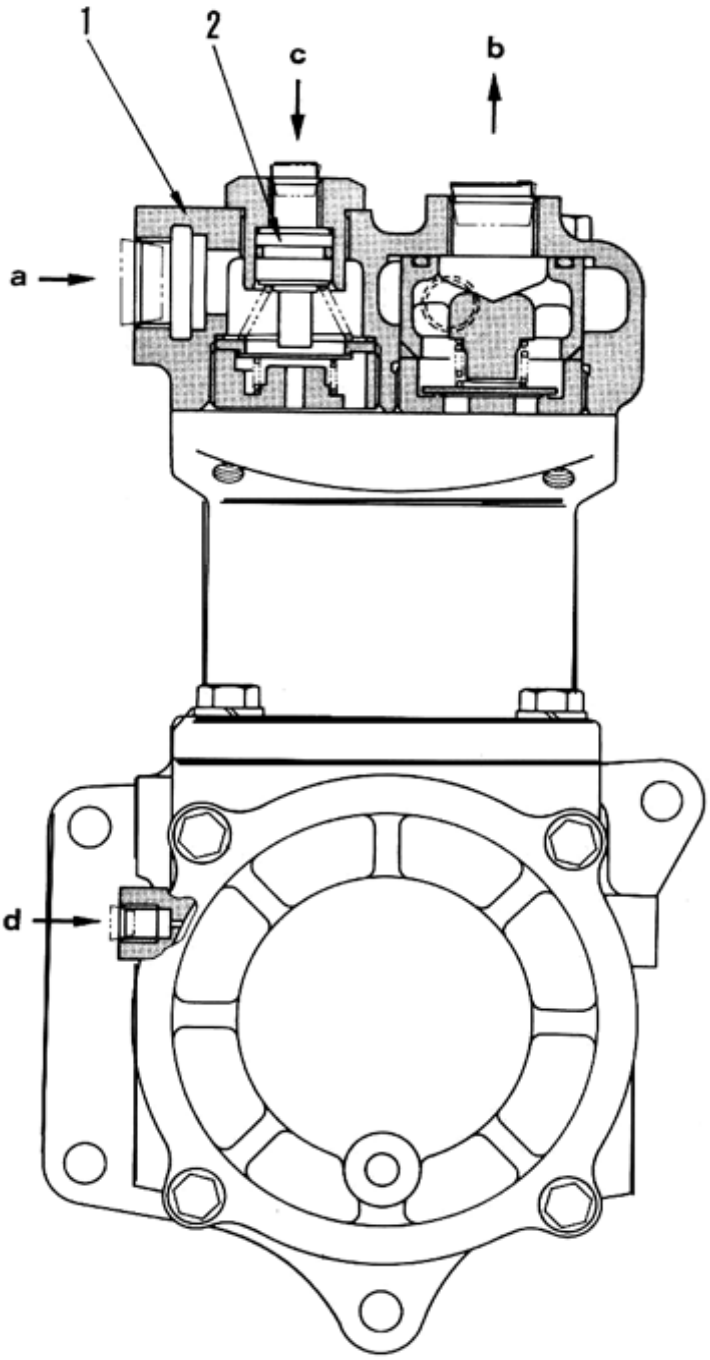


AIR COMPRESSOR



1. Cylinder head
2. Unloader valve
3. Piston ring
4. Piston
5. Cylinder
6. Connecting rod
7. Crankcase
8. Crankshaft
9. Connecting rod cap
10. Bearing cover
11. Piston pin

a.Ait intake
b.Air exhaust
c.Unloader
d.Oil inlet
e.Cooling water inlet or outlet
f. Cooling water outlet or inlet



AIR COMPRESSOR

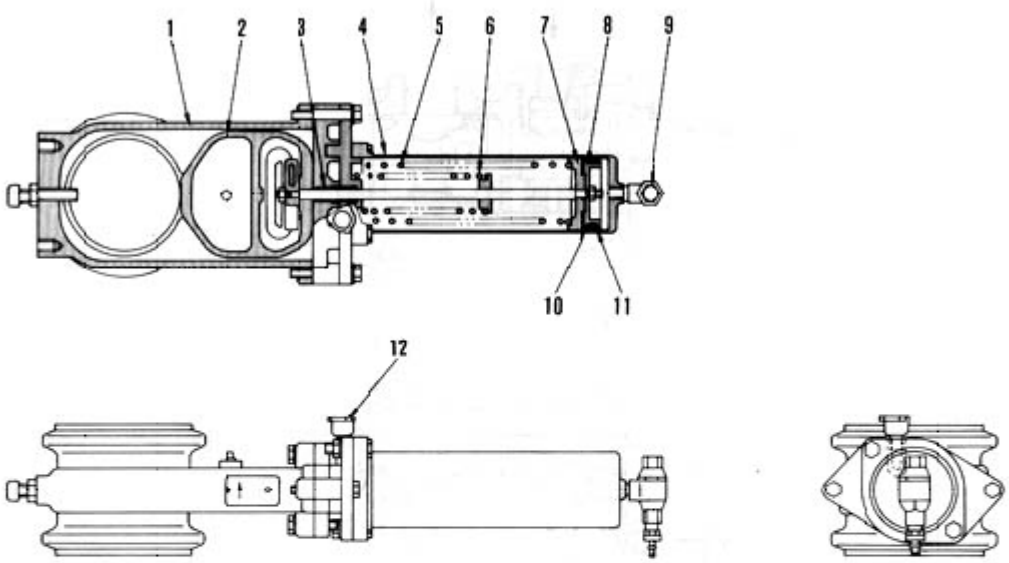
- Maker : DIESEL KIKI
- Type : Single cylinder,double acting
- Discharge volume : 340 cc/rev.
- Air pressure : 8.5 kg/cm²
- Weight : 11 kg

UNLOADER VALVE

- Valve opening pressure : 6.3 kg/cm²
- Valve shutting pressure : 5.4 kg/cm²

EXHAUST BRAKE

SLIDE VALVE TYPE



1. Valve housing
2. Gate valve
3. Guide bushing
4. Cylinder
5. Spring
6. Spring
7. Piston
8. Retainer
9. Release valve
10. Packing
11. Packing
12. Breather

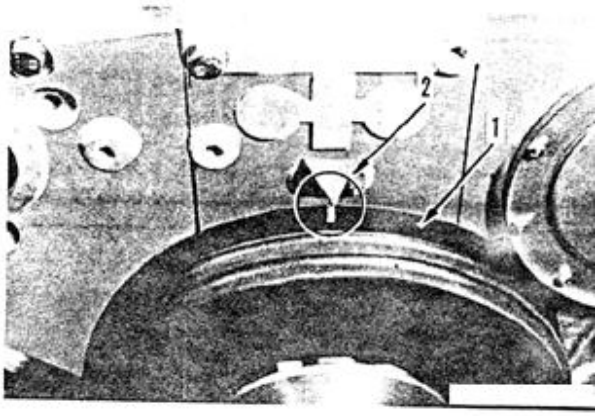
Outline

An exhaust brake is installed between the turbocharger and muffler, and works due to the air pressure from the solenoid valve, reducing engine speed by throttling the exhaust passage of the muffler from the turbocharger. The exhaust brake consists of a valve mechanism and an air cylinder which controls the valve.

ENGINE
13 TESTING AND ADJUSTING

ENGINE BODY

ADJUSTING VALVE CLEARANCE



1. Remove the rocker arm housing cover.

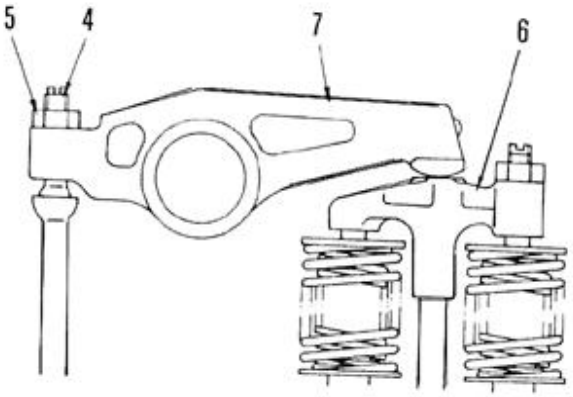
2. Rotate the crankshaft in the normal direction. while watching the movement of the intake valve of the No. 6 cylinder, bring the No. 1 cylinder into the top dead center position of the com pression stroke and align the center position of the compression stroke and align the "1.6 TOP" mark on viberation damper (1) with pointer (2).
   * When the No.1 cylinder comes near the top dead center of the compression stroke,the No.6 intake valve will start to move (open).

3. Adjust the valve clearance for valves marked • in the valve arrangement chart.

4. Rotate the crankshaft in the normal direction by one revolution and adjust the valve clearance for the remaining valves marked 0.

★ Valve arrangement chart

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



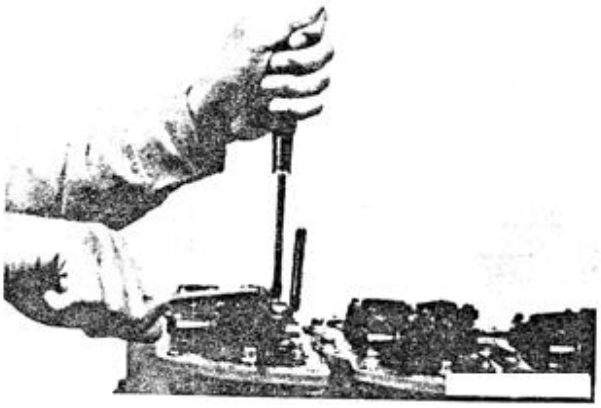
* To adjust the valve clearance, loosen lock nut (5) on adjustment screw (4), insert the feeler gausge corresponding to the specified clearance between crosshead (6) and rocker arm (7),and adjust the clearance with the adjustment screw untill the thickness guage can slide lightely.
* Valve clearance (When engine is cold)

Unit: mm

Intake valve	Exhaust valve
0.43	0.80

5. After the clearance is properly adjusted, tighten the lock nut to secure the adjustment screw.

kgm Lock nut : 6.0 ± 0.6 kgm



* The enigne firing order is 1-5-3-6-2-4.
* Intake and exhaust valve clearance may be adjusted for each cylinder in the firing order by rotating the crankshaft 120° at a time in the normal direction.

MEASURING COMPRESSION PRESSURE

MEASUREMENT PROCEDURE

⚠ While measuring the compression pressure, take care not burn yourself on the exhaust manifold or muffler,and be careful not to get caught in any revolving part of the engine.
* Measure the compression pressure while the engine is warm.
(Oil temperature : 40~ 60° c)

1. Adjust the valve clearance properly, For details, see ADJUSTING VALVE CLEARANCE.

2. Disconnect fuel injection tube (1).

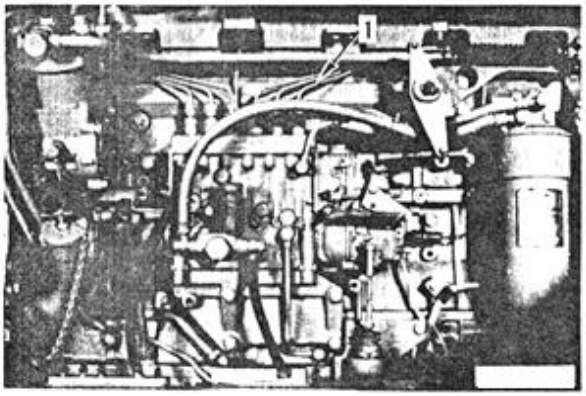
3. Remove inlet connector (2) and nozzle holder assembly (3) for each cylinder.

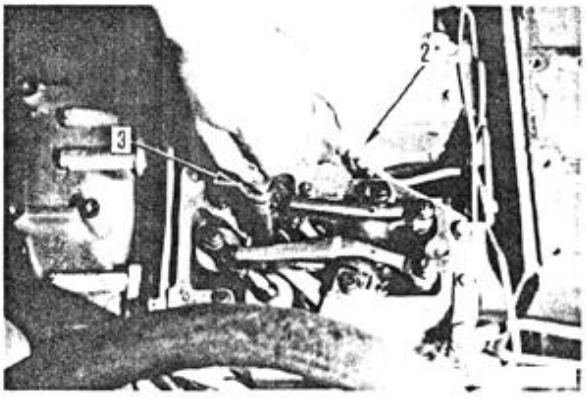
4. Install dapter (4) to the nozzle holder mounting section of the cylinder to be tighten the adapter with retainer (5) to the specified torque:
kgm Torque : 6.8± 0.75 kgm

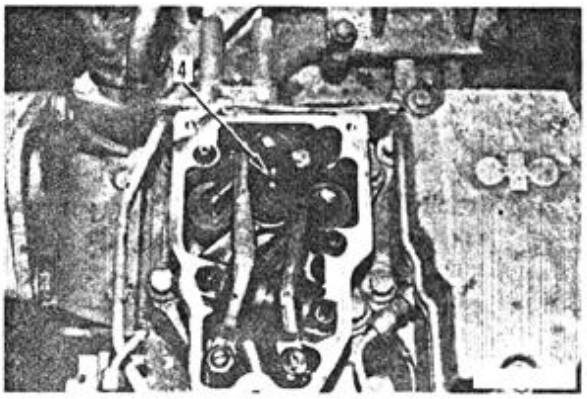
5. Connect compression gauge A to the adapter.

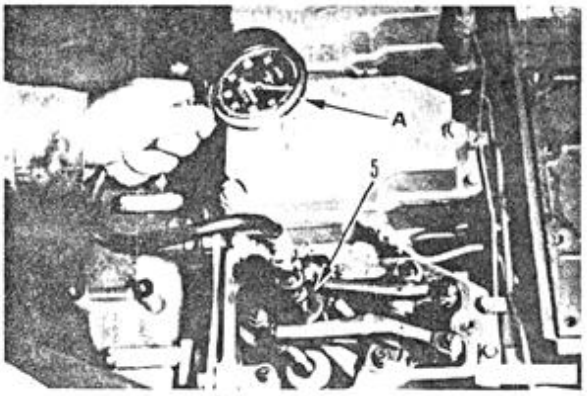
6. Place the fuel control lever in NO INJECTION position,crank the engine with the starting motor, and read the gauge when the pointer is stabilized.

⚠ If you do not put the fuel control lever in No INJECTION position, fuel will blow out.
* Most compression leakage can be prevented by applying a small amount of oil to the mounting section to the adapter.
* For the reference values of he compression pressure, see TESTING AND ADJUSTING DATA.









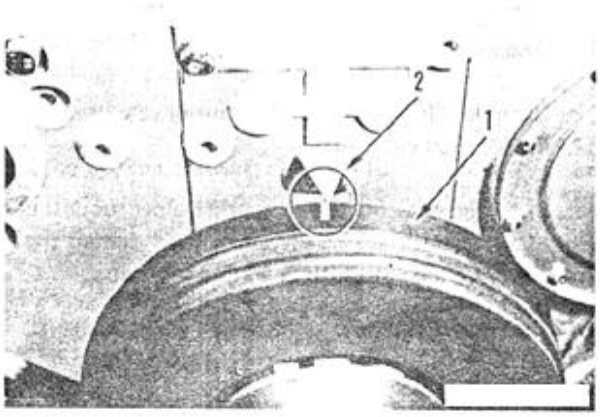
FUEL SYSTEM

CHECKING AND ADJUSTING FUEL INJECTION TIMING

There are two methods for checking and adjusting the fuel injection timing of an injection pump.

- The "MATCH MARK ALIGNTMENT" method, which is used when the injection pump is installed to the original engine and the pump is not being repaired.
- The "DELIVERY VALVE" method,which is used when a repaired or replaced injection pump is installed to the engine.

* Before inspecting and adjusting the fuel injection timing, bring the No. 1 cylinder piston to the top dead center of the compression stroke.For details, see 12 ADJUSTING VALVE CLEARANCE.



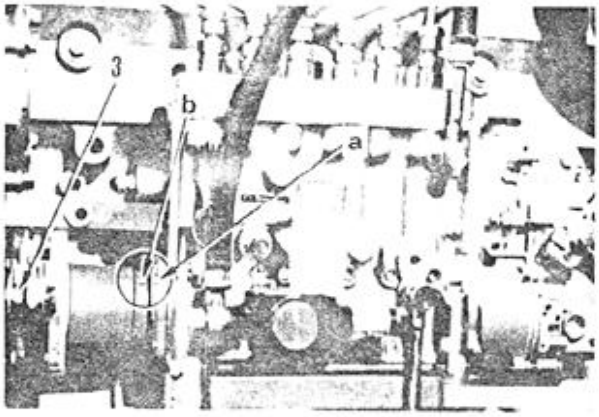
CHECKING AND ADJUSTING BY THE MATCH MARK ALIGNMENT METHOD

1. With No. 1 cylinder piston at TOP position, rotate the crankshaft 30° to 40° in the reverse direction.

2. Align the injection timing stamp line on vibration damper (1) with pointer (2) by slowly rotating the crankshaft in the normal direction.

3. Confirm that stamp line **'a'** on the injection pump is aligned with stamp line **'b'** on the coupling.

* If the stamp lines are out of alignment ,loosen nut (3), align the stamp lines by shifting the coupling, and tighten the nut.

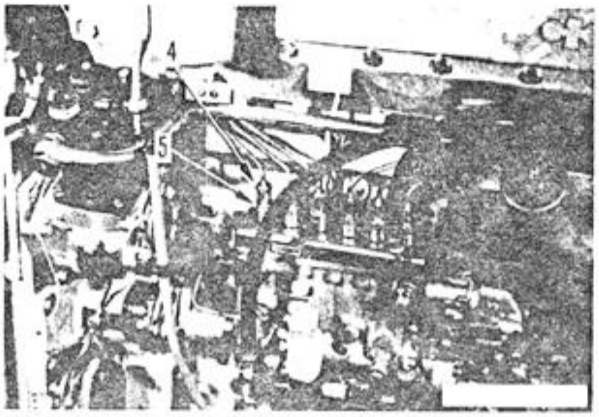


kgm Nut : 6.2 ± 0.2 kgm

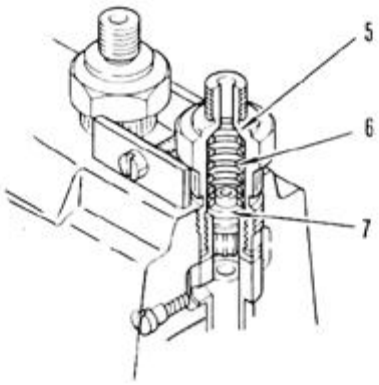
CHECKING AND ADJUSTING BY THE DELIVERY METHOD

1. Disconnect fuel injection tube (4) for the No. 1 cylinder.

2. Remove delivery valve holder (5).



3. Remove spring (6) and delivery valve (7) from the delivery valve holder, and reassemble the delivery valve holder.

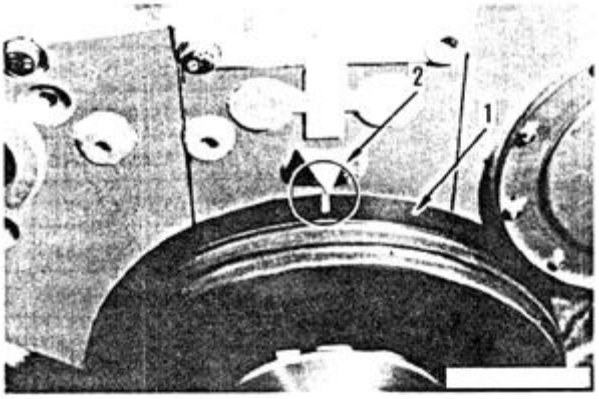


4. With No.1 cylinder piston at TOP postition, rotate the crankshaft 30° to 40° in the reverse direction.

5. Place the fuel control lever in FULL position, slowly rotate the crankshaft in the normal direction while operating the priming pump, and observe the position when the fuel stops flowing out of the delivery valve holder.

6. In the position where the outflow of fuel stops, check the injection timing stamp line on the crankshaft damper to see if it is aligned with the pointer.
   * If the injection timing stamp line passed through the pointer : The injection timing is late.
   * If the injection timing stamp line did not reach the pointer : The injection timing is advanced.

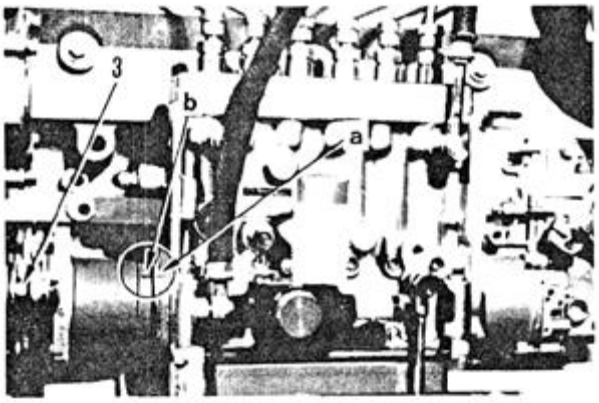
* If the inspection shows that the injection, timing is out of adjustment, adjust the fuel injection timing in the following manner.
  * After the checking and adjusting, be sure to reassemble the spring and the delivery valve.



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

2. Align the injection timing stamp line on damper (1) with pointer (2) by slowly rotating the crankshaft in the normal direction.

3. Loosen nut (3) on the injection pump mounting flange slot, and rotate the flange on the pump side litlle by little by operating the priming pump until no fuel flows out of the delivery valve holder.



4. Tighten the nut on the injection pump mounting flange slot.
   * Recheck the injection timing to see if it is properly adjusted.

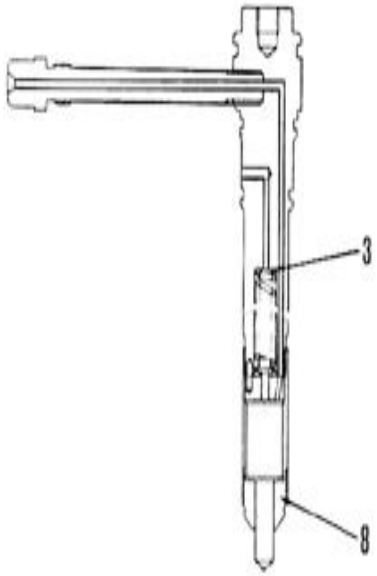
5. If match marks a and b are not aligned, stamp new one.

ADJUSTING FUEL INJECTION PRESSURE

1. Remove retaining cap (8).
2. Confirmed thickness of adjustment shim (3).
3. Insert correct shim (3) in response to the adjust ment valve of injection pressure.
4. Tighten retaining cap (8), then confirm the fuel injection pressure.

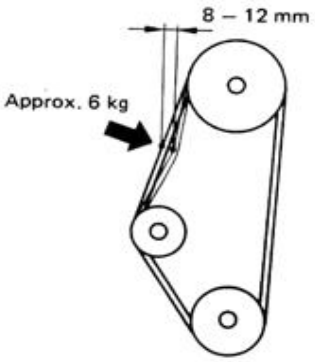
   kgm Retaining cap : 6.5 ± 0.5 kgm

   * Fuel injection pressure : 250 $^{+13}_{+5}$ kg/cm²
   * Adjustment value per shim thickness of 0.025mm: 3.5 kg/cm²
   * Prepared shims : 0.5 to 1.975mm (at intervals of 0.025 mm)
   * Refer to the parts book for part numbers of the prepared shims.



COOLING SYSTEM

CHECKING AND ADJUSTING V-BELT TENSION

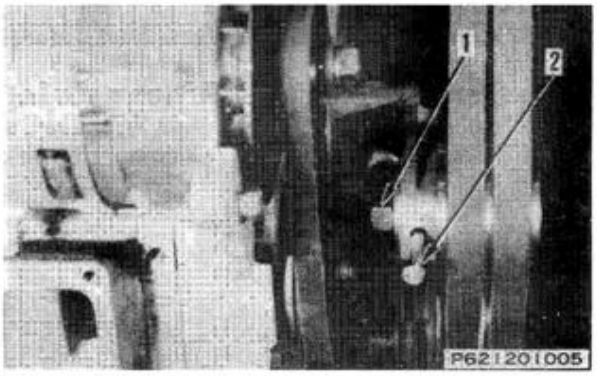


CHECKING AND ADJUSTING FAN BELT TENSION

(BS6D140-1)

1. Checking the fan belt tension.
   To check the fan belt tension, push the belt at the mid-point between the fan and tension pulleys with a force of approx. 6 kg and measure the distance that the belt sags.

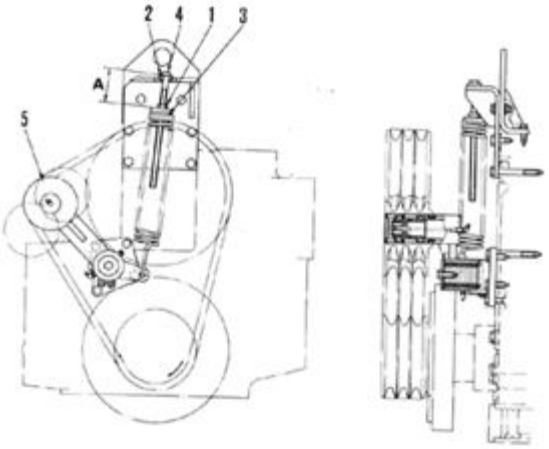
2. Adjusting the fan belt tension.
   1) Loosen tension puley mounting nut (1).
   2) Adjusting the belt tension while tightening adjust ment bolt (2).
   At the proper tension, fix the pulley by tightening tension pulley mounting nut (1).



(BSA6D140-1)

Unit : mm

Engine model	Applicable machine	Dimension A
BSA6D140-1	BE 650-3, BH40, BH35-2, BDG 360	55±4



1. Adjustment nut
2. Washer
3. Tension spring
4. Adjsutment bolt
5. Tension pulley

A. Protrusion of adjustment bolt

PUMP ASSEMBLY NUMBER
6211-71-1110 (106692-4881)

Injection Pump Type	Pump Manufacture
PE-6P	DIESEL KIKI

Applicable Machine		Applicable Engine	
Model	Serial No.	Model	Serial No.
D135A-2	10301 and up	BS6D140-1	10001 and up

Injection Timing :

	Unit	Basis	Allowance
Rotating direction		Clockwise viewed from drive end	
Injection order		1 - 5 - 3 - 6 - 2 - 4	
Injection interval		60° ± 30'	
Plunger pre-stroke	mm	4.3± 0.05	
Delivery valve Retraction volume	mm^3st	60	

Specification engine: (reference only)

Rated horsepower	hp/r/min	285 @ 2000
Maximum torque	kgm/r/min	126 @ 1400
High idling	r/min	2300 to 2400
Low idling	r/min	650 to 750

Calibration Standard :

Conditions

Service standard indicates data using calibration test parts

Manufacturer standard data for factory test.

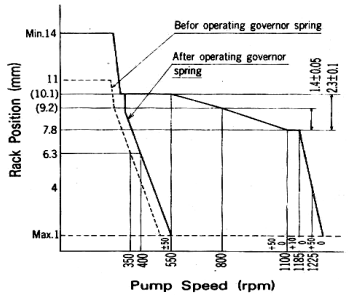
	Unit	Manufacture standard (with nearly the same actual machine parts)	Service standard (with calibration test parts)
Nozzle part no.		(105780-0000)	6211-11-3120(105015-6390)
Nozzle holder part no.		(105780-2080)	6211-11-3110(105041-7051)
Injection pipe (O/D × I/D × length)	mm	⌀8 x ⌀3 x 600	6 x 2.2 x 630 -
Test Fuel		ASTM D975 No. 2 diesel fuel or equicalent	
Fuel temperature	℃	43 to 47	
Nozzle opening pressure	kg/cm^2	175	250
Transfer pump pressure	kg/cm^2	1.6	1.6

Injection Volume

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

Rack point	Rack Position (r/min)	Pump Speed (r/min)	Service stadard (cc /100st) Basis	Service stadard (cc /100st) Allowance (Each cylinder)	Service stadard (cc /100st) Maximum variance between cylinder	Manufacturer standard (cc/100st) Basis	Manufacturer standard (cc/100st) Allowance	Manufacturer standard (cc/100st) Maximum variance between cylinder
Basic Point	8.2	1000	15.80	Each cylider 15.60 to 16.00	±0.474	17.56	Ecah cyl.	
B	9.1	700	17.86	*17.66 to 18.06	--	19.82	*	
C	Approx.	325	1.47	* 1.32 to 1.62	±0.2205	1.7	*	
D				*			*	
E				*			*	

Governor performance : (325 -1000r/min)



Machine Model	Engine Model	Injection Pump Type	Pump Manufacturer
WA500-1 302 HP	**S6D140-1** S/N 10001 and up	PE-6P	DIESEL KIKI

Pump Assembly Number

6211-71-1311 (106672-9181).... 2

( ): Manufacturer's part No.

Injection Timing

	Unit	Basis	Allowance
Rotating direction		Counterclockwise viewed from drive end	
Injection order		1–5–3–6–2–4	
Injection interval		60°	59°30' to 60°30'
Plunger pre-stroke	mm	4.3	4.25 to 4.35
Delivery valve retraction volume	mm^3	60	

Specification for engine with fan (reference only)

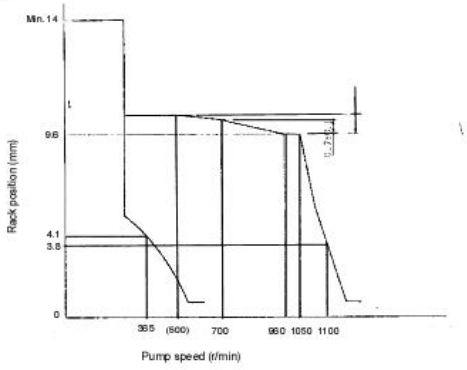
Rated horsepower:	HP/rpm	302/2100
Maximum torque:	kgm/rpm	126.5/1400
High idling:	rpm	2300 to 2400
Low idling:	rpm	700 to 750

Calibration Standard

Conditions	Unit	Manufacturer standard (with nearly the same actual machine parts)	Service standard (with calibration test parts)
Nozzle part no.		(105780-0000)	(105780-0000)
Nozzle holder part no.		(105780-2080)	(105780-2080)
Injection pipe (O/D x I/D x length)	mm	8 x 3 x 600	8 x 3 x 600
Test oil		ASTM D975 No. 2 diesel fuel or equivalent	
Oil temperature	°C	40 to 45	40 to 45
Nozzle opening pressure	kg/cm^2	175	175
Transfer pump pressure	kg/cm^2	1.6	1.6

Specifications		Rack position (mm)	Pump speed (rpm)	Injection volume (cc/500st) for manufacturer standard: Basis	Allowance	Maximum variance between cylinder	Injection volume (cc/ st) for service standard: Basis	Allowance	Maximum variance between cylinder
Calibration basic point		8.3	1050	66.95	Each cyl. 65.95 to 67.95	±1.5		Each cyl.	
• Rack positions B to E are the reference volume when adjusting the injection volume. • Marks ★ are average volumes.	B	3.5	365	5.75	★ 5.00 to 6.50	±7.5		★	
	C				★			★	
	D				★			★	
	E				★			★	

Governor Performance: (365 - 1050)



FUEL INJECTION PUMP CALIBRATIONT CHART

Pump Assembly Number

6211-71-1312 (106672-9441)

( ): Manufacturer's part No.

Injection Pump Type	Pump Manufacturer
PE-6P	DIESEL KIKI

Applicable Machine		Applicable Engine	
Model	Serial No.	Model	Serial No.
WA500-1		BS6D140-1	

Injection Timing

Rotating direction	Clockwise viewed from drive end
Injection order	1–5–3–6–2–4
Injection interval	60° ± 30'
Plunger pre-stroke mm	4.3 ± 0.05
Delivery valve retraction volume mm^3/st	60

Engine specification

Rated horsepower HP/rpm	291/2,100
Maximum torque kgm/rpm	125/1,400
High idling rpm	2,300 to 2,400
Low idling rpm	650 to 750

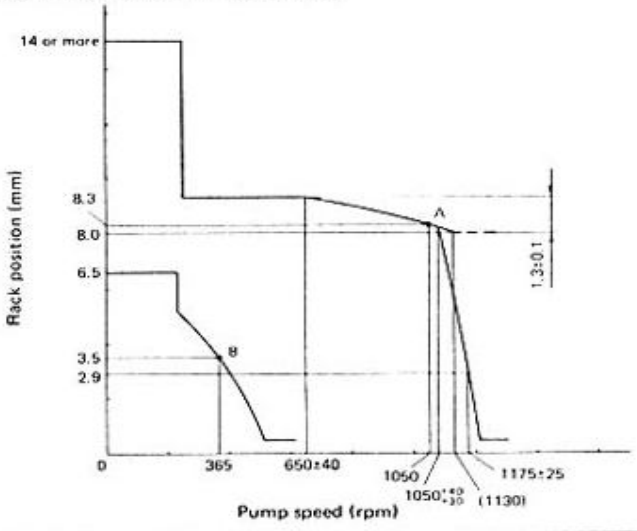
Pump tester capacity for Service standard	Motor 7.5 KW

Calibration Standard

Conditions		Service standard	Manufacturer standard
• Service standard indicates data using calibration test parts. • Manufacture standard is data for factory test.	Nozzle part no.	(105780-0000)	6211-11-3220 (105015-6390)
	Nozzle holder part no.	(105780-2080)	6211-11-3110 (105041-7050)
	Injection pipe (O/D x I/D x length) mm	8 x 3 x 600	6 x 2 x 630
	Test oil	ASTM D975 No. 2 diesel fuel or equivalent	
	Oil temperature °C	43 to 47	
	Nozzle opening pressure kg/cm^2	175	250
	Transfer pump pressure kg/cm^2	1.6	1.6

Injection volume	Rack point	Rack position (mm)	Pump speed (rpm)	Service standard (cc/ 100 st)			Manufacturer standard (cc/ 100 st)		
				Basis	Allowance	Maximum variance between cylinder	Basis	Allowance	Maximum variance between cylinder
• Rack positions B to E are the reference volume when adjusting the injection volume. • Marks ★ are average volumes.	Basic point	8.3	1050	13.39	Each cyl. 13.19 to 13.59	±0.4017	15.55	Each cyl.	
	B	Approx. 3.5	365	1.15	★ 1.0 to 1.3	±0.1725	1.7	★	
	C				★			★	
	D				★			★	
	E				★			★	

Governor performance (365 — 1050 rpm)



FUEL INJECTION PUMP CALIBRATIONT CHART

Pump Assembly Number
6211-71-1313 (106692-4710)
(106692-4712)
( ): Manufacturer's part No.

Injection Pump Type	Pump Manufacturer
PE-6P	DIESEL KIKI

Applicable Machine		Applicable Engine	
Model	Serial No.	Model	Serial No.
WA500-1		**BS6D140-1**	

Injection Timing

Rotating direction	Clockwise viewed from drive end
Injection order	1–5–3–6–2–4
Injection interval	60° ± 30′
Plunger pre-stroke mm	4.3 ± 0.05
Delivery valve retraction volume mm^3/st	60

Engine specification

Rated horsepower	HP/rpm	291/2100
Maximum torque	kgm/rpm	125/1400
High idling	rpm	2300 to 2400
Low idling	rpm	650 to 750

Pump tester capacity for Service standard	Motor 7.5 KW

Calibration Standard

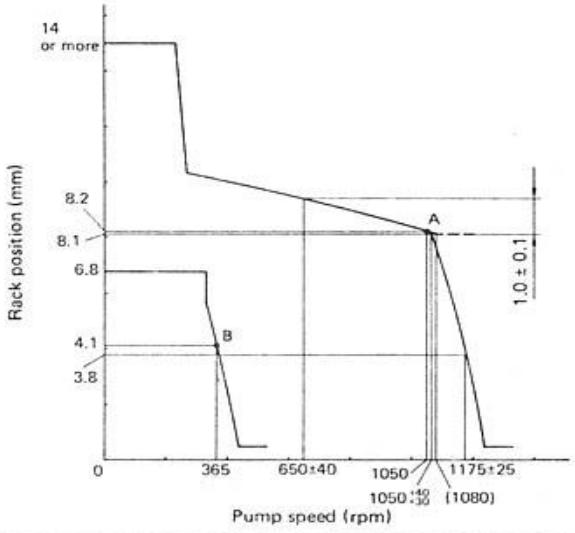
Conditions
- **Service standard** indicates data using calibration test parts.
- **Manufacture standard** is data for factory test.

	Service standard	Manufacturer standard
Nozzle part no.	(105780-0000)	6211-11-3120 (105015-6390)
Nozzle holder part no.	(105780-2080)	6211-11-3110 (105041-7051)
Injection pipe (O/D x I/D x length) mm	8 x 3 x 600	6 x 2.2 x 630
Test oil	ASTM D975 No. 2 diesel fuel or equivalent	
Oil temperature °C	43 to 47	
Nozzle opening pressure kg/cm^2	175	250
Transfer pump pressure kg/cm^2	1.6	1.6

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/ 100 st) Basis	Allowance	Maximum variance between cylinder	Manufacturer standard (cc/ 100 st) Basis	Allowance	Maximum variance between cylinder
Basic point	8.2	1050	15.42	Each cyl. 15.22 to 15.62	±0.4626	16.82	Each cyl.	
B	Approx. 3.8	365	1.42	★ 1.27 to 1.57	±0.213	1.7	★	
C				★			★	
D				★			★	
E				★			★	

Governor performance (365 – 1050 rpm)



FUEL INJECTION PUMP CALIBRATIONT CHART

Pump Assembly Number
6211-71-1330 (106672-9333)
6211-71-1331 (106672-9334)
( ): Manufacturer's part No.

Injection Pump Type	Pump Manufacturer
PE-6P	DIESEL KIKI

Applicable Machine		Applicable Engine	
Model	Serial No.	Model	Serial No.
GD825A-1	10002 and up	S6D140-1	
(For cold weather)			

Injection Timing

Rotating direction	Clockwise viewed from drive end
Injection order	1 – 5 – 3 – 6 – 2 – 4
Injection interval	60°±30′
Plunger pre-stroke mm	4.3 ± 0.05
Delivery valve retraction volume mm^3/st	60

Engine specification

Rated horsepower	HP/rpm	280/2100
Maximum torque	kgm/rpm	126/1400
High idling	rpm	2300 to 2400
Low idling	rpm	650 to 700

Pump tester capacity for Service standard	Motor 7.5 KW

Calibration Standard

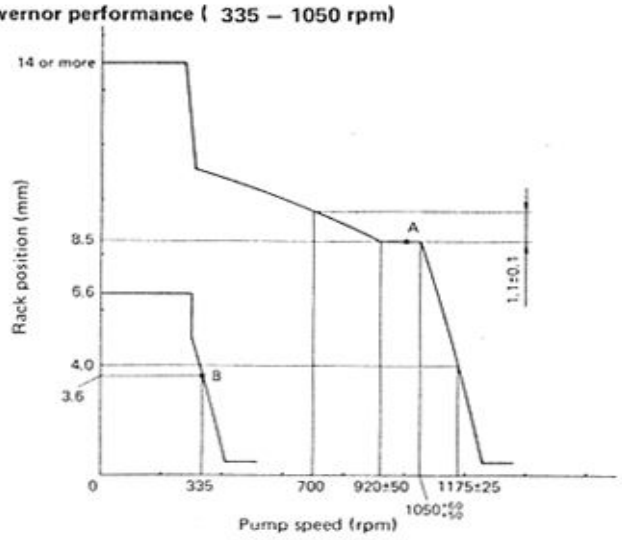
Conditions
- **Service standard** indicates data using calibration test parts.
- **Manufacture standard** is data for factory test.

	Service standard	Manufacturer standard
Nozzle part no.	(105780-0000)	6211-11-3120 (105015-6390)
Nozzle holder part no.	(105780-2080)	6211-11-3110 (105041-7051)
Injection pipe (O/D x I/D x length) mm	8 x 3 x 600	6 x 2.2 x 630
Test oil	ASTM D975 No. 2 diesel fuel or equivalent	
Oil temperature °C	43 to 47	
Nozzle opening pressure kg/cm^2	175	250
Transfer pump pressure kg/cm^2	1.6	1.6

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/ 100st) Basis	Service standard (cc/ 100st) Allowance	Service standard (cc/ 100st) Maximum variance between cylinder	Manufacturer standard (cc/ 100st) Basis	Manufacturer standard (cc/ 100st) Allowance	Manufacturer standard (cc/ 100st) Maximum variance between cylinder
Basic point	8.5	1050	13.72	Each cyl. 13.52 to 13.92	±0.4116	16.0	Each cyl.	
B	Approx. 3.6	335	1.30	★ 0.80 to 1.80	±0.195	1.3	★	
C				★			★	
D				★			★	
E				★			★	

Governor performance (335 – 1050 rpm)



FUEL INJECTION PUMP CALIBRATIONT CHART

Machine Model	Engine Model	Injection Pump Type	Pump Manufacturer
GD825A-1 285 HP	S6D140 S/N 10278 and up	PE-6P	DIESEL KIKI

Pump Assembly Number

6211-71-1320 (106672-9310)....0

( ): Manufacturer's part No.

Injection Timing

	Unit	Basis	Allowance
Rotating direction		Counterclockwise viewed from drive end	
Injection order		1–5–3–6–2–4	
Injection interval		60°	59°30' to 60°30'
Plunger pre-stroke	mm	4.3	4.25 to 4.35
Delivery valve retraction volume	mm^3	60	

Specification for engine with fan (reference only)

Rated horsepower:	HP/rpm	285/2100
Maximum torque:	kgm/rpm	128/1400
High idling:	rpm	2300 to 2400
Low idling:	rpm	650 to 700

Calibration Standard

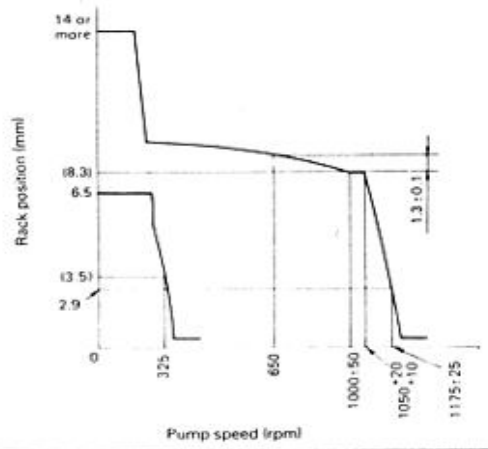
Conditions	Unit	Manufacturer standard (with nearly the same actual machine parts)	Service standard (with calibration test parts)
Nozzle part no.		(105780-0000)	(105780-0000)
Nozzle holder part no.		(105780-2080)	(105780-2080)
Injection pipe (O/D x I/D x length)	mm	8 x 3 x 600	8 x 3 x 600
Test oil		ASTM D975 No. 2 diesel fuel or equivalent	ASTM D975 No. 2 diesel fuel or equivalent
Oil temperature	°C	40 to 45	40 to 45
Nozzle opening pressure	kg/cm^2	175	175
Transfer pump pressure	kg/cm^2	1.6	1.6

Specifications

• [ ]: Reference data

		Rack position (mm)	Pump speed (rpm)	Injection volume (cc/ 500st) for manufacturer standard: Basis	Allowance	Maximum variance between cylinder	Injection volume (cc/ st) for service standard: Basis	Allowance	Maximum variance between cylinder
Calibration basic point		[8.3]	1050	80	Each cyl. 79 to 81	[±2.4]		Each cyl.	
• Rack positions B to E are the reference volume when adjusting the injection volume.	B	[3.5]	325	6.5	★ 5.75 to 7.25	±0.325		★	
	C				★			★	
	D				★			★	
• Marks ★ are average volumes.	E				★			★	

Governor performance (325 – 1050 rpm)



FUEL INJECTION PUMP CALIBRATIONT CHART

Pump Assembly Number

6211-71-1420 (106672-9401)
6211-71-1421 (106672-9402)
( ): Manufacturer's part No.

Injection Pump Type	Pump Manufacturer
PE-6P	DIESEL KIKI

Applicable Machine		Applicable Engine	
Model	Serial No.	Model	Serial No.
WS23-2		S6D140-1	
(For front engine)			

Injection Timing

Rotating direction	Clockwise viewed from drive end
Injection order	1–5–3–6–2–4
Injection interval	60° ± 30′
Plunger pre-stroke mm	4.3 ± 0.05
Delivery valve retraction volume mm^3/st	60

Engine specification

Rated horsepower	HP/rpm	400/2100
Maximum torque	kgm/rpm	159/1400
High idling	rpm	2300 to 2400
Low idling	rpm	750 to 800

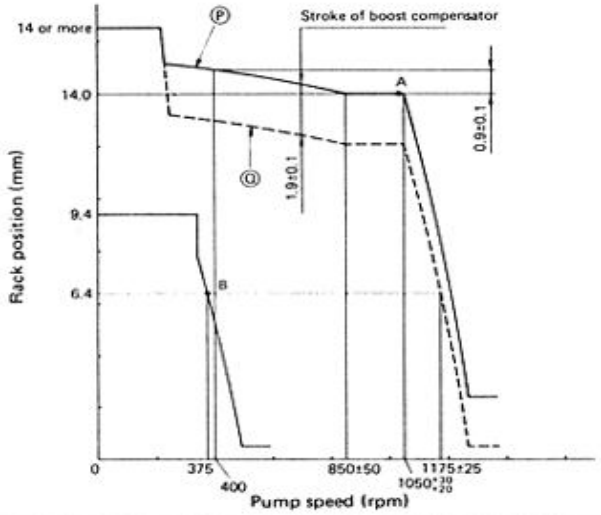
Pump tester capacity for Service standard	Motor 7.5 KW

Calibration Standard

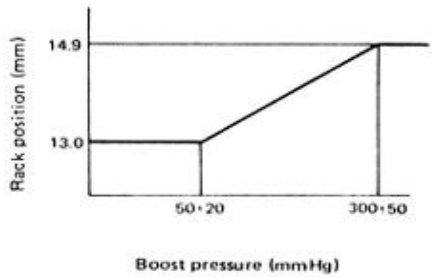
Conditions		Service standard	Manufacturer standard
• **Service standard** indicates data using calibration test parts. • **Manufacture standard** is data for factory test.	Nozzle part no.	(105780-0050)	6211-11-3320 (105015-6920)
	Nozzle holder part no.	(105780-2090)	6211-11-3110 (105041-7051)
	Injection pipe (O/D x I/D x length) mm	8 x 3 x 600	6 x 2.2 x 630
	Test oil	ASTM D975 No. 2 diesel fuel or equivalent	
	Oil temperature °C	43 to 47	
	Nozzle opening pressure kg/cm^2	175	250
	Transfer pump pressure kg/cm^2	1.6	1.6

Injection volume	Rack point	Rack position (mm)	Pump speed (rpm)	Service standard (cc/ 100 st) Basis	Allowance	Maximum variance between cylinder	Manufacturer standard (cc/ 100 st) Basis	Allowance	Maximum variance between cylinder
• Rack positions B to E are the reference volume when adjusting the injection volume. • Marks ★ are average volumes.	Basic point	14.0	1050	26.74	Each cyl. 26.54 to 26.94	±0.8022	21.2	Each cyl.	
	B	Approx. 6.4	375	2.06	★ 1.91 to 2.21	±0.309	1.7	★	
	C				★			★	
	D				★			★	
	E				★			★	

Governor performance (375 — 1050 rpm)



Boost compensator performance (400 rpm)



Line Ⓟ: At boost pressure 400 mmHg or more
Line Ⓠ: At boost pressure 0 mmHg

FUEL INJECTION PUMP CALIBRATIONT CHART

Pump Assembly Number

6211-71-1430 (106672-9411)
6211-71-1431 (106672-9412)
( ): Manufacturer's part No.

Injection Pump Type	Pump Manufacturer
PE-6P	DIESEL KIKI

Applicable Machine		Applicable Engine	
Model	Serial No.	Model	Serial No.
WS23-2		S6D140-1	
(For rear engine)			

Injection Timing

Rotating direction	Clockwise viewed from drive end
Injection order	1–5–3–6–2–4
Injection interval	60° ± 30′
Plunger pre-stroke mm	4.3 ± 0.05
Delivery valve retraction volume mm^3/st	60

Engine specification

Rated horsepower	HP/rpm	400/2100
Maximum torque	kgm/rpm	159/1400
High idling	rpm	2300 to 2400
Low idling	rpm	750 to 800

Pump tester capacity for Service standard	Motor 7.5 KW

Calibration Standard

Conditions

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

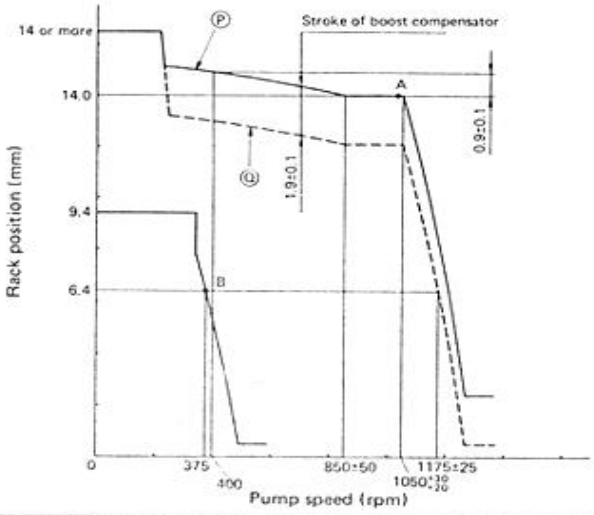
	Service standard	Manufacturer standard
Nozzle part no.	(105780-0050)	6211-11-3320 (105015-6920)
Nozzle holder part no.	(105780-2090)	6211-11-3110 (105041-7051)
Injection pipe (O/D x I/D x length) mm	8 x 3 x 600	6 x 2.2 x 630
Test oil	ASTM D975 No. 2 diesel fuel or equivalent	
Oil temperature °C	43 to 47	
Nozzle opening pressure kg/cm^2	175	250
Transfer pump pressure kg/cm^2	1.6	1.6

Injection volume

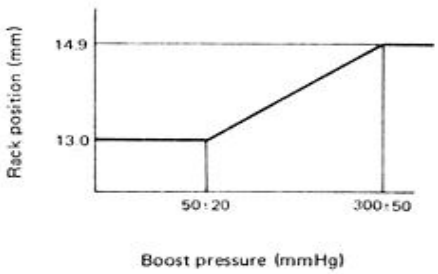
- Rack positions B to E are the reference volume when adjusting the injection volume.
- Marks ★ are average volumes.

Rack point	Rack position (mm)	Pump speed (rpm)	Service standard (cc/ 100st) Basis	Service standard (cc/ 100st) Allowance	Service standard (cc/ 100st) Maximum variance between cylinder	Manufacturer standard (cc/ 100st) Basis	Manufacturer standard (cc/ 100st) Allowance	Manufacturer standard (cc/ 100st) Maximum variance between cylinder
Basic point	14.0	1050	26.74	Each cyl. 26.54 to 26.94	±0.8022	21.2	Each cyl.	
B	Approx. 6.4	375	2.06	★ 1.91 to 2.21	±0.309	1.7	★	
C				★			★	
D				★			★	
E				★			★	

Governor performance (375 — 1050 rpm)



Boost compensator performance (400 rpm)



Line Ⓟ: At boost pressure 400 mmHg or more
Line Ⓖ: At boost pressure 0 mmHg

FUEL INJECTION PUMP CALIBRATIONT CHART

6211-71-1451 (191000-5932)

( ): Manufacturer's part No.

Injection Pump Type	Pump Manufacturer
NE(EP-11)	NIPPON DENSO

Applicable Machine		Applicable Engine	
Model	Serial No.	Model	Serial No.
HD325-5C		S6D140-1	

Injection Timing

Rotating direction	Clockwise viewed from drive end
Injection order	1 — 5 — 3 — 6 — 2 — 4
Injection interval	60° ± 30′
Plunger pre-stroke mm	3.65
Delivery valve retraction volume mm³/st	120

Engine Specification

Rated horsepower	HP/rpm	399/2100
Maximum torque	kgm/rpm	161/1400
High idling	rpm	2350 to 2450
Low idling	rpm	700 to 750

Pump tester capacity for Service standard	Motor 7.5 KW

Calibration Standard

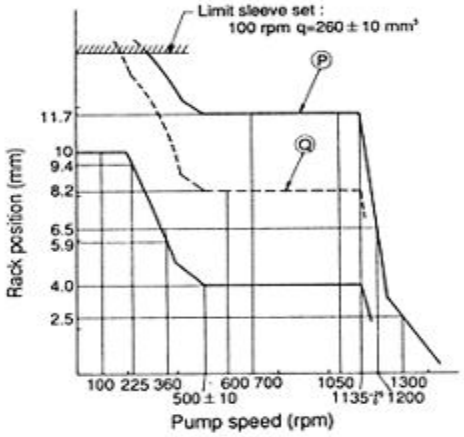
Conditions		Service standard	Manufacturer standard
• **Service standard** indicates data using calibration test parts. • **Manufacture standard** is data for factory test.	Nozzle part no.	(093400-1800)	(093400-1800)
	Nozzle holder part no.	(093100-0951)	(093100-0951)
	Injection pipe (O/D × I/D × length) mm	6 × 2.2 × 650	6 × 2.2 × 650
	Test oil	ASTM D975 No.2 diesel fuel or equivalent	
	Oil temperature °C	40 to 45	
	Nozzle opening pressure kg/cm²	250	250
	Transfer pump pressure kg/cm²	2.0	2.0

Injection volume

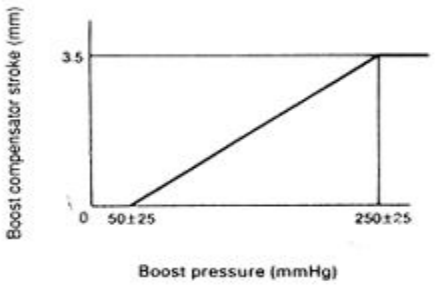
- Rack positions B to E are the reference volume when adjusting the injection volume.
- Marks ★ are average volumes.

Rack point	Rack position (mm)	Pump speed (rpm)	Service standard (cc/ 100st) Basis	Allowance	Maximum variance between cylinder	Manufacturer standard (cc/ 100st) Basis	Allowance	Maximum variance between cylinder
Basic point	11.7	700	[23.0]	Each cyl. [23.0]	Max 1.0	[23.0]	Each cyl.	
B	11.7	1050	21.8	★ 21.3 to 22.3	Max 1.0	21.8	★	
C	5.9	360	2.0	★ 1.8 to 2.2	Max 0.5	2.0	★	
D				★			★	
E				★			★	

Governor performance (360 — 1050 rpm)



Boost compensator performance (600 rpm)



Line Ⓟ : At boost pressure 400 mmHg or more
Line Ⓠ : At boost pressure 0 mmHg

FUEL INJECTION PUMP CALIBRATIONT CHART

Machine Model	Engine Model	Injection Pump Type	Pump Manufacturer
HD325-5 487 HP	**SA6D140** S/N 10185 and up	PE-6NE	NIPPON DENSO

Pump Assembly Number

6212-71-1210 (191000-1090). . . . 0

( ): Manufacturer's part No.

Injection Timing

	Unit	Basis	Allowance
Rotating direction		Clockwise viewed from drive end	
Injection order		1 – 5 – 3 – 6 – 2 – 4	
Injection interval		60°	59°30' to 60°30'
Plunger pre-stroke	mm	3.65	3.60 to 3.70
Delivery valve retraction volume	mm^3	120	

Specification for engine with fan (reference only)

Rated horsepower:	HP/rpm	487/2100
Maximum torque:	kgm/rpm	196/1400
High idling:	rpm	2350 to 2450
Low idling:	rpm	750 to 800

Calibration Standard

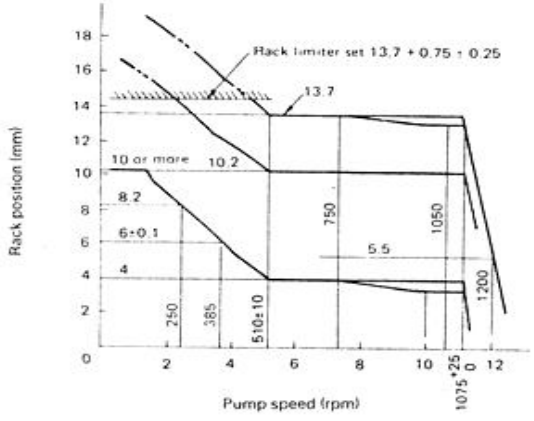
Conditions	Unit	Manufacturer standard (with nearly the same actual machine parts)	Service standard (with calibration test parts)
Nozzle part no.		093400-1800	093400-1800
Nozzle holder part no.		093100-0951	093100-0951
Injection pipe (O/D x I/D x length)	mm	6 x 2.2 x 630	6 x 2.2 x 630
Test oil		ASTM D975 No. 2 diesel fuel or equivalent	ASTM D975 No. 2 diesel fuel or equivalent
Oil temperature	°C	40 to 45	40 to 45
Nozzle opening pressure	kg/cm^2	250	250
Transfer pump pressure	kg/cm^2	2.0	2.0

Specifications

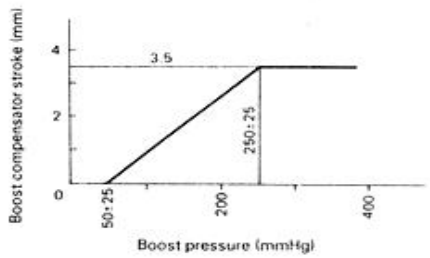
• [ ] : Reference data

		Rack position (mm)	Pump speed (rpm)	Injection volume (cc/ 100st) for manufacturer standard: Basis	Allowance	Maximum variance between cylinder	Injection volume (cc/ st) for service standard: Basis	Allowance	Maximum variance between cylinder
	Calibration basic point	13.7	700	28	Each cyl. 27.5 to 28.5	2.8 or less		Each cyl.	
• Rack positions B to E are the reference volume when adjusting the injection volume.	B	13.7	1050	26	★ 25.5 to 26.5	2.6 or less		★	
	C	5.9	385	2	★ 1.8 to 2.2	0.1 or less		★	
• Marks ★ are average volumes.	D	[13.7]	700	28	★ 27.5 to 28.5			★	
	E	[13.7]	1050	24	★ 25.5 to 26.5			★	

Governor performance



Boost compensator performance (600 rpm)



FUEL INJECTION PUMP CALIBRATIONT CHART

Pump Assembly Number
6212-71-1211(191000-1090)
6212-71-1212(191000-1091)
6212-71-1213(191000-1092)
( ): Manufacturer's part No.

Injection Pump Type	Pump Manufacturer
NE(EP-11)	NIPPON DENSO

Applicable Machine		Applicable Engine	
Model	Serial No.	Model	Serial No.
HD325-5		SA6D140-1	10582 and up

Injection Timing

Rotating direction	Clockwise viewed from drive end
Injection order	1 – 5 – 3 – 6 – 2 – 4
Injection interval	60°±30'
Plunger pre-stroke mm	3.65±0.05
Delivery valve retraction volume mm^3/st	120

Engine specification

Rated horsepower	HP/rpm	463/2100
Maximum torque	kgm/rpm	196/1400
High idling	rpm	2350 to 2450
Low idling	rpm	750 to 800

Pump tester capacity for Service standard	Motor 7.5 KW

Calibration Standard

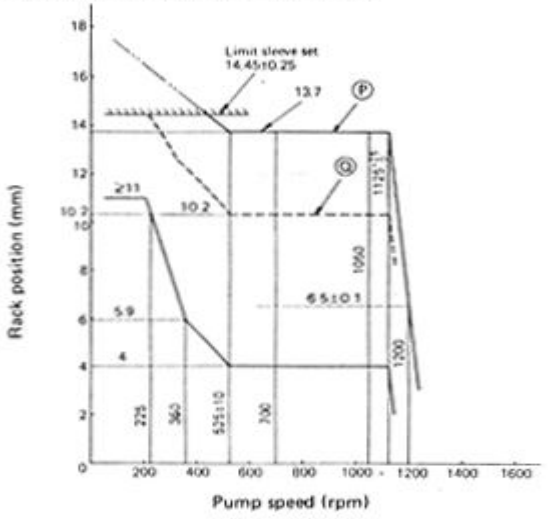
Conditions
- **Service standard** indicates data using calibration test parts.
- **Manufacture standard** is data for factory test.

	Service standard	Manufacturer standard
Nozzle part no.	(093400-1800)	(093400-1800)
Nozzle holder part no.	(093100-0951)	(093100-0951)
Injection pipe (O/D x I/D x length) mm	6 x 2.2 x 600	6 x 2.2 x 600
Test oil	ASTM D975 No. 2 diesel fuel or equivalent	
Oil temperature °C	40 to 45	
Nozzle opening pressure kg/cm^2	250	250
Transfer pump pressure kg/cm^2	2.0	2.0

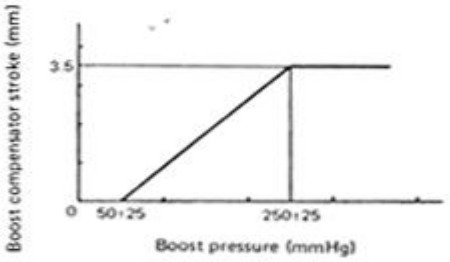
Injection volume
- Rack positions B to E are the reference volume when adjusting the injection volume.
- Marks ★ are average volumes.

Rack point	Rack position (mm)	Pump speed (rpm)	Service standard (cc/ 100 st) Basis	Allowance	Maximum variance between cylinder	Manufacturer standard (cc/ 100st) Basis	Allowance	Maximum variance between cylinder
Basic point	13.7	700	28.0	Each cyl. 27.5 to 28.5	Max. 1.0	28.0	Each cyl.	
B	13.7	1050	26.0	★ 25.5 to 26.5	Max. 1.0	26.0	★	
C	5.9	360	2.0	★ 1.8 to 2.2	Max. 0.5	2.0	★	
D				★			★	
E				★			★	

Governor performance (360 – 1050 rpm)



Boost compensator performance (600 rpm)



Line Ⓟ: At boost pressure 400 mmHg or more
Line Ⓠ: At boost pressure 0 mmHg

FUEL INJECTION PUMP CALIBRATIONT CHART

Pump Assembly Number

6212-71-1220 (191000-1360)
6212-71-1221 (191000-1361)
( ): Manufacturer's part No.

Injection Pump Type	Pump Manufacturer
NE(EP-11)	NIPPON DENSO

Applicable Machine		Applicable Engine	
Model	Serial No.	Model	Serial No.
WS23S-2	3001 and up	SA6D140-1	10428 and up

Injection Timing

Rotating direction	Clockwise viewed from drive end
Injection order	1 – 5 – 3 – 6 – 2 – 4
Injection interval	60°±30'
Plunger pre-stroke mm	3.65±0.05
Delivery valve retraction volume mm^3/st	120

Engine specification

Rated horsepower HP/rpm	450/2100
Maximum torque kgm/rpm	188/1400
High idling rpm	2300 to 2400
Low idling rpm	680 to 720

Pump tester capacity for Service standard	Motor 7.5 KW

Calibration Standard

Conditions

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

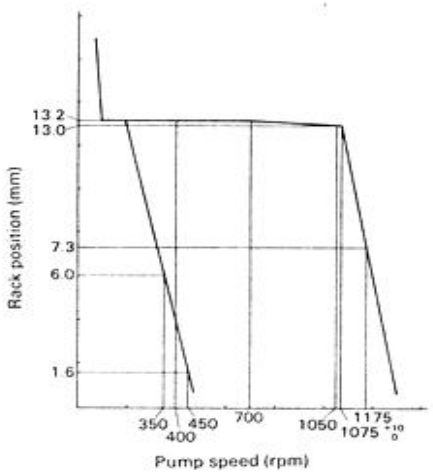
	Service standard	Manufacturer standard
Nozzle part no.	(093400-1800)	(093400-1800)
Nozzle holder part no.	(093100-0951)	(093100-0951)
Injection pipe (O/D x I/D x length) mm	6 x 2.2 x 650	6 x 2.2 x 650
Test oil	ASTM D975 No. 2 diesel fuel or equivalent	
Oil temperature °C	40 to 45	
Nozzle opening pressure kg/cm^2	250	250
Transfer pump pressure kg/cm^2	2.0	2.0

Injection volume

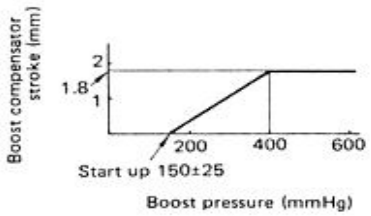
- Rack positions B to E are the reference volume when adjusting the injection volume.
- Marks ★ are average volumes.

Rack point	Rack position (mm)	Pump speed (rpm)	Service standard (cc/ 100st) Basis	Service standard (cc/ 100st) Allowance	Service standard (cc/ 100st) Maximum variance between cylinder	Manufacturer standard (cc/ 100st) Basis	Manufacturer standard (cc/ 100st) Allowance	Manufacturer standard (cc/ 100st) Maximum variance between cylinder
Basic point	13.0	1050	24.4	Each cyl. 23.9 to 24.9	Max. 1.0	24.4	Each cyl.	
B	13.2	700	27.2	★ 26.7 to 27.7	Max. 1.0	27.2	★	
C	(6.0)	350	2.0	★ 1.8 to 2.2	Max. 0.5	2.0	★	
D				★			★	
E				★			★	

Governor performance (350 – 1050 rpm)



Boost compensator performance (400 rpm)



PUMP ASSEMBLY NUMBER

41Z 718 1959

Injection Pump Type	Pump Manufacture
BOSCH	MICO

Applicable Machine	Applicable Engine	
Model	Model	
BH35-2 REAR DUMPER	BS6D140-1	

Injection Timing :

	Unit	Basis	Allowance
Rotating direction		Clockwise viewed from drive end	
Injection order		1 - 5 - 3 - 6 - 2 - 4	
Injection interval		60° ± 30'	
Plunger pre-stroke	mm	3.4± 0.05	
Delivery valve Retraction volume	mm^3st	90	

Specification engine: (reference only)

Rated horsepower	hp/r/min	292 @ 2100
Maximum torque	Nm/r/min	1652 @ 1400
High idling	r/min	2260 to 2360
Low idling	r/min	675~725

Calibration Standard :

Conditions		Unit	Manufacture standard (with nearly the same actual machine parts)	Service standard (with calibration test parts)
Service standard indicates data using calibration test parts	Nozzle part no.		----	----
	Nozzle holder part no.		----	----
	Injection pipe (O/D × I/D × length)	mm	⌀6 x ⌀2.2 x 650	----
	Test Fuel		ASTM D975 No. 2 diesel fuel or equicalent	
Manufacturer standard data for factory test.	Fuel temperature	℃	40~45	---
	Nozzle opening pressure	kg/cm^2	250	---
	Transfer pump pressure	kg/cm^2	2.0	---

Injection Volume

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

Rack point	Rack Position	Pump Speed (r/min)	Service stadard (mm^3/st) Basis	Allowance (Each cylinder)	Maximum variance between cylinder	Manufacturer standard (mm^3/ st) Basis	Allowance	Maximum variance between cylinder
Basic Point	---	1050	190	± 5	≤ 10			
B	---	700	223	± 5	≤ 10			
C	---	365	5605	± 2	≤ 5			

PUMP ASSEMBLY NUMBER

41Z 718 1959

Injection Pump Type	Pump Manufacture
BOSCH	MICO

Applicable Machine	Applicable Engine	
Model	Model	
BH35-2 /WS28-2	BS(A)6D140-1	

Injection Timing :

	Unit	Basis	Allowance
Rotating direction		Clockwise viewed from drive end	
Injection order		1 - 5 - 3 - 6 - 2 - 4	
Injection interval		60° ± 30'	
Plunger pre-stroke	mm	3.4± 0.05	
Delivery valve Retraction volume	mm^3st	90	

Specification engine: (reference only)

Rated horsepower	hp/r/min	292 @ 2100
Maximum torque	Nm/r/min	1652 @ 1400
High idling	r/min	2260 to 2360
Low idling	r/min	675~725

Calibration Standard :

Conditions

Service standard indicates data using calibration test parts

Manufacturer standard data for factory test.

	Unit	Manufacture standard (with nearly the same actual machine parts)	Service standard (with calibration test parts)
Nozzle part no.		----	----
Nozzle holder part no.		----	----
Injection pipe (O/D × I/D × length)	mm	⌀6 x ⌀2.2 x 650	----
Test Fuel		ASTM D975 No. 2 diesel fuel or equicalent	
Fuel temperature	℃	40~45	---
Nozzle opening pressure	kg/cm^2	250	---
Transfer pump pressure	kg/cm^2	2.0	---

Injection Volume

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

Rack point	Rack Position	Pump Speed (r/min)	Service stadard (mm^3/st) Basis	Allowance (Each cylinder)	Maximum variance between cylinder	Manufacturer standard (mm^3/ st) Basis	Allowance	Maximum variance between cylinder
Basic Point	---	1050	190	± 5	≤ 10			
B	---	700	223	± 5	≤ 10			
C	---	365	5605	± 2	≤ 5			

PUMP ASSEMBLY NUMBER

41z 712 1678

Injection Pump Type	Pump Manufacture
PE - 6P	DIESEL KIKI

Applicable Machine	Applicable Engine	
Model	Model	
BD155X	BS6D140-1	

Injection Timing :

	Unit	Basis	Allowance
Rotating direction		Clockwise viewed from drive end	
Injection order		1 - 5 - 3 - 6 - 2 - 4	
Injection interval		60° ± 30'	
Plunger pre-stroke	mm	4.3± 0.05	
Delivery valve Retraction volume	mm^3st	60	

Specification engine: (reference only)

Rated horsepower	hp/r/min	358 @ 2000
Maximum torque	kgm/r/min	154 @ 1400
High idling	r/min	2150 to 2250
Low idling	r/min	700~750

Calibration Standard :

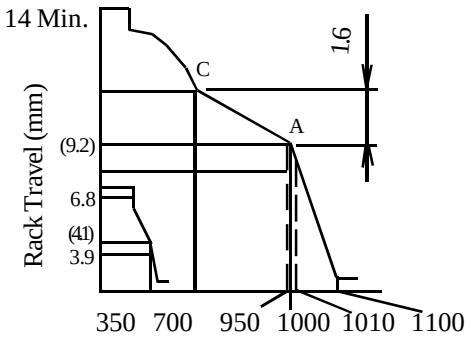
Conditions		Unit	Manufacture standard (with nearly the same actual machine parts)	Service standard (with calibration test parts)
Service standard indicates data using calibration test parts	Nozzle part no.		----	----
	Nozzle holder part no.		----	----
	Injection pipe (O/D × I/D × length)	mm	⌀6 x ⌀2.2 x 650	----
	Test Fuel		ASTM D975 No. 2 diesel fuel or equicalent	
Manufacturer standard data for factory test.	Fuel temperature	℃	40~45	40~45
	Nozzle opening pressure	kg/cm^2	250	250
	Transfer pump pressure	kg/cm^2	1.6	1.6

Injection Volume

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

Rack point	Rack Position	Pump Speed (r/min)	Service stadard (mm^3/st) Basis	Allowance (Each cylinder)	Maximum variance between cylinder	Manufacturer standard (mm^3/st) Basis	Allowance	Maximum variance between cylinder
A	7.9	1000	186	*184-188	≤ 10		Each cyl.	
B	3.8	360	13	*11- 15	≤ 5			
C	8.7	760	179	*177-181	≤ 10			
D								
E								
F								

Governor Performance (360-1000)



PUMP ASSEMBLY NUMBER
41Z 718 1601

Injection Pump Type	Pump Manufacture
PE -6P	DIESEL KIKI

Applicable Machine	Applicable Engine	
Model	Model	
BL40	BS6D140-1	

Injection Timing :

	Unit	Basis	Allowance
Rotating direction		Clockwise viewed from drive end	
Injection order		1 - 5 - 3 - 6 - 2 - 4	
Injection interval		60° ± 30'	
Plunger pre-stroke	mm	4.3± 0.05	
Delivery valve Retraction volume	mm^3st	60	

Specification engine: (reference only)

Rated horsepower	hp/r/min	325 @ 2100
Maximum torque	kgm/r/min	134 @ 1400
High idling	r/min	2300 to 2400
Low idling	r/min	700~750

Calibration Standard :

Conditions		Unit	Manufacture standard (with nearly the same actual machine parts)	Service standard (with calibration test parts)
Service standard indicates data using calibration test parts	Nozzle part no.		----	----
	Nozzle holder part no.		----	----
	Injection pipe (O/D × I/D × length)	mm	⌀6 x ⌀2.2 x 650	----
	Test Fuel		ASTM D975 No. 2 diesel fuel or equicalent	
Manufacturer standard data for factory test.	Fuel temperature	℃	40~45	40~45
	Nozzle opening pressure	kg/cm^2	250	250
	Transfer pump pressure	kg/cm^2	1.6	1.6

Injection Volume

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

Rack point	Rack Position	Pump Speed (r/min)	Service stadard (mm^3/st) Basis	Allowance (Each cylinder)	Maximum variance between cylinder	Manufacturer standard (mm^3/ st) Basis	Allowance	Maximum variance between cylinder
Basic point	7.9	1050	161	159-163	≤ 10		Each cyl.	
B	3.8	700	13	*11-15	≤ 5			
C	8.7	750	179	*177-181	≤ 10			

Governor Performance (360-1050)

PUMP ASSEMBLY NUMBER

42Z 718 2377(**All speed Governor type**)

Injection Pump Type	Pump Manufacture
NE (EP-11)	NIPPON DENSO

Applicable Machine	Applicable Engine	
Model	Model	
BH40	BSA6D140-1	

Injection Timing :

	Unit	Basis	Allowance
Rotating direction		Clockwise viewed from drive end	
Injection order		1 - 5 - 3 - 6 - 2 - 4	
Injection interval		60° ± 30'	
Plunger pre-stroke	mm	3.65± 0.05	
Delivery valve Retraction volume	mm^3st	120	

Specification engine: (reference only)

Rated horsepower	hp/r/min	487 @ 2100
Maximum torque	kgm/r/min	193 @ 1400
High idling	r/min	2260 to 2360
Low idling	r/min	725~775

Calibration Standard :

Conditions

		Unit	Manufacture standard (with nearly the same actual machine parts)	Service standard (with calibration test parts)
Service standard indicates data using calibration test parts	Nozzle part no.		----	----
	Nozzle holder part no.		----	----
	Injection pipe (O/D × I/D × length)	mm	⌀6 x ⌀2.2 x 650	----
	Test Fuel		ASTM D975 No. 2 diesel fuel or equicalent	
Manufacturer standard data for factory test.	Fuel temperature	℃	40~45	40~45
	Nozzle opening pressure	kg/cm^2	250	250
	Transfer pump pressure	kg/cm^2	1.6	1.6

Injection Volume

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

Rack point	Rack Position (r/min)	Pump Speed (r/min)	Service stadard (mm^3/st) Basis	Service stadard (mm^3/st) Allowance (Each cylinder)	Service stadard (mm^3/st) Maximum variance between cylinder	Manufacturer standard (mm^3/st) Basis	Manufacturer standard (mm^3/st) Allowance	Manufacturer standard (mm^3/st) Maximum variance between cylinder
Basic point	12.6	1050		233±5	≤ 10		Each cyl.	
B	12.8	700		*268±5	≤ 5			
C	7.3	375		*54±2	≤ 10			

Governor Performance (375-1050)

PUMP ASSEMBLY NUMBER

6212-71-1214 (**Max.-Min/ Governor type**)

Injection Pump Type	Pump Manufacture
PE-6NE	NIPPON DENSO

Applicable Machine	Applicable Engine	
Model	Model	
BH40	BSA6D140-1	

Injection Timing :

	Unit	Basis	Allowance
Rotating direction		Clockwise viewed from drive end	
Injection order		1 - 5 - 3 - 6 - 2 - 4	
Injection interval		60° ± 30'	
Plunger pre-stroke	mm	3.65± 0.05	
Delivery valve Retraction volume	mm^3st	120	

Specification engine: (reference only)

Rated horsepower	hp/r/min	487 @ 2100
Maximum torque	kgm/r/min	193 @ 1400
High idling	r/min	2350 to 2450
Low idling	r/min	725~775

Calibration Standard :

Conditions

Service standard indicates data using calibration test parts

Manufacturer standard data for factory test.

	Unit	Manufacture standard (with nearly the same actual machine parts)	Service standard (with calibration test parts)
Nozzle part no.		----	----
Nozzle holder part no.		----	----
Injection pipe (O/D × I/D × length)	mm	⌀6 x ⌀2.2 x 650	----
Test Fuel		ASTM D975 No. 2 diesel fuel or equicalent	
Fuel temperature	℃	40~45	40~45
Nozzle opening pressure	kg/cm^2	250	250
Transfer pump pressure	kg/cm^2	1.6	1.6

Injection Volume

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

Rack point	Rack Position	Pump Speed (r/min)	Service stadard (mm^3/st) Basis	Service stadard (mm^3/st) Allowance (Each cylinder)	Service stadard (mm^3/st) Maximum variance between cylinder	Manufacturer standard (mm^3/st) Basis	Manufacturer standard (mm^3/st) Allowance	Manufacturer standard (mm^3/st) Maximum variance between cylinder
Basic point	13.7	700	28	280±5	≤ 10		Each cyl.	
B	13.7	1050	26	*260±5	≤ 10		*	
C	6.0	375	2	*20±2	≤ 5		*	
D	[13.7]	700	28	*280±5			*	
E	[13.7]	1050	24	*260±5			*	

Governor Performance (375-1050)

Boost compensator performance (600 r/min).

PUMP ASSEMBLY NUMBER

42Z 710 2883

Injection Pump Type	Pump Manufacture
BOSCH	NIPPON DENSO

Applicable Machine	Applicable Engine	
Model	Model	
BL54 WHEEL LOADER	BSA6D140-1	

Injection Timing :

	Unit	Basis	Allowance
Rotating direction		Clockwise viewed from drive end	
Injection order		1 - 5 - 3 - 6 - 2 - 4	
Injection interval		60° ± 30'	
Plunger pre-stroke	mm	3.65± 0.05	
Delivery valve Retraction volume	mm^3st	120	

Specification engine: (reference only)

Rated horsepower	hp/r/min	329.5 @ 2100
Maximum torque	Nm/r/min	1792 @ 1400
High idling	r/min	2260 to 2360
Low idling	r/min	675~700

Calibration Standard :

Conditions		**Unit**	**Manufacture standard** (with nearly the same actual machine parts)	**Service standard** (with calibration test parts)
Service standard indicates data using calibration test parts	Nozzle part no.		----	----
	Nozzle holder part no.		----	----
	Injection pipe (O/D × I/D × length)	mm	⌀6 x ⌀2.2 x 650	----
	Test Fuel		ASTM D975 No. 2 diesel fuel or equicalent	
Manufacturer standard data for factory test.	Fuel temperature	℃	40 to 45	40 to 45
	Nozzle opening pressure	kg/cm^2	250	250
	Transfer pump pressure	kg/cm^2	2.0	2.0

Injection Volume

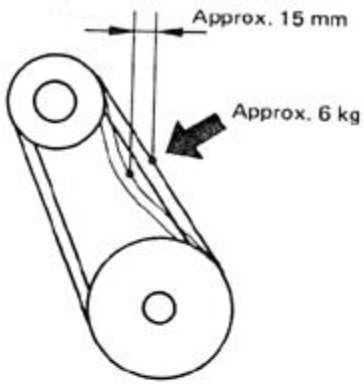
- Rack positions B to E are the reference volume when adjusting the injection volume.
- Marks ★ are average volumes.

Rack point	Rack Position (r/min)	Pump Speed (r/min)	Service stadard (mm^3/st) Basis	Allowance (Each cylinder)	Maximum variance between cylinder	Manufacturer standard (mm^3/ st) Basis	Allowance	Maximum variance between cylinder
Basic point	---	700	213	±5	≤ 10		Each cyl.	
B	---	1050	246	±5	≤ 10		*	
C	---	375	265	±2	≤ 5		*	

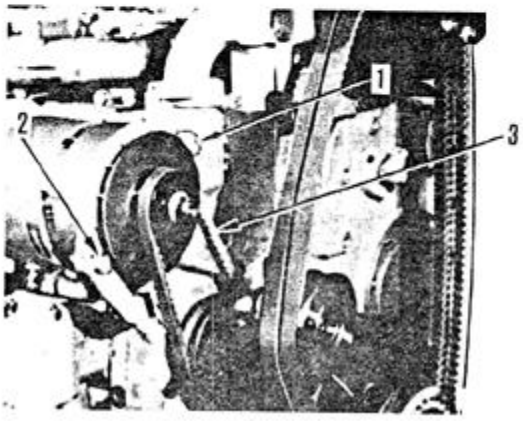
CHECKING AND ADJUSTING ALTERNATOR

BELT TENSION

1. Checking alternator belt tension.
   Push the belt (3) at mid-point between the alternator and water pump pulley with a force of approx. 6 kg and measure the distance that the belt sags.



2. Adjusting alternator belt tension.
   1) Loosen alternator mounting bolts (1) and adjust ment bolt (2).
   2) Shift the alternator upward with a pipe and tighten adjustment bolt (2) while checking the belt tension.
   Then tighten alternator mounting bolt (1) to the proper belt tension.



PERFORMANCE TEST
RUN-IN-STANDARD

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

Engine model	Applicable machine	Test Item		Order					
				1	2	3	4	5	6
BS6D140-1	BL40	Running time	min	5	10	10	10	15	10
		Engine speed	r/min	700	1000	1300	1600	1900	2100
		Load	kg	0	31	62	93	124	155
		Output	hp	--	31	81	149	236	325
	BD155X	Running time	min	5	10	10	10	15	10
		Engine speed	r/min	700	1000	1200	1600	1800	2000
		Load	kg	0	22	45	88	131	179
		Output	hp	0	22	54	141	236	358
	BG825	Running time	min	5	8	7	10	3	--
		Engine speed	r/min	700	1,300	1,650	1,900	2,100	--
		Load	kg	0	35	70	105	140	--
		Output	hp	0	46	116	200	204	--
	BH35-2	Running time	min	5	10	10	10	15	10
		Engine speed	r/min	LI	1000	1300	1600	1900	2100
		Load	kg	0	24	47	95	142	183
		Output	hp	–	17	45	118	198	283
BSA6D140-1	BE650-3/ BE1600-1	Running time	min	2	8	7	10	13	--
		Engine speed	r/min	700	1150	1400	1650	1800	--
		Load	kg	0	60	120	180	240	--
		Output	hp	–	70	170.5	301.4	438.4	--
	BH40	Running time	min	5	10	10	10	15	10
		Engine speed	r/min	750	1000	1300	1600	1900	2100
		Load	kg	0	46	93	139	185	232
		Output	hp	–	46	121	223	351	487
	BL54	Running time	min	5	10	10	10	15	10
		Engine speed	r/min	LI	1000	1400	1600	1900	2100
		Load	kg	0	90	128	168	189	213
		Output	hp	--	66	132	198	264	329.5
BSA6D140G1	BDG 360 kVA	Running time	min	5	5	10	10	15	10
		Engine speed	r/min	LI	1100	1200	1300	1400	1500
		Output	NM	--	275	550	1100	1650	2135

PERFORMANCE TEST RUN-IN-STANDARD

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

Engine model	Applicable machine	Test Item		Order					
				1	2	3	4	5	6
BS(A)6D140-1	WS 28-2	Running time	min	5	10	10	10	15	10
		Engine speed	r/min	LI	1,000	1,300	1,600	1900	2100
		Load	kg	0	24	47	95	142	183
		Output	hp	-	17	45	118	198	283
	BH35-2	Running time	min	5	10	10	10	15	10
		Engine speed	r/min	LI	1000	1300	1600	1900	2100
		Load	kg	0	24	47	95	142	183
		Output	hp	–	17	45	118	198	283

PERFORMANCE TEST CRITERIA

Engine model	Applicable machine	Test Item	Specified Value	Enigne Speed (r/min)	Dynamometer (kg)
BS6D140-1	BG825A-1 MOTOR **GRADER**	Flywheel horsepower Maximum Torque High idling speed Low Idling speed	284 HP/2,100 r/min 128 kgm/1,440 r/min 2,350 ± 50 r/min 650+50 -0	2,095-2,105 1,300-1,500 2,300-2,400 650-700	139.8-148.3 175.8-186.7 0 0
	BH35-2 BOTTM DUMPER	Flywheel horsepower Maximum torque High idling speed Low idling speed	280 kW /2,100 r/min 1628 Nm/1,400 r/min 2,310 ± 50 rpm 675~725 r/min	2,095-2,105 1,300-1,500 2,260-2,360 675-725	183~195 226-245 0 0
	BD155X, **WHEEL** DOZER	Flywheel horsepower Maximum Torque High idling speed Low Idling speed	320 hp/2,000 r/m 144 kgm/1,400 r/min 2,200 ± 50 rpm 700+50 r/min +0	1,995-2,005 1,300-1,500 2,150-2,250 700-750	175-184 208-221 0 0
	BL40 WHEEL LOADER	Flywheel horsepower Maximum torque High idling speed Low idling speed	300 hp/2,100 r/min 131 kgm/1,500 r/min 2,350 ± 50 r/min 700 ± 50 r/min	2,095-2,105 1,400-1,600 2,300-2,400 700-750	150~160 182-193 0 0
BSA6D140-1	BH40 BOTTOM DUMPER	Flywheel horsepower Maximum Torque High idling speed Low Idling speed	462 hp/2,100 r/min 189 kgm/1,400 r/min 2,400 ± 50 r/min 750±25 r/min	2,095-2,105 1,300-1,500 2,260-2,360 725~775	225~235 262~277 0 0
	BL54 WHEEL LOADER	Flywheel horsepower Maximum torque High idling speed Low idling speed	309 kW/2,100 r/min 1750 Nm/1,400 r/min 2,310 ± 50 r/min 675~700 r/min	2,095-2,105 1,300-1,500 2,260-2,360 675~700	232.1-245.7 256-271.4 0 0
BSA6D140G1	BDG360 kVA DG SET	Flywheel horsepower High idling speed Low idling speed	309 kW/1,500 r/min 1,550 ± 10 r/min 1000 ± 25 r/min	1,500	276.7~294.0 0 0

* The values in the table are indicated at stadard conditions (atmospheric temperature 25°C, & atmospheric pressure 743 mm Hg).
* The values given for the dynometer loads, output and torque are with the fan removed,so they differ from those of the specification.
* Values are standardized under the following conditions: muffler & Air cleaner is installed; alternator under no load idling; and air compressor (if installed) Open.
* Dynamomenters are given for the case of the arm length 716 mm.
* Fuel used: ASTM D975 No. 1 or No. 2 diesel fuel (sub zero operating condition).
* Lubrication oil used : CLASS-CD SAE30.

Output (kW)	Torque (Nm)	Fuel comsumption (sec./300 cc)	Coolant **Temperature(°C)**	Lubricant oil temp--erature (°C)	Lubricant oil pressure (kg/cm²)	Exhaust tempera -ture(°C) (t: Intake temp. - 20°C)
293.5-311.5	-	Min. 18.8	70-95	90-110	3.0-5.0	650 max.
-	125.7-133.7	24.0-25.6	70-95	90-110	-	650 max.
0	0	-	70-80	90-110	-	-
0	0	-	70-80	80 min	1.0 min	-
283-301	-	Min 14.5	75-90	80-110	3.0~5.0	700 max
-	1590-1720	-	75-90	80-110	-	700 max
0	0	-	75-90	80-110	-	-
0	0	-	75-90	80 min	1.5 min	-
349-368	-	Min 15	70-95	90-110	3.0-5.0	700 max.
-	149-158	---	70-95	90-110	-	700 max.
0	0	---	70-80	90-110	-	-
0	0	---	70-80	80 min	1.2 min	-
315-335	-	Min. 17	70-95	90-110	3.0-5.0	700 max
-	130-138	-	70-95	90-110	-	700 max
0	0	-	70-80	90-110	-	-
0	0	-	70-80	80 min	1.2 min	-
473~501	--	Min 11.0	70-95	90-110	3.0-5.0	700 max
---	187.6~198.4	0	70-95	90-110	3.0-5.0	700 max
0	0	0	70-80	90-110	3.0-5.0	---
0	0	0	70-80	80 Min	1.2 Min	---
317~326	--	Min 13.8	70-95	80-110	2.0- 4.0	700 max
---	0	0	70-95	80-110	---	---
0	0	0	70-80	80-110	---	---
0	0	0	70-80	80 Min	1.2 Min	---
309~319	–	Min 13.8	80-90	80-110	2.5- 5.0	700 max
0	0	0	80-90	80-110	---	---
0	0	0	80-90	80 Min	1.5 Min	---

PERFORMANCE TEST CRITERIA

Engine model	Applicable machine	Test Item	Specified Value	Enigne Speed (r/min)	Dynamometer (kg)
BS(A)6D140-1	BH35-2 BOTTM DUMPER	Flywheel horsepower	280 kW /2,100 r/min	2,095-2,105	183~195
		Maximum torque	1628 Nm/1,400 r/min	1,300-1,500	226-245
		High idling speed	2,310 ± 50 rpm	2,260-2,360	0
		Low idling speed	675~725 r/min	675-725	0
	WS28-2 WATER SPRINKLER	Flywheel horsepower	280 kW /2,100 r/min	2,095-2,105	183~195
		Maximum torque	1628 Nm/1,400 r/min	1,300-1,500	226-245
		High idling speed	2,310 ± 50 rpm	2,260-2,360	0
		Low idling speed	675~725 r/min	675-725	0

* The values in the table are indicated at stadard conditions (atmospheric temperature 25°C, & atmospheric pressure 743 mm Hg).
* The values given for the dynometer loads, output and torque are with the fan removed,so they differ from those of the specification.
* Values are standardized under the following conditions: muffler & Air cleaner is installed; alternator under no load idling; and air compressor (if installed) Open.
* Dynamomenters are given for the case of the arm length 716 mm.
* Fuel used: ASTM D975 No. 1 or No. 2 diesel fuel (sub zero operating condition).
* Lubrication oil used : CLASS-CD SAE30.

Output (kW)	Torque (Nm)	Fuel comsumption (sec./300 cc)	Coolant **Temperature(°C)**	Lubricant oil temp- -erature (°C)	Lubricant oil pressure (kg/cm²)	Exhaust tempera -ture(°C) (t: Intake temp. - 20°C)
283-301	-	Min 14.5	75-90	80-110	3.0~5.0	700 max
-	1590-1720	-	75-90	80-110	-	700 max
0	0	-	75-90	80-110	-	-
0	0	-	75-90	80 min	1.5 min	-
283-301	-	Min 14.5	75-90	80-110	3.0~5.0	700 max
-	1590-1720	-	75-90	80-110	-	700 max
0	0	-	75-90	80-110	-	-
0	0	-	75-90	80 min	1.5 min	-

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 ~ 2,000 rpm
2	Battery S.G	Battery, coolant tester	795-500-1000	1.100 ~ 1.300
3	Freezing temperature of cooling water			-5° C ~50° C
4	Water temperature, oil temperature, air intake temperature	Thermistor temperature gauge	790-500-1300	0° C ~200° C 0° C~1,000° C
5	Exhaust temperature			
6	Lubrication 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 ~ 1,500 mmHg
9	Blow-by pressure			0 ~ 1,000 mmH_2O
10	Intake resistance			- 1,000 ~ 0 mmH_2O
11	Compression pressure	Compression gauge	795-502-1205	0~ 70 kg/cm²
		Adapter	795-502-1510	
12	Blow-by pressure	Blow-by checker	799-201-1504	0~ 500 mmH_2O
13	Valve clearance	Feeler gauge	795-125-1210	0.43, 0.80 mm
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 0.1and 0.2 water content standard samples.
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 water system	Radiator cap tester	799-202-9001	0 ~ 2 kg/cm²
19	Radiator blockage (wind speed)	Anemometer (Air speed gauge)	799-202-2001	1 ~ 40 m/s
20	Engine cranking	Cranking kit	799-610-1000	
21	Electrical circuits	Tester	Commercially available	Current, voltage, resistance

Engine Model				BS(A)6D140-1			
Applicable machine model				BE650-3, BE1600-1		BG825A-1	
Classification	Item	Condition,etc.	Unit	Standard value	Permissible value	Standard value	Permissible value
Performance	Engine speed	High idling speed	r/min	1,980 ± 50	1,930 - 2,030	2,350 ± 50	2,300-2,400
		Low idling speed	r/min	750 +50 +0	750-800	650+50 +0	650-700
	Necessary	0° C	r/min	Min.110	-	Min. 110	-
	Starting speed	- 20° C (with starting aid)	r/min	Min. 85	-	Min. 85	-
Intake and exhaust system	Intake resistance	At all speed	mmH_2O	Max. 300	762	Max. 300	762
	Intake pressure	At rated output	mmHg	-	-	Min. 300	-
	Exhaust pressure (Turbine inlet press.)	At rated output	mmHg	-	-	Min. 540	-
	Exhaust temperature (Turbine inlet temp.)	All speed (intake air temp.:20° C)	° C	Max. 700	Max. 700	Max. 650	700
	Exhaust gas color	Quick acceleration (Low idling-High idling)	Bosch Scale	Max. 6.0	8.0	Max. 5.0	7.0
		At rated output		Max.2.0	3.0	-	-
		At high idling		Max. 2.0	3.0	Max. 1.5	2.5
	Valve clearance (When engine is hot or cold.)	Intake valve	mm	0.43	-	0.43	-
		Exhaust valve	mm	0.80	-	0.80	-
Engine body	Compression pressure(SAE30 oil)	Oil temperature:40°C~60°C (Engine speed)	Kg/cm² (r/min)	Min. 29 (200 - 250)	Min.20 (200 - 250)	Min. 32 (160-200)	22 (200-250)
	Blow-by pressure (SAE30 oil)	At rated output water temp.:Min 70°C	mmH_2O	Max. 200	400	Max. 100	200
Lubrication system	Oil Pressure (Oil temp.:Min.80°C)	SAE30 oil	Kg/cm²	2.5-5.0	1.8	3.0-5.1	2.1
		At rated output SAE10W oil	Kg/cm²	2.0 -5.0	1.4	-	-
		SAE30 oil	Kg/cm²	Min. 1.2	0.7	Min. 1.0	0.7
		At low idling SAE10W oil	Kg/cm²	Min. 1.0	0.7	-	-
Fuel system	Oil temperature	All speed (Oil in oil pan)	° C	80 - 110	120	80-110	120
	Oil consumption ratio	At continuous rated output (Ratio of fuel consumption)	%	Max. 0.5	1.0	0.5	1.0
	Fuel injection pressure	Nozzle tester	Kg/cm²	250+10 + 5	225	250+10 + 5	225
	Fuel injection timing	B.T.D.C	degree	28±1(BE650) 25±1(BE1600)	28±1(BE650) 25±1(BE1600)	27 ± 1	27 ± 1
Cooling system	Radiator pressure valve	Opening pressure (Differential pressure)	Kg/cm²	0.75 ± 0.1	0.75 ± 0.1	0.50± 0.1	0.50± 0.1
	Fan speed	At rated engine speed	r/min	1,000±25(BE650) 910±25(BE1600)	-	1.766±45	1,721-1,811
	Fan belt tension	Deflects when pushed with a force of 6kg	mm	see page 12-0081		7	5-9

* The values given in the Testing & Adjusting data are NOT for adjustment of the output. Do not use these values as a guide to change the setting of the fuel injection pump.

Engine Model				BS6D140-1			
Applicable machine model				BL40		BD155X	
Classification	Item	Condition,etc.	Unit	Standard value	Permissible value	Standard value	Permissible value
Performance	Engine speed	High idling speed	r/min	2,350 ± 50	2,300 - 2,400	2,200 ± 50	2,150-2,350
		Low idling speed	r/min	700 +50 +0	700-750	700+50 +0	700-750
	Necessary -	0° C		r/min	Min. 110	-	Min. 110
Intake and exhaust system	Starting speed	- 20° C (with starting aid)	r/min	Min. 85	-	Min. 85	-
	Intake resistance	At all speed	mmH_2O	Max. 300	762	Max. 300	762
	Intake pressure	At rated output	mmHg	Max. 75	-	Min. 300	-
	Exhaust pressure (Turbine inlet press.)	At rated output	mmHg	650	700	Min. 650	-
	Exhaust temperature (Turbine inlet temp.)	All speed (intake air temp.:20° C)	° C	Max. 700	Max. 700	Max. 650	700
	Exhaust gas color	Quick acceleration (Low idling-High idling)	Bosch	Max. 5.0	8.0	Max. 5.0	7.0
		At rated output	Unit	Max.2.0	3.0	Max.2.0	-
	Valve clearance (When engine is hot	At high idling Intake valve	mm	Max. 2.0 0.43	3.0 -	Max. 2.0 0.43	2.5 -
Engine body	or cold.)	Exhaust valve	mm	0.80	-	0.80	-
	Compression	Oil temperature:40°C~60°C	Kg/cm²	Min. 32	Min.22	Min. 32	22
	pressure(SAE30 oil)	(Engine speed)	(r/min)	(160 - 250)	(200 - 250)	(160-250)	(200-250)
	Blow-by pressure	At rated output	mmH_2O	Max. 100	200	Max. 100	200
Lubrication system	(SAE30 oil)	water temp.:Min 70°C SAE30 oil	Kg/cm²	3.5~5.0	2.1	3.0~5.0	2.1
		At rated output SAE10W oil	Kg/cm²	2.4 -4.5	1.8	2.4~4.5	1.8
	Oil Pressure (Oil temp.:Min.80°C)	SAE30 oil	Kg/cm²	Min. 1.2	0.7	Min. 1.2	0.7
		At low idling SAE10W oil	Kg/cm²	Min. 1.0	0.7	Min. 1.0	0.7
Fuel system	Oil temperature	All speed (Oil in oil pan)	° C	80 - 110	120	80-110	120
	Oil consumption ratio	At continuous rated output (Ratio of fuel consumption)	%	Max. 0.5	1.0	Max. 0.5	1.0
	Fuel injection pressure	Nozzle tester	Kg/cm²	250+10 + 5	225	250+10 + 5	225
	Fuel injection timing	B.T.D.C	degree	27±1	27±1	27 ± 1	27 ± 1
Cooling system	Radiator pressure	Opening pressure	Kg/cm²	0.5 ± 0.1	0.5 ± 0.1	0.5± 0.1	0.5± 0.1
	valve Fan speed	(Differential pressure) At rated engine speed	r/min	---	---	1,350±30	1320~1380
	Fan belt tension	Deflects when pushed with a force of 6kg	mm	12	10~14	12	10~14

* The values given in the Testing & Adjusting data are NOT for adjustment of the output. Do not use these values as a guide to change the setting of the fuel injection pump.

Engine Model				BS(A)6D140-1			
Applicable machine model				BH35-2(BS6D140-1)		BH40(BSA6D140-1)	
Classification	Item	Condition,etc.	Unit	Standard value	Permissible value	Standard value	Permissible value
Performance	Engine speed	High idling speed	r/min	2,310 ± 50	2,300 - 2,400	2,310 ± 50	2,260-2,360
		HI Max-Min govr.				2,400 ± 50	2,350-2,450
		Low idling speed	r/min	700±25 +0	675~725	700±25	725-775
	Necessary Starting speed	0° C - 20° C (with starting aid)	r/min r/min	Min. 110 Min. 85	- -	Min. 110 Min. 85	-- --
Intake and exhaust system	Intake resistance	At all speed	mmH_2O	Max. 300	762	Max. 300	762
	Intake pressure	At rated output	mmHg	Max. 75	-	Max. 75	-
	Exhaust pressure (Turbine inlet press.)	At rated output	mmHg	650	700	650	700
	Exhaust gas color	Quick acceleration (Low idling-High idling)	Bosch	---	---	Max 6.0	Max.8.0
		At rated output	Unit	Max.2.0	3.0	Max.2.0	3.0
		At high idling		Max. 2.0	3.0	Max. 2.0	3.0
	Valve clearance (When engine is hot or cold.)	Intake valve	mm	0.43	-	0.43	-
		Exhaust valve	mm	0.80	-	0.80	-
Engine body	Compression pressure(SAE30 oil)	Oil temperature:40°C~60°C (Engine speed)	Kg/cm² (r/min)	Min. 29 (200 - 250)	Min.20 (200 - 250)	MIn. 29 (200 - 250)	Min 20 (200 - 250)
	Blow-by pressure (SAE30 oil)	At rated output water temp.:Min 70°C	mmH_2O	Max. 125	225	Max. 200	m1.
Lubrication system	Oil Pressure (Oil temp.:Min.80°C)	SAE30 oil At rated output	Kg/cm²	3.5~5.0	2.1	2.5~5.0	2.1
		SAE10W oil At rated output	Kg/cm²	2.5~4.5	1.8	2.0~4.5	1.8
		SAE30 oil At low idling	Kg/cm²	Min. 1.2	0.7	Min. 1.2	0.7
		SAE10Woil At low idling	Kg/cm²	Min. 1.0	0.7	Min. 1.0	0.7
Fuel system	Oil temperature	All speed (Oil in oil pan)	°C	80 - 110	120	80 - 110	120
	Oil consumption ratio	At continuous rated output (Ratio of fuel consumption)	%	Max. 0.5	1.0	Max. 0.5	1.0
	Fuel injection pressure	Nozzle tester	Kg/cm²	250+10 + 5	225	250+10 + 5	225
	Fuel injection timing	B.T.D.C	degree	27±1	27±1	28±1	28±1
Cooling system	Radiator pressure valve	Opening pressure (Differential pressure)	Kg/cm²	0.5 ± 0.1	0.5 ± 0.1	0.5 ± 0.1	---
	Fan speed	At rated engine speed	r/min	---	---	---	---
	Fan belt tension	Deflects when pushed with a force of 6kg	mm	12	10~14	12	10~14

 * The values given in the Testing & Adjusting data are NOT for adjustment of the output. Do not use these values as a guide to change the setting of the fuel injection pump.

Engine Model				BS(A)6D140-1			
Applicable machine model				BH35-2(BSA6D140-1)		WS28-2(BSA6D140-1)	
Classification	Item	Condition,etc.	Unit	Standard value	Permissible value	Standard value	Permissible value
Performance	Engine speed	High idling speed	r/min	2,310 ± 50	2,300 - 2,400	2,310 ± 50	2,300-2,400
		HI Max-Min govr.					
		Low idling speed	r/min	700±25 +0	675~725	700±25	675~725
	Necessary	0° C	r/min	Min. 110	-	Min. 110	--
	Starting speed	- 20° C (with starting aid)	r/min	Min. 85	-	Min. 85	--
Intake and exhaust system	Intake resistance	At all speed	mmH_2O	Max. 300	762	Max. 300	762
	Intake pressure	At rated output	mmHg	Max. 75	-	Max. 75	-
	Exhaust pressure (Turbine inlet press.)	At rated output	mmHg	650	700	650	700
	Exhaust gas color	Quick acceleration (Low idling-High idling)	Bosch	---	---	----	----
		At rated output	Unit	Max.2.0	3.0	Max.2.0	3.0
		At high idling		Max. 2.0	3.0	Max. 2.0	3.0
	Valve clearance (When engine is hot or cold.)	Intake valve	mm	0.43	-	0.43	-
		Exhaust valve	mm	0.80	-	0.80	-
Engine body	Compression pressure(SAE30 oil)	Oil temperature:40°C~60°C (Engine speed)	Kg/cm^2 (r/min)	Min. 29 (200 - 250)	Min.20 (200 - 250)	MIn. 29 (200 - 250)	Min 20 (200 - 250)
	Blow-by pressure (SAE30 oil)	At rated output water temp.:Min 70°C	mmH_2O	Max. 125	225	Max. 125	225
Lubrication system	Oil Pressure (Oil temp.:Min.80°C)	SAE30 oil	Kg/cm^2	3.5~5.0	2.1	3.5~5.0	2.1
		At rated output SAE10W oil	Kg/cm^2	2.5~4.5	1.8	2.5~4.5	1.8
		SAE30 oil	Kg/cm^2	Min. 1.2	0.7	Min. 1.2	0.7
		At low idling SAE10Woil	Kg/cm^2	Min. 1.0	0.7	Min. 1.0	0.7
Fuel system	Oil temperature	All speed (Oil in oil pan)	°C	80 - 110	120	80 - 110	120
	Oil consumption ratio	At continuous rated output (Ratio of fuel consumption)	%	Max. 0.5	1.0	Max. 0.5	1.0
	Fuel injection pressure	Nozzle tester	Kg/cm^2	250+10 + 5	225	250+10 + 5	225
	Fuel injection timing	B.T.D.C	degree	27±1	27±1	27±1	27±1
Cooling system	Radiator pressure valve	Opening pressure (Differential pressure)	Kg/cm^2	0.5 ± 0.1	0.5 ± 0.1	0.5 ± 0.1	0.5 ± 0.1
	Fan speed	At rated engine speed	r/min	---	---	---	---
	Fan belt tension	Deflects when pushed with a force of 6kg	mm	12	10~14	12	10~14

* The values given in the Testing & Adjusting data are NOT for adjustment of the output. Do not use these values as a guide to change the setting of the fuel injection pump.

Engine Model				BSA6D140-1		BSA6D140G	
Applicable machine model				BL54		360 kVA DGSET	
Classification	Item	Condition,etc.	Unit	Standard value	Permissible value	Standard value	Permissible value
Performance	Engine speed	High idling speed	r/min	2,310 ± 50	2,260 - 2,360	1,560 ± 50	1,555-1,565
		Low idling speed	r/min	675 +25 0	675~700	1000±25	975~1025
	Necessary	0° C	r/min	Min. 110	-	Min. 110	-
	Starting speed	- 20° C (with starting aid)	r/min	Min. 85	-	Min. 85	-
Intake and exhaust system	Intake resistance	At all speed	mmH_2O	Max. 300	650	Max. 300	650
	Intake pressure	At rated output	mmHg	Max. 75	-	Min. 300	-
	Exhaust pressure (Turbine inlet press.)	At rated output	mmHg	650	700	Min. 650	700
	Exhaust gas color	Quick acceleration (Low idling-High idling)	Bosch Scale	---	---	---	---
		At rated output		Max.2.0	3.0	Max.2.0	3.0
		At high idling		Max. 2.0	3.0		
	Valve clearance (When engine is hot or cold.)	Intake valve	mm	0.43	-	0.43	---
		Exhaust valve	mm	0.80	-	0.80	---
Engine body	Compression pressure(SAE30 oil)	Oil temperature:40°C~60°C (Engine speed)	Kg/cm² (r/min)	Min. 29 (200 - 250)	Min.20 (200 - 250)	Min. 29 (200-250)	22 (200-250)
	Blow-by pressure (SAE30 oil)	At rated output water temp.:Min 70°C	mmH_2O	Max. 200	380	Max. 200	380
Lubrication system	Oil Pressure (Oil temp.:Min.80°C)	SAE30 oil	Kg/cm²	2.5~5.0	2.1	2.5~5.0	2.1
		At rated output SAE10W oil	Kg/cm²	2.4 -4.5	1.8	2.5~4.5	1.8
		SAE30 oil	Kg/cm²	Min. 1.2	0.7	Min. 1.2	0.7
		At low idling SAE10Woil	g/cm²	Min. 1.0	0.7	Min. 1.0	0.7
Fuel system	Oil temperature	All speed (Oil in oil pan)	°C	80 - 110	120	80-110	120
	Oil consumption ratio	At continuous rated output (Ratio of fuel consumption)	%	Max. 0.5	1.0	Max. 0.5	1.0
	Fuel injection pressure	Nozzle tester	Kg/cm²	250+10 + 5	225	250+10 + 5	225
	Fuel injection timing	B.T.D.C	degree	28±1	28±1	28±1	28±1
Cooling system	Radiator pressure valve	Opening pressure (Differential pressure)	Kg/cm²	0.5 ± 0.1	---	0.5±0.1	---
	Fan speed	At rated engine speed	r/min	---	---	---	---
	Fan belt tension	Deflects when pushed with a force of 6kg	mm	12	10~14	12	10~14

* The values given in the Testing & Adjusting data are NOT for adjustment of the output. Do not use these values as a guide to change the setting of the fuel injection pump.

TROUBLESHOOTING

METHOD OF READING TROUBLESHOOTING TABLE

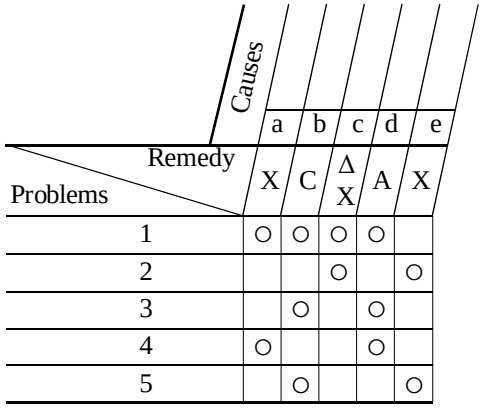
DESCRIPTION OF SYMBOLS USED IN TROUBLESHOOTING TABLE

The following symbols are used in the " Remedy " column to indicate the method of eliminating the cause of a fault.

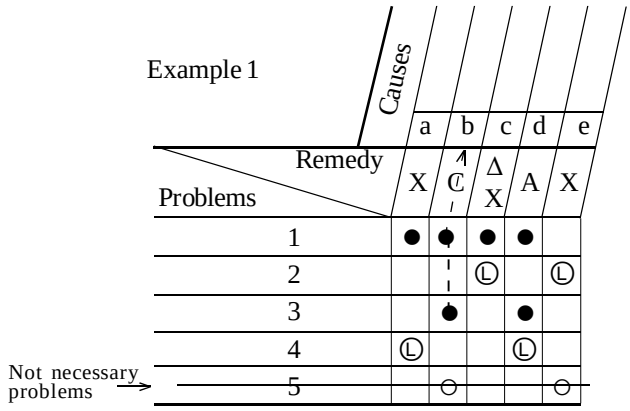
X : Replace ; Δ : Repair
A : Adjusting; C : Clean

METHOD OF READING TROUBLE-SHOOTING TABLE

- The symbol ○ in the table is inserted only for causes which can be diagnosed. If a casuse can not be diagnosed, the corresponding box is left blank.
- If the result of problems 1 using the troubleshooting table shown at right is abnormal, the cause of the trouble can be assumed to lie between a and d. because it is not possible to make a problems regarding e, it is necessary to perform the next problems (owing to the possibility of a multiple fault).
  If the result of problems 1 is normal, the cause of the fault does not lie between a and d. In such a case, before diagnosing the cause as e, however, carry out a check by means of problems 2 or 5.
- If now the result of problems 1 is abnormal and the result of problems 2 normal, the cause is one of a, b or d. In additon, if the result of problem 3 is abnormal, the cause will be narrowed To determine which of b or d is the actual cause, perform problems 4.
- If the result of problems is abnormal, blacken out the corresponding ○ in the table and then perform the next problems on these causes in order to narrow the likely causes.

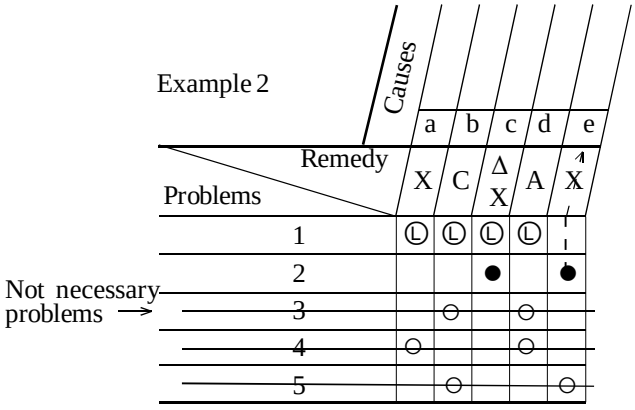


Example 1:
Problems 1→ Abnormal
Problems 2→ Normal
Problems 3→ Abnormal
Problems 4→ Normal
} From the table of example 1, the cause of the fault is b.



Example 2 :
Problems 1→ Normal
Problems 2→ Abnormal
} From the table of example 2, the cause of the fault is e.

★ In example 2, it is evident that the cause is e without carrying ot problems 2 however problems 2 is performed by way of an additional check.



Example 3 :

Problems 1→Abnormal
Problems 2→Normal
Problems 3→Normal
} From the table of example 3, the cause is one of a, c and e.

Continue problems

Problems 4→Normal
Problems 5→Normal
} From the table of example 3-1, the cause is c.

Example 3

Problems \ Causes / Remedy	a	b	c	d	e
	X	C	ΔX	A	X
1	●	●	●	●	
2			●		●
3		Ⓛ		Ⓛ	
4	○			○	
5		○			○

Example 3-1

Problems \ Causes / Remedy	a	b	c	d	e
	X	C	ΔX	A	X
1	●	●	●	●	
2			●		●
3		Ⓛ		Ⓛ	
4	Ⓛ			Ⓛ	
5		Ⓛ			Ⓛ

Example 4 :

Problems 1→Abnormal
Problems 2→Normal
} From the table of example 4, the cause is one of a, b or d.

Continue problems

Problems 3→Abnormal
Problems 4→Abnormal
Problems 5→Normal
} From the table of example 4-1, the cause is a or d.

Example 4

Problems \ Causes / Remedy	a	b	c	d	e
	X	C	ΔX	A	X
1	●	●	●	●	
2			Ⓛ		Ⓛ
3		○		○	
4	○			○	
5		○			○

Example 4-1

Problems \ Causes / Remedy	a	b	c	d	e
	X	C	ΔX	A	X
1	●	●	●	●	
2			Ⓛ		Ⓛ
3		●		●	
4	●			●	
5		Ⓛ			Ⓛ

As can be seen from the above examples, it is not necessary to perform all of the problems.

Also, looking at a particular cause, no matter how many marks there are in the column corresponding to that cause, it will cease to be an actual cause if there is even one Ⓛ mark in the same column.

TROUBLESHOOTING TABLE

1. Starting defective or badness.

1) Engine does not turn.

Questions to ask operator before starting trouble-shooting

1. Did machine stop suddenly during operation ? → Damage or seizure of internal parts.
2. Did machine make abnormal noise during operation ? → Damage parts.

★ **Cause h:** battery charging rate

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

- Specific gravity should be at least figure for 70% charging rate.
- In cold weather, specific gravity must be at least figure for 75% charging rate.

No.	Problems \ Cause / Remedy	a Stopping piston from moving by foreign matter in cylinder.	b Damage to connecting rod or crankshaft	c Bushing and metal biting into each other	d Intake and exhaust valves are blocked in cylinder	e Damage to pump or supply system	f Failure in power train	g Seizure of moving parts	h Battery insufficiently charged → See No. 20	i Damage to pinion or ring gear	j Pinion movement force insufficient, wrong meshing position	k Battery terminal connection defective, wiring defective	l Electrical system defective → See No. 20
	Remedy	X	X	X	X	X	X	X	X	X Δ	Δ X	–	
1	When setting the starting switch to START; 1) No sound of pinion moving out.											○	
	2) Pinion grates.									○			
	3) pinion engages but does not turn.	○	○	○	○	○	○						
2	When checking battery, electrolyte level or specific gravity is low.							○					
3	When cranking engine with barring tool; 1) Does not move.						○						
	2) Moves backlash only.				○								
	3) Can be turned in reverse direction.	○	○	○									
4	Remove head cover. When checking valve cotter, it is out of place.			○									
5	Remove oil pan. When checking internal parts, they are abnormal.		○										
6	Remove cylinder head. When checking internal parts, forein matter appears.	○											

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X : Replace ; Δ : Repair

A : Adjusting; C : Clean

2) Engine turns but no exhaust gas is emitted.

Check before troubleshooting

1. Is there any fuel in fuel tank ?
2. Is fuel feed valve open ?
3. Is fuel piping leaking or damaged between fuel tank and injection pump ?
4. Is there any leak from fuel filter ?
5. Is there any water, rust or sludge mixed with fuel drained from fuel tank or fuel filter ? (Injection pump or nozzle are frequent causes of failure.)

No.	Problems / Remedy / Cause	a. Injection pump plunger seized, rack rusted	b. Feed pump piston seized	c. Fuel filter element clogged	d. Fuel piping clogged between fuel tank and injecton pump
		XC	X	X	C
1	No fuel comes out even if injection pump bleed plug is loosened and priming pump operated.				○
2	When cranking engine with starting motor; 1) Injection pump (coupling) does not rotate.				
	2) No fuel comes out even if injection pump bleed plug is loosened.		○		
	3) No fuel spurts out even if injection pump pipe sleeve nut is loosened.	○	○		
3	When removing injection pump tappet cover, control rack does not move.	○			

The following symbols are used to indicate the action to be taken when a cause of failure is locked.

X : Replace ; Δ : Repair
A : Adjusting; C : Clean

3) Exhaust gas in emitted but engine does not start.

If there is always great difficulty in starting, lack of output power is a possible cause, so perform this troubleshooting.

Check before troubleshooting

1. Is dust indicator red ? → Air cleaner element clogged.
2. Is SAE30 oil being used at temperature below 0° C? (Oil viscosity is too high) → At temperature below 0°C,use SAE10W oil.
3. Is ASTM D975 No. 2 diesel fuel being used at temperatures below - 10°C? (Clogging caused by precipitated parafin)→ Use ASTM D975 No. 1 at temperature below - 10°C.
4. Is fuel control lever bent? Is there any play? Is the pin out of place?

No.	Problems / Remedy	Cause: Foreign matter causing block between cylinder head and air cleaner (a)	Injection timing defective (rarely sole cause of failure) (b)	Valve clearance defective (rarely sole cause of failure) (c)	Piston, ring or liner worn (d)	Injector nozzle clogged or seized (e)	Injection pump plunger sized or worn (f)	Injection pump rack function defective (g)	Air cleaner elements clogged (h)	Battery charge too low → See No. 20 (i)	Electrical intake air heater wiring broken (j)	Electrical intake air heater wiring defective (k)
		C	A	A	X	CX	X	XΔ	CX	AX	ΔX	ΔX
1	When turning starting switch to HEAT. (At cold weather operation). 1) Heater signal lamp does not light.										○	○
	2) Heater mount does not become warm.										○	○
2	Rotating speed of starting motor is too slow to start engine.									○		
3	When checking battery, electrolyte level or specific gravity is too low.									○		
4	Engine starts if air cleaner element is removed.								○			
5	When removing injection pump tappet cover, control rack and plunger do not move.						○					
6	When checking injector nozzle with nozzle tester, it does not inject.					○						
7	Compression pressure is too low; blow-by is high.				○							
8	Valve clearance is not proper value.			○								
9	Injection timing is not proper position.		○									
10	Air cleaner does not aspirate air. (After maintenance)	○										

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X : Replace ; Δ : Repair
A : Adjusting; C : Clean

2. Engine stopped during operation.

Questions to ask operator before troubleshooting.

1. Did engine stop slowly?→ Fuel supply cut.
2. Did engine stop suddenly?→ Internal parts damaged or seized.
3. Did engine make abnormal noise?→parts damaged.

Check before troubleshooting

1. Is there any fuel in fuel tank?
2. Is fuel control lever bent? Is there any play? Is the pin out of place?
3. Is fuel piping leaking or damaged between fuel tank and injection pump.
4. Is bleed hole of fuel tank cap clogged?

No.	Problems \ Cause	Injection pump plunger seized (a)	Feed pump piston seized (b)	Fuel filter element clogged (c)	Fuel piping clogged between fuel tank and injection pump (d)	Part of intake or exhaust valve blocking cylinder (e)	Pump or other auxiliary mechanism seized (f)	Piston or bearing or moving part seized (g)	Failure of machine power train (h)
	Remedy	X	X	XC	C	X	X	X	XΔ
1	Starting motor cranks engine, but engine stops if gear shift lever is moved to any speed position.								○
2	Starting motor does not crank engine 1) engine does not turn when cranking engine with barring tool.							○	
	2) Engine turns backlash distance only.						○		
	3) Engine can be turned in reverse direction.				○				
3	No fuel comes out even if injection pump bleed plug is loosened and priming pump operated.			○					
4	When cranking engine with starting motor; 1) Injection pump (coupling) does not rotate.								
	2) No fuel comes out even if injection pump bleed plug is loosened.		○						
	3) No fuel spurts out even if injection pump pipe sleeve nut is loosened.	○	○						
5	When removing injection pump tappet cover, control rack does not move.	○							

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X : Replace ; Δ : Repair
A : Adjusting; C : Clean

3. Engine runs abnormally.

1) Engine speed is too high.

	Cause	Remedy
a	Governor function defective	XA△
b	Governor adjustment defective	A

2) Engine does not stop.

	Cause	Remedy
a	Fuel control lever linkage is bent; there is too much play; pin is out of position; something is catching.	△
b	Injection pump control rack function defective	X△
c	Injection pump function defective (part other than rack)	XA△
d	Governor function defective	XA△

3) Hunting.

	Cause	Remedy
a	Air sucking into system between fuel tank and feed pump	X△
b	Governor function defective	XA△
c	Governor adjustment defective	A
d	Injection pump control rack function defective	X△

★ Set injection pump and governor on test stand when adjusting.

★ Making up fuel pump by injecting more fuel than standing may damaged engine.

4. Fuel consumption too high.

. Before starting the troubleshooting, ask the operator why he noticed the fuel consumption was too high.

	Cause	Remedy
a	External leakage of fuel; Fuel tank, injection pump, fuel filter and piping. (Common cause when fuel consumption increases suddenly)	X△
b	Excessive fuel injection, poor fuel combustion ratio (in this case exhaust gas is black).	Follow "6. Exhaust gas is black".
c	Internal leakage of fuel; Injection nozzle spray condition defective Injection nozzle O-ring damaged. (In this case, oil level rises and oil smells of kerosens)	△ Change oil

The following symbols are used to indicate the action to be taken when a cause of failure is located.

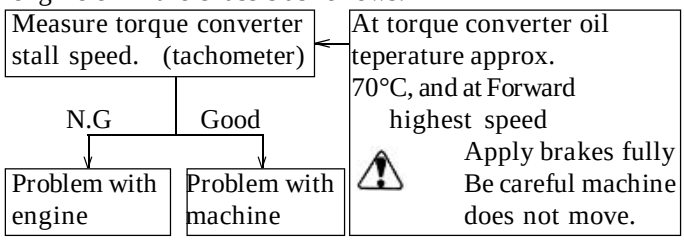
X : Replace ; Δ : Repair

A : Adjusting; C : Clean

5. Lack of power.

★ If lack of power is accompanied by black exhaust gas, follow problems "6. Black exhaust smoke."

★ First troubleshoot whether the cause is in the engine or in the chassis as follows.



. Judge mainly checking for track tension, brake function, acceleration and engine high idling speed when mounting DIRECT transmission.

Check before troubleshooting

1. Is fuel piping damaged or fuel leaking between fuel tank and injection pump?
2. Is bleed hole of fuel tank cap clogged?
3. Is tube damaged or leaking between injection pump and nozzle holder?
4. Is incorrect fuel being used?
5. Is there any water, rust or sludge mixed with fuel drained from fuel tank?
   (Injection pump or nozzle are frequent causes of failure.)
   (Check strainer clogged when no fuel comes out.)

No.	Problems / Remedy	Cause a: Injection pump control rack function defective	b: Injection pump plunger seized	c: Injection nozzle seized or clogged	d: Fuel filter element clogged	e: Fuel piping clogged between fuel tank and injection nozzle	f: Fuel tube leaking between fuel tank and feed pump	g: Fuel piping leaking between feed pump and injector nozzle	h: Fuel control lever linkage bent, loose or out of adjustment
		XΔ	X	XC	X	C	XΔ	XΔ	ΔA
1	Even with fuel control lever at FULL position, injection pump lever does not contact to the full-stopper.								○
2	When operating priming pump; 1) No reaction or slight reaction and quick return.					○	○	○	
	2) No reaction or slight reaction with normal return.						○		
3	No fuel comes out even if injection pump bleed plug is loosened and priming pump operated.				○	○			
4	Improper engine-running happens by hunting.				○				
5	When checking with nozzle tester, injection spray is defective or injection pressure is low.			○					
6	No fuel spurts out even if injection pump pipe sleeve nut is loosened.		○	○					
7	Some cylinder little or no pulse when injection pipe is held between fingers.		○						
8	When removing injection pump tappet cover and checking movement of plunger, piston does not move up and down.		○						
9	When removing injection pump tappet cover and checking movement of control rack, does not move smoothly.	○							

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X : Replace ; Δ : Repair
A : Adjusting; C : Clean

6. Exhaust gas is black.

Check before troubleshooting

1. Is dust indicator red?→Air cleaner element clogged.
2. Is injection pump seal out of position?→Pump out of ad justment (excessive injection).
3. Is air leaking between turbocharger and cylinder head?
4. Is standard spec. machine operating at high altitude?

No.	Problems \ Remedy	Cause: Auto-timer defective (a)	Injection pump defective (b)	Turbocharger seized (c)	Muffler, exhaust pipe damaged or clogged (d)	Valve clearance defective (e)	Defective contact between valve and valve seat (f)	Piston, ring or liner worn (g)	Improper injection timing (h)	Injection nozzle blocked, spray defective (i)	Air cleaner elements clogged (j)
		XΔ	XΔ	XΔ	ΔC	A	ΔX	X	A	CX	XC
1	Exhaust gas color improves when air cleaner element is removed.										○
2	When checking with nozzle tester, defective injection spray is defective or injection pressure is low.									○	
3	Match marks of injection pump plunger and coupling are not properly aligned. Checking injection timing by delivery method shows timing is out of adjustment.								○		
4	Blow-by is excessive.							○			
5	Compression pressure is lack.						○	○			
6	Valve clearance is too large or too small.					○					
7	Exhaust gas color improves when muffler is removed.				○						
8	Turbocharger is sluggish when turned by hands.			○							
9	Exhaust gas color improves when injection pump is replaced.		○								
10	Exhaust gas color improves when auto-timer is replaced. (For engines with auto-timer)	○									

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X : Replace ; Δ : Repair
A : Adjusting; C : Clean

7. Exhaust gas is blue. (Combustion of engine oil)

Check before troubleshooting

1. Has engine continued to run for over 20 mins at low idling?→ Oil coming up into cylinder, oil leak from seal at turbocharger turbine side.
2. Has engine continued to run for over 20 mins at high idling?→ Oil coming up or down into cylinder, oil leak from seal at turbocharger blower side.
3. Is turbocharger oil return pipe damaged?→ oil leak from seal turbocharger seal.

No.	Problems / Remedy	Intake valve, valve guide worn (oil coming down into cylinder) a	Breather element clogged b	Piston, ring or liner worn (oil coming up into cylinder) c	Seal worn at turbocharger tubine side d	Seal worn at turbocharger blower side e
		X	C	X	X	X
1	Inside of turbocharger intake pipe is coated with oil.					○
2	Turbocharger shaft play is excessive.				○	○
3	Compression pressure is lack.			○		
4	Blow-by is excessive.			○		
5	When checking breather element, it is clogged with oil.		○			
6	Remove cylinder head. When checking intake valve and valve guide, the clearance of them is big.	○				

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X : Replace ; Δ : Repair
A : Adjusting; C : Clean

8. Oil Consumption too high.

Before starting the problems, ask the operator why he noticed the fuel consumption was too high.

★ If answer is: “Oil consumption was high and exhaust gas was blue”, follow problems “7. Exhaust gas is blue”.

Check before troubleshooting

Is engine or engine lower part coated with oil.
(Remove earth and sand and check.)

No.	Problems / Remedy	Cause a: Rear seal or seal contact face worn or damaged	b: Oil cooler damaged	c: Oil leaking from oil drain plug	d: Oil leaking from cylinder head, oil pan, gear case, flywheel housing and mounts	e: Oil leaking from oil piping	f: Oil leaking from oil filter or oil cooler	g: Oil leaking from turbocharger
	Remedy	XΔ	X	Δ	XΔ	ΔX	ΔX	ΔX
1	Oil leaking out of engine (check around engine).				○			
2	Cooling water is mixed with engine oil.		○					
3	Oil in main clutch or TORQFLOW transmission or damper increases.	○						

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X : Replace ; Δ : Repair
A : Adjusting; C : Clean

8. Oil Consumption too high.

Before starting the problems, ask the operator why he noticed the fuel consumption was too high.

★ If answer is: "Oil consumption was high and exhaust gas was blue", follow problems "7. Exhaust gas is blue".

Check before troubleshooting

Is engine or engine lower part coated with oil.
(Remove earth and sand and check.)

No.	Problems \ Remedy	Cause	a	b	c	d	e	f	g
			Rear oil seal or seal contact face worn or damaged	Oil cooler damaged	Oil leaking from oil drain plug	Oil leaking from cylinder head, oil pan, under frame, gear case, flywheel housing and mounts	Oil leaking from oil piping	Oil leaking from oil filter or oil cooler	Oil leaking from turbocharger
			XΔ	X	Δ	XΔ	ΔX	ΔX	ΔX
1	Oil leaking out of engine (check around engine).					○			
2	Cooling water is mixed with engine oil.			○					
3	Oil in main clutch or TORQFLOW transmission or damper increases.	○							

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X : Replace ; Δ : Repair
A : Adjusting; C : Clean

9. Oil level rises. (Mixed water or fuel)

Check before troubleshooting

- Is the cooler of engine oil dirt - white?→ Mixed water.

No.	Problems \ Remedy	Cause	a	b	c	d	e	f	g	h	i	j	k	l
			XΔ	XΔ	XΔ	X	X	X	X	X	X	X	X	X
1	Water mixed with engine oil.							O			O	O	O	
2	Fuel mixed with engine oil.				O							O		
3	Oil in main clutch or TORQFLOW transmission or damper decreases.			O										
4	Seal or seal contact face of hydraulic pump drive shaft is worn or damaged.		O											

Cause:
a Failure in hydraulic pump for machine
b Rear oil seal or seal contact face worn or damaged
c Oil leaking inside injection pump (forced lubrication pump)
d Fuel leaking inside cylinderhead cover.
e Nozzle holder defective
f Liner O-ring damaged
g Cylinder block or cylinder liner damaged
h Cylinder head gasket damaged
i Oil cooler element or O-ring damaged
j Rocker arm housing gasket damaged
k Rocker arm housing damaged (Fuel spill and air bleed circuit)
l Air compressor damaged

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X : Replace ; Δ : Repair
A : Adjusting; C : Clean

10. Oil quickly becomes dirty.

Before starting the troubleshooting, ask the operator the following questions.

1. Were oil and oil filter changed in accordance with the "Recommend"?
2. Was improper oil used?

No.	Problems \ Remedy	Oil cooler thermo valve defective (a)	Leak of exhaust gas through seal on tubrocharger turbine side (b)	Piston, ring or liner worn (c)	Valve or valve guide worn (d)
		XΔ	XΔ	X	XΔ
1	Exhaust gas is blue when engine is run at high speed with light load.			○	○
2	Compression pressure is lack.			○	○
3	Blow-by excessive.			○	
4	After running at high idling for approx. 10 mins., oil can be seen leaking from turbocharger turbine outlet.		○		
5	Turbocharger shaft play is excessive.		○		
6	Oil cooler thermo valve does not open	○			

★ If the above problems does not reveal the cause, a common secondary cause of dirty oil is carbon from incomplete combustion mixing with the oil. In this case follow problems in "6. Exhaust gas is black".

The following symbols are used to indicate the action to be taken when a cause of failure is located.
X : Replace ; Δ : Repair
A : Adjusting; C : Clean

11. Engine oil pressure gauge indicator fluctuates abnormally.

No.	Problems / Remedy	Regulator valve defective (a)	Instrument panel loose (b)	Engine oil pressure gauge defective (c)	Lack of oil in oil pan (fluctuation occurs particularly when operating on slopes) (d)
		A ΔX	Δ	X	A
1	Oil level in oil pan is too low. (Check whether oil consumption is excessive.)				○
2	Fluctuation stops when gauge is replaced.			○	
3	Mounts in instrument panel are loose. (Check directly)		○		
4	Regulator valve is catched, spring is fatigued, valve or valve guide is damaged. (Check directly)	○			

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X : Replace ; Δ : Repair
A : Adjusting; C : Clean

12. Lack of oil pressure.

(At enigne speed of over 700 rpm, indicator of engine oil pressure gauge is to left of “Opearating range”.)

Question to be asked before starting troubleshooting.

Is SAE 10W oil being used at temperature above 0°C?

No.	Problems \ Remedy	Oil pump defective	Regulator valve function defective	Oil strainer in oil pan clogged	Oil pipe in oil pan damaged or clogged	Bearing or journal worn	Oil filter element clogged and bypass valve function defective	Oil hose, tube clogged or damaged	Engine oil pressure gauge tube clogged or damaged	Gauge defective	Lack of oil in oil pan (particularly with engine operating on slopes)	Water or fuel mixed with oil – see No. 9	Oil leaking from connection of oil hose and tube	Oil leaking from tube or connections of engine oil pressure gauge	Oil cooler thermostat function defective
		a	b	c	d	e	f	g	h	i	j	k	l	m	n
		Δ X	Δ XA	C	X C	X	X ΔA	C XΔ	C XΔ	X	A	–	X Δ	X Δ	X
1	Oil temperature is excessive.														○
2	Oil is leak from hose or tube. (Check for signs of external oil leakage.)												○		
3	Water or fuel mixed with fuel.											○			
4	Oil in oil pan is lack (no sign of external oil leakage).									○					
5	Engine oil pressure is normal if gauge is replaced.								○						
6	Oil hose, tube are clogged or damaged. (Check directly)							○							
7	Oil filter is clogged and regulator valve function is defective. (Check directly)						○								
8	Metal particles are caught in oil filter element. K.O.W.A (oil analysis) shows abnormality.				○										
9	Remove oil pan. When checking oil, strainer is clogged or oil pipe is damaged.			○											
10	Regulator valve is catching, spring is fatigued, valve or valve guide is damaged. (Check directly)		○												
11	Oil pump does not rotate smoothly and oil pump shaft play is excessive.	○													

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X : Replace ; Δ : Repair

A : Adjusting; C : Clean

13. Oil in cooling system.

	Cause	Remedy
a	Pipe broken in oil cooler, O-ring damaged	X
b	Head gasket damaged	X
c	Cylinder head cracked	X
d	Cylinder block cracked	X
e	Rocker arm housing gasket damaged Rocker arm housing damaged.	X

14. Water temperature does not rise.

Water temperature gauge indicator is to left of "Operating range"

★ In cold weather operation, if reversible fan and radiator shutters are not fitted, the engine may not warm up.

No.	Problems / Remedy	Cause: Thermostat defective (stays open) (a)	Cause: Water temperature gauge defective (b)
		X	X
1	Water temperature rises if gauge is replaced.		○
2	When thermostat is removed, it is found to stay open; or performance test shown cracking temperature is too low.	○	

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X : Replace ; Δ : Repair

A : Adjusting; C : Clean

15. Water temperature rises excessively.

(Water temperature gauge indicator goes to right of "Operating range". engine over heats)

Never remove the radiator cap when the temperature is still high. Boiling water may spurt out and cause serious burns.

★ When the engine overheats, stopping the engine immediately means water is no longer sent out by the water pump. As a result the temperatre of the parts being cooled rises sharply and this may cause cracking or other damage to the engine.

Before starting the troubleshooting, ask the operator the following questions.

1. Is anti-freeze being used in summer?
2. Is water being supplied according to the "Operation and maintenace Manual".

Check before troubleshooting

1. Is machine being operated under excessive load?
2. Is fan damaged or deformed?
3. Is belt groove of fan pulley or crank pulley worn?
4. Are radiator shutter and reversible fan being used properly ?

No.	Problems \ Remedy / Cause	a	b	c	d	e	f	g	h	i	j	k	l	m	n
		A	ΔX	X	X	X	XΔ	CX	A	X	X	X	XΔ	XΔ	XΔ
		Excessive use of machine with torque converter stalled	Torque converter damaged	Water temperature gauge defective	Thermostat seal defective (does not open)	Thermostat defective (does not open)	Water pump defective	Radiator core fins clogged or damaged	Fan belt tension incorrect	Cylinder block or head cracked	Head gasket damaged	Cylinder liner or piston ring damaged	Water leaking from water tube or hose	Water leaking from radiator	Water leaking from water pump or oil cooler
1	Coolant level is too low.									○			○		
2	Cooling water mixed with oil.									○					
3	Fan belt loosens.							○							
4	Radiator core is damaged or clogged with mud or dust.						○								
5	Difference in temperature between upper and lower tanks is extreme.					○									
6	Radiator is only slightly warm.			○	○										
7	Valve opens when testing thermostat only.			○											
8	If water temperature gauge is replaced, it returns to normal.		○												
9	Torque converter oil temperature is too high. (with TORQFLOW transmission)	○													

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X : Replace ; Δ : Repair
A : Adjusting; C : Clean

16. Too much vibration.

No.	Problems \ Remedy	Cause	a	b	c	d	e	f	g	h	i	j	k	l	m	n
			Wear of front support pilot	Cam follower stuck or brocken	Intake or exhaust valve stuck	Intake or exhaust valve broken	Bushings or bearings (main bearing, connecting rod bearing, cam bushing, etc.) worn	Injection pump plunger seized; function defective	Injector nozzle seized	Injection pump out of adjustment (excessive injection)	Injection nozzle clogged, spray defective	Thermostat defective (stays open)	Governor defective	Air in fuel piping between fuel tank and feed pump	Vibration damper defective	Engine mounting bolts loose
			ΔX	X	X	X	X	XΔ	X	A	CX	X	Δ AX	ΔX	X	Δ
1	Engine mounting bolts are loose. (Check directly)															○
2	Vibration damper is not warm to touch after operation, during operation, gear noise is also excessive.													○		
3	Air is mixed in fuel system.												○			
4	Engine runs abnormally at low idling. (No air in fuel line; exhaust gas color normal)						○					○				
5	Exhaust gas is black.								○	○	○					
6	Water temperature does not rise or rises slowly.										○					
7	When checking injection nozzle tester, injection spray is defective or injection pressure is low.							○		○						
8	Injection pump seal is out of position, injection pump is out of adjustment. (Check directly with pliers)								○							
9	When loosening injection pipe sleeve nuts in order at low idling, speed of some cylinders does not change.						○	○								
10	Oil pressure is low at low idling.					○										
11	Remove cylinder head when checking it, the cam follower or intake and exhaust valves are abnormal.			○	○											
12	When removing cam follower cover and check, the cam follower is abnormal.			○												
13	The wear and clearance of front support pilot is large.	○														

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X : Replace ; Δ : Repair
A : Adjusting; C : Clean

17. Abnormal noises emitted.

★ When noises indicating internal damaged are being emitted continuing to operate machine may make the damage worse.

★ As far as possible, classify the abnormal noise to make location of the cause easier.

Type of noise;

- Interface
- Abnormal combustion
- Gear
- Internal, external
- Engine, power train

No.	Problems / Remedy	a X	b X	c X	d ΔX	e XΔ	f CX	g X	h X	i A	j X	k X	l X	m A	n ΔX
	Cause	Valve or piston broken	Valve stem or tappet stuck or worn	Timing gear or oil pump gear or P.T.O. gear broken or worn	Bolt missing from connecting rod cap or main cap	Camshaft bushing or balancer bushing out of place	Injector nozzle clogged	Injector nozzle seized	Piston, ring or liner worn	Valve clearance defective	Injection pump plunger defective	Vibration damper defective	Thermostat defective	Injection pump out of adjustment (excessive injection)	Interference of fan or fan belt; fan deformed
1	External or interference engine noise occurs.														○
2	Exhaust gas is black.					○		○	○			○	○		
3	Combustion noise is abnormal.					○	○		○	○		○	○		
4	Seal is broken. (Check injection volume on test stand.)												○		
5	Water temperature does not rise.											○			
6	Vibration damper is not warm to touch after operation; during operation, gear noise is also excessive.										○				
7	When loosening injection pipe sleeve nut and setting engine to low idling, engine speed does not change.									○					
8	Valve clearance is too large or too small.								○						
9	Compression pressure is lack; blow-by is excessive.							○							
10	When checking injector nozzle with nozzle tester, injection spray is defective or injection pressure is low.					○	○								
11	Remove oil pan. When checking it, internal engine noise is excessive.				○										
12	Remove gear cover. Gear noise is occured.		○												
13	When removing cylinder head, Internal engine noise is excessive.	○													

Other causes of abnormal noise (direct check)

	Cause	Remedy
o	PTO gear damaged or worn	X
p	Air compressor damaged	X
q	Turbocharger damaged	X

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X : Replace ; Δ : Repair
A : Adjusting; C : Clean

18 Excessive wear of engine parts.

Before starting the troubleshooting, ask the operator the following questions.

1. Is the specified oil being used?
2. Is the specified fuel being used?
3. Is the air cleaner element cleaned and replaced according to the "Recommend"?
4. Is the fuel filter element cleaned and replaced according to the "Recommend"?
5. Are the engine oil and oil filter element replaced according to the "Recommend"?
6. Has there been repeated rapid acceleration, or rapid gear shifting?
7. Is the machine warmed up before operation, and left idlig before stopping engine according to the "Recommend"?

No.	Problems \ Remedy / Cause	a	b	c	d	e	f	g	h
		X	C	—	—	—	—	ΔX	X
			Filter element damaged or clogged	Dirt or water mixed with fuel	Dirty oil	Water mixed with oil	Fuel mixed with oil	Abnormal combustion	Air leaking into system between air cleaner and cylinder head	Air cleaner element damaged
1	Dirt gets into engine. (Check directly)							○		
2	Exhaust gas is black. (See problems "6. Exhaust gas is black")						○			
3	Fuel is mixed with oil. (See problems "9. Oil level rise")					○				
4	Water is mixed with oil. (See problems "9. Oil level rise")				○					
5	Oil is dirty. (See problems "10. Oil quickly becomes dirty")			○						
6	Dirt or water drains out when fuel tank drain plug is removed.		○							
7	Fuel filter is dirty or damaged.	○								

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X : Replace ; Δ : Repair
A : Adjusting; C : Clean

19. Engine does not start because of fault in electrical system. (Chek starting circuit)

When checking, take care not to be caught in fan or other rotating parts if engine statrs.

Check before troubleshooting

1. Is battery electrolyte level or specific gravity too low?
2. Check starting circuit for broken or disconnected wires, loose terminals or short circuits (Visual check)
   Battery ↔ Safety relay ↔ Starting switch ↔ Battery relay switch ↔ Battery
3. Immediately after repair, mistaken wiring connection is possible cause.
4. When problems (1-1), ''Engine does not turn'' give cause i "Electrical system defective'' use this problems.

No.	Problems / Remedy	Starting motor defective	Internal wiring or performance of safety relay defective	Internal wiring or performance of safety switch defective	Internal wiring or performance of battery relay switch defective	Internal wiring or performance of starting switch defective
	Cause	a	b	c	d	e
	Remedy	XΔ	Δx	Δx	Δx	Δx
1	If terminals (B) and (C) of starting motor are connected, pinion moves out. ★ Sparks are produced by this test. ⚠ When pinion movement is confirmed, disconnect-terminals immediately.		○	○	○	○
2	If terminals (B) and (C) of starting switch are connected, engine will start.					○
3	If terminals (b) and (E) of battery relay switch are connected, engine will start.				○	
4	If plug terminal of safety switch is connected to terminal (B) or (+) of starting motor, engine will start.			○		
5	If terminals (B) and (C) of safety relay are connected, engine will start.		○			
6	Starting motor does not turn even if No. 1 starting motor terminals (B) and (C) are connected.	○				

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X : Replace ; Δ : Repair
A : Adjusting; C : Clean

20. Battery does not charge. (Chek charging circuit)

When checking, take care not to be caught in fan or other rotating parts if engine starts. Take care also to cause short circuits.

Before starting the troubleshooting, ask the operator if the battery is old (in use for 2 or more years).

Check before troubleshooting

1. Is alternator drive belt loose?
2. Check starting circuit for broken or disconnected wires, loose terminals or short circuits. (Visual check, continuity check)
   Battery ↔ Safety switch ↔ Ammeter ↔ Regulator ↔ Starting motor↔ Alternator↔ Battery relay switch ↔ Battery
3. Do lamps or heater exceed specified limit? Are they left on?
   ★ When engine is stopped and charged lamp stays on, or ammeter indicator deflects to one side, lamps are still on, or there is a short circuit.
4. Following repairs, mistaken wiring connection is possible cause.

No.	Problems \ Remedy	Cause: Alternator defective (a)	Internal wiring or performance of regulator defective (b)	Internal wiring or performance of ammeter or charging lamp defective (c)	Internal wiring or performance of starting switch defective (d)	Battery defective (e)
		XΔ	X	ΔX	ΔX	X
1	During operation, deflection of ammeter and charging lamp are normal.					○
2	Continuity test using tester shows: 1) Little or no continuity when terminals (ACC) and (B) of starting switch are connected. (with switch ON)				○	
	2) When the starting switch is ON, continuity between them above 1) is proper, but when being OFF, no continuity.				○	
	3) Little or no continuity between (+) terminal and (−) terminal of ammeter or charging lamp.			○		
3	Run engine at medium speed (1,000 – 1,500 rpm) and measure charging voltage with tester. Tester does not show charging voltage (26 – 30V) between terminal (E) of alternator and terminal (B) of alternator, or between terminal (E) of alternator and terminal (R) of alternator.	○	○			

The following symbols are used to indicate the action to be taken when a cause of failure is located.

X : Replace ; Δ : Repair
A : Adjusting; C : Clean

ENGINE

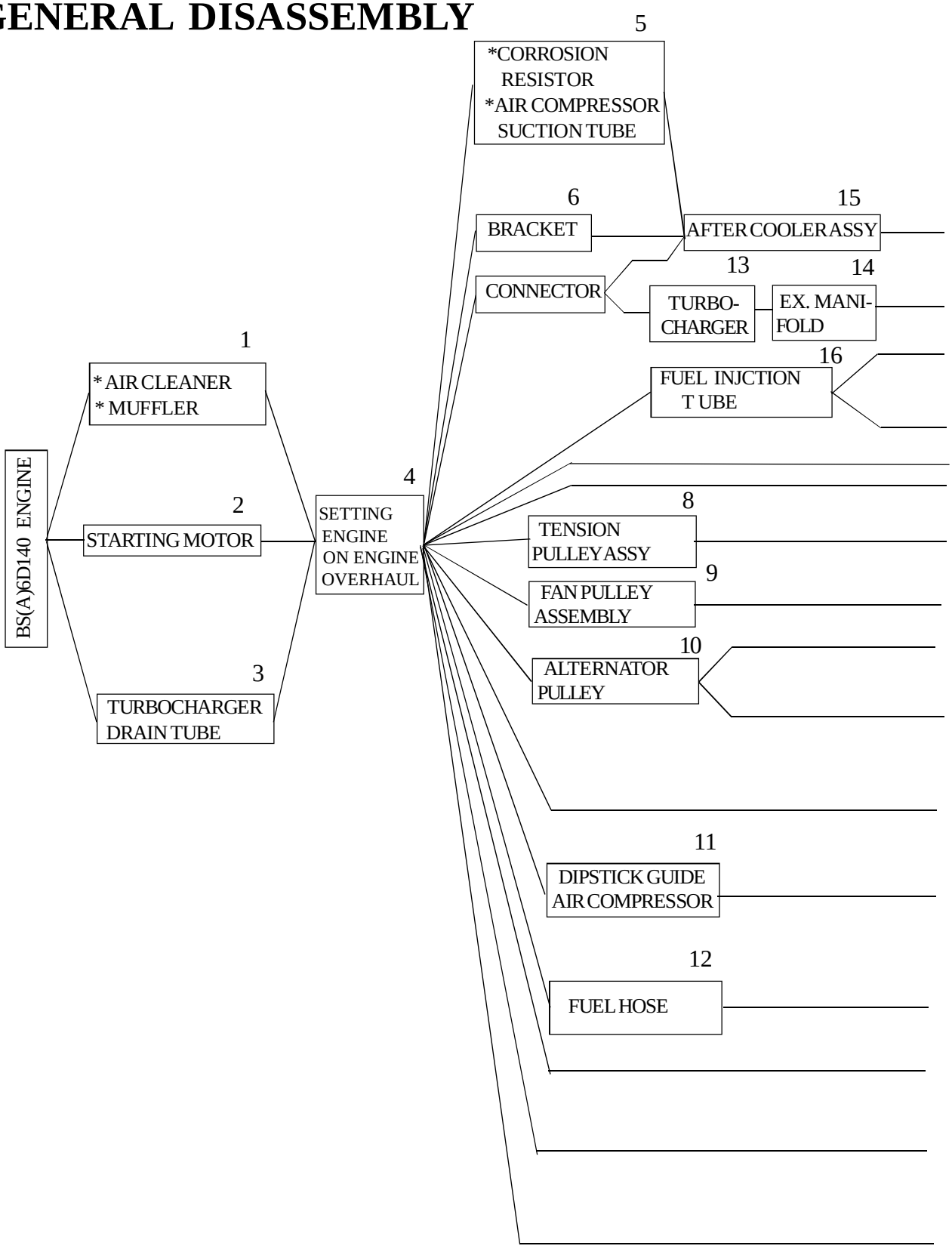
14 DISASSEMBLY AND ASSEMBLY

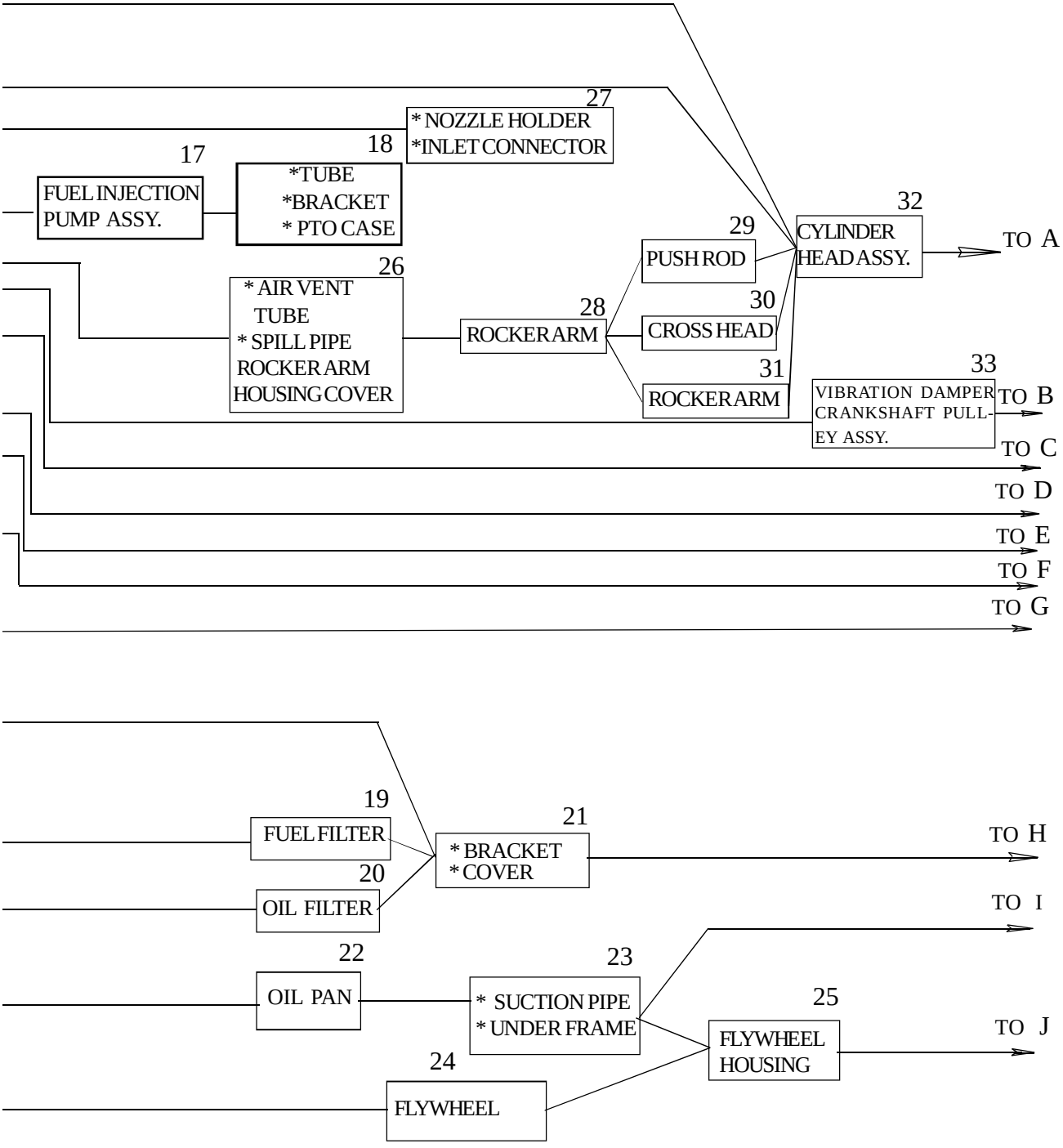
NOTE:

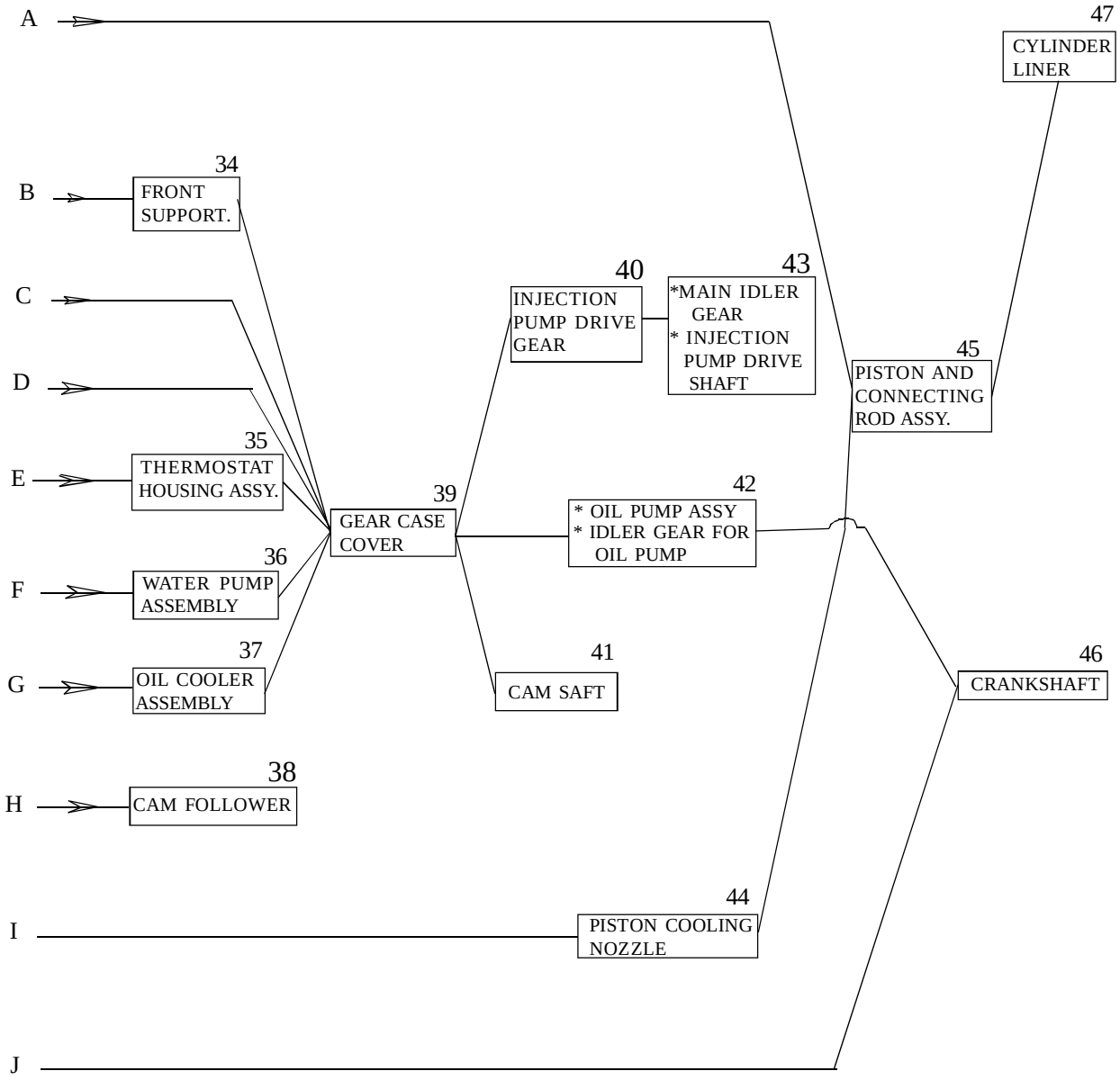
* This chapter deals with procedures both for general disassembly and assembly putting emphasis on BSA6D140-1 engine in case overhaul stand is used.

* When machine serial numbers and/or enigne bases are different, or when engine without after cooler is handled, some of procedures mentioned here may differ in details part, but the essentials of the procedures are the same.

GENERAL DISASSEMBLY




27
* NOZZLE HOLDER
*INLET CONNECTOR
18
17
FUEL INJECTION PUMP ASSY.
*TUBE
*BRACKET
* PTO CASE
32
29
CYLINDER HEAD ASSY.
TO A
PUSH ROD
26
* AIR VENT TUBE
* SPILL PIPE
ROCKER ARM HOUSING COVER
28
ROCKER ARM
30
CROSS HEAD
31
ROCKER ARM
33
VIBRATION DAMPER CRANKSHAFT PULLEY ASSY.
TO B
TO C
TO D
TO E
TO F
TO G
19
FUEL FILTER
21
* BRACKET
* COVER
TO H
20
OIL FILTER
TO I
22
OIL PAN
23
* SUCTION PIPE
* UNDER FRAME
25
FLYWHEEL HOUSING
TO J
24
FLYWHEEL


A
B
C
D
E
F
G
H
I
J
34
FRONT SUPPORT.
35
THERMOSTAT HOUSING ASSY.
36
WATER PUMP ASSEMBLY
37
OIL COOLER ASSEMBLY
38
CAM FOLLOWER
39
GEAR CASE COVER
40
INJECTION PUMP DRIVE GEAR
41
CAM SAFT
42
* OIL PUMP ASSY
* IDLER GEAR FOR OIL PUMP
43
*MAIN IDLER GEAR
* INJECTION PUMP DRIVE SHAFT
44
PISTON COOLING NOZZLE
45
PISTON AND CONNECTING ROD ASSY.
46
CRANKSHAFT
47
CYLINDER LINER

Special tools

	Part No.	Part Name	QTY
A	790-901-1260	Adapter	1
B	790-501-2000	Engine overhaul stand	1
C	795-102-2102	Spring pusher	1
D	795-100-1190	Piston ring tool	1
E	795-236-1000	Liner puller	1
F	795-502-1121	Gauge	1

Preparatory work

- Clea off all mud and dirt.
- Drain cooling water and engine oil

Engine oil : approx. 30l

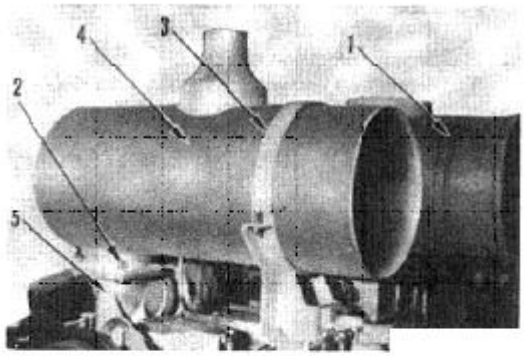
- Prepare stable engine stand which will prevent the engine from falling over, then put the engine securely in the stand.

kg Engine assembly: approx. 1420kg

(The weight of the engine differs according to the model of machine on which it is mounted.)

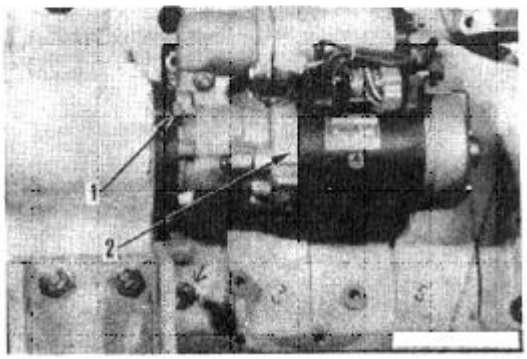
1. Air Cleaner , muffler

1) Remove hose connecting to turbocharger, then re move tube and lift off air cleaner(1).
2) Remove connecting bolts (2) of exhaust connector, remove band (3) and then remove muffler (4).
3) Remove exhaust connector (5).
   * When removing the turbocharger connection, cover the openings to prevent dirt or dust from entering the turbocharger.



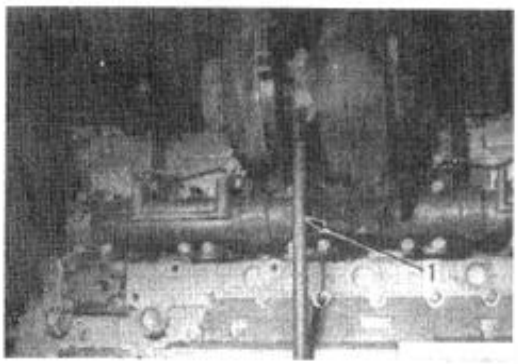
2. Strating motor

Remove mounting bolts (1), then remove starting motor (2).



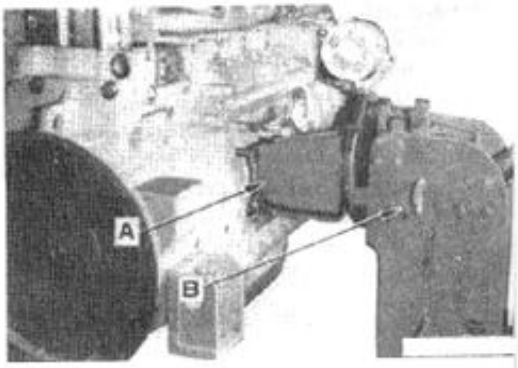
3. Turbocharger drain tube

Remove turbocharger drain tube (1).



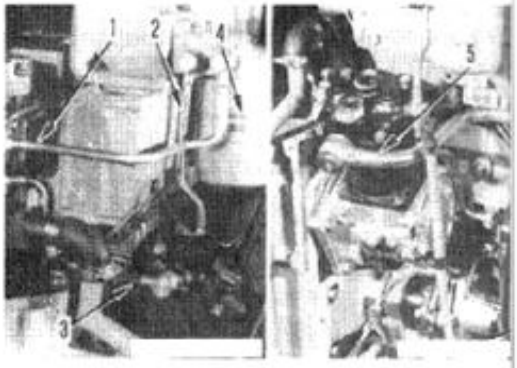
4. Setting engine in engine overhaul stand

1) Install adapter A on engine.
2) Sling engine assembly, align the adapter with engine overhaul stand B, and install engine assembly.



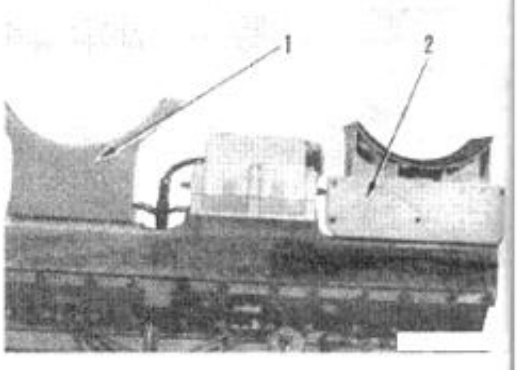
5. Corrosion resistor,air compressor suction tube

1) Remove tubes (1), (2) and (3).
2) Remove corrosion resistor (4).
3) Remove air compressor suction tube (5).



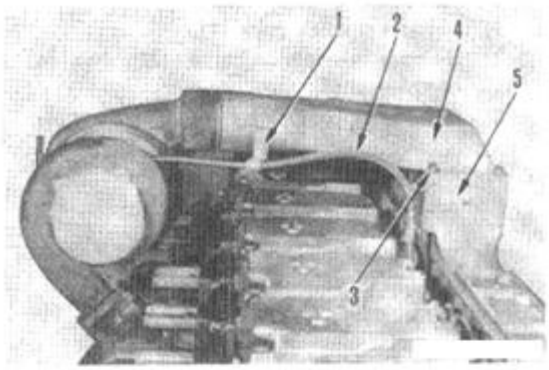
6. Bracket

Remove mounting bolts, then remove brackets (1) and (2).



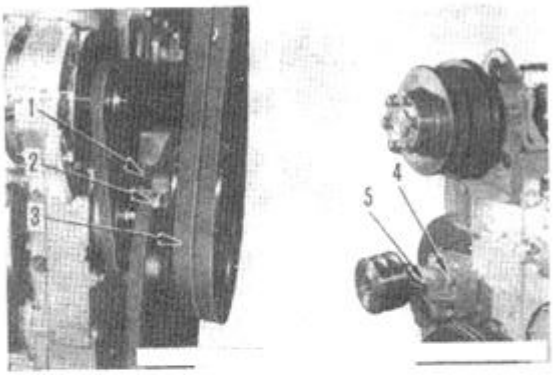
7. Connector

1) Remove clamp (1), then remove turbocharger lubrication tube (2).
2) Remove mounting bolts (3), then remove connector (4) and electrical intake air heaters.



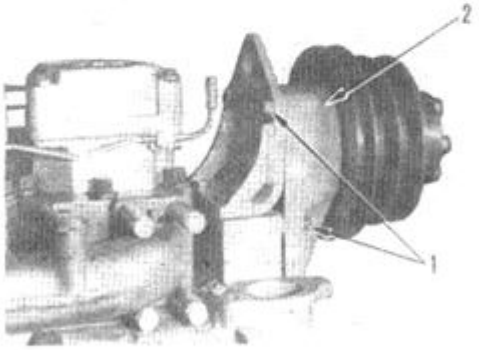
8. Tension pulley assembly

1) Loosen tension pulley assembly mounting nuts (1).
2) Loosen adjustment bolt (2), move tension pulley toward inside, then remove V-belts (3).
3) Remove mounting bolts (4), then remove tension pulley assembly (5).



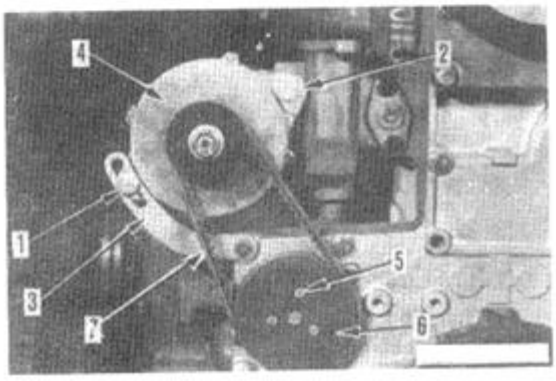
9. Fan pulley assembly

Remove mounting bolts (1), then remove fan pulley assembly (2).



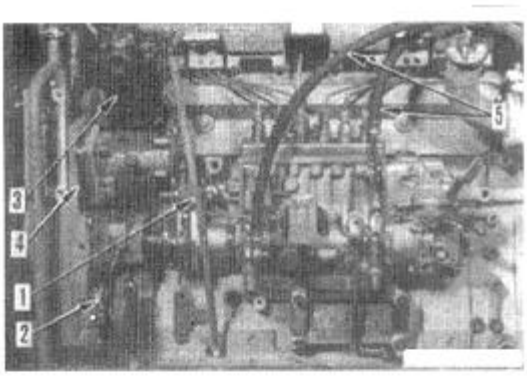
10. Alternator pulley

1) Remove adjustment bolt (1) for belt tension, then loosen alternator fastening bolt (2) and push down alternator to remove V-belts.
2) Remove plate(3).
3) Remove fastening bolt (2), then remove alternator (4).
4) Remove mounting bolts (5), then remove pulley (6).



11. Dipstick guide,air compressor

1) Remove dipstick guide (1).
2) Remove lubrications tube (2), then remove air compressor (3).
3) Remove air compressor mounting plate (4).

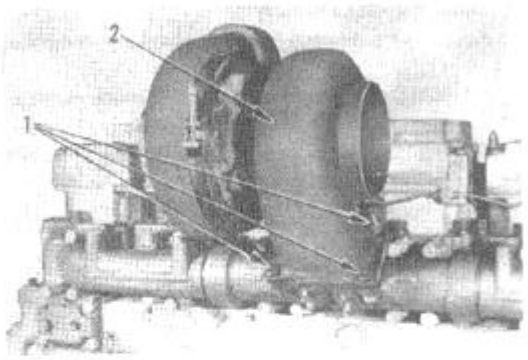


12. Fuel hose

Remove fuel hoses (5).

13. Turbocharger

Remove mounting bolts (1), then remove turbo charger (2).



14. Exhaust manifold

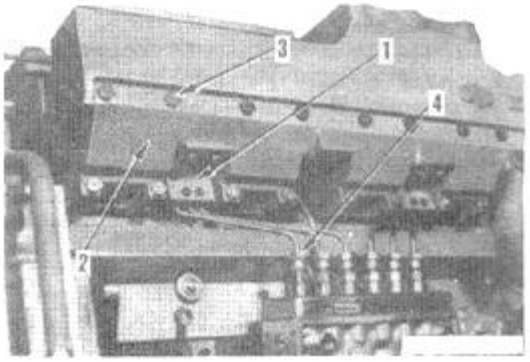
Remove mounting bolts (1), then remove exhaust manifold (2).

15. After-cooler assembly

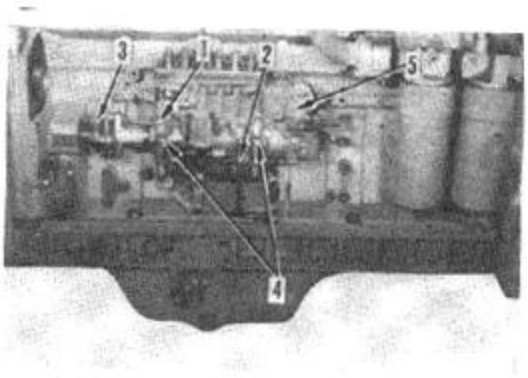
1) Remove clamps (1).
2) Sling after-cooler assembly (2), remove mounting bolts (3), then lift off after-cooler assembly.

16. Fuel injection tube

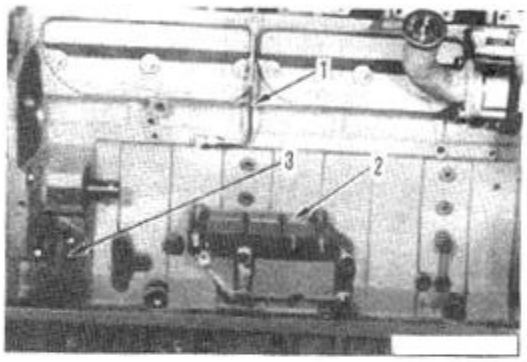
Remove fuel injection tubes (4).



17. Fuel injection pump assembly
    1) Remove lubrication tubes (1) and (2).
    2) Remove coupling bolts (3).
    3) Remove mounting bolts (4), then remove fuel injection pump assembly (5).



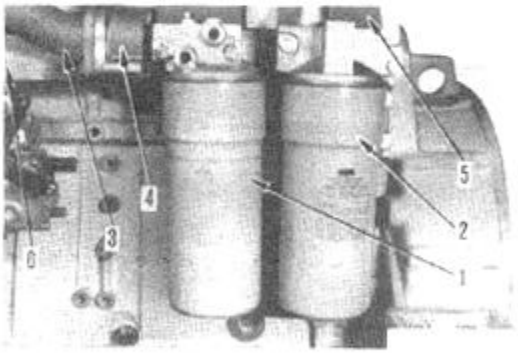
18. Tube, Bracket, PTO case
    1) Remove turbocharger lubrication tube (1).
    2) Remove fuel injection pump bracket (2).
    3) Remove PTO case (3).



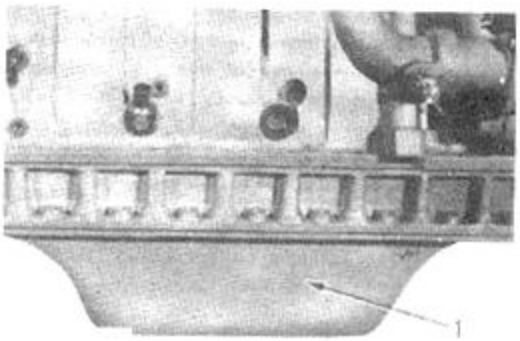
19. Fuel filter
    Remove oil filter (1).

20. Oil filter
    Remove oil filter (2).

21. Bracket, cover
    1) Remove fuel filter bracket (4) together with oil filter (3).
    2) Remove oil filter bracket (5) and cover (6).

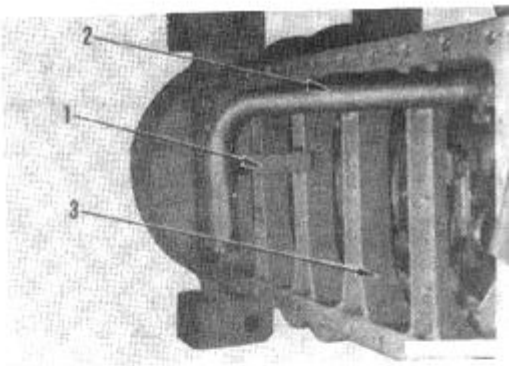


22. Oil pan
    Remove oil pan (1).



23. Suction pipe, under frame

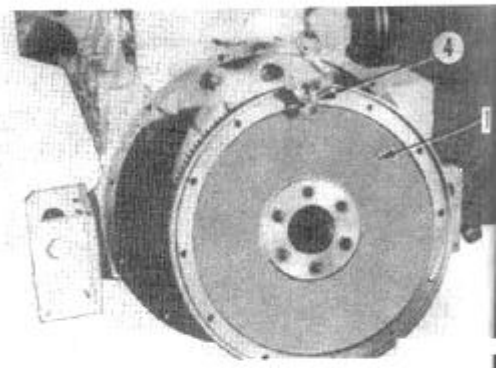
1) Remove bracket (1), then remove suction pipe (2).
2) Remove under frame (3).



24. Flywheel

Using eye bolt ④ (Dia. = 12 mm, pitch =1.75 mm), sling flywheel (1), then remove.

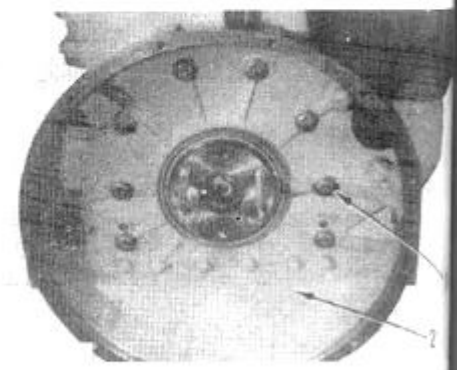
kg Flywheel : 55 kg



25. Flywheel housing

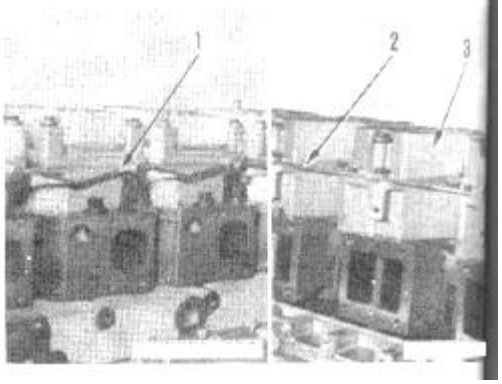
Remove mounting bolts (1), sling flywheel housing (2), then remove.

kg Flywheel housing : 42 kg



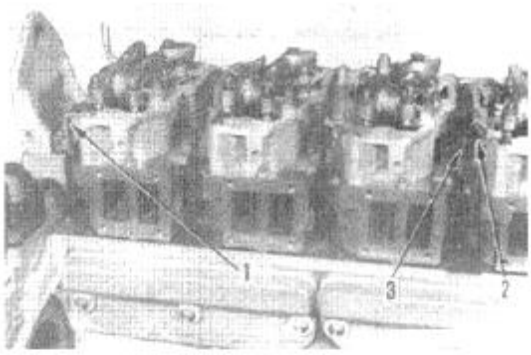
26. Air vent tube, spill pipe, rocker arm housing cover

1) Remove air vent tube (1).
2) Remove spill pipe (2).
3) Remove rocker arm housing covers (3).



27. Nozzle holder, inlet connector

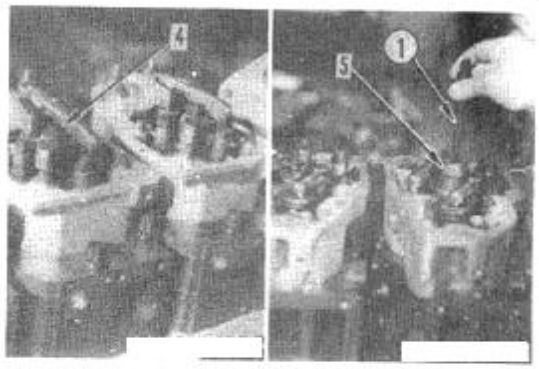
1) Remove compressor pipe bracket (1).
2) Loosen locknut (2), then remove inlet connector (3).



3) Remove mounting bolts (4) and bracket, using bolt

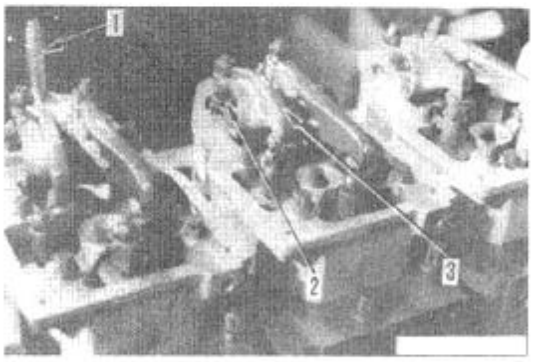
① (Dia. =10 mm, pitch =1.5),remove nozzle holder (5).

* Mark each nozzle holder with a number before removing. Keep the nozzle holders in a safe place and be careful not to damage them.
* Check that there is a gasket fitted to the tip of the nozzle holder.



28. Rocker arm

1) Remove turbocharger lubrication tube bracket (1).
2) Remove mounting bolts (2), then remove rocker arm (3).
   * Loosen lock nuts of adjustment screws, then loosen each adjustment screw 2 - 3 turns to avoid excessive pressure being brought to bear on the push rods when installing the rocker arm.



29. Push rod

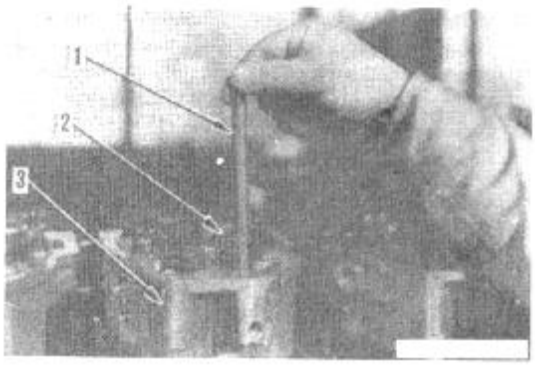
Remove push rod (1).

30. Crosshead

Remove crosshead (2).

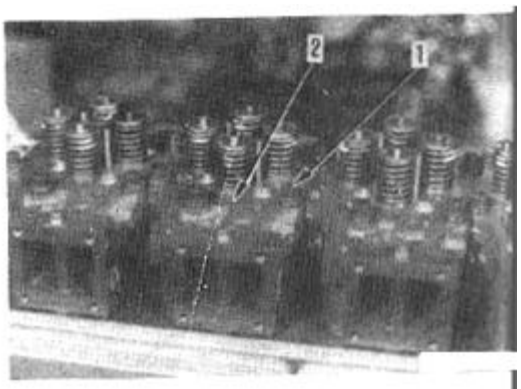
31. Rocker arm housing

Remove mounting bolts, then remove rocker arm housing (3).



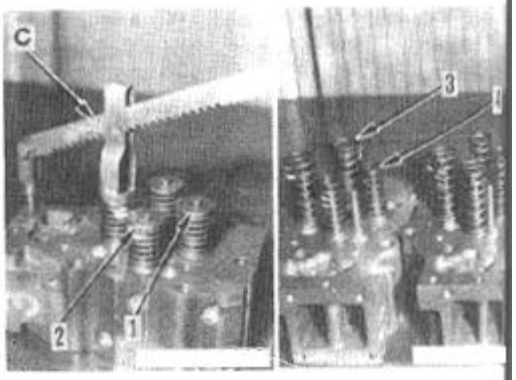
32. Cylinder head assembly

1) Remove mounting bolts (1), then remove cylinder head assembly (2).
2) Remove each cylinder head gasket.

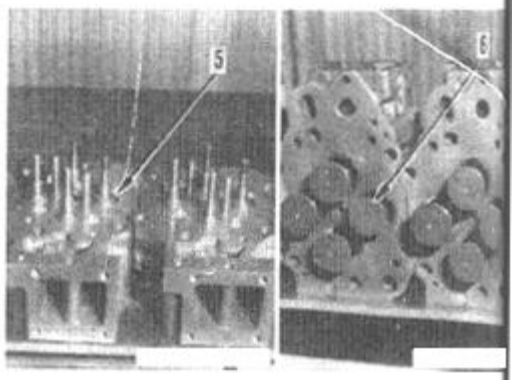


- **Disassmeble cyinder head assembly as follows.**

i) Using spring pusher C, compress valve spring and remove cottor (1).
ii) Remove upper valve seat (2), outer valve spring (3), inner valve spring (4).



iii) Remove lower valve seat (5).
iv) Lift up cylinder head and remove valves (6).

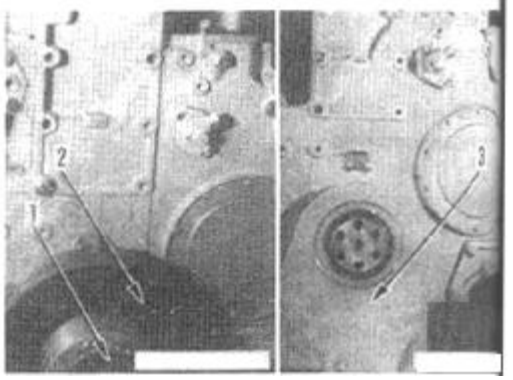


33. Vibration damper • crankshaft pulley assembly

Remove mounting bolts (1), then remove vibration damper, crankshaft pulley assembly (2).

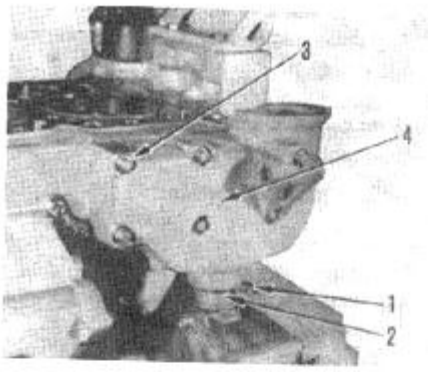
34. Front support

Remove front support (3).



35. Thermostat housing

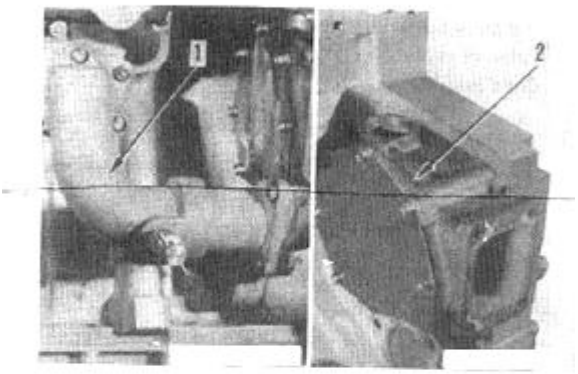
1) Remove ring (1), then move tube (2) up.
2) Remove mounting bolts (3), then remove thermo -stat housing (4).



36. Water pump assembly

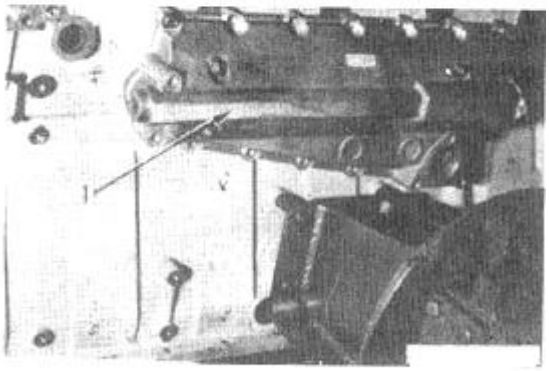
Remove tube (1), then remove water pump assembly (2).

* The mounting bolts for the water pump are also used to tighten the gear case cover.



37. Oil cooler assembly

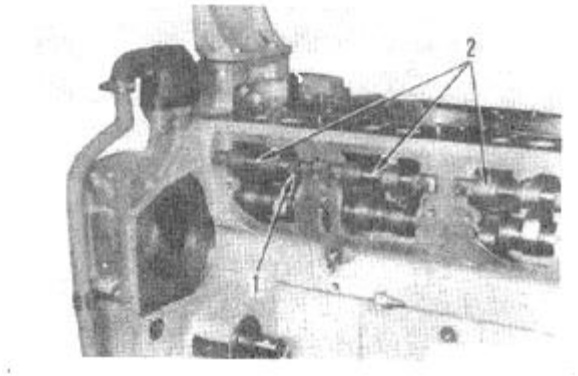
Remove oil cooler assembly (1).



38. Cam follower

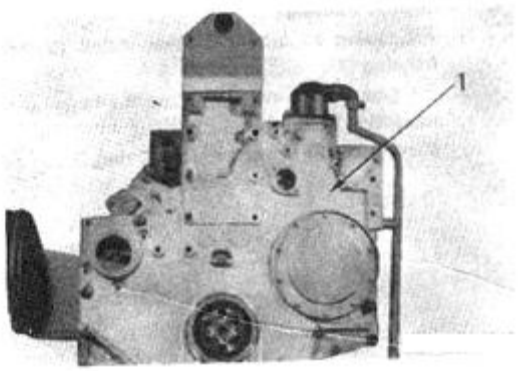
Remove cover, then remove mounting bolts (1) and cam follower (2).

* Each of twelve mounting bolts (1) has its own oil holes so pass wire through the holes and keep the bolts in a safe place to prevent them from being lost.



39. Gear case cover

Remove gear case cover (1).



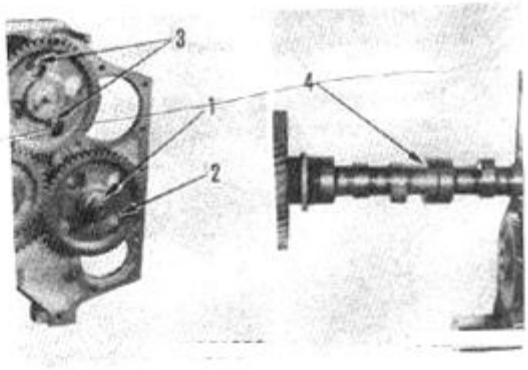
40. Injection pump drive gear

Remove mounting nut (1), then remove injection pump drive gear (2).

41. Camshaft

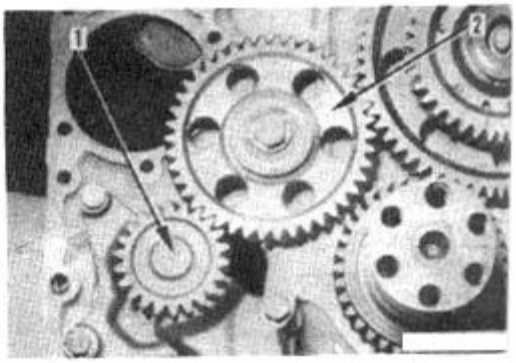
Align mounting bolts (3) with camshaft gear hole and remove mounting bolts then remove camshaft (4).

* When removing the camshaft, rotate the camshaft to prevent damage to the cam bushing.



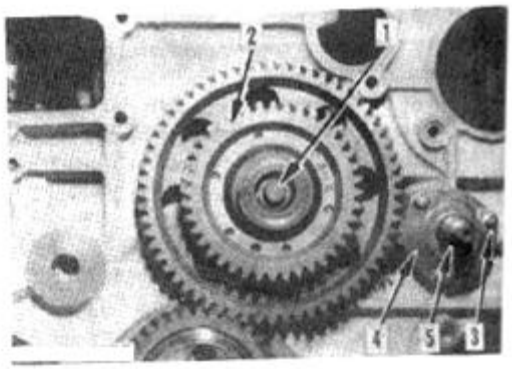
42. Oil pump assembly, sub tidler gear

1) Remove oil pump assembly (1).
2) Remove sub idler gear (2).



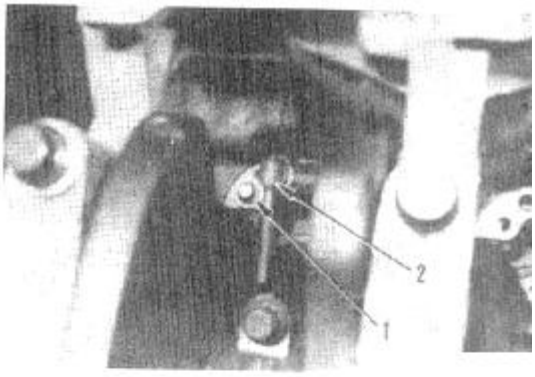
43. Main idler gear, injection pump drive shaft

1) Remove mounting bolt (1), then remove main idler gear (2).
2) Remove mounting bolts (3), remove thrust plate (4) and injection pump drive shaft (5).



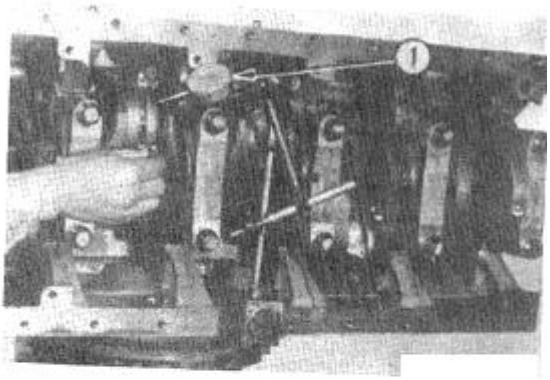
44. Piston cooling nozzle

Remove mounting bolt (1), then remove piston cooling nozzle (2).

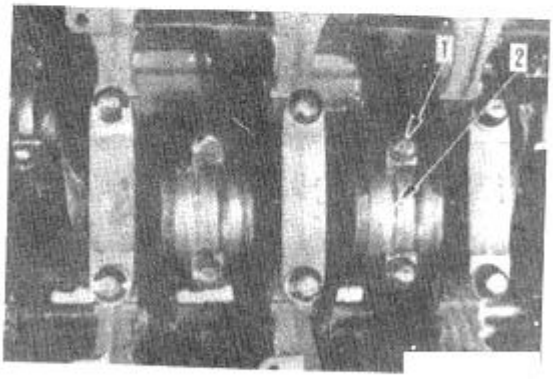


45. Piston and connecting rod assembly

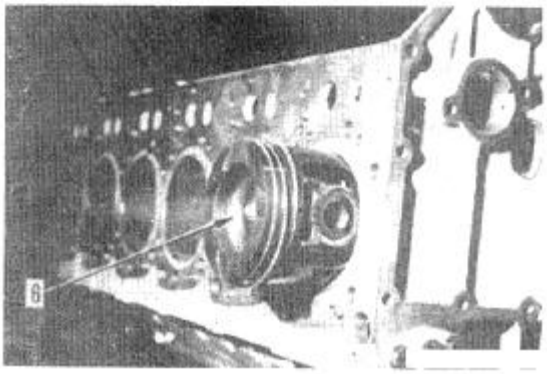
1) Check number on connecting rod cap.
   * Check that the cap number and the cylinder number match, and that the number is stamped at the cam end. If there is no number, stamp a number before removing.
2) Rotate crankshaft so that piston to be removed is at bottom dead center.
3) Using fine sandpaper, remove carbon at top of liner.
   * If necessary, measure the end play of the connecting rod with dial gauge ① before removing the connecting rod assembly.



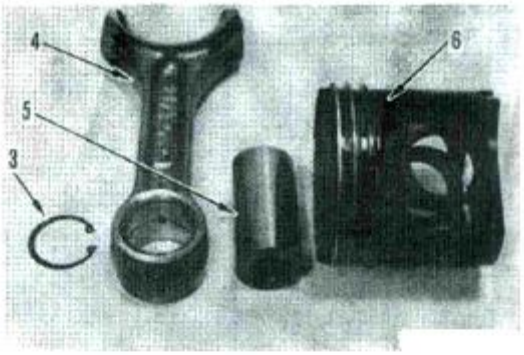
4) Remove bolts (1) of connecting rod cap.
5) Tap cap with plastic hammer and remove connect ing rod cap (2) together with connecting rod bearing.
   * Be careful not to damage the threads of the connecting rod bolts.



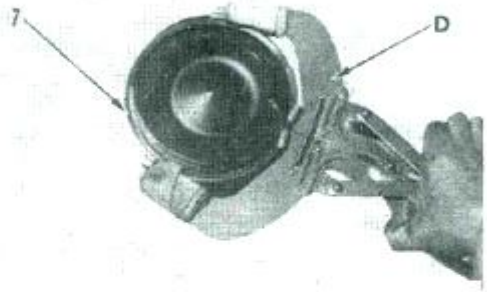
6) Using wooden bar, push piston and connecting rod from oil pan side. Support piston (6) at cylinder head side and remove.
   * When removing , be careful not to damage the inside surfaces of the liner with the corners of the connecting rod.
7) Remove remaining pistons and connecting rods in the same way.
   * Keep piston and connecting rods in a safe place and be careful not ot damage the sliding surface of the piston or the bearing.
   * Keep the connecting rod and cap assembled to prevent mistakes when assembling, and keep together with the bearing.



- Disassemblw piston and connecting rod assembly as follows.
  i) Remove snap ring (3).
  ii) Hold connecting rod (4) by hand, and tap out piston pin (5) from opposite side. Disconnect piston assembly (6) and connecting rod.
  iii) Remove snap ring on opposite side.

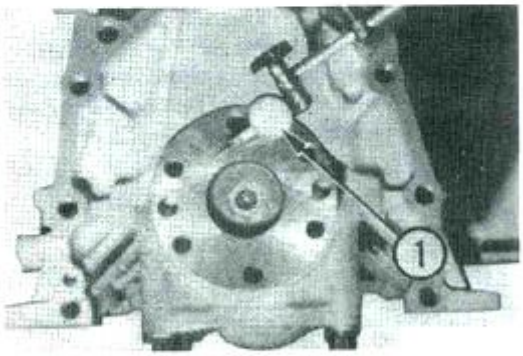


iv) Using piston ring tool D, remove piston rings (7).
* Keep piston, connecting rod, bearing, piston rings and piston pin in sets according to cylinder number.

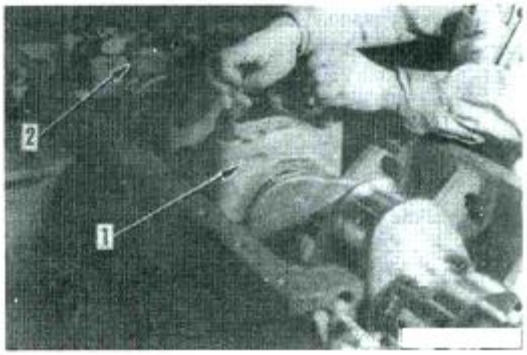


46. Crankshaft

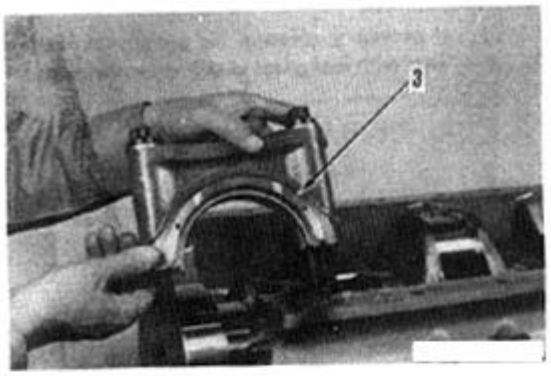
* If necessary, measure the end play of the crankshaft with dial gauge ① before removing the crankshaft.



1) Remove mounting bolts (2) of main bearing cap (1).
2) Insert bolts (2) in holes in main bearing cap, then remove main bearing cap while shaking the cap with the inserted bolts.



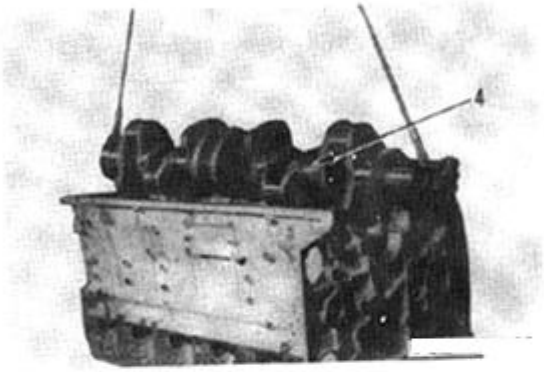
3) The lower thrust bearings (3) are assembled on both sides of the No. 7 main bearing cap, to after removing, mark the poisition for assembly.



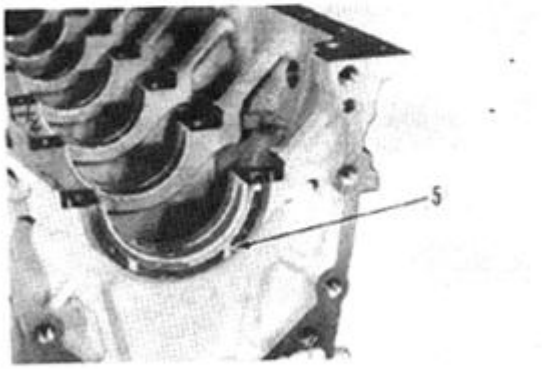
4) Using a wire, remove crankshaft (4).

kg crankshaft : 132 kg

* When slinging the crankshaft, be careful not to let it hit or damage the cylinder block.
* Keep the crankshaft in a safe place, and be careful not to damage the machined surface.

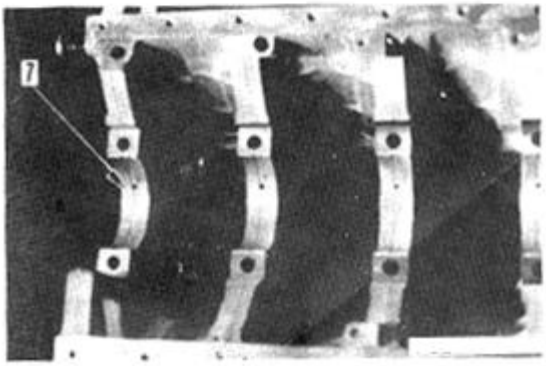


5) Remove upper thrust bearings (5).



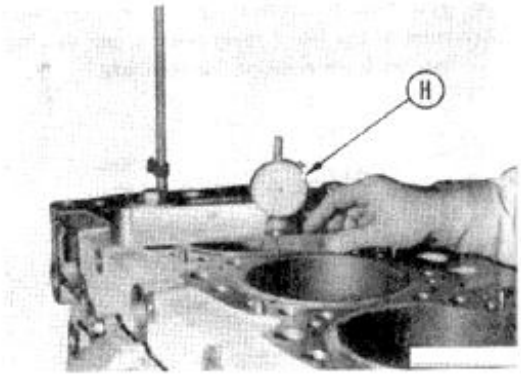
6) Remove upper main bearing (6).

* Mark the positions for assembly of the main bearing caps, main bearings and thrust bear ings with tags or felt pen. Keep in sets accord ing to the cap number keep them in a safe place and be careful not to damage them.

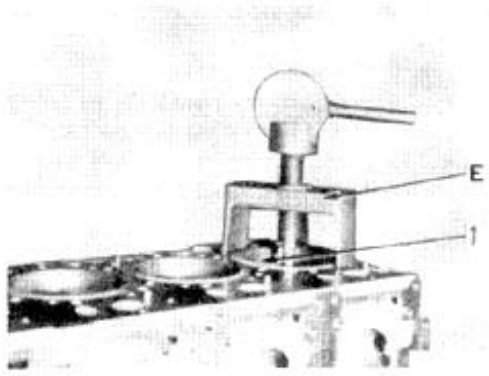


47. Cylinder liner

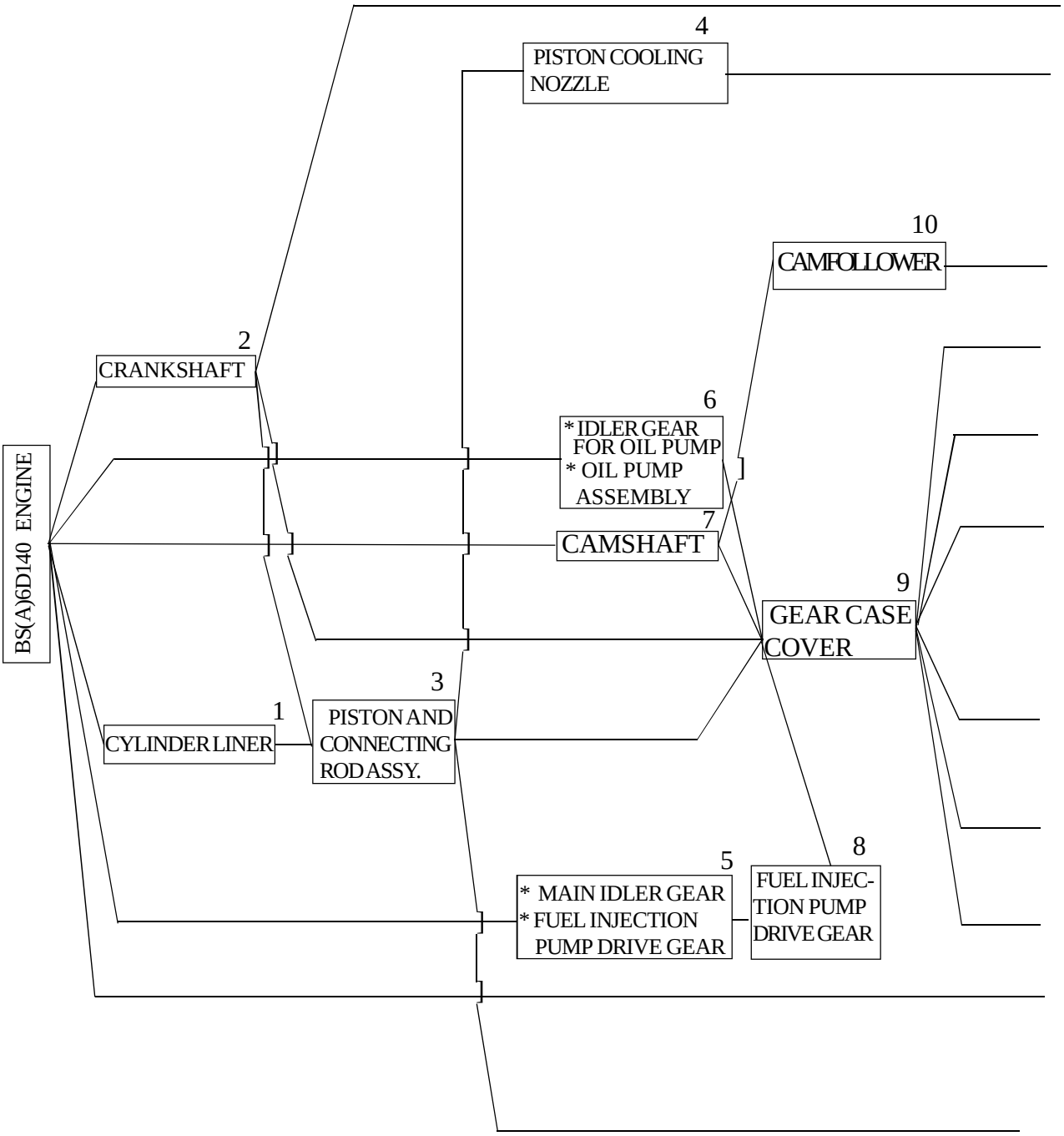
* If necessary,measure the protrusion of the cylinder liner with dial gauage H before removing the liner.

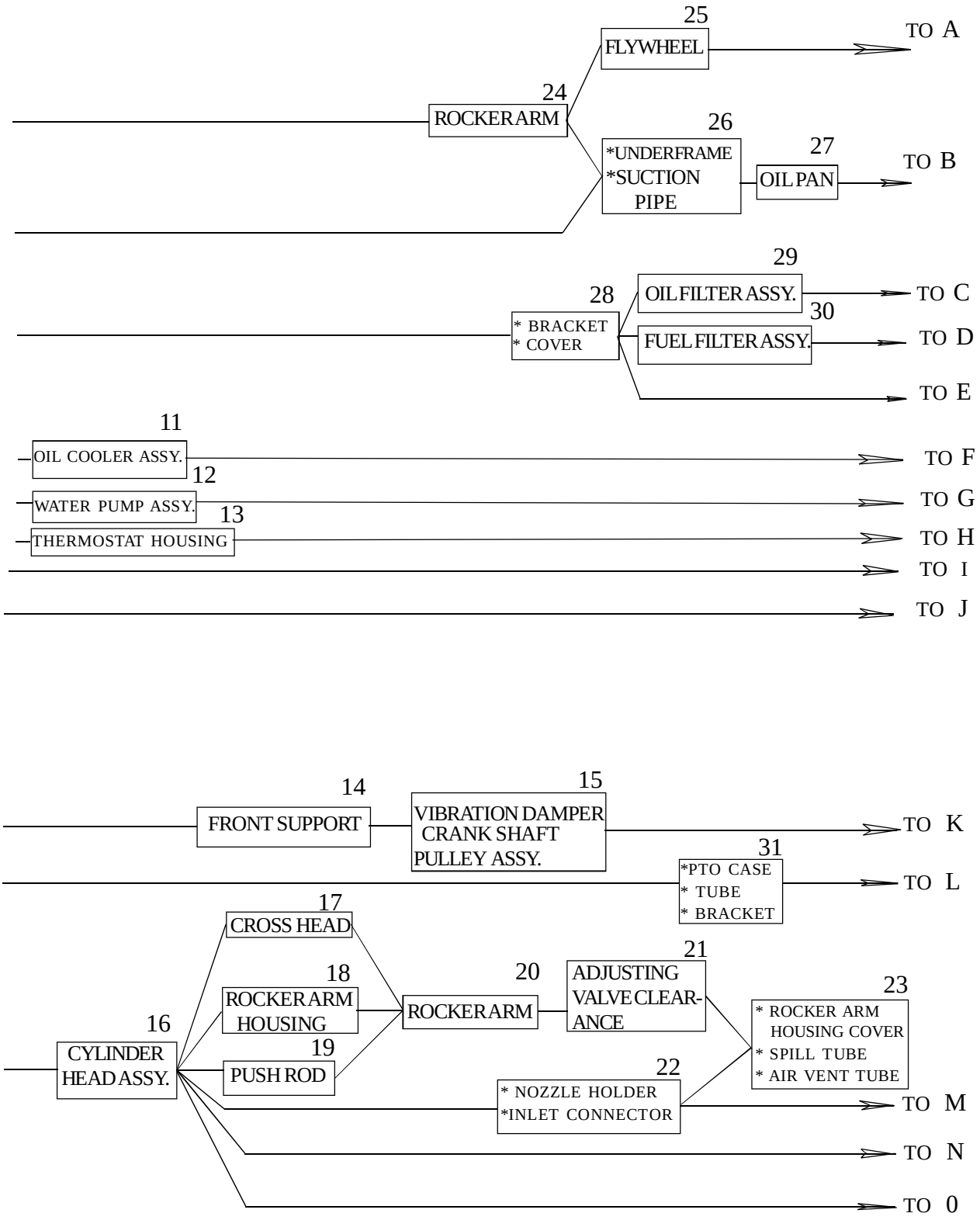


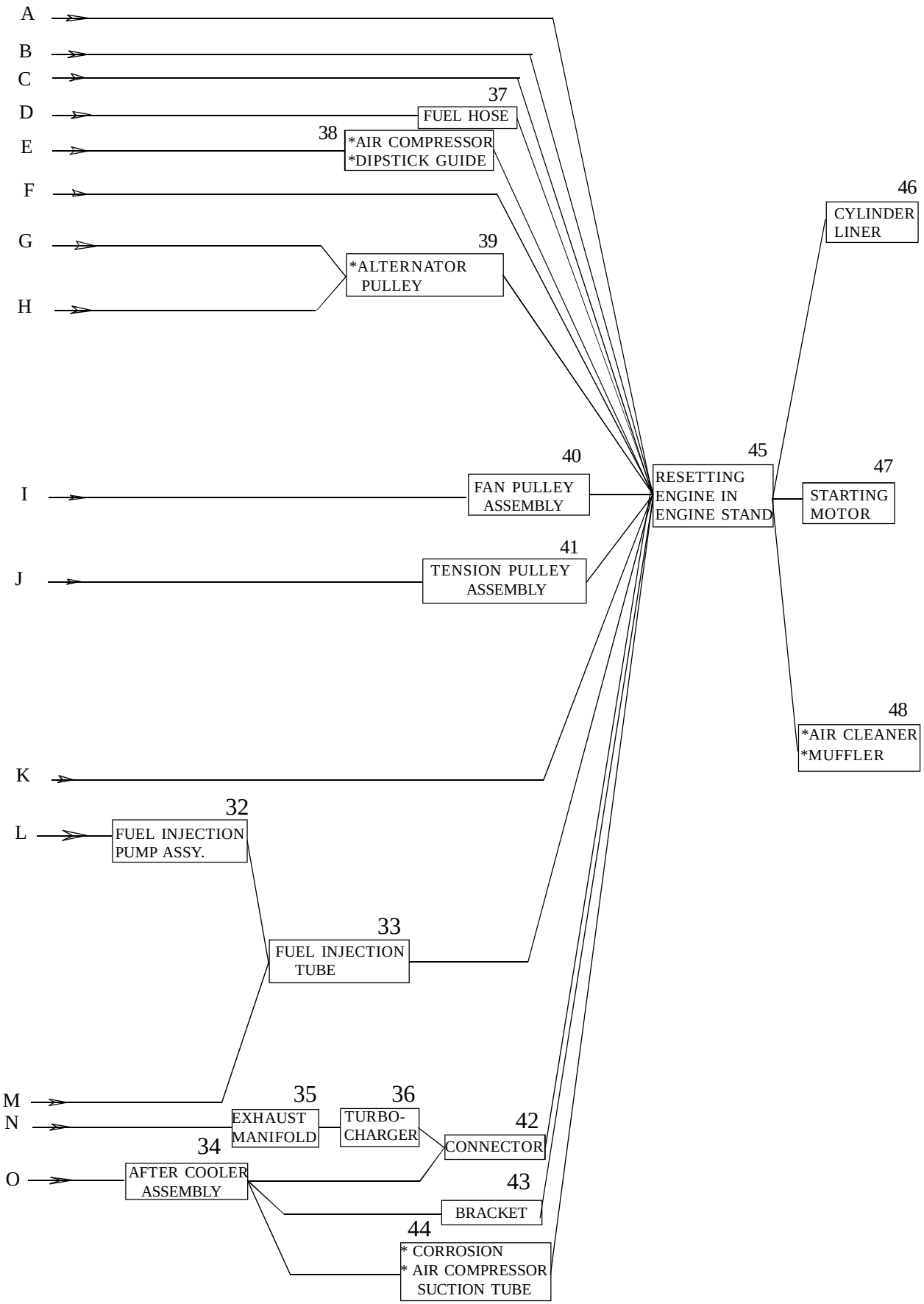
Using liner puller E, remove cylinder liner (1).



GENERAL ASSEMBLY



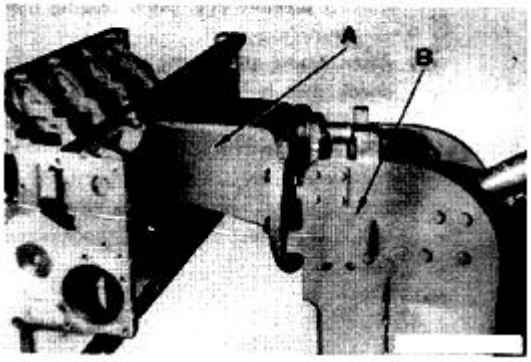

25
FLYWHEEL
TO A
24
ROCKER ARM
26
*UNDERFRAME
*SUCTION PIPE
27
OIL PAN
TO B
29
28
OIL FILTER ASSY.
TO C
* BRACKET
* COVER
30
FUEL FILTER ASSY.
TO D
TO E
11
OIL COOLER ASSY.
TO F
12
WATER PUMP ASSY.
TO G
13
THERMOSTAT HOUSING
TO H
TO I
TO J
14
FRONT SUPPORT
15
VIBRATION DAMPER
CRANK SHAFT
PULLEY ASSY.
TO K
31
*PTO CASE
* TUBE
* BRACKET
TO L
17
CROSS HEAD
21
18
20
ADJUSTING
VALVE CLEAR-
ANCE
23
ROCKER ARM
HOUSING
ROCKER ARM
* ROCKER ARM
HOUSING COVER
* SPILL TUBE
* AIR VENT TUBE
16
19
CYLINDER
HEAD ASSY.
PUSH ROD
22
* NOZZLE HOLDER
*INLET CONNECTOR
TO M
TO N
TO 0


A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
37
FUEL HOSE
38
*AIR COMPRESSOR
*DIPSTICK GUIDE
39
*ALTERNATOR PULLEY
40
FAN PULLEY ASSEMBLY
41
TENSION PULLEY ASSEMBLY
32
FUEL INJECTION PUMP ASSY.
33
FUEL INJECTION TUBE
35
EXHAUST MANIFOLD
36
TURBO-CHARGER
42
CONNECTOR
34
AFTER COOLER ASSEMBLY
43
BRACKET
44
* CORROSION
* AIR COMPRESSOR SUCTION TUBE
45
RESETTING ENGINE IN ENGINE STAND
46
CYLINDER LINER
47
STARTING MOTOR
48
*AIR CLEANER
*MUFFLER

SPECIAL TOOLS

	Part No.	Part Name	QTY
A	790-901-1260	Adapter	1
B	790-501-2000	Engine overhaul stand	1
C	795-102-2102	Spring pusher	1
D	795-100-1190	Piston ring tool	1
F	795-230-5472	Liner driver	1
G	795-236-1500	Piston holder	1
H	795-502-1121	Gauge	1
I	795-125-1210	Feeler gauge	1

* Clean all parts, and check for dents, scores or casting defects. Coat the machined surfaces of all parts with engine oil before installing. Check that all the oil and water passages are clear



Preparatory work

- Install adapter A on cylinder block, set cylinder block on engine overhaul stand B.

- Prepare the cylinder block before inserting the cylinder liner as folllows.

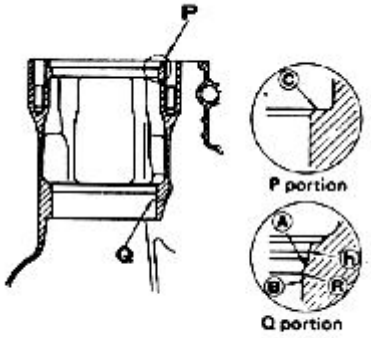
  1) Using sandpaper, remove rust and scale from faces Ⓐ and Ⓑ untill machined surface can be seen.

  2) Using No. 60 sandpaper, polish portions Ⓡ and ⓗ to give a smooth finish. If there is a sharp corner formed or any burrs on portion Ⓡ, remove with a scraper or sandpaper. Be particularly careful to finish this surface smoothly to prevent damage to the O-ring.

  3) If there is pitting on face Ⓑ and it cannot be repaired, replace cylinder block.

  4) If there is pitting on face Ⓐ or portion Ⓡ, polish to give a smooth finish.

  5) Inspect counterbore and remove all burrs. Remove all chips and dirt from face Ⓒ. Such dirt will cause defective sealing of the liner,leakage of water, or defective portrusion of the liner.
     * If there is any damage, corrosion or pitting in the counterbore, repair it.



1. Cylinder liner

* On the liner O-ring and crevice seal, replace with new ones, just before assembling the liner.

1) Install liner O-rings and crevice seals

i) Check that there is no rust or pitting in cylinder liner ring grooves or outside circumference of liner.

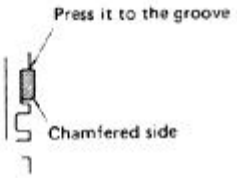
- Pitting causes leakage of water, so if any pitting is found, replace the liner.

ii) Coat liner ring grooves, O-rings, and crevice seals with engine oil.

* The crevice seal and black O-ring will get swollen and degraded because of oil.
To prevent this, avoid leaving these parts immersed in oil.

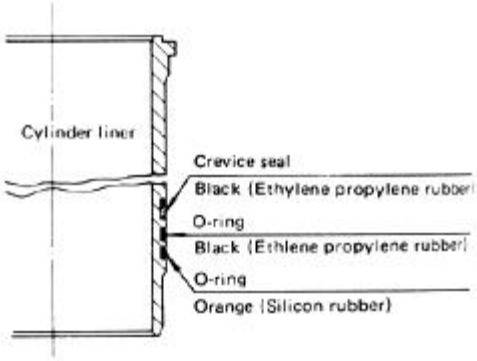
iii) After fitting the O-ring on the cylinder liner, check that it is not twisted. If it is twisted, use a smooth bar (approx. 10 mm O.D) to remove the twist from the O-ring.

iv) To prevent crevice seal from twisting when it is installed, press whole circumference so that it fits into top of the seal groove when installing.



v) Assemble liner O-ring and crevice seal as shown in diagram.

* Assemble the crevice seal with the chamfered side at the bottom.



2) Insert cylinder liner

i) Coat liner ring grooves and cylinder block O-ring grooves with engine oil.

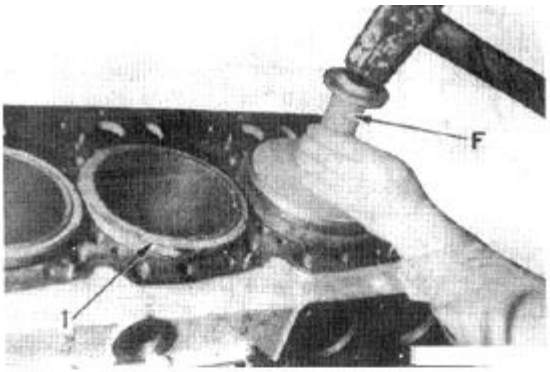
ii) Set mark “A or B” on the top face of liner facing front and insert liner in cylinder block.

* Be careful not to damage the O-ring.

iii) Using your weight, push liner in with both hands.

* If the liner does not go in smoothly when you apply your weight, the O-ring may be broken. Check that there are no burns in the cylinder block.

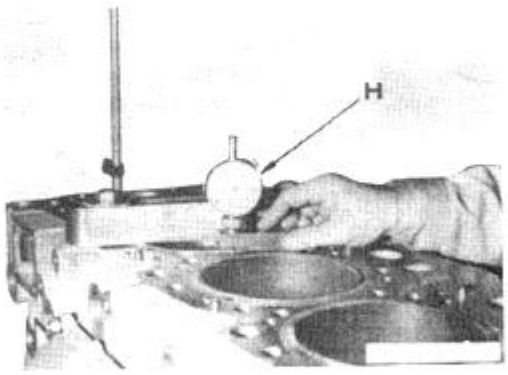
iv) Using liner driver F, press fit cylinder liner (1) in cylinder block.



v) After press fitting cylinder liner ,use dial gauge H to measure protrusion of cylinder liner.

* When measuring the protrusion of the liner, press the liner with a plate to prevent the O-ring from pushing up the liner.

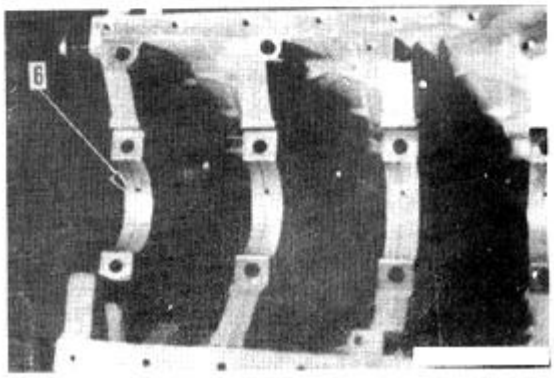
* Protrusion of cylinder liner : 0.07-0.15 mm



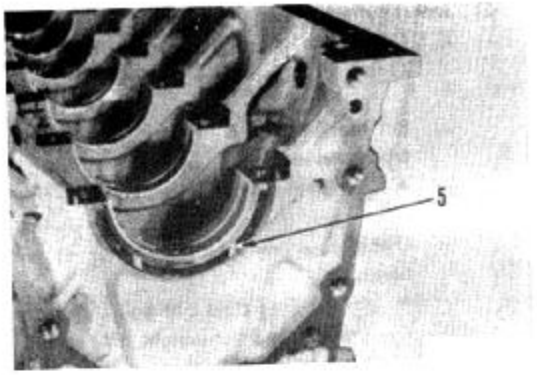
2. Crankshaft

1) Align protrusion of upper main bearing (6) with notch in cylinder block, and install in cylinder block.

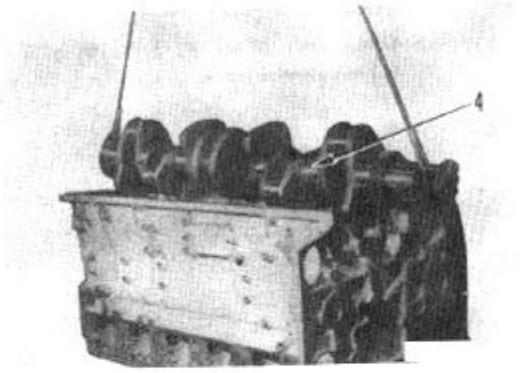
* Check that there is no dirt or dust stuck to the rear face of the bearing. Coat the inside face of the bearing with engine oil before assembling.



2) Knock in roll pin so that it protrudes 2.7 -3.4 mm from block, then install upper thrust bearings (5).
   * Install the thrust bearings with the groove on the outside.

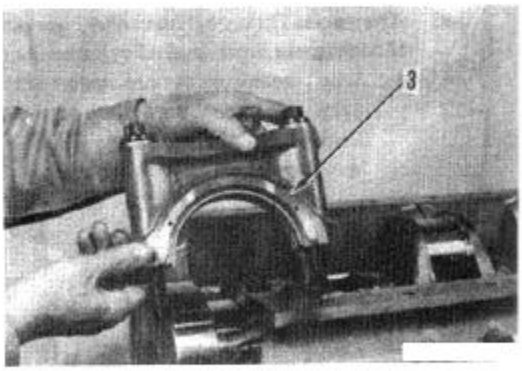


3) Using a wire, sling crankshaft (4) and set in position on cylinder block.
   * When installing the crankshaft, be careful not to let it hit or damage the cylinder block.
   * If the crankshaft gear has been replaced, heat the crankshaft gear in an electric furnace at 200°C for 30 minutes, then shrink fit.



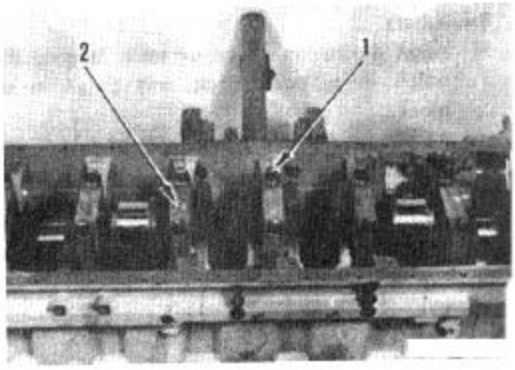
4) Align protrusion of lower main bearing with notch in main bearing cap and install bearing.
   * Check that there is no dirt or dust stuck to the rear face of the bearing when installing.

5) Knock in roll pin so that is protrudes 2.7 - 3.4 mm from cap, then assemble thrust bearings (3) on both sides of No. 7 main cap.
   * Install the thrust bearings with the groove on the crankshaft side.



6) Coat journal surfaces of crankshaft with the engine oil.
   * Check that the number on main bearing cap (2) matches the cylinder block number, and install main bearing cap.
   * Install the main bearing cap with the part number casting mark facing the front of the engine.

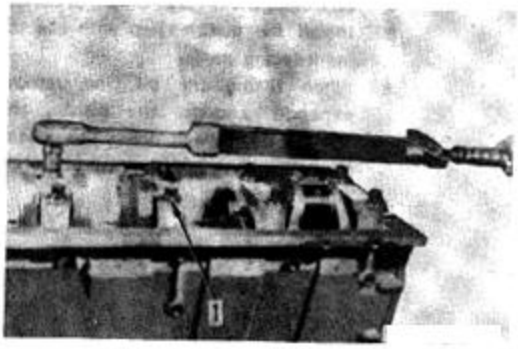
7) Coat washer and threads of mounting bolts of main bearing cap with engine oil. Screw in bolts (1) to fit main bearing cap completely.

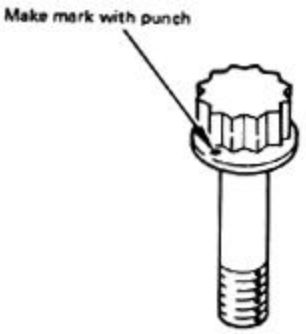


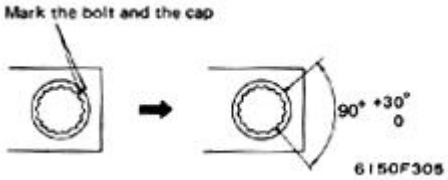
8) Tighten mounting bolts (1) of main bearing cap as follows.
   * When tightening the mounting bolts of the main bearing cap, start in the middle and work to the outside.Then tighten all the mounting bolts again .to the next step.
   kgm Mounting bolt of main bearing cap.

Unit: Kgm

Order	Target	Range
1st step	12	11-13
2nd step	22	21.5-22.5
3rd step	Mark the bolts and the cap with a felt-tip pen, and turn the bolts with following degree	
	90°	90°-120°



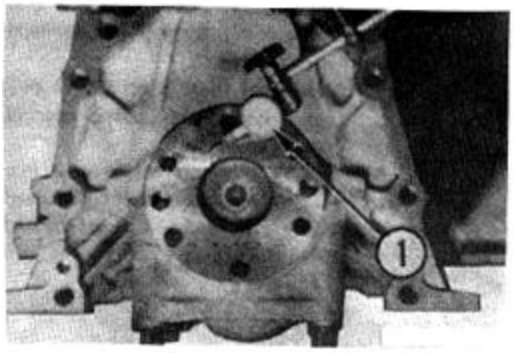




* Make a punch mark on the bolt head each time the bolts are used. If there are already five marks on the bolt head replace with new bolts.

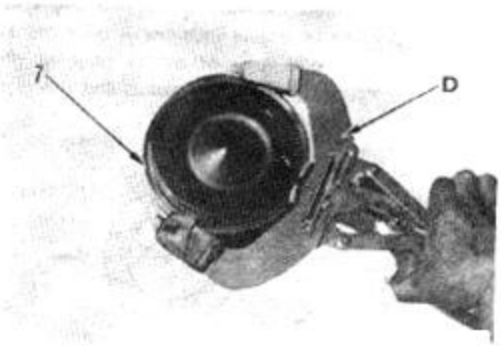
9) After tightening bolts, rotate crankshaft and check that it rotates smoothly.

10) Measure end play of crankshaft with dia; gaugue (1).
   * End play L 0.14-0.315 mm

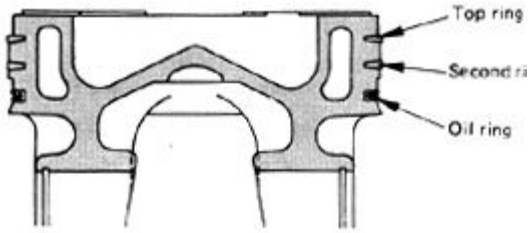


3. Piston and connecting rod assembly

1) Assemble piston and connecting rod assembly as follows.
   i) Using piston ring tool D, install piston rings (7) on piston.

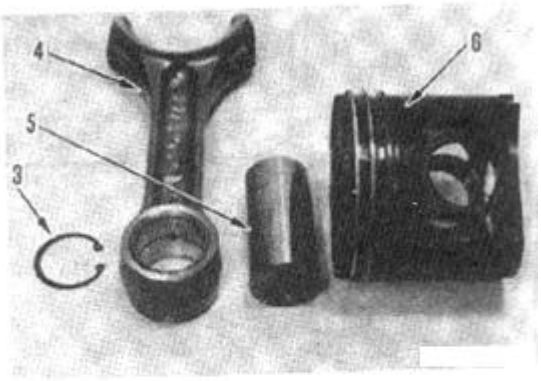


* Assemble the rings as shown in the diagram.
* Install the piston rings with the stamped mark facing up.
* When fitting the oil ring, remove the expander and fit the piston, then fit the oil ring,when doing this,check that the expander is fittered completely inside the ring groove.



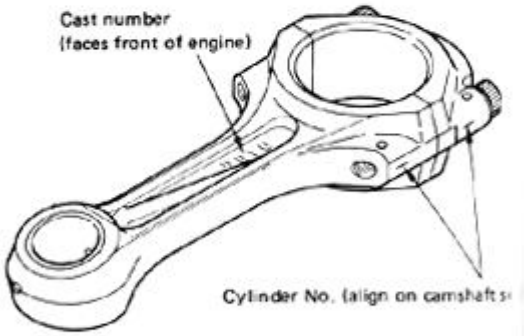
ii) Set piston and connecting rod.
* Match cylinder number on piston head with number stamped on connecting rod, and set numbers facing in the correct direction. Then insert piston pin (5) and assemble piston (6) to connecting rod (4).

iii) Install snap rings (3) on both sides to secure piston pin.

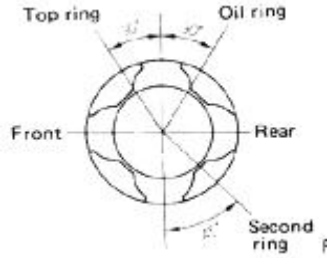


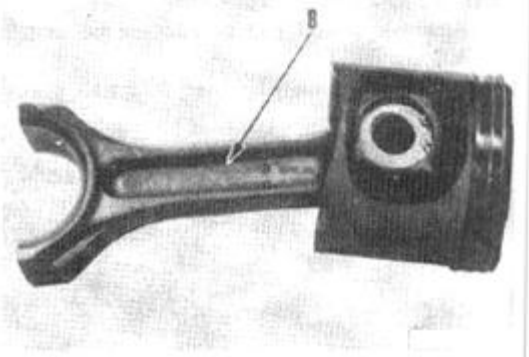
iv) Align protrusion of upper main bearing of connecting rod with notch in connecting rod and install bearing.
* Check that there is no dirt or dust stuck to the rear face of the bearing when installing.

2) Set crankshaft to bottom dead center in cylinder to be assembled, then coat inside surface of connecting rod bearing and inside surface of cylinder with engine oil.

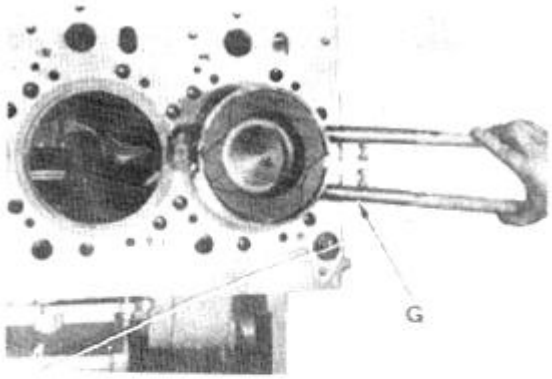


3) Set cast number on connecting rod facing front of engine (number is on camshaft side), align end gaps of piston rings as shown in diagram, and insert piston and connecting rod assembly (8).

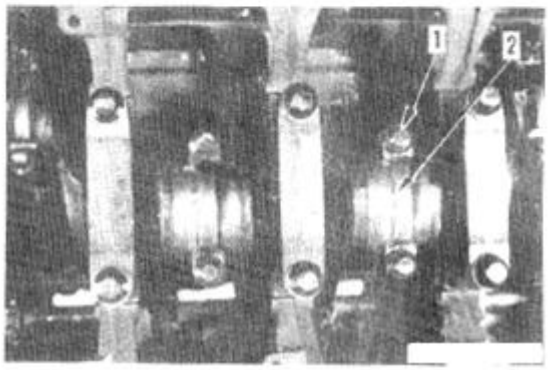




4) Using piston holder G, compress piston rings and push in piston head with wooden bar.



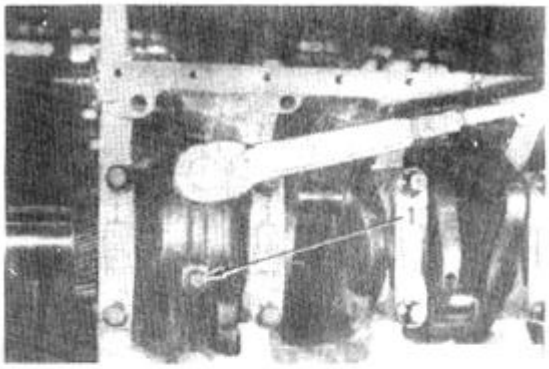
5) Align protrusion of lower main bearing with notch in connecting rod cap and assemble. Align connecting rod cap (2) with mark on connecting rod and install.
   * Check that there is no dirt or dust stuck to the rear face of the bearing when installing.
   * Coat the sliding surface of the connecting rod cap with engine oil.



6) Coat bolt threads and bolt seat with engine oil (SAE30). Tighten mounting bolt (1) of connecting rod as follows.
   kgm mounting bolt of connecting rod

Unit : kgm

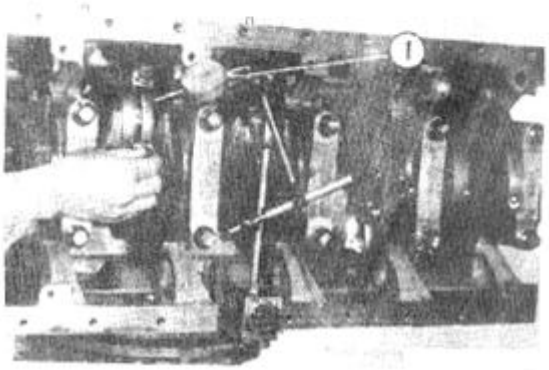
Order	Target	Range
1st step	13	12.5 - 13.5
2nd step	Mark the bolts and the cap with a felt-tip pen and turn the bolts with following degrees.	
	90°	90°-120°



* Make a punch mark on the bolt head each time the bolts are used. If there are already five marks on the bolt head, replace with new bolts.

7) After installing piston and connecting rod assembly, rotate crankshaft and check that if rotates smoothly. There must be no catching or other abnormality.

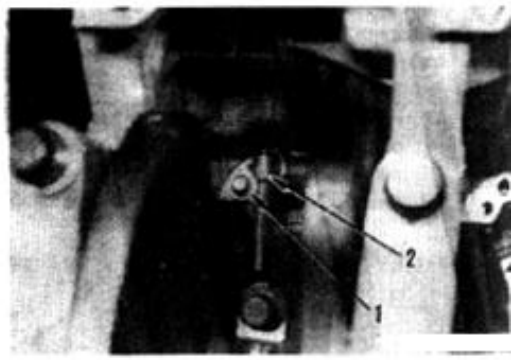
8) Measure side clearance of connecting rod with dial gauge ①.
   * Side clearance : 0.100-0.274 mm



4) Piston cooling nozzle

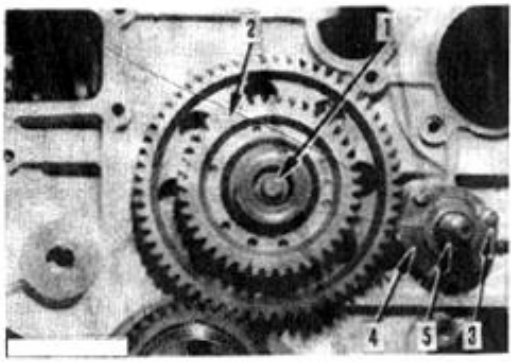
Fit O-ring, then fit piston cooling nozzle (2) and install mounting bolts (1).

* Check that the tip of each nozzle is directed at the center of each piston shaker hole.



5) Main idler gear, fuel injection pump drive shaft

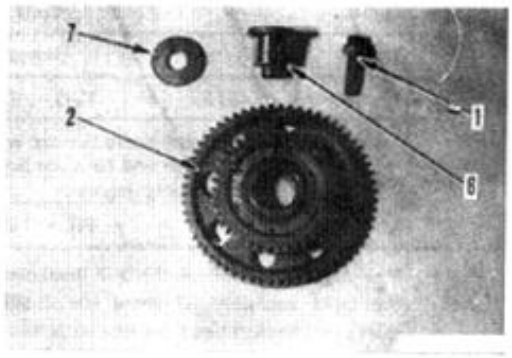
1) Coat fuel injection pump drive shaft (5) with engine oil and install.
2) Install thrust plate (4), then install mounting bolts (3).



3) Install shaft (6) to main idler gear (2), then fit washer (7) on inside.
4) Align "A" mark on crankshaft gear with "A" mark on main idler gear (2), then tighten mounting bolts (1).

kgm Idler mounting bolt :

Engine No.	
upto 10368	32.5 ± 2.5 kgm
10369 and up	41.0 ± 2.5 kgm



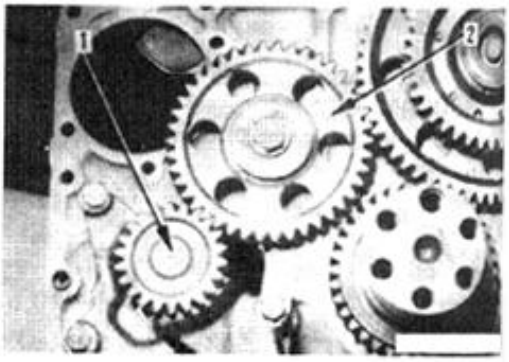
6) Sub idler gear, oil pump assembly

1) Install sub idler gear (2).
2) Fit O-ring and install oil pump assembly (1).

kgm Sub idler mounting bolt :

Engine No.	
upto 10368	32.5 ± 2.5 kgm
10369 and up	41.0 ± 2.5 kgm

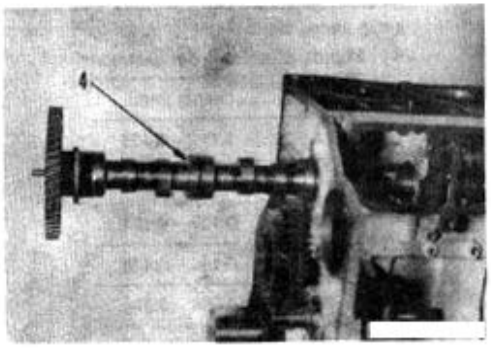
kgm Oil pump mounting bolt : 11.25 ± 1.25 kgm



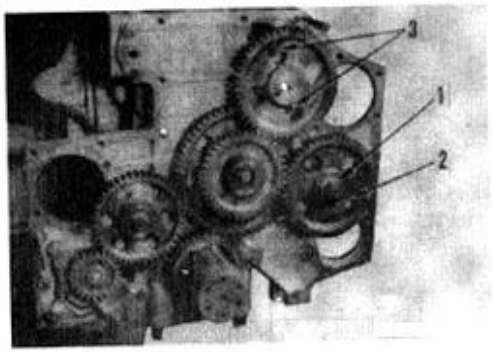
7) Camshaft
Coat camshaft jouranal surfaces with engine oil. Align "B" mark of camshaft gear with "B" mark of main idler gear, then tighten mounting bolts (3) of camshaft (4).

kgm Moounting bolt of plate : 11.25 ± 1.25 kgm

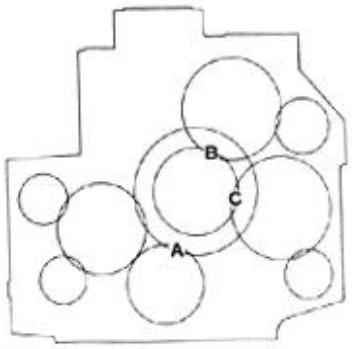
* When installing the camshaft, rotate the camshaft to prevent damage to the cam bushing.
* If the camshaft gear has been replaced, heat the camshaft gear in an electric furnace at 220 - 240° C for 30 minutes, then shrink fit the gear.



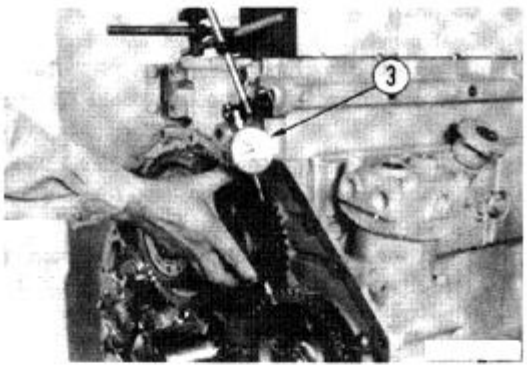
8) Fuel injection pump drive gear
Fit key to shaft, align "C" mark of main idler gear with "C" mark of drive gear, then fit drive gear (2) and tighten nut (1).
kgm Nut : 17.5 ± 2.5 kgm



* Check that the match marks of each drive gear and idler gear are aligned.



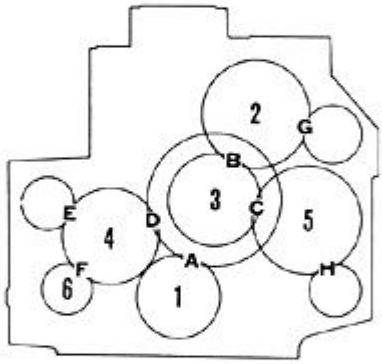
* Measure backlash and end play of each of gear using a dial gauge ③.
* Standard backlash for each gear



Position	Range (mm)
A	0.141 - 0.425
B	0.129 - 0.391
C	0.129 - 0.391
D	0.141 - 0.426
E	0.095 - 0.346
F	0.080 - 0.417
G	0.118 - 0.369
H	0.118 - 0.369

* Standard end play for each gear

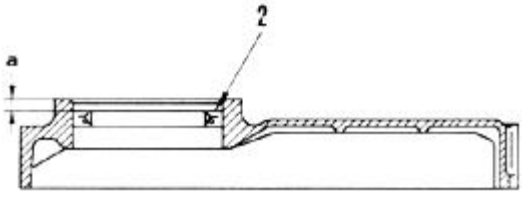
Position	Range (mm)
1	0.14 - 0.315
2	0.10 - 0.25
3	0.05 - 0.17
4	0.05 - 0.17
5	0.07 - 0.20
6	0.03 - 0.088



9) Gear case cover

1) Using push tool (outside diameter : 120 mm), press fit oil seal (2) to cover.
   * Press-fitting interference 'a' of oil seal :

$5.0\ ^{+1}_{0}$ mm



Lip of oil seal (50 - 80% of space) : Grease (G2 - Ll)

   * When installing the gear case cover, remove the service meter gear box.

When the sheet gasket is in use :

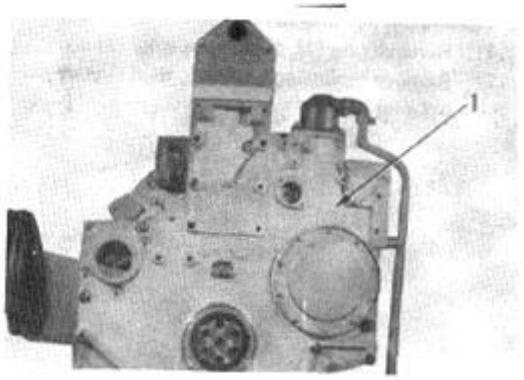
2) The sheet gasket is stuck on the gear case cover and dried up.

when no sheet gasket is used :

2) Coat with gasket sealant.

Contact surface : Gasket sealant (LG-7)

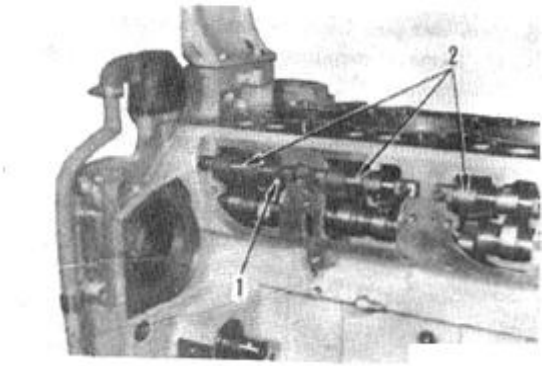
3) Install gear case cover (1).
   * When installing the cover, be careful not to damage the oil seal.
4) Install service meter gear box.



10) Cam follower

1) Align cam follower (2) with dowel pin, then tighten mounting bolts (1).
   kgm Mounting bolt : 5.2 ± 0.8 kgm
2) Fit O-ring and install cover.
   kgm Mounting bolt : 1.15 ± 0.15 kgm

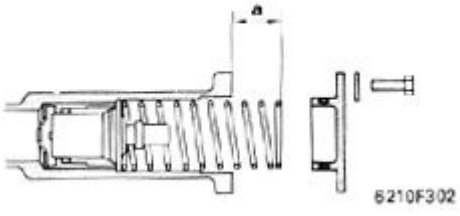
* The mounting bolts for the cam follower are fitted with lubrication holes, so check that the holes are clear.

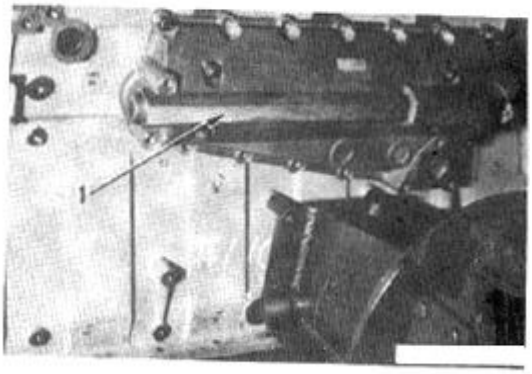


11) Oil cooler assembly

Fit gasket and install oil cooler assembly (1).

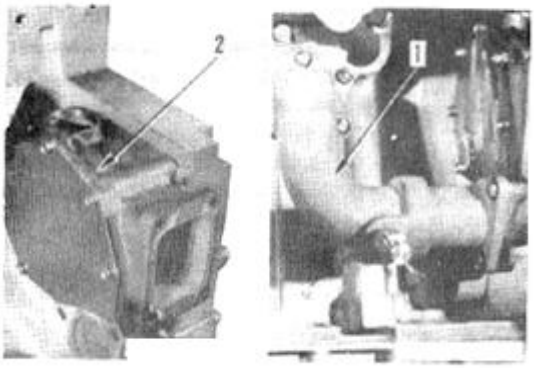
* When installing servo valve, confirm the overhang amount of spring. Fix spring again when exceeding standard value.
  overhang amount of spring a : 24 mm



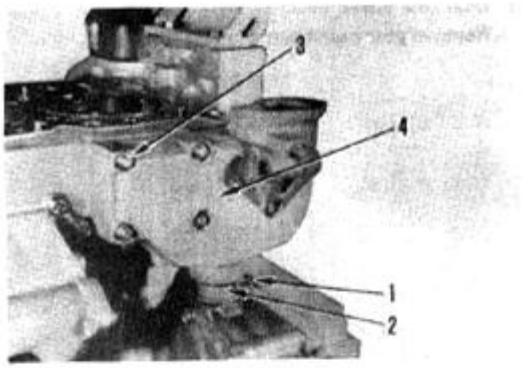


12) Water pump assembly

1) Fit O-ring and install water pump assembly (1).
   * The mounting bolts of the water pump are used to tighten the gear case.
2) Fit gasket and install tube (2).

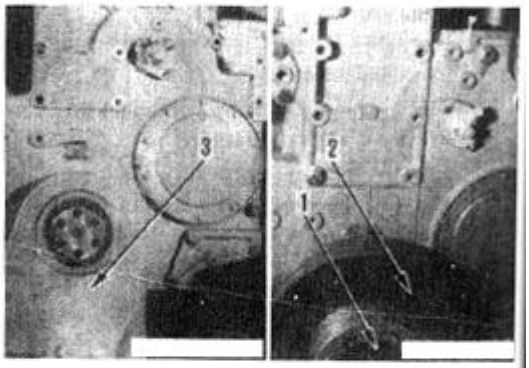


13) Thermostat housing
1) Fit O-ring to tube (2), then install to thermostat housing (4).
2) Fit gasket and install themostat housing (4) with mounting bolts (3).
3) Move tube (2) down and install ring (1).

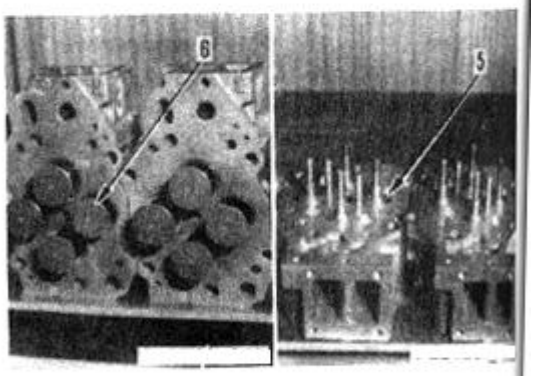


14) Front support
Install front support (3).

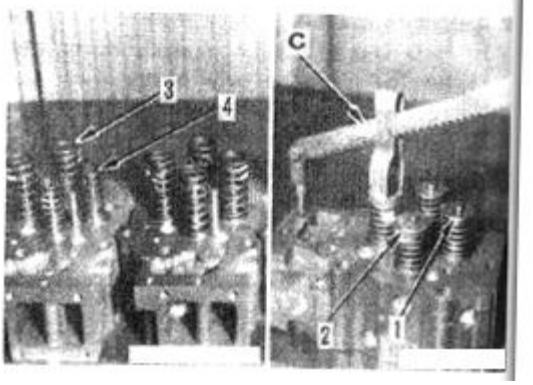
15) Vibration damper,crankshaft pulley assembly
Install vibration damper, crankshaft pulley assembly (2), then tighten with mounting bolt (1).
kgm Mounting bolt : 28.5 ± 3.0 kgm



16) Cylinder head assembly
1) Assemble cylinder head assembly as follows.
i) Coat valve stem and inside surfaces of valve guide with engine oil, then assemble valve (6).
ii) Raise cylinder head and assemble lower valve seat (5).

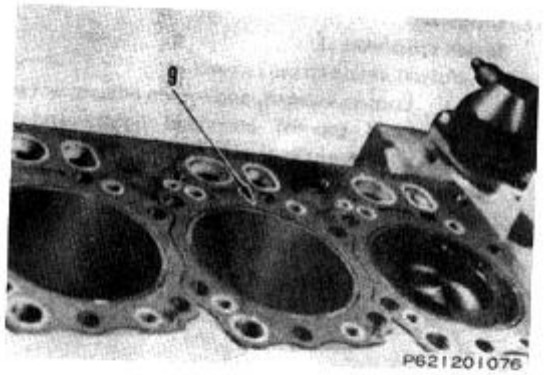


iii) Install inner valve spring (4) and outer valve spring (3), then assemble valve (6).
iv) Using spring pusher C, compress valve spring and install valve cotter (1).
* Tap the valve stem with a plastic hammer to check that the cotter is completely fitted in the groove of the valve stem.



2) Check that the mounting surfaces of the cylinder head and cylinder block are clean and that there is no dirt or foreign matter inside the cylinder. Set cylinder head gasket (9) in position.

* When installing the gasket , check that the grommets correctly in place



3) Install cylinder head assembly (2), then tighten mounting bolts (1).

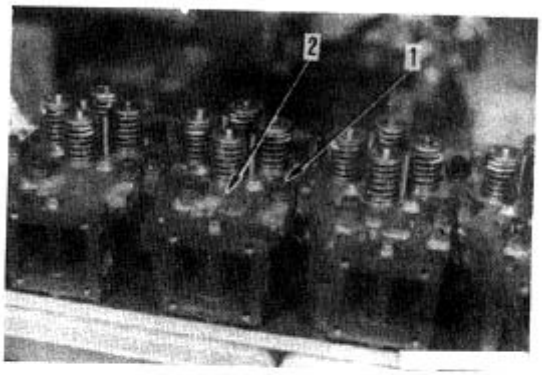
Coat threads of mounting bolts and under part of bolt head with antifriction compound (LM-P) or engine oil.

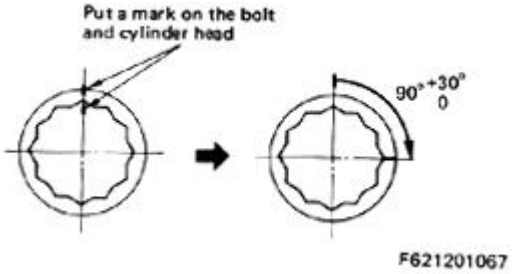
* Tighten the mounting bolts 2 - 3 turns by hand, then tighten as follows.

kgm Cylinder head mounting bolt :

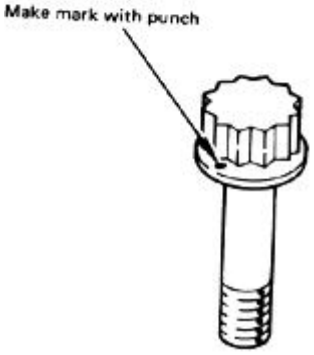
Unit : kgm

Bolt No.	Order	Target	Range
① l ⑥	1st step	15	14 - 16
	2nd step	22	21.5 - 22.5
	3rd step	Mark the bolts and the cylinder head with a felt-tip pen, and turn the bolts with following degrees.	
		90°	90° - 120°
⑦	-	6.75	6.0-7.5





* Make a punch mark on the bolt head each time the bolts are used. If there are already five marks on the bolt head, replace with new bolts.



17) Crosshead

Install crosshead (1).

* Adjust crosshead as follows.

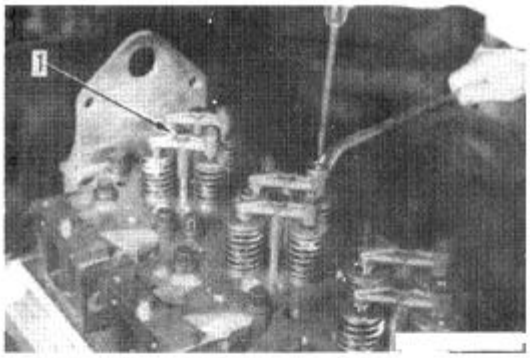
i) Loosen locknut, and loosen adjustment screw.

ii) Hold top of crosshead lightly and tighten adjustment screw.

iii) Tighten adjustment screw untill it contacts valve stem, then tighten a further 20°.

iv) Tighten locknut to hold in position.

kgm Locknut : 6.0 ± 0.6 kgm



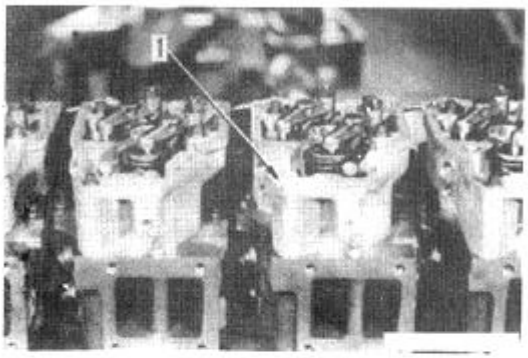
18) Rocker arm housing

Fit gasket and install rocker arm housing (1).

kgm Mounting bolt :

(10M bolt) 6.5 ± 0.75 kgm

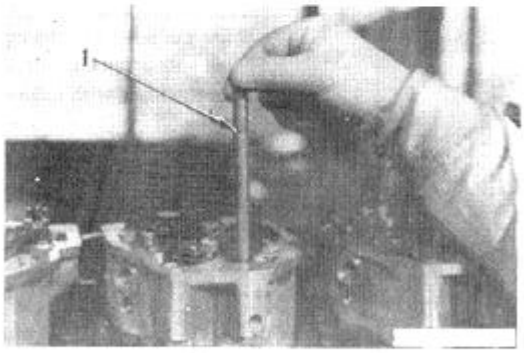
(12M bolt) 11.25 ± 1.25 kgm



19) Push rod

Install push rod (1).

* Check that the push rod is properly fitted in the cam follower.



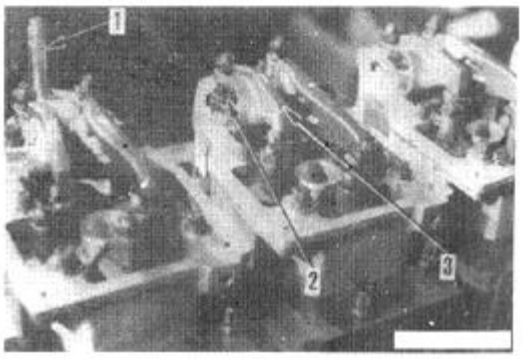
20) Rocker arm

1) Install rocker arm (3) and tighten with mounting bolts (2).

* Check that the ball of the adjustment screw is properly fitted into the socket of the push rod.

kgm Mounting bolt : 10.0 ± 0.5 kgm

2) Install turbocharger lubrication tube bracket (1).



21) Adjusting valve clearance

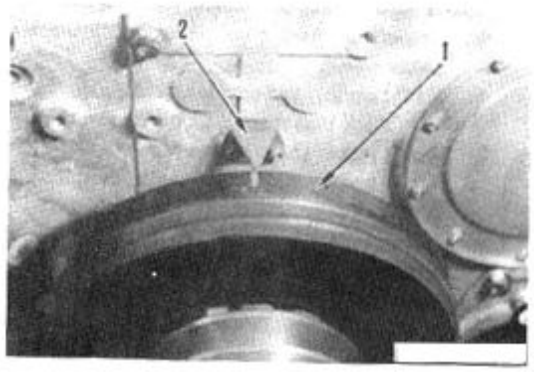
Adjust valve clearance as follows.

* Adjust the clearance between the crosshead and rocker arm to the following values.

* Valve clearance (when engine is hot or cold).

Unit mm

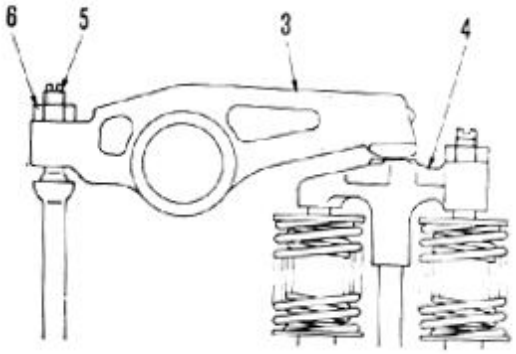
Intake valve	Exhaust valve
0.43	0.80



* Crank the engine and follow the firing order to adjust the valve clearance of each cylinder.

Firing order : 1 - 5 - 3 - 6 - 2 - 4

1) Rotate the crankshaft in the normal direction to align pointer (2) with the 1,6 TOP mark on vibration damper (1). When rotating, check the movement of the valves.



2) To adjust, insert feeler gauge l between rocker arm (3) and crosshead (4) and turn adjustment screw (5) untill clearance is a sliding fit.

3) Tighten locknut (6) to hold adjustment screw in position.

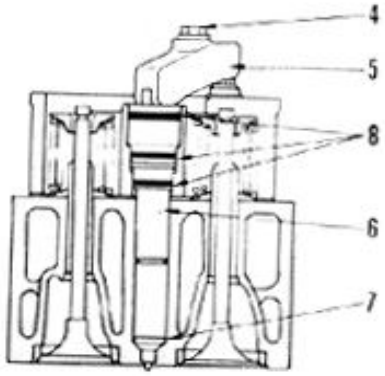
kgm Locknut : 6.0 ± 0.6 kgm

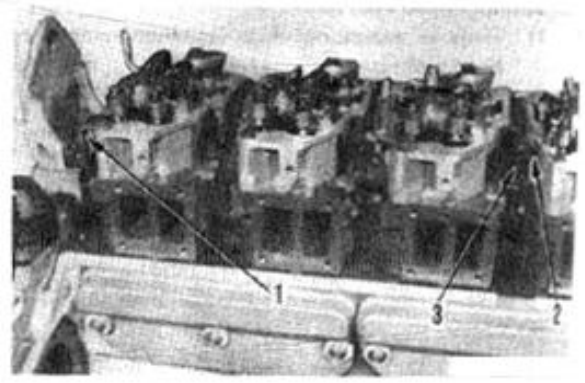
* After tightening the lock nut, check the clearance again.

22) Nozzle holder, inlet connector

* Check that there is no dirt or dust inside the nozzle holder sleeve.

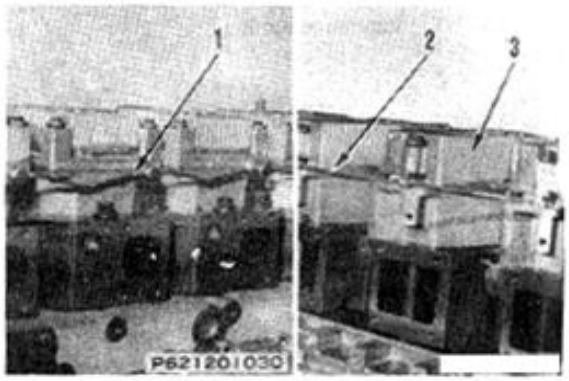
1) Fit O-ring (8), and coat with engine oil.
   * Check that there is no damage to the O-ring.
2) Install gasket (7) to nozzle holder.
3) Align nozzle holder (6) with mounting hole of inlet connector and insert nozzle holder.
4) Insert inlet connector (3) in rocker arm housing and tighten partially.
5) Fit holder (5), then fit ball washer to mounting bolt (4) and tighten mounting bolt.
   * Install one end of the holder to the rocker arm housing, lay on the bolt head and tighten with the bolt.
6) Tighten inlet connector (3), then tighten locknut (2).
   kgm Holder mounting bolt : 6.75 ± 0.75 kgm
   Inlet connector : 3.8 ± 0.3 kgm
   Locknut : 4.0 ± 0.5 kgm
7) Install air compressor pipe bracket (1).





23) Rocker arm housing cover, spill pipe, air vent tube

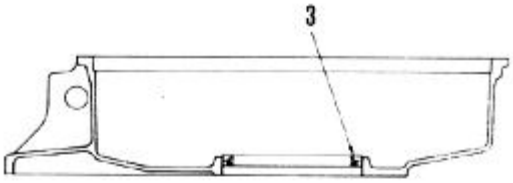
1) Fit O-ring and install rocker arm housing cover (3).
2) Fit gaskets on both sides and install spill pipe (2).
3) Fit gaskets on both sides and install air vent tube (1).



24) Flywheel housing

1) Using push tool (outside diameter : 180 mm),press fit oil seal (3) on housing.

Coat lip surface of oil seal (50 - 80% of lip space) with greade (G2 - Ll).

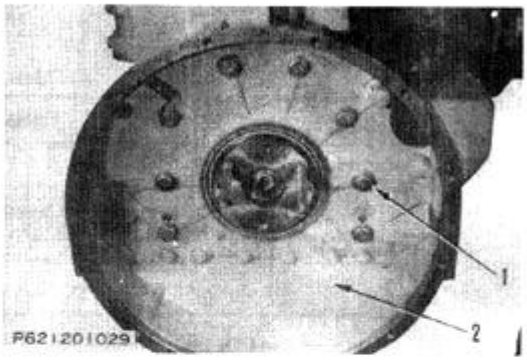


2) Sling flywheel housing (1). coat mounting surface with gasket sealant. then install on cylinder block and tighten bolts (2).

* When installing the housing, be careful not to damage the oil seal.

Contact surface : Gasket sealant (LG-7)

Coat the bolt threads and seat face with engine oil before tightening.

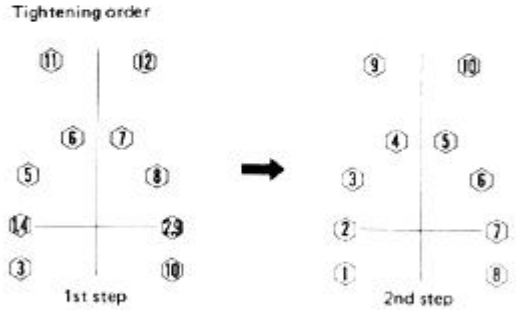


* Tighten the mounting bolts of the flywheel housing in the order shown in the diagram and to the following torques.

kgm Flywheel housing mounting bolt

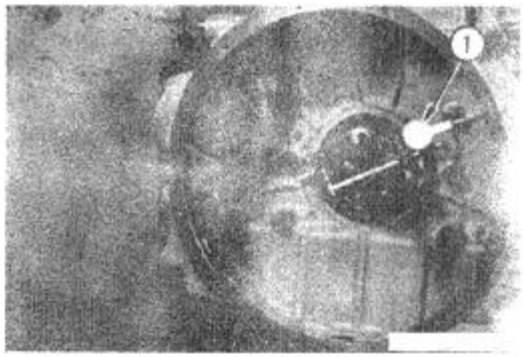
Unit : kgm

Order	Target	Range
1st step	19	15-24
2nd step	28	25-31.5



3) After installing the flywheel housing,measure the radial runout face runout and using dial gauge ①.

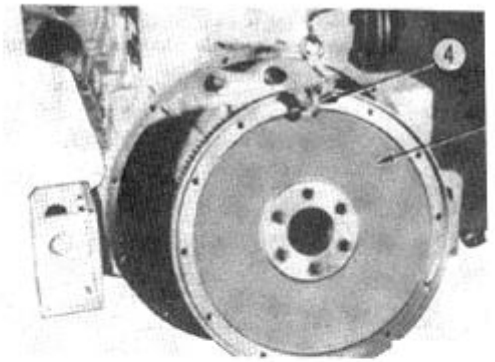
* Radial runout : Max. 0.30 mm
* Face runout : Max. 0.30 mm



25) Flywheel

1) Using eye bolt ④ (Dia.= 12mm, pitch =1.75), sling flywheel (1), install the flywheel to the crankshaft, and tighten the mounting bolt.

Coat the threads of the bolts and the seat face, with engine oil SAE No. 30 before tightening the bolts.



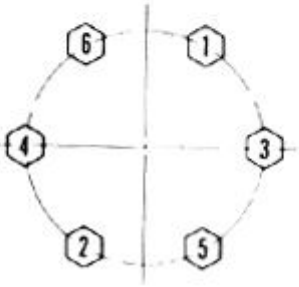
2) Tighten mounting bolts as follows.

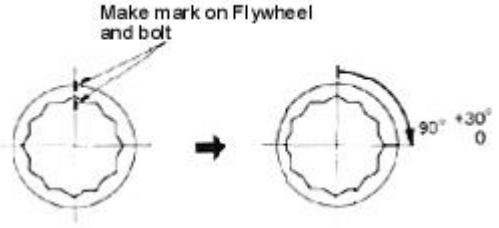
kgm FLywheel mounting bolt

Unit : kgm

Order	Target	Range
1st step	12	11.5-12.5
2nd step	Mark the bolts and the flywheel with a felt-tip pen, and turn the bolts with following degrees.	
	90°	90° - 120°

Tightening Order





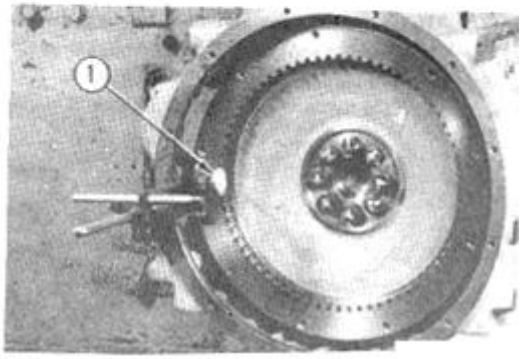
Make mark with punch

* Make a pucnch mark on the bolt head each time the bolts are used. If there are already five marks on the bolt head, replace with new bolts.

3) After installing the flywheel, measure the face runout and radial runout using dial gauge ①.

* Face runout : Max. 0.30 mm

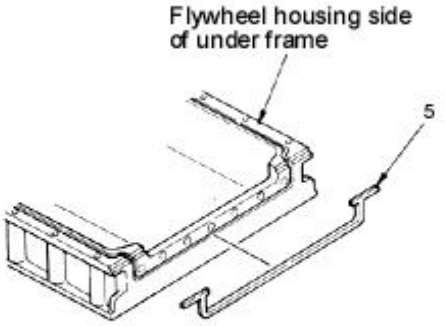
* Radial runout : Max. 0.30 mm



When the under frame is provided:

26) Under frame, suction pipe

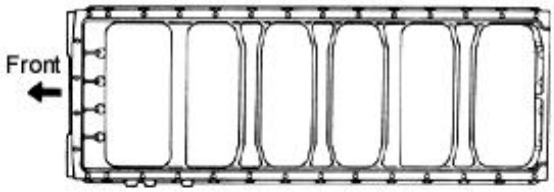
1) Assemble packing (5) to rear face of under frame.



2) Coat groove on top face of underframe with gasket sealant.

Groove of underframe :
Gasket sealant (LG-7)

* Be careful not to get the gasket sealant on the protruding part of the packing.



3) Install under frame (3) to cylinder block and flywheel housing, and tighten mounting bolt partially at 4 places at front and rear.

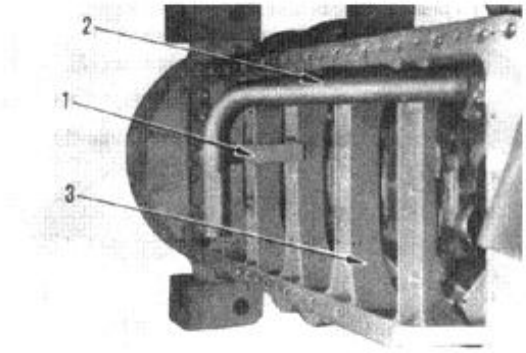
* Assemble with wavy end facing front of engine.

* Be careful not to let the packing protrude from the packing groove or slip out of position.

4) Tighten bolts on both cylinder block and flywheel housing sides.

kgm Mounting bolt : 6.75 ± 0.75 kgm

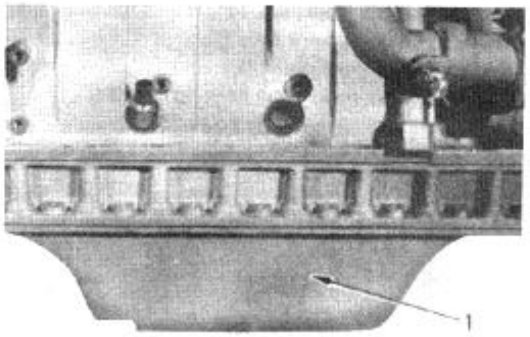
5) Fit O-ring, then fit suction pipe (2) and install bracket (1) to the under frame.



When the underframe is not provided :

26. suction pipe

1) Fit O-ring, then fit suction pipe (2) and install bracket (1) to the cylinder block.

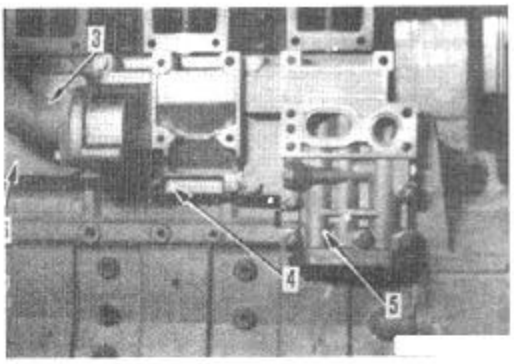


27. Oil pan

Fit gasket and install oil pan (1).

28. Bracket cover

1) Fit O-ring and install cover (6).
2) Fit O-ring and install valve adapter (5).
3) Fit O-ring and install fuel filter bracket (4) together with fuel filter (3).

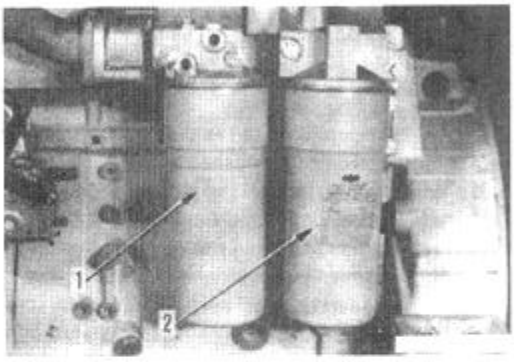


29. Oil filter assembly

Fuel O-ring and install oil filter assembly (2).

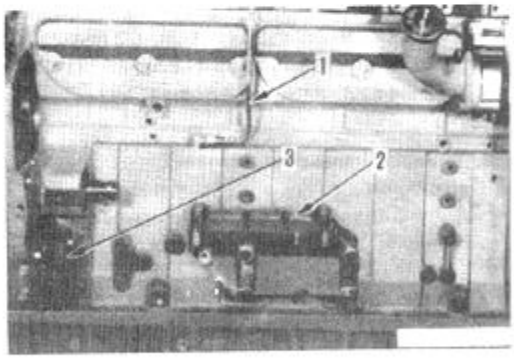
30. Fuel filter assembly

Install fuel filter assembly (1).



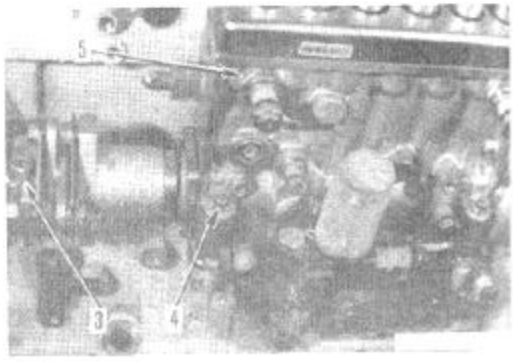
31. PTO case tube, bracket

1) Fit O-ring and install PTO case (3).
2) Install fuel injection pump bracket (2).
   kgm Bracket mounting bolt : 11.7 ± 0.8 kgm
3) Install turbocharger lubrication tube (1).



32. Fuel injection pump assembly

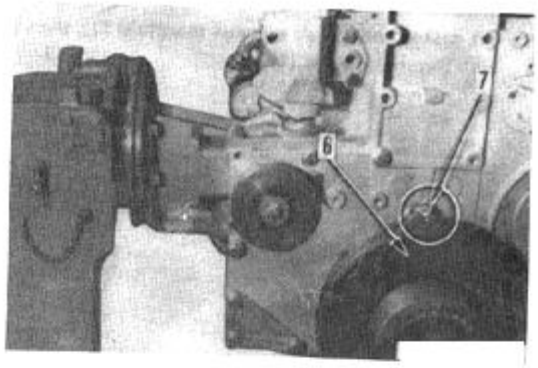
1) Knock key into drive shaft of fuel injection pump,align key groove of pump coupling, then align fuel injection pump (5) with pin of bracket and set in position.
2) Install 4 mounting bolts (4) of fuel injection pump, then tighten coupling bolt (3).
   kgm Mounting bolt : 6.7 ± 0.8 kgm
   kgm Coupling bolt : 7.95± 0.65 kgm



3) Adjust fuel injection timing as follows.

i) Rotate crankshaft in normal direction and align pointer (7) with injection timing line on vibration damper (6).

* When doing this, if the line on the timer side is not at the front, rotate one more turn.

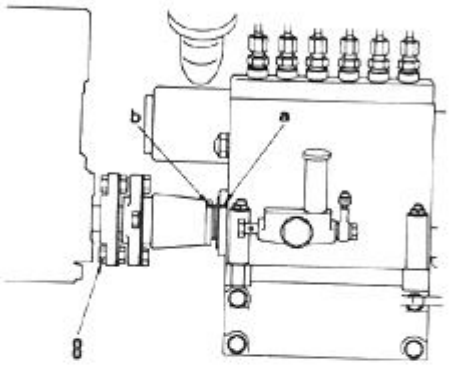


ii) Check that line a on injection pump side is aligned with line b on coupling side.

* if the lines are not aligned, loosen nut (8) and move the coupling to align the lines, then tighten the nut to the specified tightening torque.

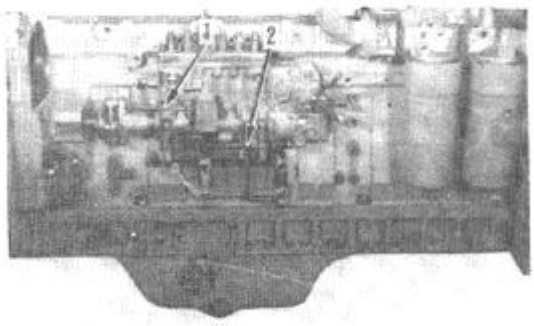
kgm Nut : 6.2 ± 0.2 kgm

* After repairing or replacing the fuel injection pump, or if there is no line, adjust the injection timing by the delivery valve method.



4) Fit gaskets on both sides and install lubrication tubes (2) and (1).

kgm Joint bolt : 2 ± 0.2 kgm

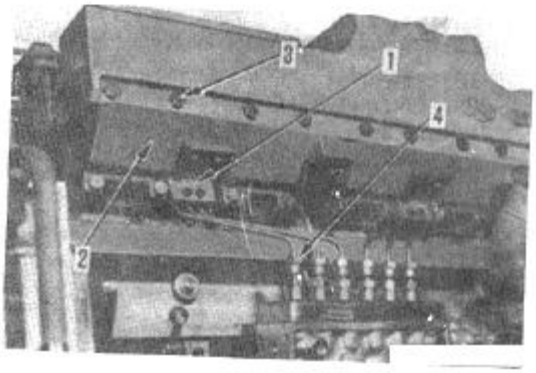


33. Fuel injection tube

Install fuel injection tube (4).

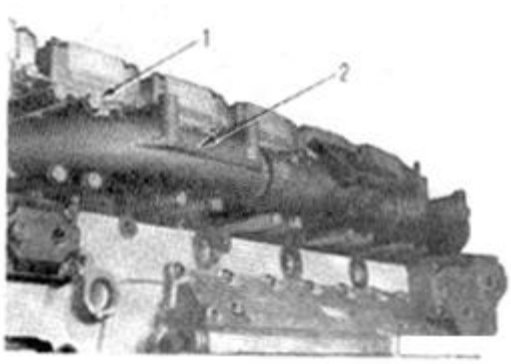
34. After cooler assembly

1) Fit gasket, sling after-cooler assembly (2) and tighten mounting bolts (3).
2) Install clamp (1) of fuel injection tube.



35. Exhuast manifold

Fit gasket and install exhaust manifold (2). then tighten with mounting bolts (1).



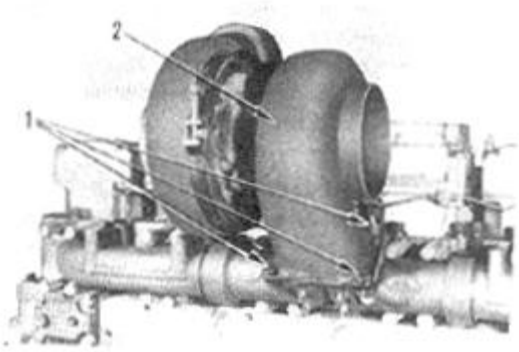
36. Turbocharger

Fit gasket and tighten turbocharger (2) with mounting bolts (1).

kgm Mounting bolt and nut :

- For BE650 5 - 6 kgm
- Except above machines 6.5 - 7.5 kgm

Coat the threads of the bolts and the seat face, with antifriction compund (LM-P) before thightening the bolts.

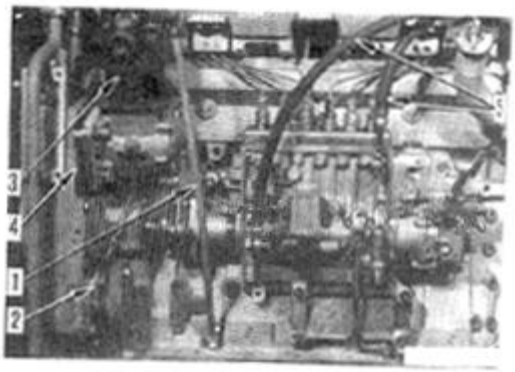


37. Fuel hose

Fit gaskets on both sides and install fuel hose (5).

38. Dipstick guide, air compressor

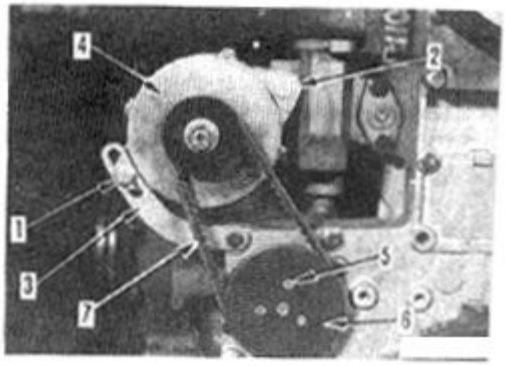
1) Fit O-ring and install air compressor mounting plate (4).
2) Fit O-ring and install air compressor (3), then install lubrication tube (2).
3) Install dipstick guide (1).



39. Alternator pulley

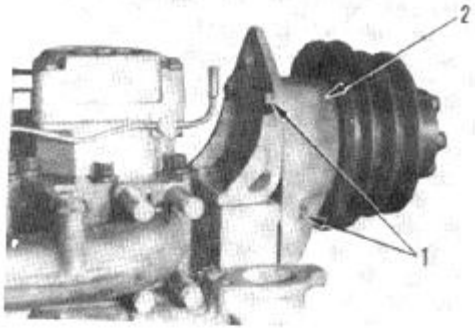
1) Install pulley (6) and tighten with mounting bolt (5).
2) Set alternator (4) on bracket, tighten fastening bolt (2) paritally, then temporarily install plate.
3) Fit V-belts (7) in grooves of pulley and install adjustment bolt (1) for belt tension.
4) Using bar or pipe, raise alternator. when belt tension is correct, tighten bolts (2) and (1).

* The belt should deflect about 15 mm when pushed with a finger pressure of 6 kg at a point midway between the pulleys.



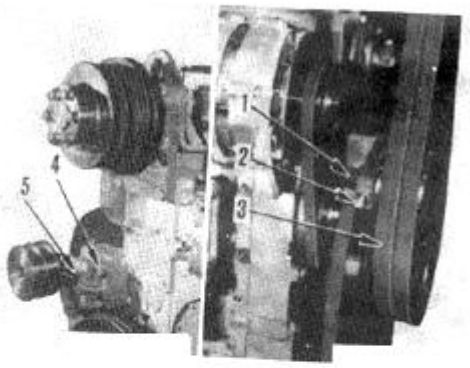
40. Fan pulley assembly

Install fan pulley assembly (2) and tighten with bolts (1).



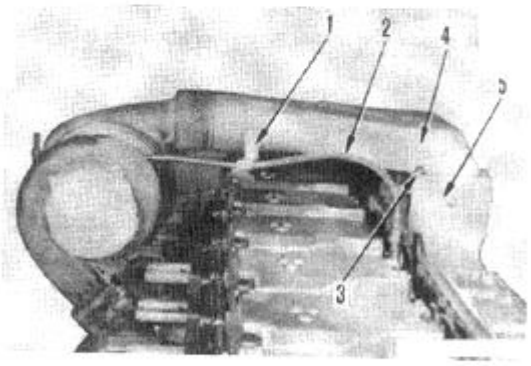
41. Tension pulley assembly

1) Install tension pulley assembly (5) and tighten with bolts (4).
2) Fit V-belt (3) in groove of pulley.
3) Screw in adjustment bolt (2) and move tension pulley to outside.when belt tension is correct, tighten tension locknut (1).
   * Th belt should deflect about 8 - 12 mm When pushed with a finger pressure of 6 kg at a point midway between the pulleys.



44. Connector

1) Fit gaskets and install electrical intake air heater (5) and connector (4), then tighten mounting bolts (3).
2) Install turbocharger lubrication tube (2), then secure with clamp (1).

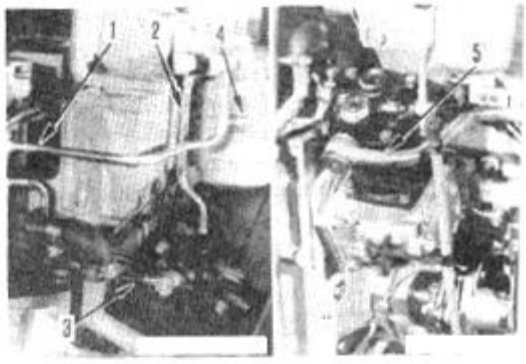


43. Bracket

Tighten brackets (2) and (1) with mounting bolts.

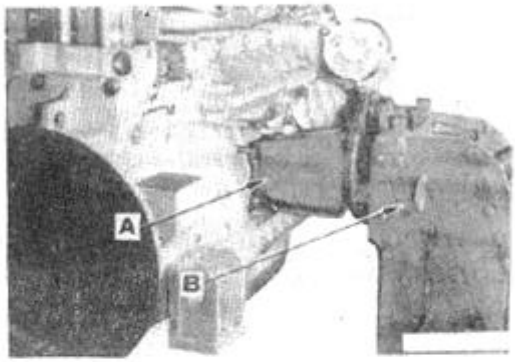
44. Corrosion resistor, air compressor suction tube

1) Install corrosion resistor assembly (4).
2) Install tubes (3), (2) and (1).
3) Install air compressor suction tube (5).



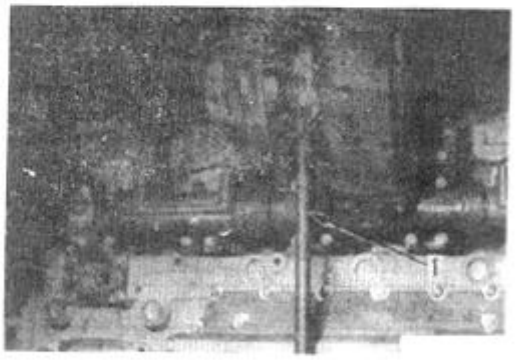
45. Resetting engine in engine stand

1) Sling engine assembly, remove bolts connecting adapter A and engine overhaul stand B to disconnect engine assembly.
2) Set engine assemby on engine stand.
3) Remove adapter.



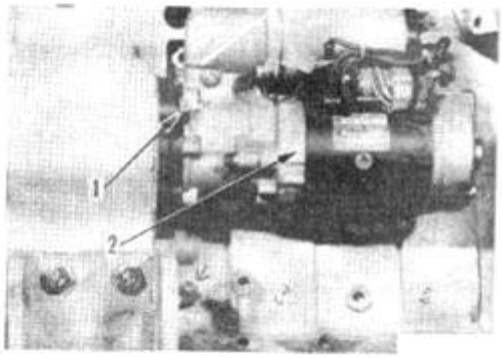
46. Turbocharger drain tube

Fix gasket and install turbocharger drain tube (1).



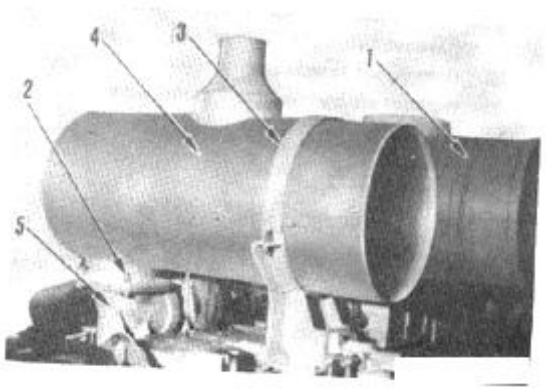
47. Starting motor

Fit gasket and install starting motor (2) with mounting bolts (1).



48. Air cleaner, muffler

1) Raise air cleaner (1) and install, Then fit hose connecting to turbocharger, connect air compres -sor suction tube and secure with band.
2) Install exhaut connector (5).
3) Fit gasket and install muffler (4) with mounting bolts (2), then secure with band (3).



Refilling with oil

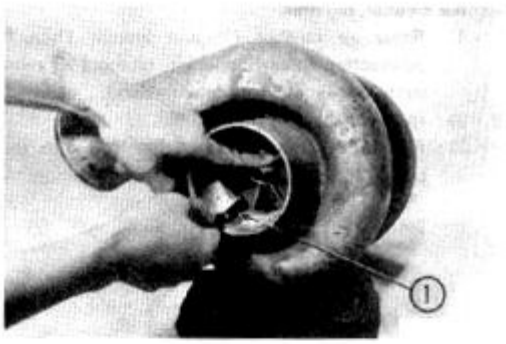
1) Check that enigne darin plug is tightened.
2) Add engine oil through oil filter to the specified level.

Engine oil pan : Approx. 30 l

* Check the oil level after mounting the engine on the machine, and add oil to the specified level.

DISASSEMBLY OF TURBOCHARGER

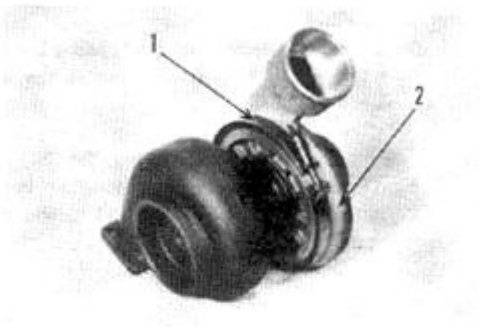
- Before disassmbling the turbocharger, clean its outside surface and apply match marks to ensure that the blower housing and turbine housing are reassembled in their original positions.



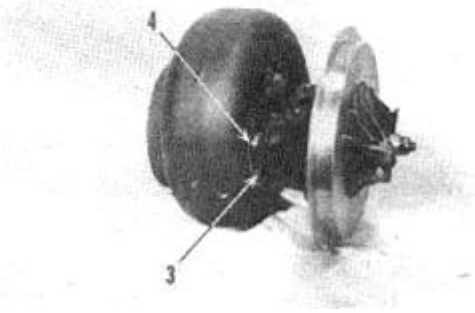
* Replace the entire rotor ass'y, if the dynamic balance check on the rotor ass'y is impracticable.

* Before disassembling the turbocharger assembly, measure the radial clearance in the following manner and keep the measurement on record.
1) Depress the front end of the rotor in the radial direction with a finger.
2) Measure the clearance between the blower impeller and the housing by using filler gauge ①.

1. Blower housing
1) Remove the nut and V-band clamp (1).
2) Remove blower housing (2).
* When removing the blower housing, take care not to damage the blower impeller.

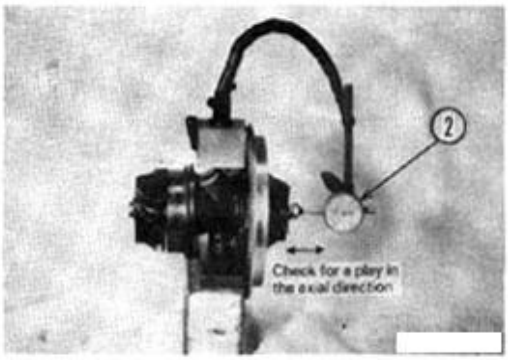


2. Turbine housing
1) Straighten the lock washer, remove mouting bolts (3), and then remove lock plate (4).

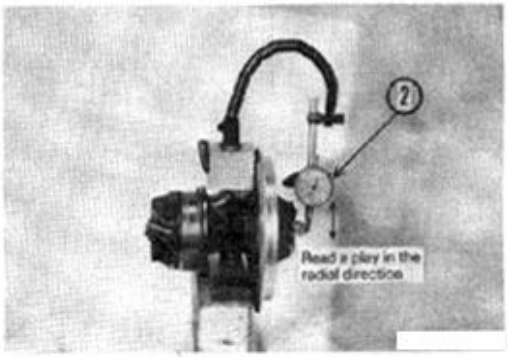


2) Remove turbine housing (5).
* Take care not to damage the turbine impellers when removing the turbine housing.

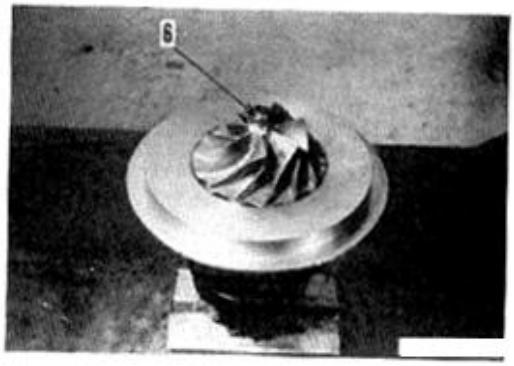
* Before removing the blower impeller, measure the end play and the radial play of the rotor ass'y in the following manner and keep the measurement on record.
  1) Measurement of the end play (A play in the axial suction).
     i) Set dial gauge (2) in position.
     ii) Read the dial gauge indicator when the rotor ass'y is moved in the axial direction.



  2) Measurement of the radial play (A play in the radial direction)
     i) Set dial gauge (2) in position.
     ii) Read the dial gauge indicator when the rotor ass'y is moved in the radial direction.



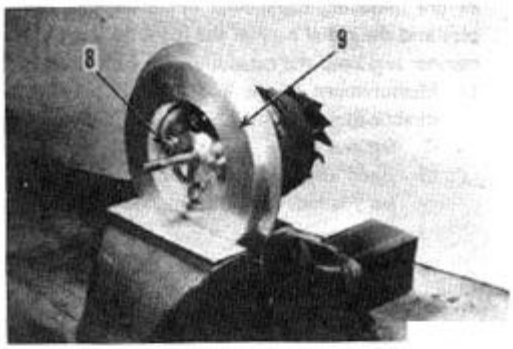
3. Blower Impellers
  1) Clamp the end of the turbine rotor in a vice.
     * Securely clamp the turbine rotor in the vice to as to prevent it from overturning or from falling.
  2) Loosen and remove nut (6).
  3) Extract the blower impellers from the turbine rotor in the following manner.
     i) Immerse the rotor ass'y in the oil that is heated at 140 to 160°C to 5 to 20 minutes.



     ii) Extract blower impellers (7) from the turbine rotor.
        * When extracting the blower impeller, take care not to apply an excessive force to the impeller.

4. Back plate (Diffuser plate)

1) Straighten the lock washer and remove bolt (8).
2) Remove turbine rotor from the back plate (9).

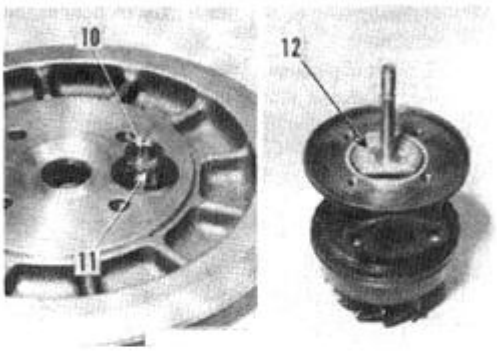


5. Flinger

1) Pull out finger (10) from the back plate.
2) Remove seal ring (11) from the flinger.

6. Thrust bearing

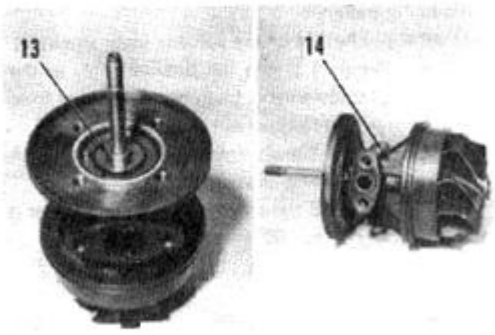
Remove thrust bearing (12).



7. Thrust collar

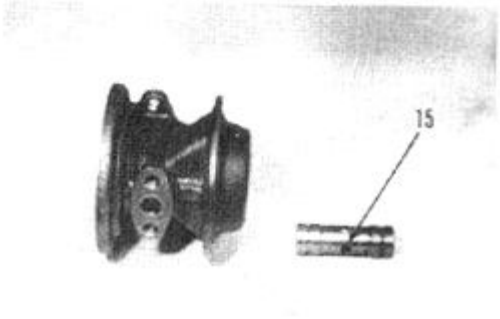
Remove turbine rotor from the center housing (14).

* Take care not to damage the journal bearing.

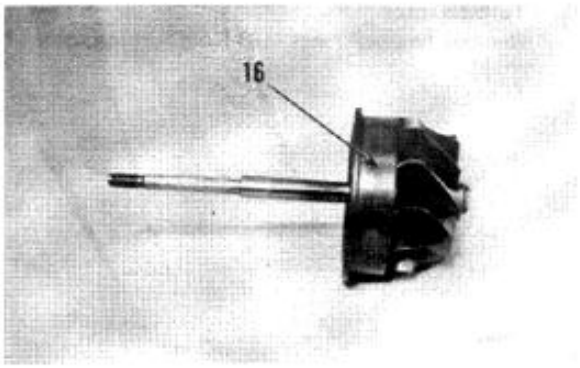


9. Journal bearing

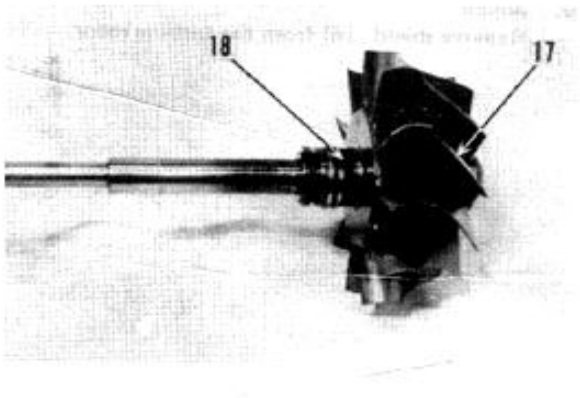
Remove journal bearing (15).



10. Shield
Remove shield (16) from the turbine rotor.

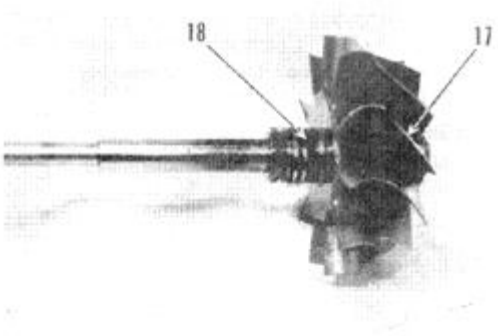


11. Turbine rotor
Remove two seal rings (18) from turbine rotor (17).



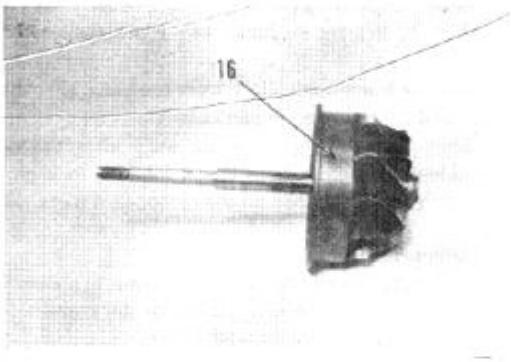
ASSEMBLY OF TURBOCHARGER

- Before assembling parts, wash and clean the parts, allow them to dry by air blow, and apply engine oil to the sliding parts.
- Remove burrs completely from the parts. (pay attention to seal ring grooves, in particular.)
  * When reassembling the rotor ass'y after the dynamic balance check has been made, be sure to align all the match marks stamped on the component parts.



1. Turbine rotor

1) Clamp the end of the turbine rotor in a vice.
   * Securely clamp the rotor to prevent it from overturning or from falling.
2) Fit seal rings (18) into turbine rotro (17).
   * Apply a coat of engine oil to the side of seal rings and install the seal rings in such away that the gap of each ring is positioned at 180° apart from that of the neighboring ring.

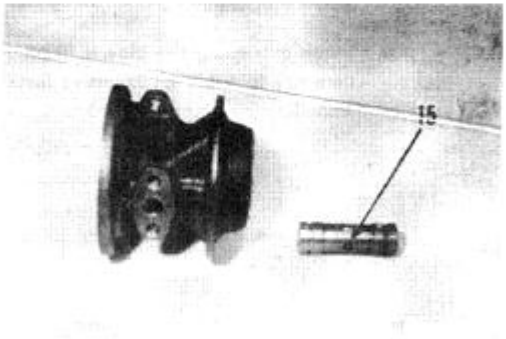


2. Shield

Install shield (16) into the turbine rotor.

3. Journal housing

Install journal bearing (15).
* Apply sufficient amount of engine oil to the inside, outside, and both sides of the journal bearing prior to the installation.

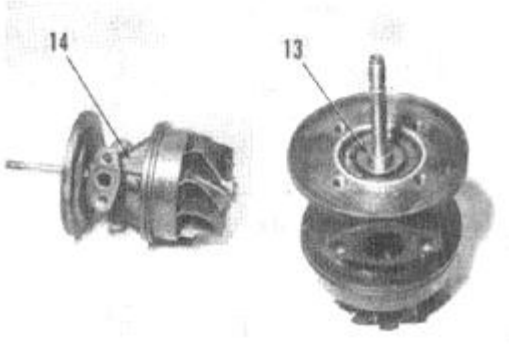


4. Center housing

Installing center housing (14) on the turbine rotor.
* When installing the center housing, take care to prevent the seal ring from slipping out.

5. Thrust collar

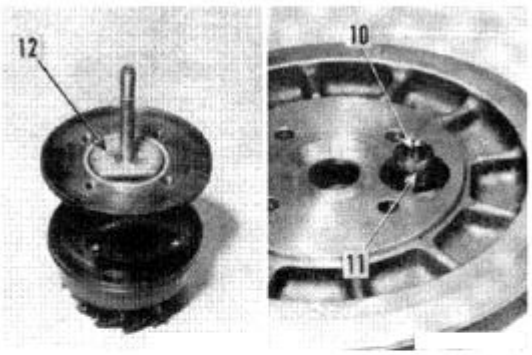
1) Install thrust collar (13).
   * Make sure that the thrust collar is free from foreign matter on both sides,apply engine oil to both sides of the collar and install the collar with the match mark aligning with the mating mark.
2) Drive a dowel pin in the center housing.



6. Thrust bearing

Install thrust bearing (12) with the dowel pin fitted in position.

* Before installing the thrust bearing, apply engine oil to both sides of the oil hole.



7. Flinger

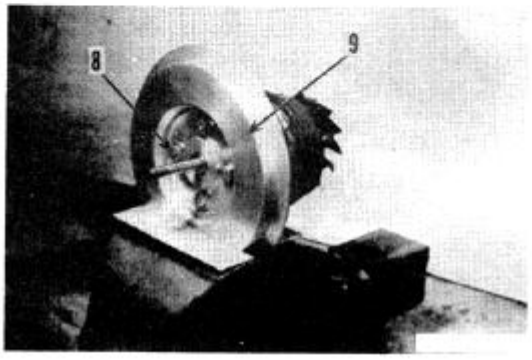
Fit seal ring (11) into flinger (10).

* Apply enigne oil to the sides of the seal ring.

8. Back plate (Diffuser plate)

1) Fit an O-ring to the center housing.
   * Apply some grease (G2-L1) to the O-ring.
2) Install flinger into the back plate (9).
   * Let the gap of the seal ring on the flinger direct to the oil filler port on the center housing.
3) Install the turbine rotor onto the back plate.
4) Tighten bolts (8) and bend the Lock washer.

kgm Mounting bolt : 3.2 ± 0.2 kgm

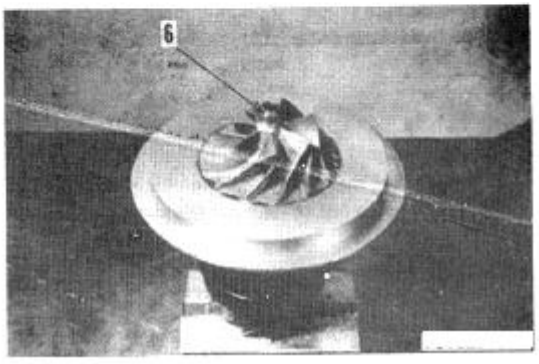


9. Blower Impellers

1) Install blower impellers onto the turbine rotor in the following manner.
   i) Immerse blower impellers (7) in the oil that is heated at 140° to 160° C for 5 to 20 minutes.
   ii) Install the blower impellers onto the turbine rotor, aligning the match mark.
   * Apply engine oil to the inner face of the blower impeller and install the impeller without using an excessive force.

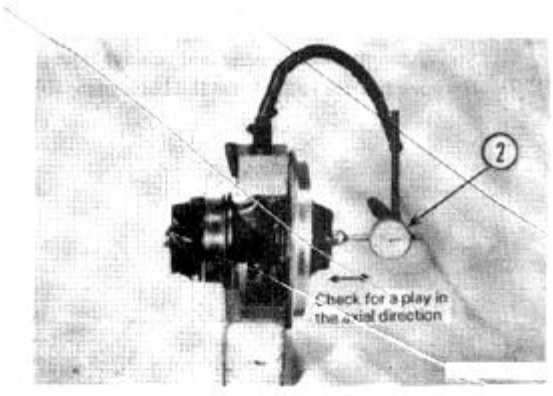
2) Tighten nut (6).
   When tightening the nut, take care not to allow any of match marks to be out of alignment.

kgm Nut : 2.9 ± 0.3 kgm



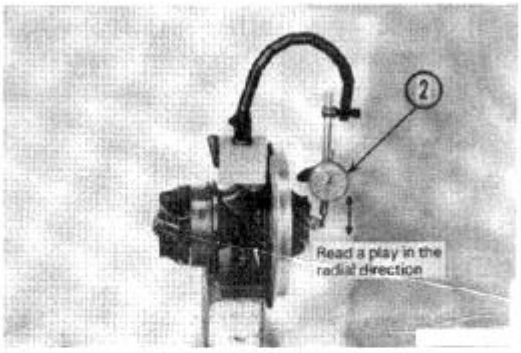
* Measure the end play and the radial play of the rotor ass'y in the following manner.
  1) Measurement of the end play (A play in the axial direction)
     i) Set dial gauge (2) in position.
     ii) Read the dial gauge indicator when the rotor ass'y is moved in the axial direction.

        * Standard value : 0.08 to 0.13 mm

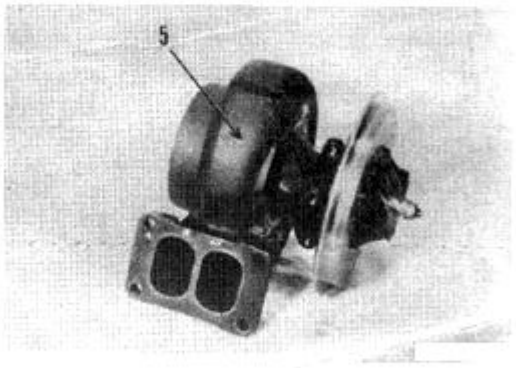


  2) Measurement of the radial play (A play in the radial play direction)
     i) Set dial gauge (2) in position.
     ii) Read the dial gauge indicator when the rotor ass'y is moved in the radial direction.

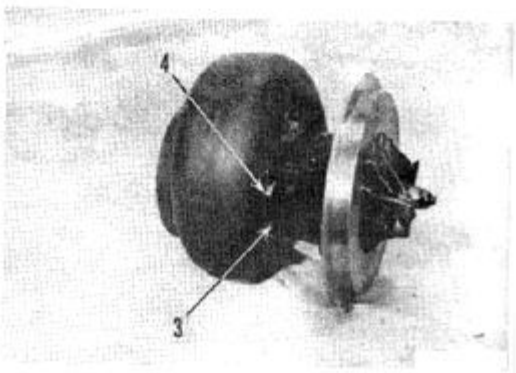
        * Standard value : 0.25 to 0.43



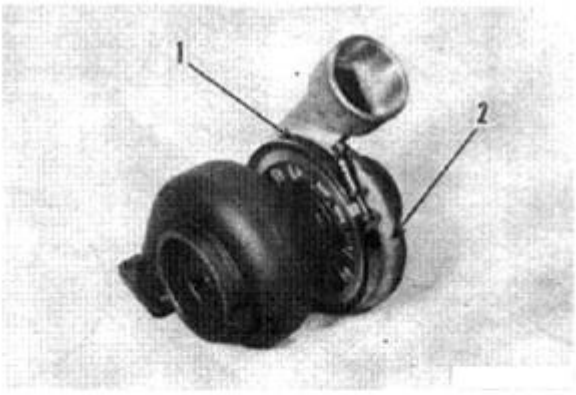
10. Turbine housing
  1) Install the turbine housing (5) into the center housing and the rotor ass'y.



  2) Install lock plate (4), tighten mounting bolt (3), and bend the lock washer.
     Mounting bolt : Antifriction com -pound disulfide (LM-P)
     kgm Mounting bolt : 6.75 ± 0.75 kgm

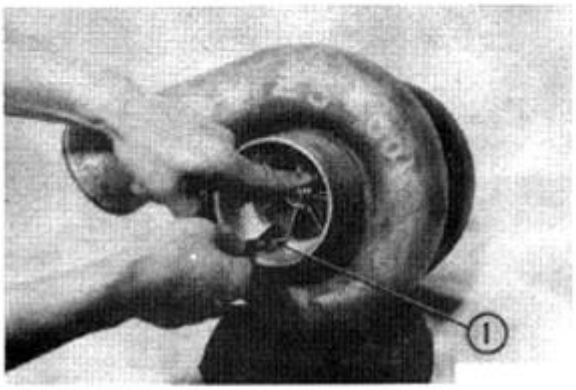


11. Blower housing
    1) Install blower housing (2), aligning it with the center housing and the rotor ass'y.
       * Apply a thin coat of grease (G2-L1) to the flange section and install it with care not to damage the blower impeller.
    2) Tighten V-band clamp (1).
       kgm Clamp nut : 0.9 ± 0.1 kgm



* Measure the clearance in the radail direction in the following manner.
  1) Depress the end of the rotor in the radial direction with a finger.
  2) Measure the clearance between the blower impeller and the housing by using filter gauge ①.

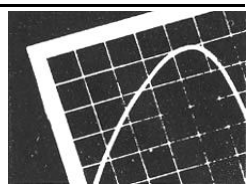
  Standard value : 0.20 mm (Min. clearance)



* After completing the assembly, rotate the rotor ass'y while deprssing it lightly and make sure that the rotor can be rotated smoothly without binding.

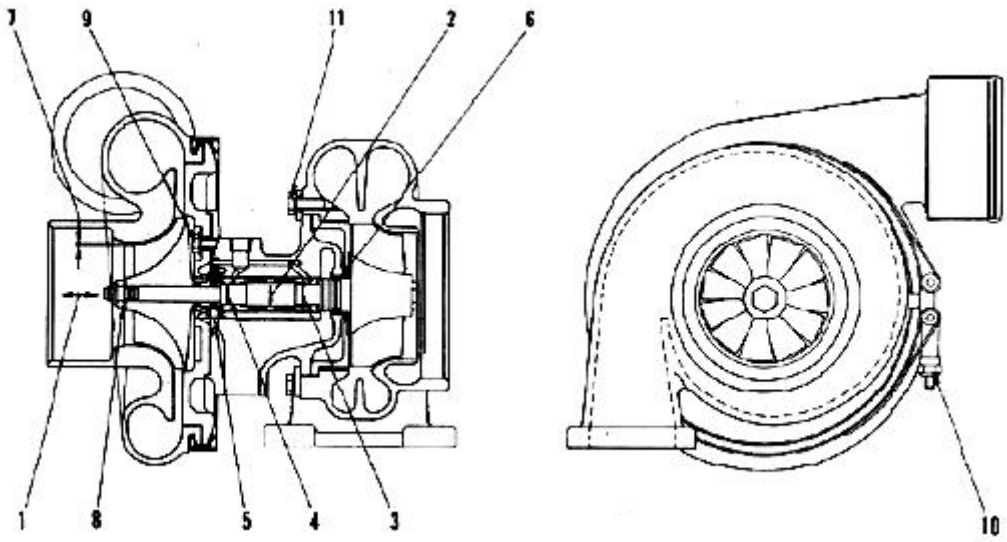
ENGINE

15 MAINTENANCE STANDARD



TURBOCHARGER

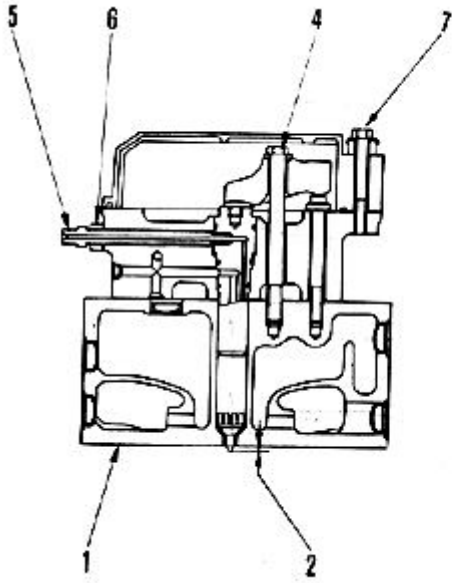
KTR110/KKK

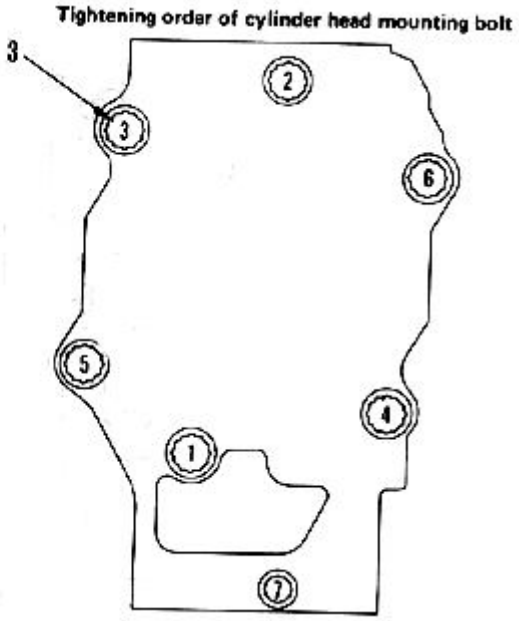


Unit: mm

No	Check item		Criteria					Remedy
1	End play		Standard			Repair limit		
			0.08 to 0.13			0.18		Replace parts
2	Radial play		0.25 to 0.44			0.60		Replace parts
3	Standardize Tolarance Inner diameter of center housing.		Repair limit					
				Shaft	Hole	Shaft	Hole	
			23	-0.040 -0.057	+0.021 0	22.92	23.03	
4	Inner diameter of journal bearing. Outside diameter of wheel shaft.		15	-0.032 -0.043	+0.009 -0.003	14.95	15.04	
5	Bend of wheel shaft		Repair limit : 0.010 (Total indicated runout)					Replace
	Thickness of thrust bearing		Standardize	Tolarance		Repair limit		
				Width	Groove	Width	Groove	
			5	-0.08 -0.11	+0.02 0	4.86	5.04	
6	Thickness of seal ring	Turbine side	2	-0.08 -0.10	-0.03 -0.04	1.85	2.05	
		Blower side	1.6	-0.08 -0.10	-0.03 -0.04	1.45	1.65	
7	**Clearance b/w blower housing& impeller**		Tolerance : (min.) 0.20					Replaced parts
8	Tightening torque of blower impeller locknut		2.9 ± 0.3 kgm					
9	Tightening torque of diffuser plate mounting bolts		3.15 ± 0.35 kgm					Tighten
10	Tightening torque of V band locknut		0.9 ± 0.1 kgm					
11	Tightening torque of turbine housing bolt		5.0 ± 0.5 kgm					

CYLINDER HEAD

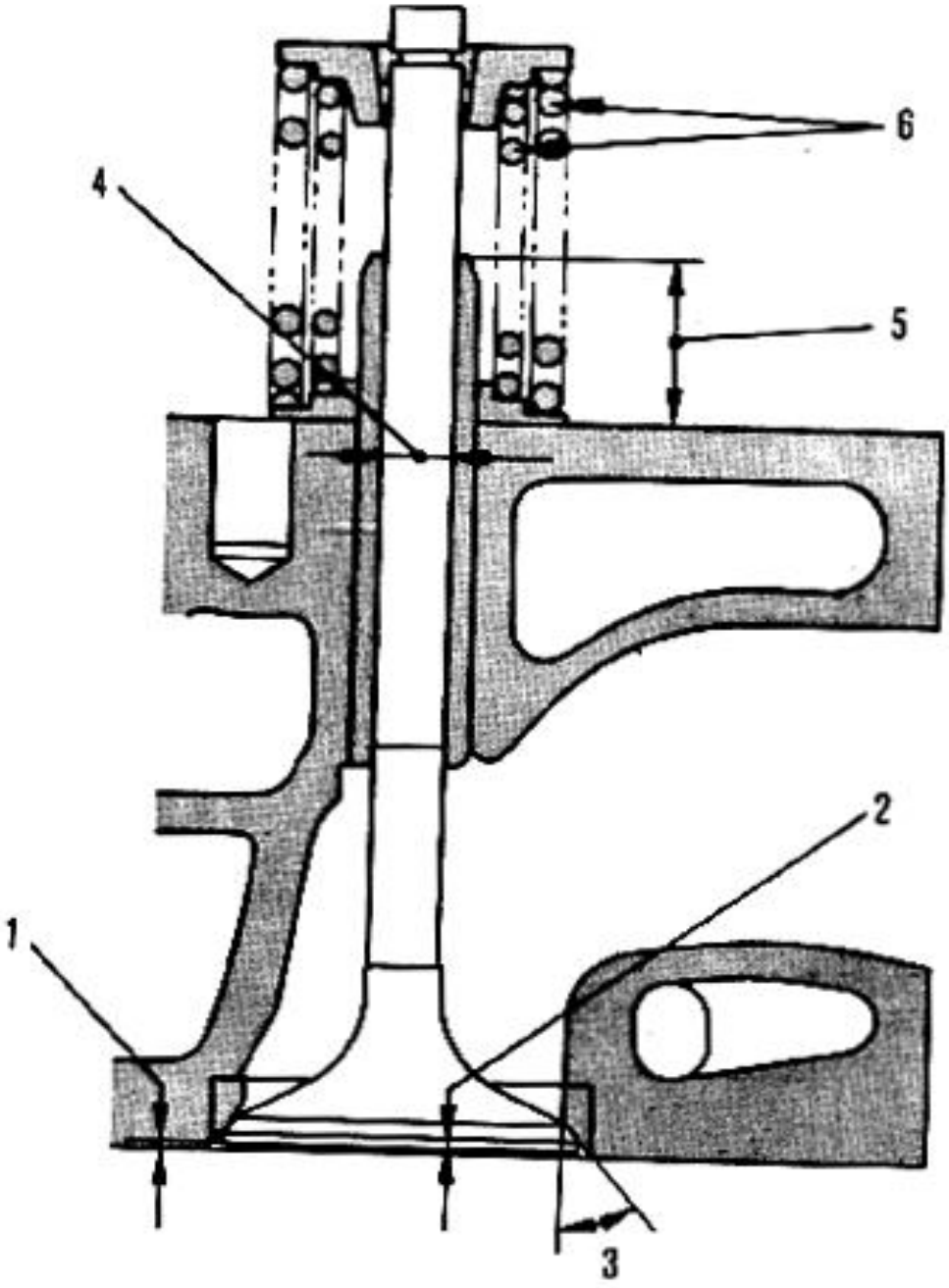




Uunit: mm

No.	Check item	Criteria				Remedy
1	Distortion of cylinder head mounting surface	Standard: 0 - 0.06		Repair limit: 0.09		Repair by grinding or replace
2	Protrusions of nozzles	Engine		Standard		Replace nozzle or cylinder head
		S6D140-1		4.8-5.6		
		SA6D140-1		4.65-5.65		
3	Tightening torque of cylinder head mounting bolts (Coat the thread area with molybdenum disulfide or engine oil)	Bolt No.	Order	Target valve (kgm)	Range (kgm)	Tightening in seque -nce as indicated above
		① - ⑥	1st step	15	14 - 16	
			2nd step	22	21.5-22.5	
			3rd step	Retighten with 90°	90°-120°	
		⑦	-	7	6 - 7.5	
4	Tightening torque of nozzle holder mounting bolt	6.8 ± 0.7 kgm				Retighten
5	Tightening torque of fuel inlet connector	3.8 ± 0.3 kgm				
6	Tightening torque of connector pipe locknut	4.0 ± 0.5 kgm				
7	Tightening torque of cylinder head cover mounting bolt	0.5 ± 0.1 kgm				

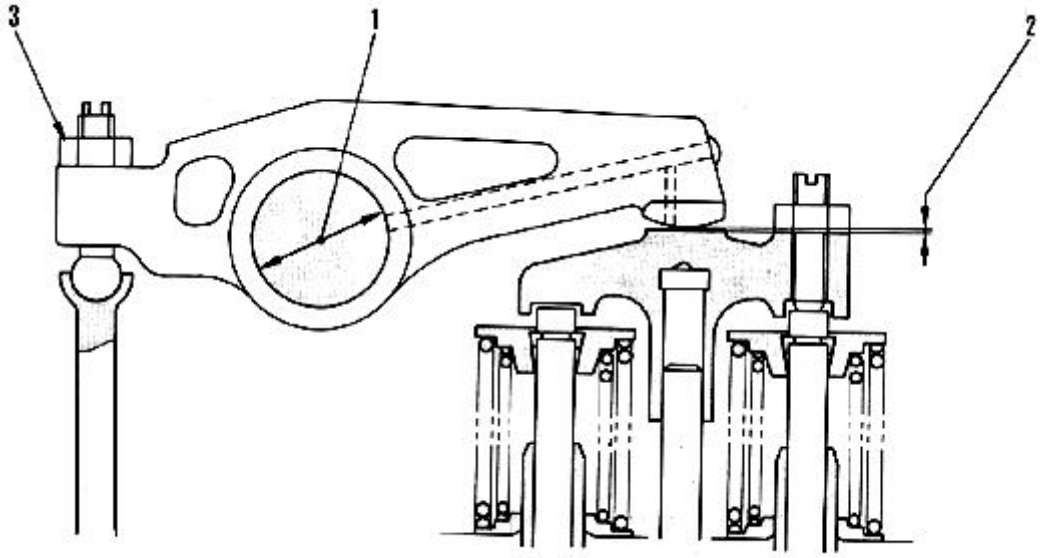
VALVE,VALVE SPRING AND VALVE GUIDE



unit: mm

No.	Check item	Criteria				Remedy
1	Amount of valve sinking	Valve	Standard size	Tolerance	Repair limit	Replace valve or valve seat
		Intake valve	0	±0.10	0.70	
		Exhaust valve	0	±0.10	0.70	
2	Thickness of valve lip	Valve	Standard size		Repair limit	Replace valve
		Intake valve	2.4		1.9	
		Exhaust valve	2.0		1.6	
3	Valve seat angle	Valve	Standard		Tolerance	Repair or replace valve &valve seat
		Intake vlave	60°		±0°15’	
		Exhaust vlave	45°		±0°15’	
4	Outside diameter of valve stem	Intake valve	10		-0.045 -0.060	Replace valve
		Exhaust valve	10		-0.075 -0.090	
	Inside diameter of valve guide	Before inseting	10		+0.019 +0.001	Replace valve guide
		After inserting	10		+0.019 -0.020	
	Clearance between valve guide and valve stem	Valve	Standard clearance		Clearance limit	Replace valve or valve guide
		Intake valve	0.029 - 0.084		0.22	
		Exhaust valve	0.065 - 0.100		0.24	
	Bend of valve stem	Repair limit : 0.02 (Total indicated runout,for 100)				Replace valve
5	Protrusion of valve guide	Standard size		Tolerance		Repair
		23		+0.2		
6	Valve spring	Valve spring	Standard size			Repair limit		Replace valve spring
			Free length	Installed length	Installled load	Free length	Installed load	
		Inner (Small)	82.2	51.0	48.4±2.4 kg		43.6 kg	
		Outer (Large)	65.5	46.0	23.6±1.2 kg		21.2 kg	
	Squareness of valve spring	Repair limits: 2° (For both end)						

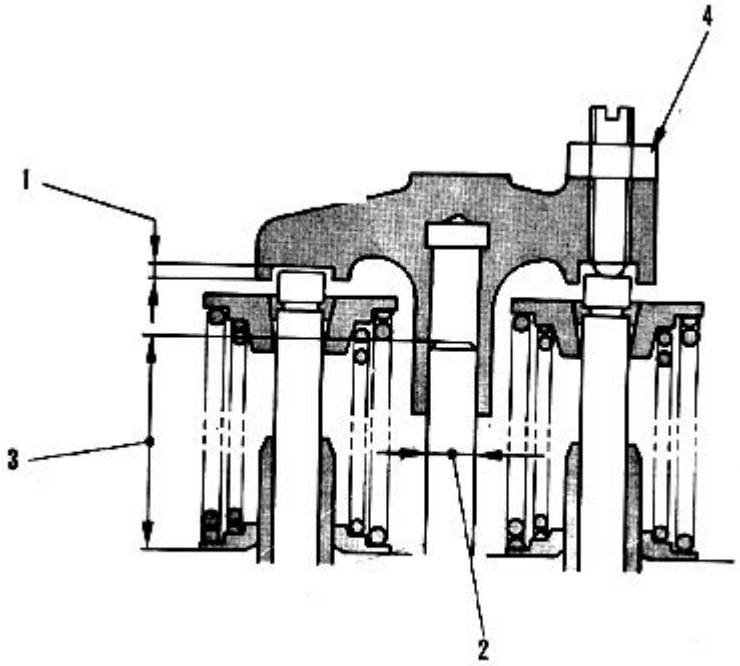
ROCKER ARM AND SHAFT



unit: mm

No.	Check item	Criteria			Remedy
1	Outside diameter of rocker arm shaft	Standard size: 32.0	Tolerance: ± 0.0065		Replace rocker arm shaft
	Inside diameter of rocker arm bushing	32.0	+0.087 +0.035		Replace rocker arm
	Clearance between rocker arm shaft and rocker arm bushing	Standard clearance: 0.0285 - 0.0935	Clearance limit: 0.13		Replace rocker arm rocker arm shaft
2	Valve clearance (When engine is hot or cold)	Valve	Standard size	Tolerance	Adjust
		Intake	0.43	± 0.02	
		Exhaust	0.80	± 0.02	
3	Tightening torque of rocker arm adjustment screw locknut	6.0 ± 0.6 kgm			

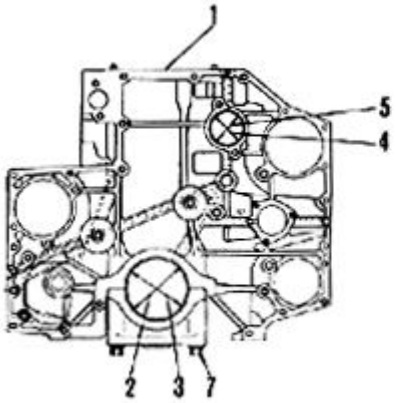
CROSSHEAD AND GUIDE

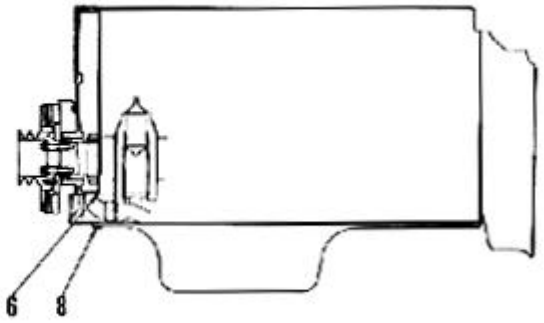


unit: mm

No.	Check item	Criteria			Remedy
		Standard size	Tolerance	Repair limit	
1	Depth of crosshead stem	3	+0.3 0	3.14	
2	Inside diameter of crosshead	11	+0.06 +0.02	11.17	Replace
	Outside diameter of crosshead guide	11	+0.011 0	10.95	
3	Protrusion of crosshead guide	49.0	± 0.25	-	Repair
4	Tightening torque of crosshead locknut	6 ± 0.6 kgm			

CYLINDER BLOCK

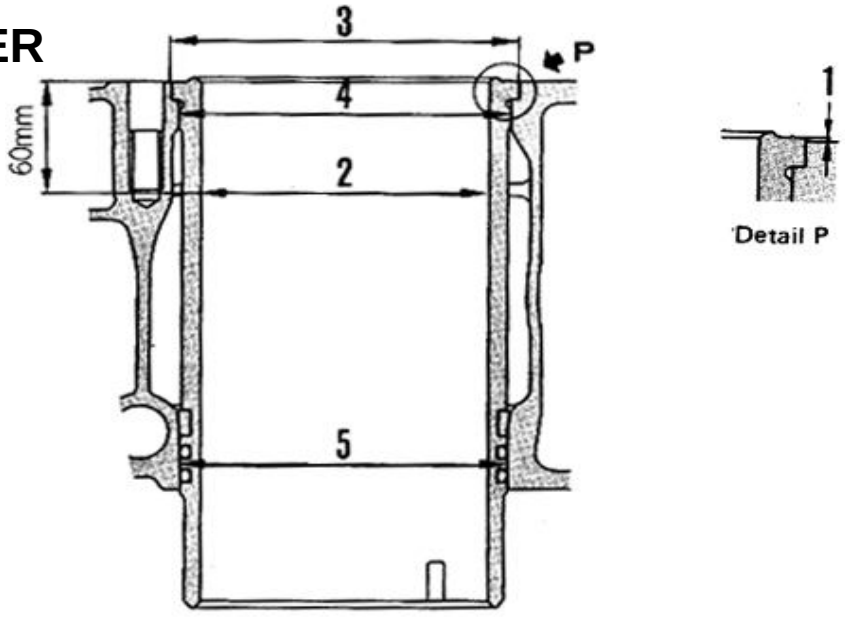




unit: mm

No.	Check item	Criteria			Remedy
1	Distorsion of cylinder head mounting surface	Standard size: 0 - 0.09		Repair limit: 0.135	Repair by grinding or replace
2	Inside diameter of main bearing hole	Standard size: 127		Tolerance: +0.018 -0.006	Repalce main bearing cap
	Thickness of main bearing	3.5		0 -0.010	Replace main bearing cap
	Roundness of main bearing hole	Repair limit : 0.005			
3	Inside diameter of main bearing	Standard size: 120	Tolerance: +0.038 -0.006	Repair limit: 120.15	Replace main bearing
4	Inside diameter of camshaft bushing hole	69	+0.030 0		Repair or replace cylinder block
5	Inside diameter of camshaft bushing	65	+0.060 0	65.15	Replace cam shaft bushing
6	Difference of face between cylinder block and front cover	Repair limit : 0.14			Repair by re-assembling
7	Tightening torque of main bearing cap bolt (Coat thread area with engine oil)	Order	Target(kgm)	Range (kgm)	Retighten
		1st step	12	11 - 13	
		2nd step	22	21.5 - 22.5	
		3rd step	Retighten with 90°	90 - 120°	
8	Tightening torque of oil pan mounting bolt and under frame mounting bolt	6.75 ± 0.75 kgm			

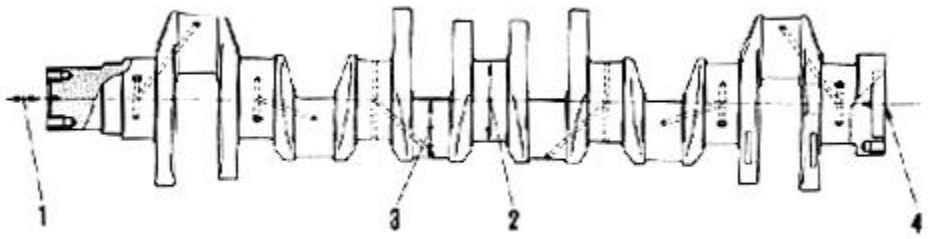
CYLINDER LINER



unit: mm

No.	Check item	Criteria			Remedy
1	Protrusion of cyliner liner	Permissible renge: 0.07 to 0.15			Replace cylinder liner or block
2	Inside diameter of cylinder liner	Standard size	Tolerance	Repair limit	
		140	+0.041 +0.021	140.22	
	Roundness of cylinder liner	Repair limit: 0.08			
	Cylindricity of cylinder liner	Repair limit: 0.08			Replace cylinder liner
3	Outside diameter of cylinder liner(Counter bore lower part)	Standard size	Tolerance		
		170.2	0 -0.10		
	Clearance between cylinder liner and block (Counter bore)	Standard : 0 - 0.163			Replace cylinder lin liner/cylinder block
4	Outside diameter of cylinder liner(Counter bore bottom)	Standard size	Tolerance		Replace cylinder liner
		161.2	+0.090 +0.050		
	Interference b/n cylinder liner & block(Counter bore bottom)	Standard interference	Interference limit		Replace cylinder liner or cylinder block
		0.02 - 0.12	0.02		
5	Outside diameter of cylinder liner (O-ring)	Standard size	Tolerance		Replace cylinder liner
		158	-0.024 -0.049		
	Clearance between cylinder liner and block (O-ring)	Standard : 0.024 - 0.089			Replace cylinder liner or cylinder block

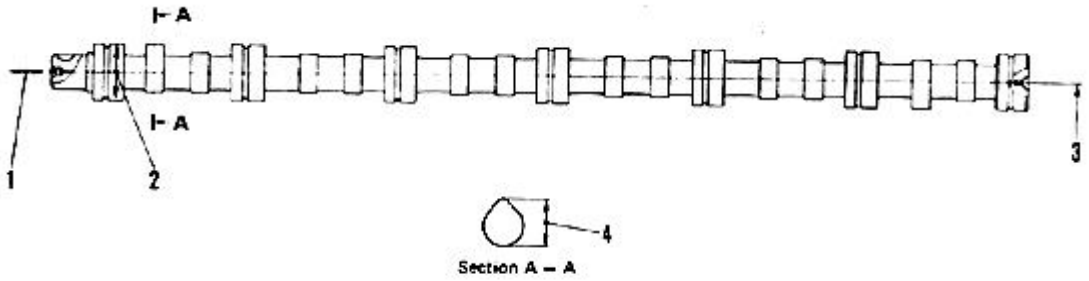
CRNAKSHAFT



unit: mm

No.	Check item	Criteria				Remedy
1	End play	Standard size: 0.140 - 0.315		Repair limit: 0.50		Repair by using over size thrust-bearing/replace
2	Outside diameter of main journal		Standard size	Tolerance	Repair limit	Repair by using over size bearing or replace
		S.T.D.	120.00		119.88	
		0.25US	119.75	+0.050	119.63	
		0.50US	119.50	-0.068	119.38	
		0.75US	119.25		119.13	
		1.00US	119.00		118.88	
	Roundness of main journal	Standard size: 0 - 0.010		Repair limit: 0.020		
	Clearance of main journal	Standard size: 0.044 - 0.106		Clearance limit: 0.27		Replace main bearing
3	Outside diameter of crank pin journal		Standard size	Tolerance	Repair limit	Repair by using under size bearing or replace
		S.T.D	90.00		89.88	
		0.25US	89.75	-0.050	89.63	
		0.50US	89.50	-0.068	89.38	
		0.75US	89.25		89.13	
		1.00US	89.00		88.88	
	Roundness of pin journal	Standard size: 0 - 0.010		Repair limit: 0.020		
	Clearance of pin journal	Standard size: 0.044 - 0.106		Clearance limit: 0.24		Replace connecting rod bearing
4	Straightness of all main journals	Standard size: 0 - 0.150		Repair limit: 0.20		Repair by using under size bea-bearing/replace
	Straightness of two main journals	0 - 0.050		0.10		

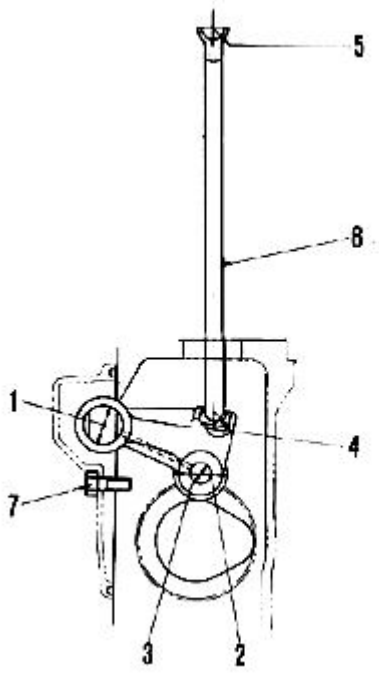
CAMSHAFT



unit: mm

No.	Check item	Criteria				Remedy
1	End play	Standard size: 0.1 - 0.25		Repair limit: 0.36		Replace thrust plate
2	Outside diameter of camshaft journal	Standard size: 65		-0.016 -0.036		Replace camshaft
	Clearance of camshaft journal	Standard size: 0.016 - 0.096		Clearance limit: 0.15		Replace camshaft bushing
3	Bend of camshaft	Repair limit: 0.03 (Total indicated runout)				
4	Cam height	Cam	Standard size	Tolerance	Repair limit	Replace camshaft
		Intake side	55.48	± 0.1	55.08	
		Exhaust side	55.75	± 0.1	55.35	

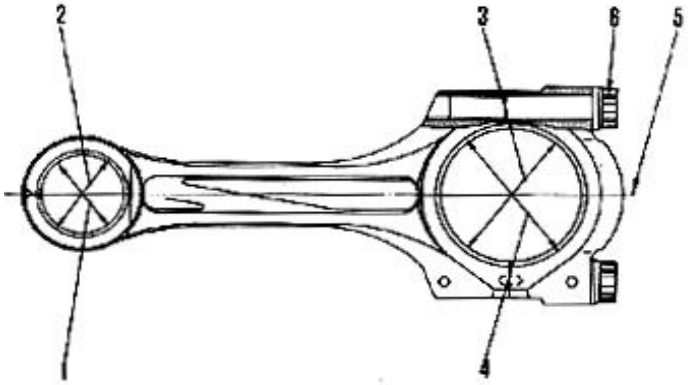
CAM FOLLOWER AND PUSH ROD



unit: mm

No.	Check item	Criteria			Remedy
1	Outside diameter of cam follower shaft	Standard size 22	Tolerance -0.021 -0.034	Repair limit 21.96	Replace
	Inside diameter of cam follower shaft hole	22	+0.021 0	22.04	
2	Outside diameter of cam roller	31.7	+0.05 +0.02	31.50	
	Inside diameter of cam roller	12.7	+0.038 +0.013	12.78	
3	Outside diameter of cam roller pin	12.63	± 0.006	12.56	
4	Radius of push rod ball end	Standard size 12.7	Tolerance 0 -0.20		
5	Radius of push rod Socket end	13.4	0 -0.20		
6	Bend of push rod	Repair limit : 0.3 (Total indicated runout)			
7	Tightening torque of cam foll--ower housing mounting bolt	1.15 ± 0.15 kg			

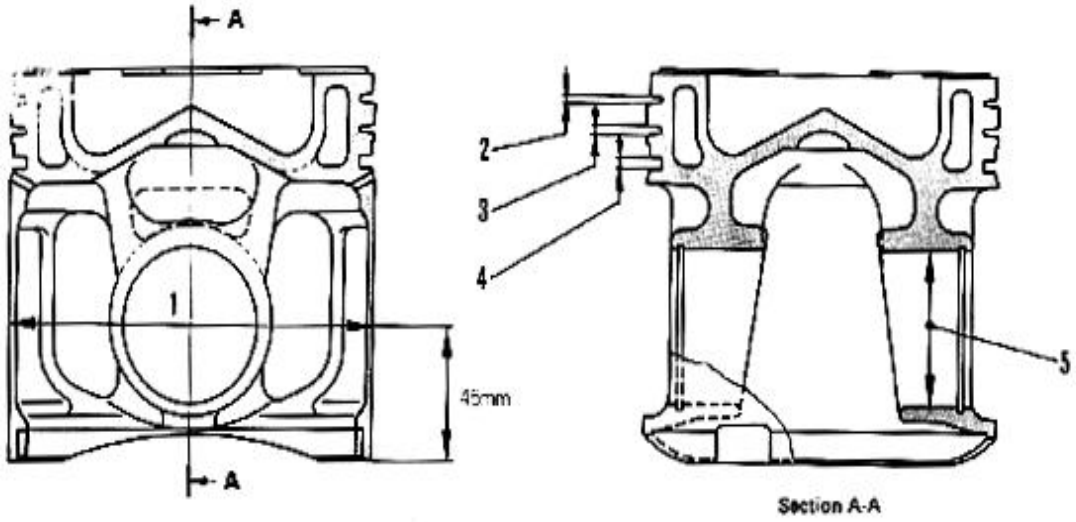
CONNECTING ROD



unit: mm

No.	Check item	Criteria			Remedy
1	Inside diameter of bushing at connecting rod small end	Standard size: 52	Tolerance: +0.049 +0.030	Repair limit: 52.09	Replace bushing
	Clearance between bushing at connecting rod small end and piston pin	Standard clearance: 0.030 - 0.055		Clearance limit: 0.11	Replace bushing or piston pin
2	Inside diameter of bushing hole at connecting rod small end.	Standard size: 57.4		Tolerance: +0.030 0	Replace connecting rod
3	Inside diameter of bearing at connecting rod big end	Standard size: 90	Tolerance: +0.042 -0.008	Repair limit: 90.15	Replace bearing
4	Inside diameter of bearing hole at connecting rod big end (* Measure after tightening connecting rod cap bolt with specified torque)	Standard size: 95		Tolerance: +0.026 -0.004	Replace connecting rod
	Thickness of connecting rod bearing	Standard size: 2.5	Tolerance: +0.002 -0.008	Repair limit: -	Replace bearing
5	Parallelism and twist of connecting rod		Item: Parallelism / Twist	Standard size: 0 - 0.20 / 0 - 0.30	Repair limit: 0.25 / 0.35	Replace connecting rod
6	Tightening torque of connecting rod cap mounting bolt (Coat bolt threads & nut seats with engine oil)	Standard size: 1st step	Target (kgm): 13	Range (kgm): 12.5 - 13.5	Replace connecting rod
		2nd step	Retighten with 90°	90° - 120°	

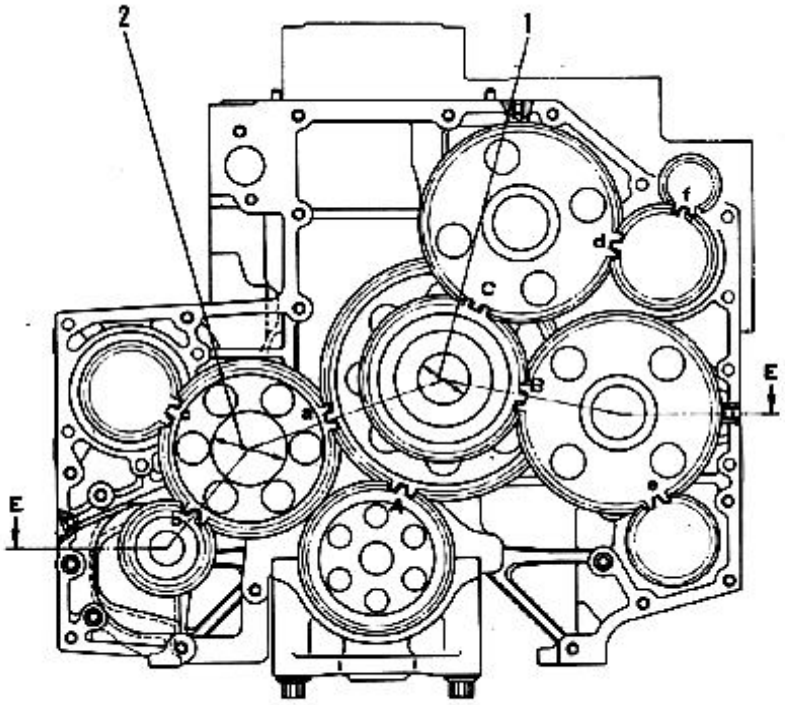
PISTON, PISTON RING AND PISTON PIN

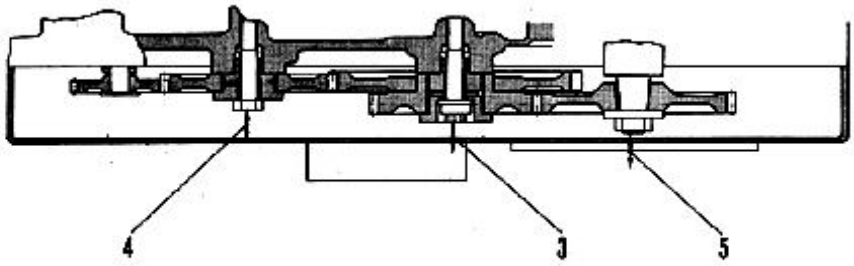


unit: mm

No.	Check item	Criteria				Remedy
1	Outside diameter of piston	Standard size	Tolerance	Repair limit		Replace piston
		140	-0.070 -0.085	139.81		
2 4	Thickness of piston ring	No.	Measuring point	Standard size	Tolerace	Replace piston ring
		2	Top ring	2.4	-0.015 -0.035	
		3	Secong ring	2.41	-0.010 -0.035	
		4	Oil ring	4	-0.010 -0.030	
	Width of piston ring groove	2	Top ring	Judge using groove wear gauge		Replace piston
		3	Second ring			
		4	Oil ring	0.02-0.06	+0.14	
	Clearance between piston ring and 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	0.02 - 0.06	0.14	
	Piston ring gap	2	Top ring	0.42 - 0.57	2.0	Replace pis piston ring or cylinder liner
		3	Second ring	0.42 - 0.57	1.5	
		4	Oil ring	0.37 - 0.52	1.0	
5	Outside diameter of piston pin	Standard size		Tolerance		Replace piston pin
		52		0 -0.006		
	Inside diameter of piston pin hole	52		+0.045 +0.035		Replace piston
	Clearance between piston pin and piston	Standard Clearance		Tolerance limit		Replace piston or piston pin
		0.035 - 0.051		0.10		

TIMING GEAR

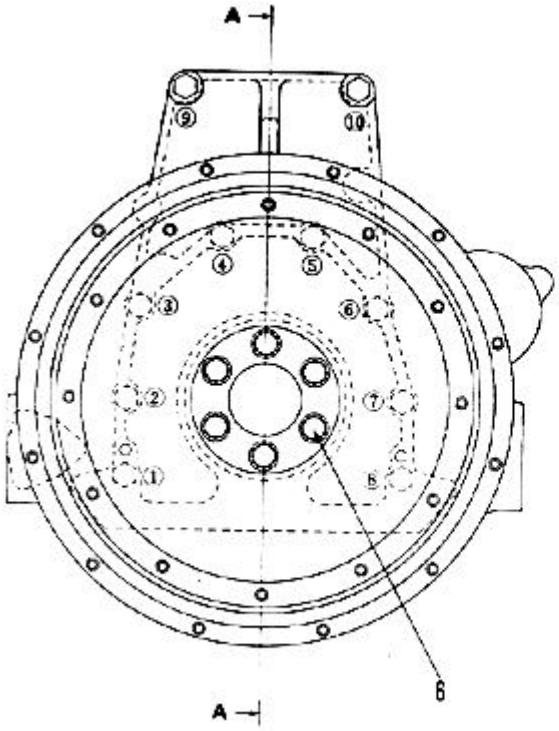


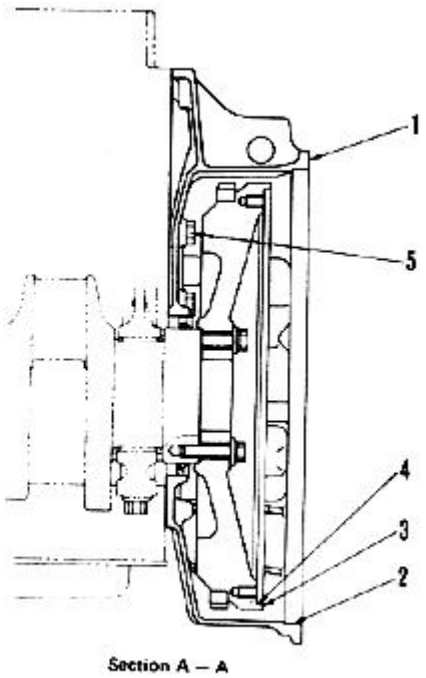


Section E – E

<table>
<tr><th>No.</th><th>Check item</th><th colspan="7">Criteria</th><th>Remedy</th></tr>
<tr><td></td><td rowspan="10">Backlash of each gear</td><td>Measri-ng point</td><td colspan="3">Gears</td><td>Standard Size</td><td>Repair limit</td><td></td></tr>
<tr><td>A</td><td colspan="3">Crankshaft gear and main idler gear (Large)</td><td>0.141-0.425</td><td rowspan="9">0.6</td><td rowspan="9">Replace</td></tr>
<tr><td>B</td><td colspan="3">Main idler gear (small) and injection pump drive gear</td><td>0.129-0.391</td></tr>
<tr><td>C</td><td colspan="3">Main idler gear (small) and camshaft gear</td><td>0.129-0.391</td></tr>
<tr><td>a</td><td colspan="3">Main idler gear (Large)and sub idler gear</td><td>0.141-0.426</td></tr>
<tr><td>b</td><td colspan="3">Sub idler gear and oil pum -p drive gear</td><td>0.080-0.417</td></tr>
<tr><td>c</td><td colspan="3">Sub idler gear and water pump drive gear</td><td>0.095-0.346</td></tr>
<tr><td>d</td><td colspan="3">Camshaft gear and air compressor drive gear</td><td>0.118-0.369</td></tr>
<tr><td>e</td><td colspan="3">Injection pump drive gear and PTO gear (Lower)</td><td>0.118-0.369</td></tr>
<tr><td>f</td><td colspan="3">Compressor drive gear and PTO gear (Upper)</td><td>0.025-0.486</td></tr>
<tr><td rowspan="3">1</td><td rowspan="3">Clearance between main idler gear bushing and shaft</td><td>Engine No.</td><td>Standard size</td><td colspan="2">Tolerance</td><td>Standard Clearance</td><td>Clearance limit</td><td rowspan="5">Replace bushing</td></tr>
<tr><td></td><td></td><td>Shaft</td><td>Bushing</td><td></td><td></td></tr>
<tr><td>10001-10368</td><td>47.6</td><td>+0.014 +0.001</td><td>+0.085 +0.030</td><td>0.016-0.084</td><td>0.20</td></tr>
<tr><td></td><td>10369 and up</td><td>56</td><td>-0.016 -0.029</td><td>+0.055 0</td><td>0.016-0.084</td><td>0.20</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">Clearance between sub gear gear bushing and shaft</td><td>10001-10368</td><td>47.6</td><td>+0.014 +0.001</td><td>+0.085 +0.030</td><td>0.016-0.084</td><td>0.20</td></tr>
<tr><td>10369 and up</td><td>50</td><td>-0.016 -0.029</td><td>+0.055 0</td><td>0.016-0.084</td><td>0.20</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">End play of main idler gear</td><td colspan="4">Standard size</td><td colspan="2">Repair limit</td><td rowspan="3">Replace thrust bearing</td></tr>
<tr><td colspan="4">0.05 - 0.17</td><td colspan="2">0.4</td></tr>
<tr><td>4</td><td>End play of sub idler gear</td><td colspan="4">0.05 - 0.17</td><td colspan="2">0.4</td></tr>
<tr><td>5</td><td>End play of injection pump drive gear</td><td colspan="4">0.07 - 0.20</td><td colspan="2">0.4</td><td></td></tr>
</table>

FLYWHEEL AND FLYWHEEL HOUSING



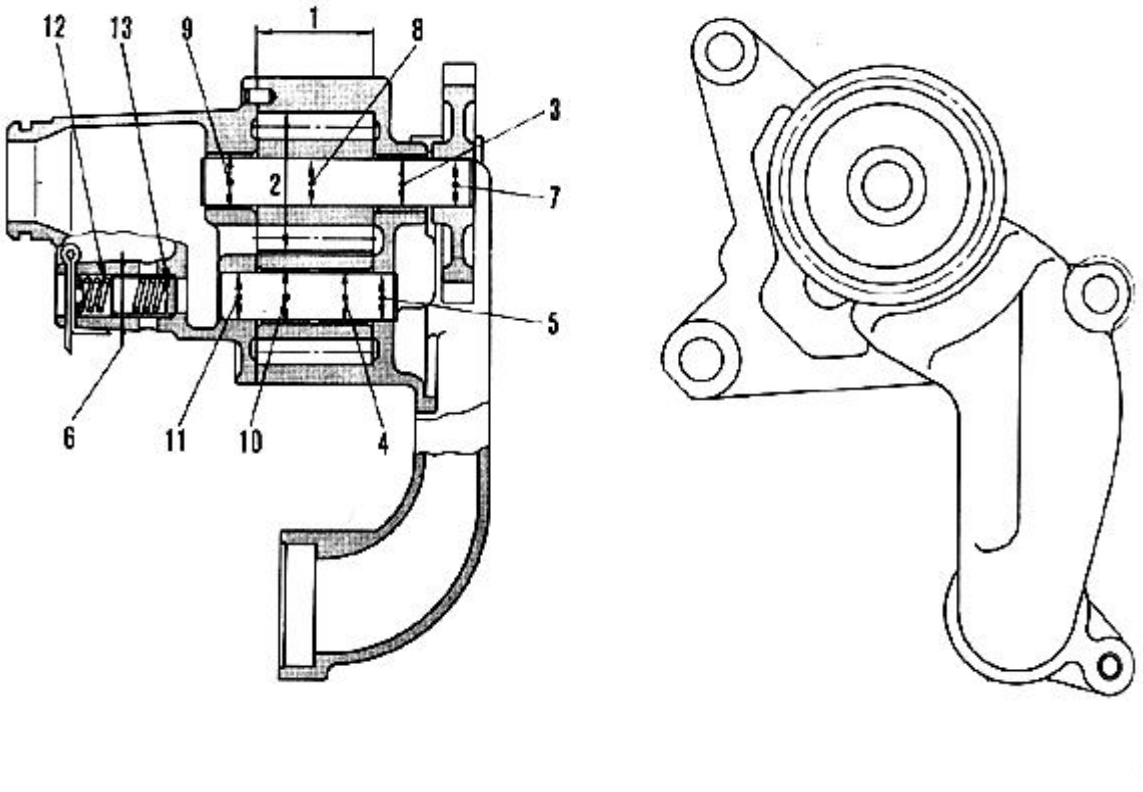


unit: mm

No.	Check item	Criteria				Remedy
1	Face runout of flywheel housing	Repair limit : 0.2				Replace
2	Radial runout of flywheel housing	Repair limit : 0.2				
3	Face runout of flywheel	Repair limit : Diameter of measuring points * 0.0005				
4	Radial runout of flywheel	Repair limit : 0.13				
5	Tightening torque of flywheel housing mounting bolts(Coat thread areas with engine oil)	Order	Tightening order	Targer(kgm)	Range (kgm)	Retighten
		1st step	②→⑦→①→②→③→④ ⑤→⑥→⑦→⑧→⑨→⑩	19.5	15 - 24	
		2nd step	①→②→③→④→⑤ ⑥→⑦→⑧→⑨→⑩	28.0	25 - 31.5	
6	Tightening torque of flywheel mounting bolts (Coat thread areas with engine oil)		Order	Target(kgm)	Range(kgm)	
			1st step	12	11.5 - 12.5	
			2nd step	Retigtening with 90°	90° - 120°	

LUBRICATION SYSTEM

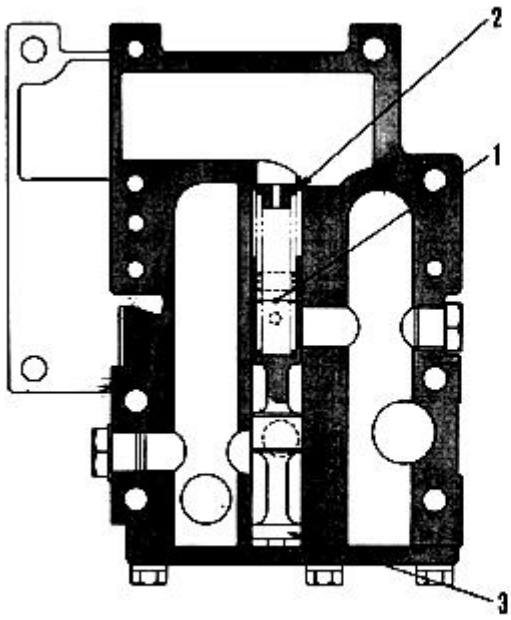
OIL PUMP AND MAIN RELIEF VALVE

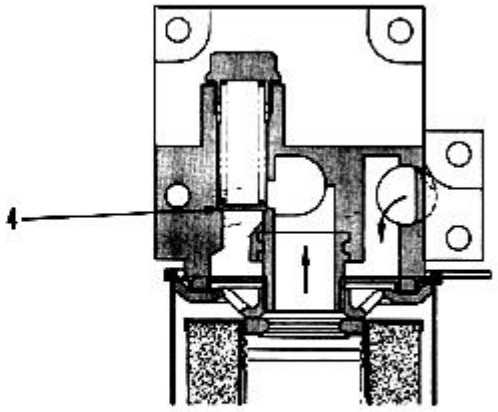


unit: mm

No.	Check item	Criteria					Remedy
1	Axial clearance of pump gear	Standard size	Tolerance: Gear thickness	Tolerance: Housing width	Standard clearance	Clearance limit	Replace
		45	0 -0.025	+0.067 +0.040	0.03 - 0.088	0.10	
2	Radial clearance of pump gear	Standard size	Tolerance: Gear O.D	Tolerance: Housing I.D	Standard clearance	Clearance limit	
		51.4	-0.15 -0.21	+0.06 0	0.033- 0.10	0.13	
3	Clearance between drive shaft and pump body bushing	Standard size	Tolerance: Shaft	Tolerance: Hole	Standard clearance	Clearance limit	Replace bushing
		18	+0.106 +0.088	+0.173 +0.146	0.040- 0.085		
4	Clearance between driven shaft and driven gear bushing	18	+0.090 +0.070	+0.147 +0.122	0.032- 0.077		
5	Clearance between drive shaft and body	18	+0.090 +0.070	+0.129 +0.102	0.012- 0.059		
6	Clearance between relief valve and pump cover	16	-0.040 -0.060	+0.043 0	0.040- 0.103		
7	Interference between drive shaft and oil pump drive gear	Standard size	Tolerance: Shaft	Tolerance: Hole	Standard Interference	Interference limit	Replace
		18	+0.106 +0.088	+0.065 +0.047	0.023- 0.059	-	
8	Interference between drive gear and drive shaft	18	+0.106 +0.088	+0.063 +0.028	0.025- 0.078	-	
9	Interference between drive shaft bushing and pump cover	21	+0.090 +0.065	+0.021 0	0.044- 0.090	-	
10	Interference between driven shaft bushing and driven gear	21	+0.090 +0.065	+0.035 0	0.030 - 0.090	-	
11	Interference between driven shaft and pump cover	18	+0.090 +0.070	+0.040 +0.022	0.030 - 0.068	-	
12	Main relief valvae spring	Standard size: Free length	Standard size: Installed length	Standard size: Installed load	Repair limit: Free length	Repair limit: Installed length	Replace
		49.1	32.0	12.9 kg		11.6 kg	
13	Main relief valve set pressure	Standard : 8.0 ± 0.5 kg/cm²					Replace

REGULATOR VALVE AND SAFETY VALVE

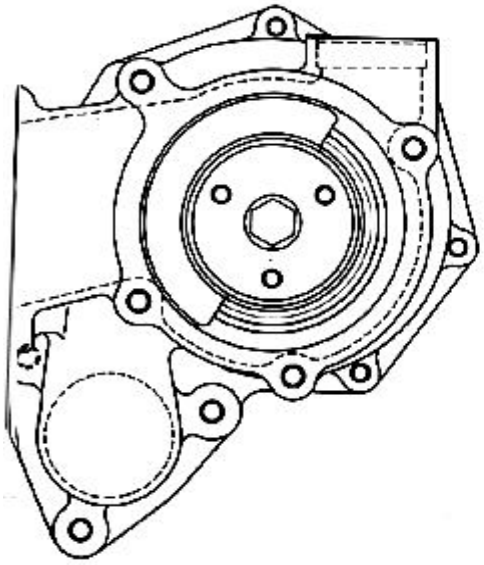


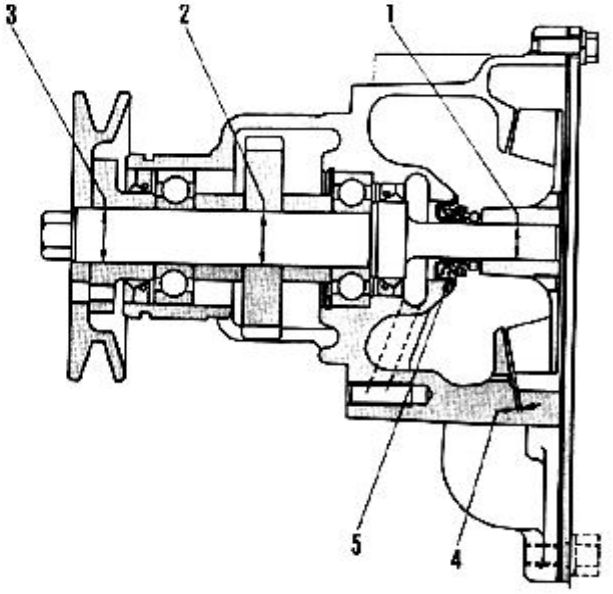


unit: mm

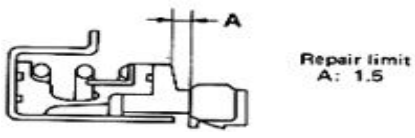
No.	Check item	Criteria					Remedy
		Standard size	Tolerance		Standard Clearance	Clearance limit	
			Valve	Body			
1	Clearance between regulator valve and body	22	+0.15 +0.12	+0.28 +0.22	0.07 - 0.16		Replace valve or body
		Standard size			Repair limit		
2	Regulator valve spring	Free length	Installed length	Installed load	Free length	Installed load	Replace spring
		83	79	1.64 kg		1.54 kg	
3	Regulator valve set pressure	3.2 ± 0.2 kg/cm²					Replace
4	Safety valve set pressure	2.0 ± 0.2 kg/cm²					

COOLING SYSTEM
WATER PUMP
BS6D140-1

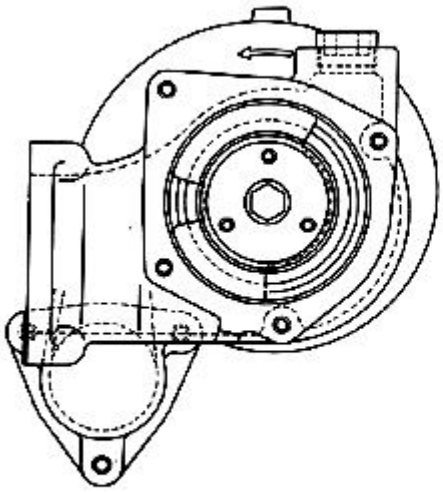


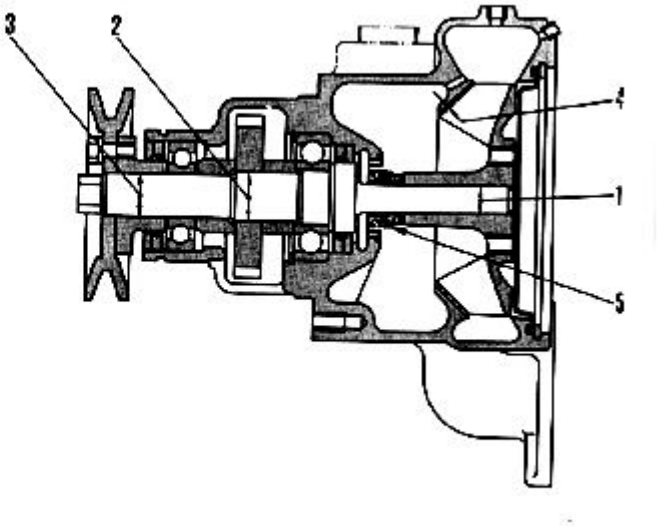


t: mm

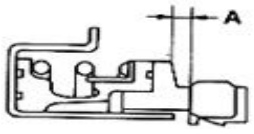
No.	Check item	Criteria					Remedy
		Standard size	Tolerance		Standard interference	interference limit	
			Shaft	Hole			
1	Interference between impeller and shaft	15.9	+0.018 +0.005	-0.020 -0.050	0.025 - 0.068	-	
2	Interference between drive gear and shaft	25	+0.015 +0.002	-0.023 -0.053	0.025 - 0.068	-	
3	Interference between pulley flange and shaft	25	+0.015 +0.002	-0.023 -0.053	0.025 - 0.068	-	Replace
4	Clearance between impeller and body	Standard clearance : 0.30 - 1.0 (Including end play)					
5	Abrasion seal ring in water seal	 Repair limit A: 1.5					

BS(A)6D140-1





unit: mm

No.	Check item	Criteria					Remedy
		Standard size	Tolerance		Standard interference	interference limit	
			Shaft	Hole			
1	Interference between impeller and shaft	16	- 0.082 -0.095	-0.120 -0.150	0.025 - 0.068	-	
2	Interference between drive gear and shaft	28	+0.015 +0.002	-0.023 -0.053	0.025 - 0.068	-	
3	Interference between pulley flange and shaft	25	+0.015 +0.002	-0.021 -0.041	0.023 - 0.056	-	Replace
4	Clearance between impeller and body	Standard clearance : 0.6 - 0.9 (Including end play)					
5	Abrasion seal ring in water seal	 Repair limit A: 1.5					