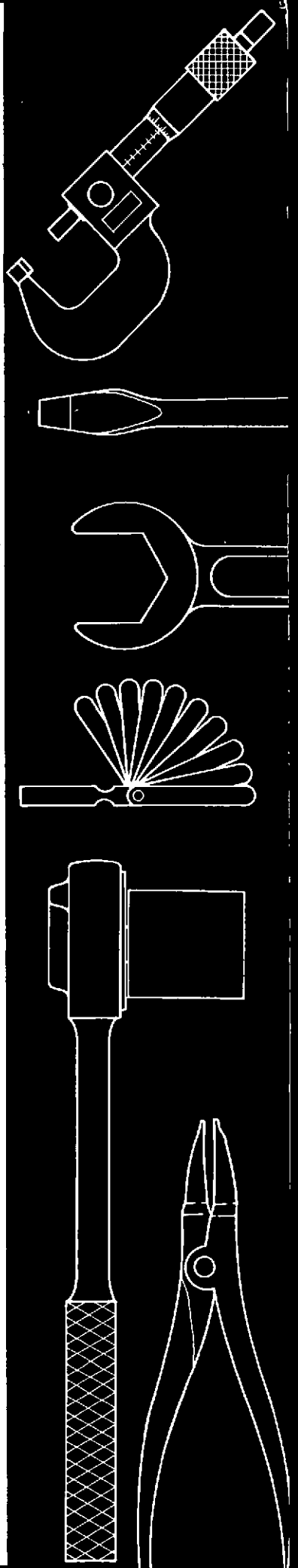
MWM DIESEL

SHOP MANUAL

D327 SERIES



MWM Diesel, Inc.

3200 Pointe Parkway
Norcross, GA 30092
(404) 441-1384
Telex 6712325 MWMMD

Assembly Instructions

This Manual is primarily designed for workshop use and contains useful information on engine disassembly and assembly.

The tasks involved are described and illustrated in the specified sequence.

Go/no go dimensions are stated for parts subject to wear, showing when these items need replacing.

The Operating Instructions serve as a supplement to this Repair Manual.

Please do not hesitate to get in touch with our Service Department should you require additional information pertaining to this Manual.

MWM Diesel, Inc.
3200 Pointe Parkway
Norcross, Georgia 30092
Phone: 404-441-1384

Contents:

1. Special Tools and Fixtures

Dismantling and reassembling the engine necessitates not only standard workshop tools such as:

- Set of fork spanners
- Socket set
- Set of ring spanners
- Set of hex key wrenches
- Torque wrenches
- Set of screwdrivers
- Set of circlip pliers

but also the following special tools and fixtures:

1.1 Valve remover
1.2 Valve grinder
1.3 Holding- and- pulling off devise for the injection pump driving gear
1.4 Holding- and- pulling off device for injection timing devise
1.5 Piston ring clamp
1.6 Nozzle tester
1.7 Compression tester
1.8 Stand
1.9 Installation plate
1.10 Installation plate
1.11 Set special tools
1.12 Installer

These special tools and fixtures are illustrated *below with their order numbers.*

Special tools are being designed by Owatonna Tool Co., Service Tool Division, 2013 4th St. N.W., 55060. They will be released through service bulletins. Contact MWM Murphy Diesel for details.

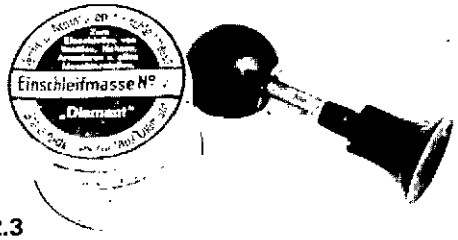
1.1 Valve remover

6.208.0.690.001.6

1.5 Piston ring clamp

6.087.105.2000.1

1.2 Valve grinder

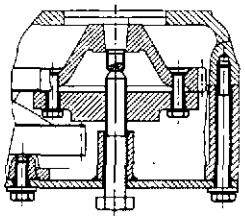


6.088.801.3012.3

1.6 Nozzle tester

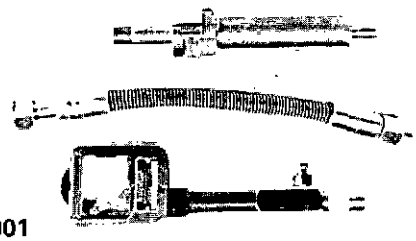
6.0530.40.0.0001

1.3 Holding- and- pulling off device for the injection pump driving gear



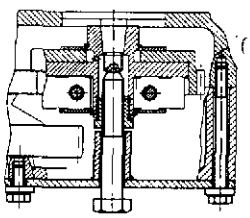
6.226.0.690.010.6

1.7 Compression tester 6.208.0.690.003.4



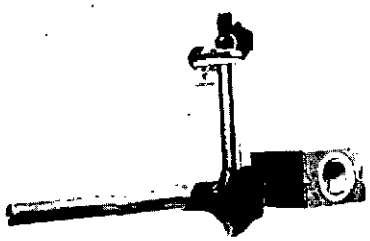
6.0561.70.0.1001

1.4 Holding- and- pulling off device for injection timing devise



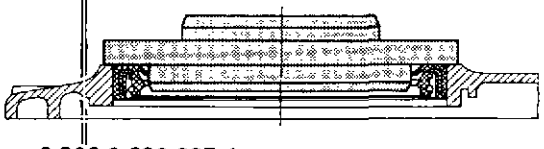
6.226.0.690.009.6

1.8 Stand



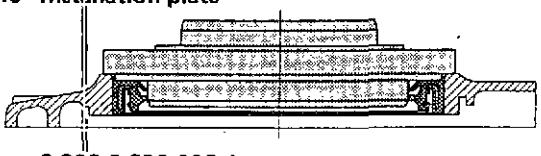
6.086.005.0002.0

1.9 Installation plate



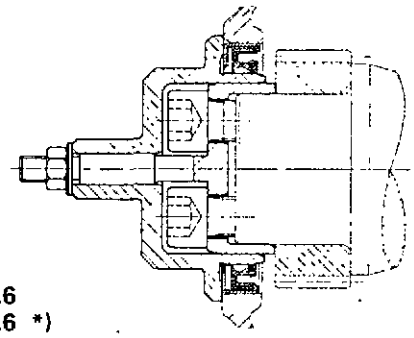
6.206.0.690.005.4

1.10 Installation plate



6.206.0.690.008.4

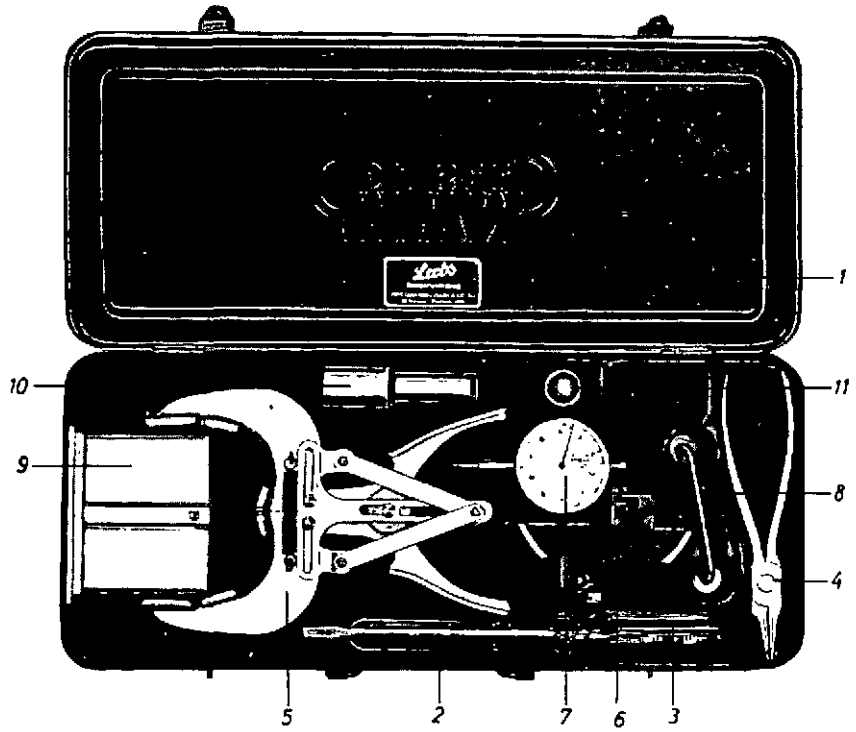
1.12 Installer



6.226.0.690.006.6
6.226.0.690.003.6 *)

*) For engines bearing 9-digit numbers

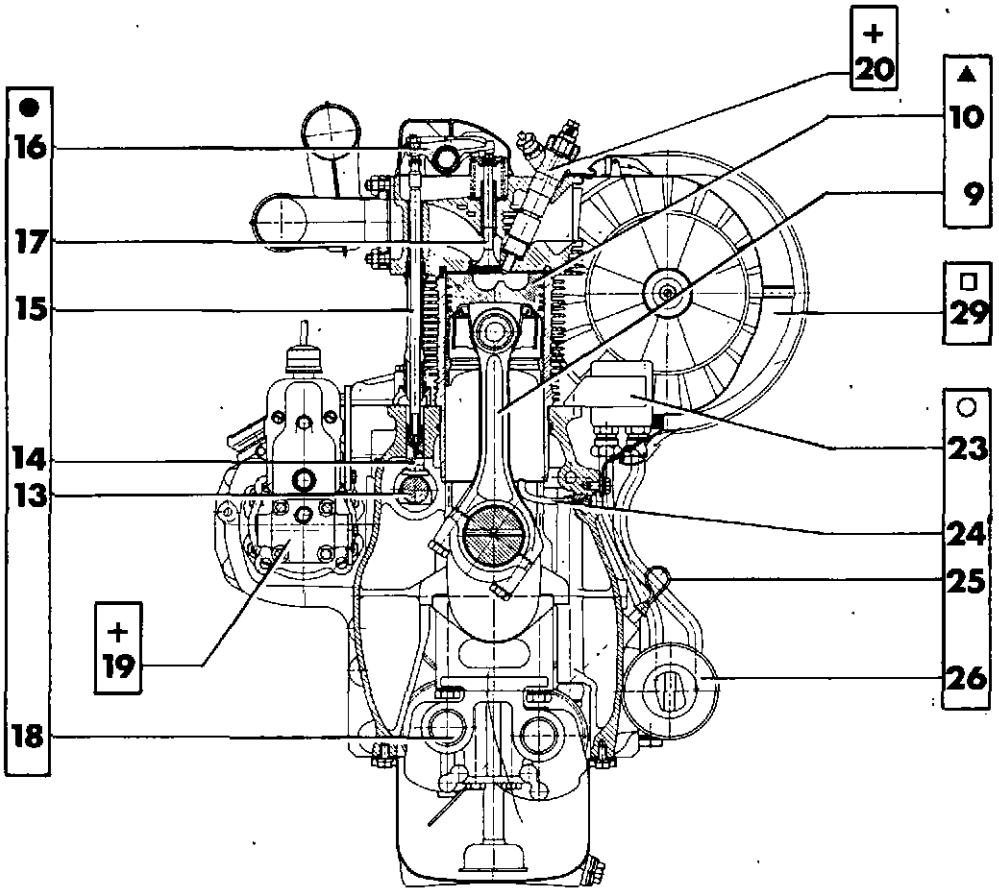
1.11 Set Special Tools
6.000.0.018.502.7

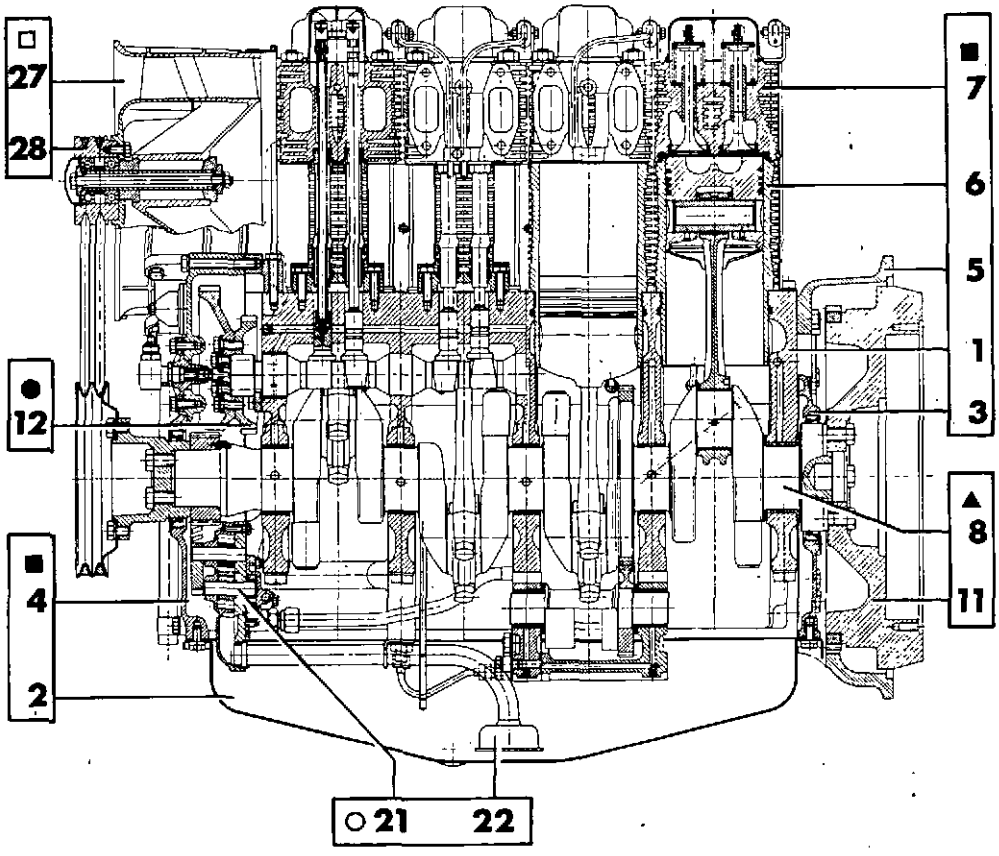


No.	Description	Part No.
1	Tool cassette C1612/01	6.085.610.2001.5
2	Screwdriver A1x7x150	6.086.460.5001.0
3	Screwdriver 2DIN5262	6.086 461.1002.1
4	Pliers C19 DIN 5256 (for gudgeon pin circlip)	6.086.009.0000.2
5	Piston ring clamp 65-110RD	6.087.105.1000.2
6	Tester CH1612/4 (for testing cylinder liner projection and upper piston clearance)	6.088.801.2031.4
7	Gauge A10DIN878 (for tester, CH1612/4)	6.086.001.0002.1
8	Overflow tube, CH1612/6 (for testing start of delivery of injection pump)	6.088.801.4010.7
9	Overflow beaker, CH1774/21.2 (for overflow tube, CH1612/6)	6.088.801.4010.8
10	Socket wrench, CH1612/9 (for slotted nuts on injection setter)	6.088.801.4010.9
11	Set of screwdrivers SW 8 4kt 12.5 (for fastening bolt on V-belt pulley on hub)	6.086.425.0008.1

Weight complete approx. 3.3 kg — Overall dimensions of tool cassette approx. 445x185x50 mm

2. Engine section views showing assembly





Assembly symbology ■ ▲ ● + ○ □
to facilitate identification

■ **Housing and housing items**
- 1 Crankcase
- 2 Oil pan
- 3 Front wall cover (flywheel end)
- 4 Front wall cover (timing gear end)
- 5 Flywheel housing
- 6 Finned cylinder
- 7 Cylinder head

▲ **Drive gear**
- 8 Crankshaft
- 9 Connecting rod
- 10 Piston
- 11 Flywheel

● **Timing and valve control**
- 12 Gears (drive)
- 13 Camshaft
- 14 Mushroom-head tappet
- 15 Pushrod
- 16 Rocker arm
- 17 Inlet and exhaust valves
- 18 Balance weight

\+ **Fuel system**
- 19 Injection pump
- 20 Injection valve

○ **Oil circuit**
- 21 Oil pump
- 22 Lube oil intake pipe
- 23 Oil cooler
- 24 Nozzle for piston cooling
- 25 Oil dipstick
- 26 Lube oil filter

□ **Cooling system**
- 27 Cooling air blower
- 28 Sheave
- 29 Cooling air housing

3. Dismantling/Assembly Sequences

The engine disassembly stages described in detail in Section 4 are listed alphabetically in table 3.1 with their corresponding numbers. Using these numbers in conjunction with the numerically arranged tabel 3.2, you can quickly find the sequence in which the preceding disassembly stages are to be executed. The numbers of these operations are given as assembly sequences in the righthand column.

3.1 Table, alphabetical

Working stage		see No.
Remove	balance weight	4.16
Remove	camshaft	4.26
Remove	connecting rod	4.17
Remove	cooling air blower	4.8
Remove	cooling air housing	4.2
Remove	crankshaft	4.29
Remove	cylinder head	4.10
Remove	cylinder head cover	4.6
Remove	exhaust and intake pipe	4.3
Remove	filter head	4.21
Remove	finned cylinder	4.12
Remove	flywheel	4.24
Remove	flywheel housing	4.25
Remove	front wall cover (flywheel end)	4.25
Remove	front wall cover (timing gear end)	4.19
Remove	fuel delivery lines	4.9
Remove	guide plate	4.11
Remove	hub from crankshaft	4.18
Remove	injection pump	4.23
Remove	injection valve	4.4
Dismantle	injection valve	4.5
Drain	lube oil	4.1
Remove	lube oil line	4.20
Remove	main bearing	4.28
Remove	mushroom-head tappet	4.27
Remove	oil cooler	4.14
Remove	oil pan	4.15
Remove	oil pump	4.22
Remove	piston	4.13
Remove	rocker arm	4.7
Remove	valves	4.10.2

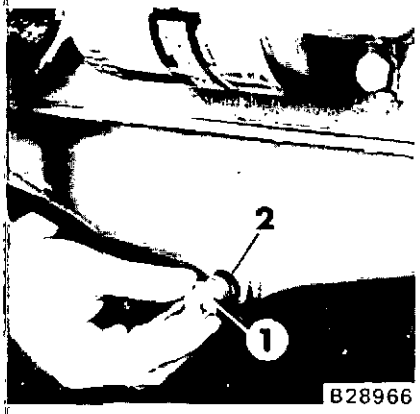
3.2 Table, numerical

No.	Operations	Numbers of working stages required beforehand (assembly sequences)
4.1	Drain lube oil	
4.2	Remove cooling air housing	
4.3	Remove exhaust and intake pipe	
4.4	Remove injection valve	
4.5	Dismantle injection valve	4.4
4.6	Remove cylinder head cover	
4.7	*Remove rocker arm*	4.6
4.8	Remove cooling air blower	
4.9	Remove fuel delivery lines	
4.10	Remove cylinder head	4.2 | 4.6 | 4.7 | 4.9
4.11	Remove guide plate	4.2
4.12	Remove finned cylinder	4.2 | 4.3 | 4.6 | 4.7 | 4.9 | 4.10 | 4.11
4.13	Remove piston	4.2 | 4.3 | 4.6 | 4.7 | 4.9 | 4.10 | 4.11 | 4.12
4.14	Remove oil cooler	4.2
4.15	Remove oil pan	4.1
4.16	Remove balance weight (on 4 cylinder engines)	4.1 | 4.15
4.17	Remove connecting rod	4.1 | 4.2 | 4.3 | 4.6 | 4.7 | 4.9 – 4.13
4.18	Remove hub from crankshaft	
4.19	Remove front wall cover (timing gear end)	4.1 | 4.15 | 4.18
4.20	Remove lube oil line	4.2
4.21	Remove filter head	4.20
4.22	Remove oil pump	4.1 | 4.15 | 4.18 | 4.19
4.23	Remove injection pump	4.9 Pos. 2
4.24	Remove flywheel	
4.25	Remove flywheel housing and front wall cover	4.1 | 4.15 | 4.24
4.26	Remove camshaft	4.1 | 4.6 | 4.7 | 4.15 | 4.18 | 4.19
4.27	Remove mushroom-head tappet	4.1 | 4.6 | 4.7 | 4.15 | 4.16 | 4.18 | 4.19 | 4.26
4.28	Remove main bearing	4.1 | 4.15 | 4.16
4.29	Remove crankshaft	4.1 | 4.15 | 4.16 | 4.18 | 4.19 | 4.24 | 4.25 | 4.28

4. Dismantling the engine

- Clean engine exterior thoroughly prior to dismantling.
- Select location (workbench) which is well lit, providing for unrestricted movement and free of dirt and swarf
- Place tools and fixtures in readiness
- Refer to alphabetical table on page 5 for survey of working stages involved
- The jobs listed in this table are to be carried out step-by-step in the sequence shown and as illustrated
- Please read the corresponding description of the jobs involved prior to starting work, so that you are fully familiar with the scope involved

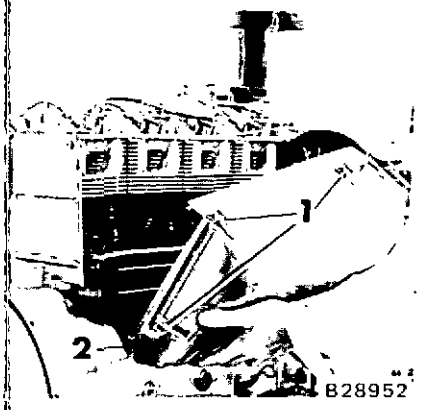
4.1 Drain Lube Oil



Sequence:

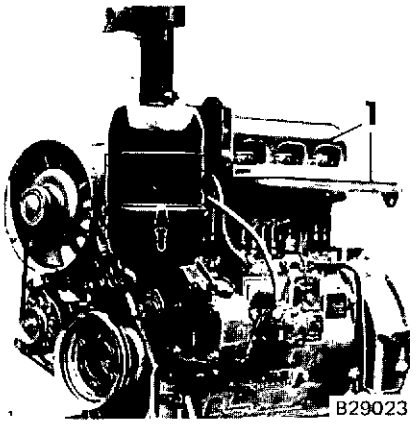
1. Place catchment vessel in readiness to catch the draining oil (oil quantity see page 4 to 7 of operating instructions).
2. Back off the oil drain plug 1 and remove, taking care not to lose the gasket 2.
3. Wait until no more oil emerges.

4.2 Remove Cooling Air Housing



1. Open all clips 1.
2. Remove cooling air housing
3. Take care not to lose rubber gasket 2.

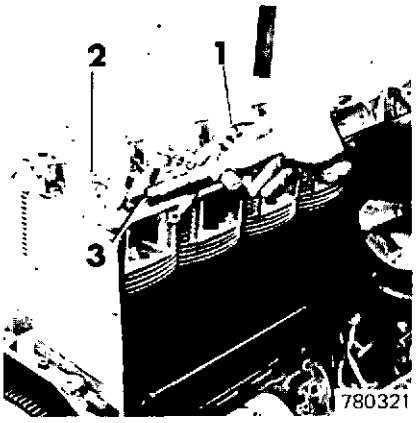
4.3 Remove Exhaust and Intake Pipe



Sequence:

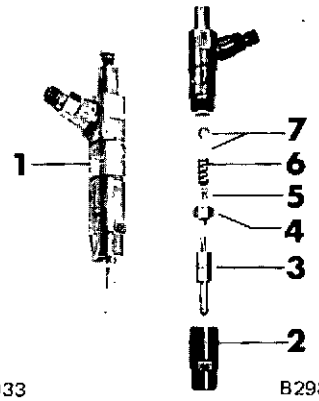
1. Remove nuts from exhaust and intake pipe 1.
2. Take care not to lose cylinder head gasket when removing the exhaust and intake pipe.

4.4 Remove Injection Valve



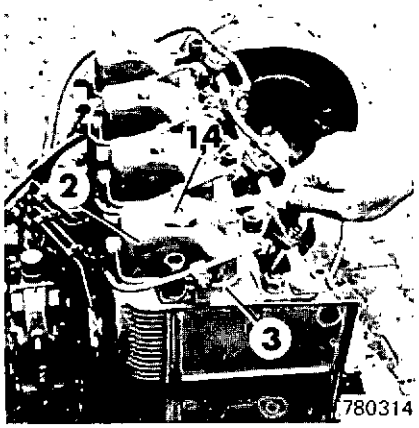
1. Unscrew leakage oil line 1.
2. Unscrew fuel delivery line 2 on injection valve.
3. Remove injection valve.
4. Take care not to lose gasket 3.

4.5 Dismantle Injection Valve



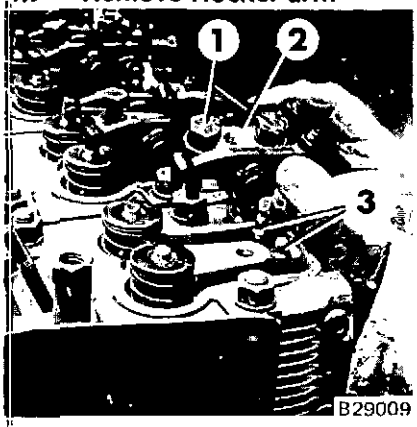
1. Clamp injection valve 1 in vice.
2. Unscrew nut 2.
3. Remove multiple hole nozzle 3 (renew, if required).
4. Remove washer 4, pressure pin 5, coil spring 6 and shims 7. See also section 7.4

4.6 Remove Cylinder Head Cover



1. Remove hex bolt 1.
2. Remove cylinder head cover.
3. Take care not to lose gasket 3 and seal 4.

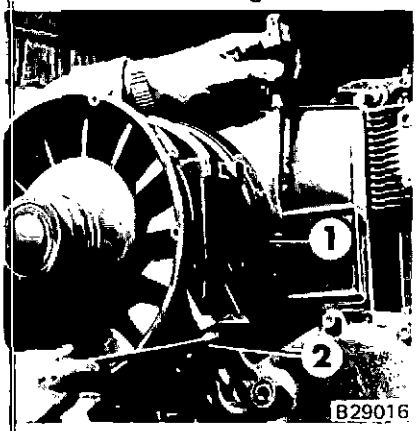
4.7 Remove Rocker arm



Sequence:

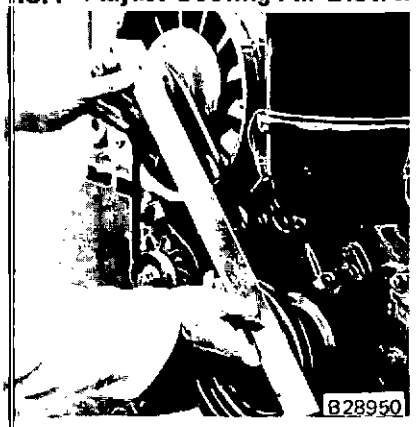
1. Remove hexagon bolts 1.
2. Remove rocker arm 2.
3. Remove pushrod 3.

4.8 Remove Cooling Air Blower



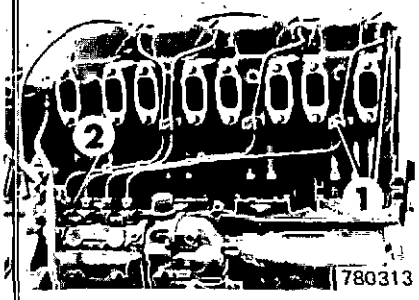
1. Loosen clamp ring 1 with screwdriver.
2. Remove hexagon bolts 2 (4 in all).
3. Remove cooling air blower.

4.8.1 Adjust Cooling Air Blower



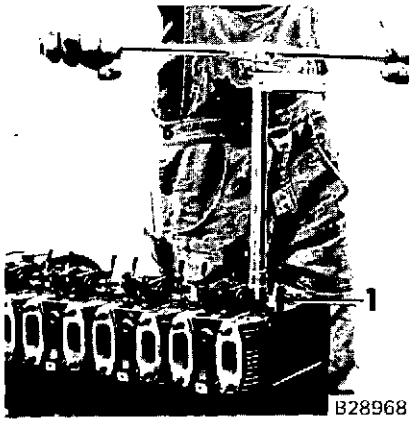
When fitting the V-belt pulley of the blower it must precisely line up with the V-belt pulley on the crankshaft.

4.9 Remove Fuel Delivery Lines



1. Unscrew pipe clamp halves 1 on cylinder head.
2. Unscrew nuts 2 on injection pump.
3. Remove fuel delivery lines complete.

4.10 Remove Cylinder Head

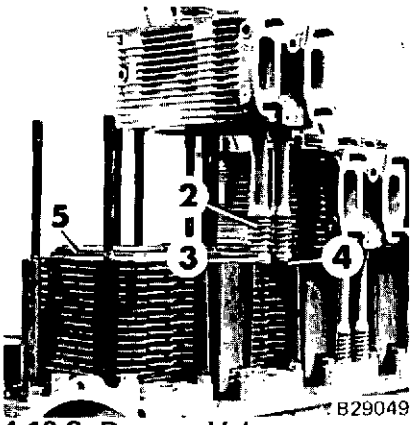


Sequence:

1. Remove hexagon nuts 1 (4 each per cylinder head) on the pull anchors using the socket head wrench.

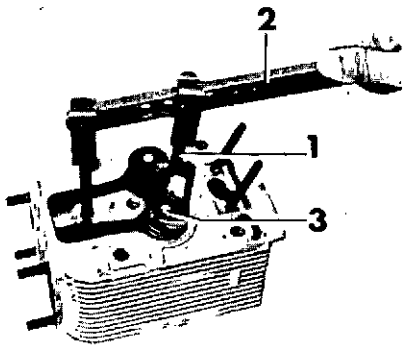
Assembly note:
Observe torque requirements of section 6.2.

4.10.1



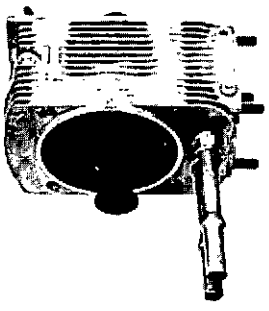
3. Remove each cylinder head.
4. Do not lose compression spring 2, compression ring 3, O-ring 4 and gasket 5.

4.10.2 Remove Valves



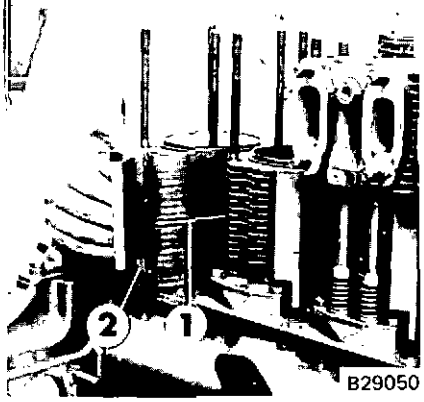
1. Locate valve removal fixture 1.
2. Press lever 2.
3. Remove valve cone halves 3 using heavily greased clip of screwdriver.
4. Remove valve spring and spring plate.

4.10.3



5. Withdraw valve from bottom.

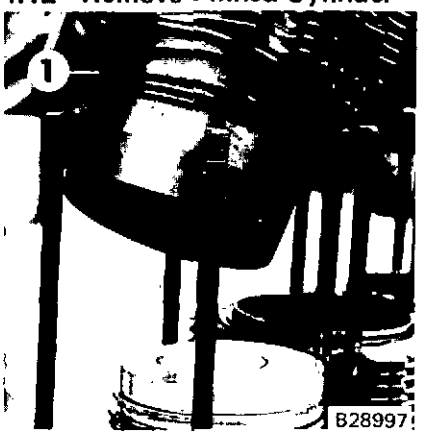
4.11 Remove Guide Plate



Sequence:

1. Unscrew hexagon nut on threaded rod 1.
2. Remove guide plate.

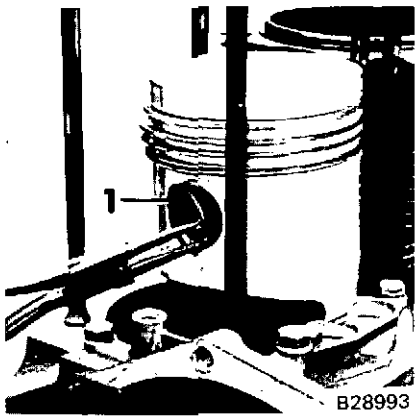
4.12 Remove Finned Cylinder



1. Remove finned cylinder from top.
2. Take care not to lose shim 1.

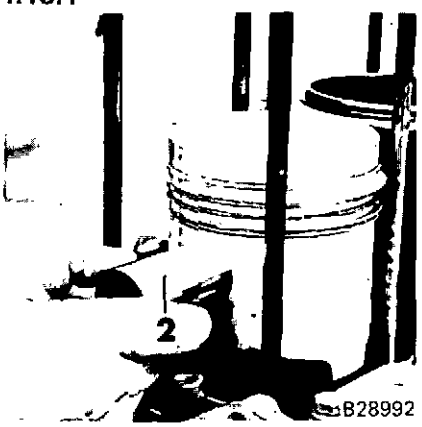
Assembly instruction:
Butting joints of the piston rings must be each staggered 180° (i.e. opposing in sequence).
Renew O-ring in crankcase.

4.13 Remove Piston



1. Remove retainer.

4.13.1



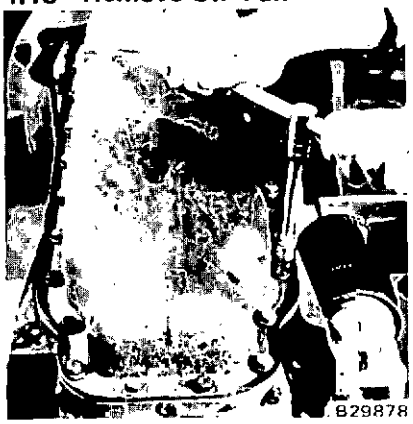
2. Remove wrist pin 2.
3. Remove piston.

4.14 Remove Oil Cooler

Sequence:

1. Unscrew nuts on the line connections 1.
2. Unscrew hexagon bolts on crankcase 2.
3. Remove oil cooler.

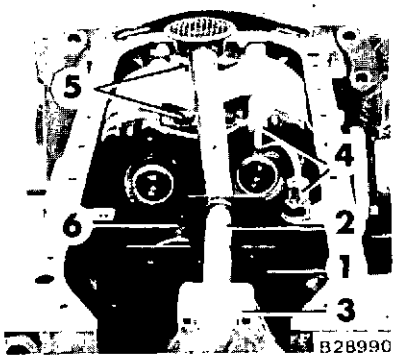
4.15 Remove Oil Pan



1. Remove all bolts from oil pan.
2. Loosen and remove oil pan from gasket using screwdriver or lever.
3. Ensure absolute cleanliness of the gasket surfaces.

Assembly instruction:
Coat joint between crankcase and end cover with sealant
Observe torque requirements of section 6.2.

4.16 Remove Balancing Weight



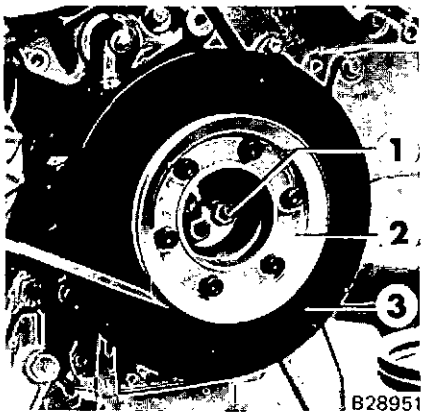
1. Remove both bolts on support 1.
2. Remove lube oil intake line 2 from lube oil pump 3. Do not lose O-ring.
3. Unscrew lube oil line from balancing weight at the nuts 4.
4. Remove hexagon bolts 5.
5. Remove balancing weight.
6. Do not lose spacer 6 under balancing weight.
   See section 6.4.1.

4.17 Remove Connecting Rod

1. Unscrew connecting rod bolt 1 using socket head wrench.
2. Remove bolts together with connecting rod bearing cap.
3. Do not lose connecting rod bearing shells.

Instruction note:
Insert bearing shells noting the locating pin. Observe torque requirements of section 6.2.

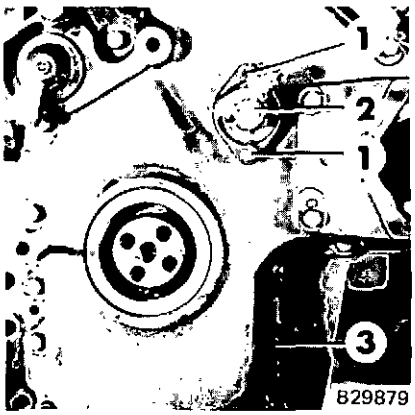
4.18 Remove Hub from Crankshaft



Sequence:

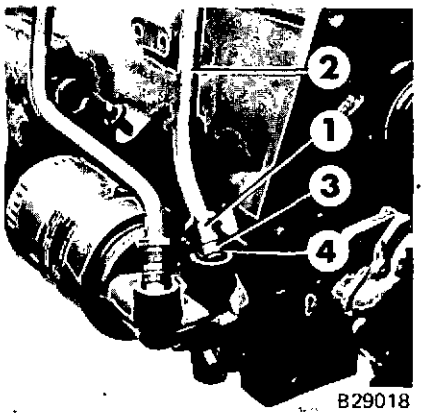
1. Unscrew fastening bolts 1 using socket head wrench.
2. Hold crankshaft during
   Caution:
   Do not damage conrod end surface.
3. Remove hub including V-belt pulley 2 and vibration damper 3 from crankshaft.

4.19 Remove Front Wall Cover



1. Unscrew hexagon bolts 1.
2. Remove angle drive 2.
3. Do not lose seal and lug of angle drive.
4. Unscrew all fastening bolts 3 (15 in all).
5. Loosen and remove front wall cover by gentle side tapping.

4.20 Remove Lube Oil Line



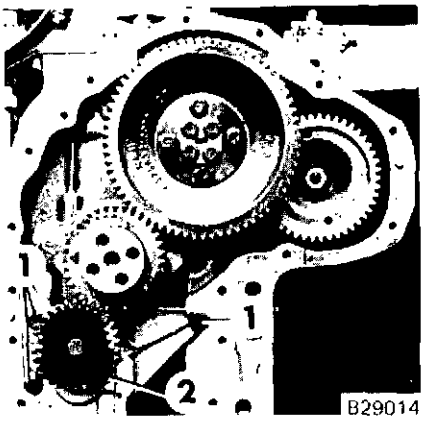
1. Remove screw inserts 1.
2. Remove lube oil lines 2.
3. Do not lose washer 3 and seal 4.

Assembly instruction:
Renew seals.

4.21 Remove Filter Head

1. Remove hexagon bolts (3 in all) from crankcase 1.
2. Remove filter head 2 complete.
3. Do not lose gasket 3.

4.22 Remove Oil Pump

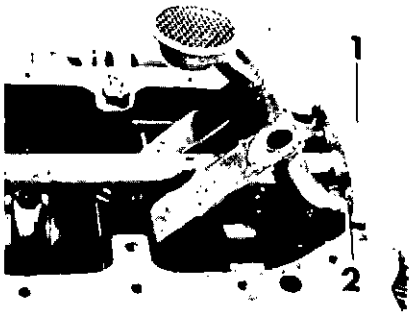


Sequence:

1. Remove hexagon bolts 1.
2. Remove oil pump 2.

Assembly instruction:
Observe torque requirements *of section 6.2.*

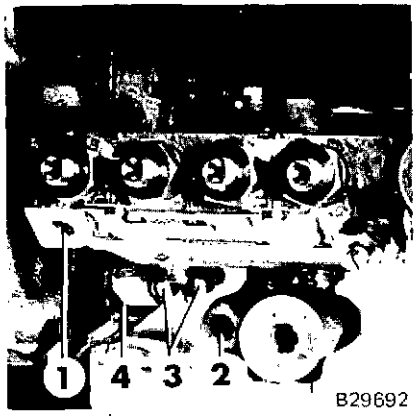
4.22.1 Remove Double Oil Pump



1. Remove fastening bolts (3 in all, arrangement shown in 4.22).
2. Remove double oil pump 1.

Assembly instruction:
Renew O-rings 2.

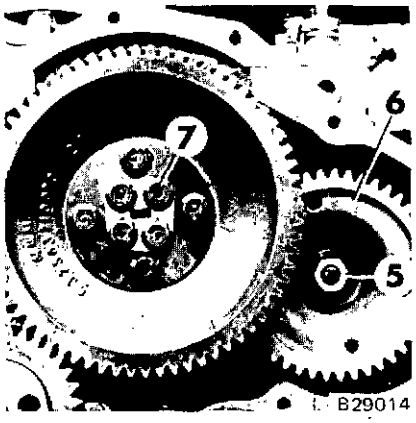
4.23 Remove Injection Pump



1. Remove speed adjustment and shutdown linkage from injection pump.
2. Unscrew all fuel lines connecting injection pump and fuel delivery pump (location 1 and 2).
3. Unscrew nut 5 on gear 6 and slotted nut on injection timing device using socket head wrench No. 10 and tool set 1.11.
4. Remove gear and injection timing device respectively using removal tool (special tool No. 1.3 or No. 1.4).
5. Remove hexagon nuts 3.
6. Remove injection pump.
7. Take care not to lose gasket 4.

Assembly instruction:
Observe torque requirements of *section 6.2.*

4.23.1



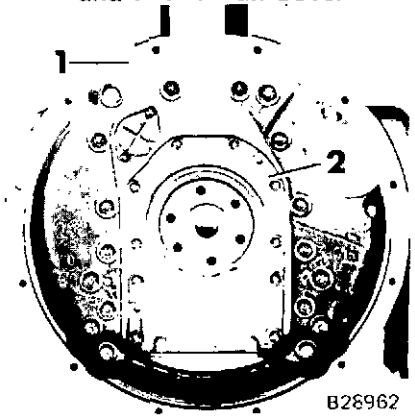
4.24 Remove Flywheel

Sequence:

1. Hold crankshaft.
   Caution!
   Avoid damaging the surface of the connecting rod ends.
2. Unscrew fastening bolts with socket wrench.
3. Lift flywheel from crankshaft.

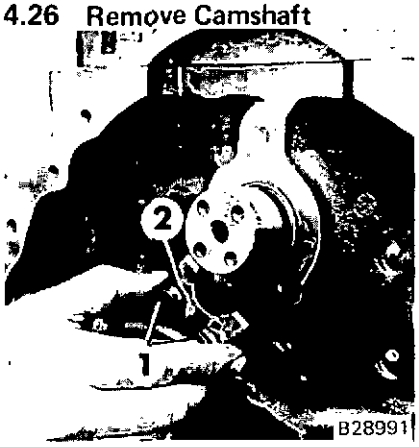
Assembly instruction:
Observe torque requirements of section 6.2.

4.25 Remove Flywheel Housing and Front Wall Cover



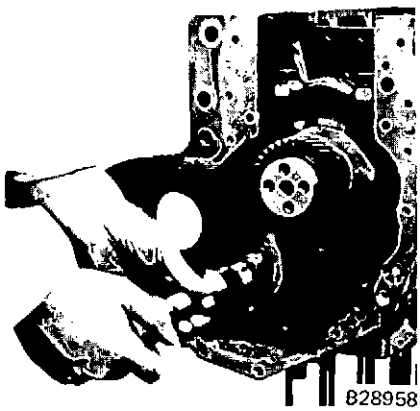
1. Unscrew fastening bolts on flywheel housing 1.
2. Loosen and remove housing by gentle tapping.
3. Unscrew fastening bolts on front wall cover 2.
4. Remove front wall cover.
5. Take care not to lose gasket.

4.26 Remove Camshaft



1. Unscrew fastening bolts 7 (Fig. 4.23.1).
2. Remove speedometer drive and gears.
3. Unscrew hexagon bolts 1.
4. Remove segment 2 for locating camshaft. Fig. 22, page 27.
5. Place engine on head.
6. Press all mushroom-head tappets downwards (in direction of cylinder).

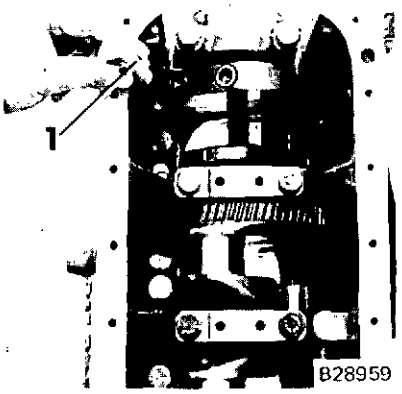
4.26.1



7. Carefully withdraw camshaft with engine standing on head. Turn camshaft during removal.

Note:
On some 6-cylinder engines, camshaft thrust segment is on flywheel end. See Fig. 4, page 27.

4.27 Remove Mushroom-head Tappet



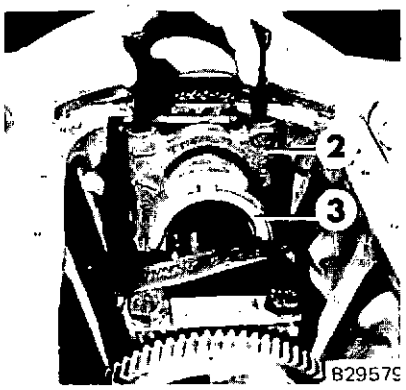
Sequence:

1. Remove mushroom-head tappet 1 *from case bore.*

4.28 Remove Main Bearing

1. Remove main bearing bolts 1.

4.28.1

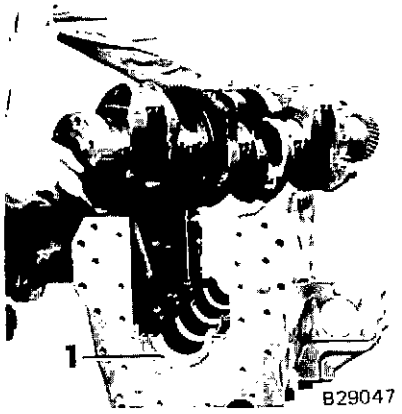


2. Lift off cap 2.
   Caps are numbered.
3. Take care not to loose bearing shells and ring halves 3.

Assembly instruction:
Do not mix bearing shells, ring halves and bearing caps. (see section 6.3).

Observe torque requirements of section 6.2.

4.29 Remove Crankshaft



1. Lift crankshaft from crankcase.
2. Do not mix bearing shells 1 on reassembly.

5. Go/No go Dimensions on Wearing Parts

1. General

- After having dismantled the engine carefully clean and dry all component parts.
- All parts subject to wear and tear after a certain time are listed in the following along with the dimensions as new and their go/no go dimensions.
- Carefully gauge the items and check the surfaces (using a micrometer at room temperature 20°C).
- Replace any items with no go dimensions.

Go/No go dimensions are given for the following parts:

1. Crankshaft
2. Gearwheel for crankshaft
3. Crankshaft for engine mass balancing
4. Gear ring for mass balancing
5. Ring halves
6. Thrust shell bearing
7. Main bearing bush
8. Big-end bearing
9. Connecting rod
10. Gudgeon pin
11. Piston, complete
12. Finned cylinder
13. Amount of valve depression
14. Inlet and exhaust valve cones
15. Valve seating insert, inlet and exhaust premachined
16. Valve guide
17. Rocker bracket
18. Rocker
19. Camshaft
20. Camshaft bore in crankcase
21. Camshaft bearing bush
22. Key to fix camshaft
23. Mushroom-head tappet
24. Washer to fix camshaft
25. Spur gear for camshaft
26. Spur gear for injection pump drive
27. Spur gear for injection pump
28. Injection timing device
29. Mass balancing shaft
30. Mass balancing gearwheel
31. Bearing bush for mass balancing
32. Bearing ring for mass balancing
33. Pulley with ball bearing
34. Cooling air blower

These numbers are the item numbers given in the first column in section 5.2.

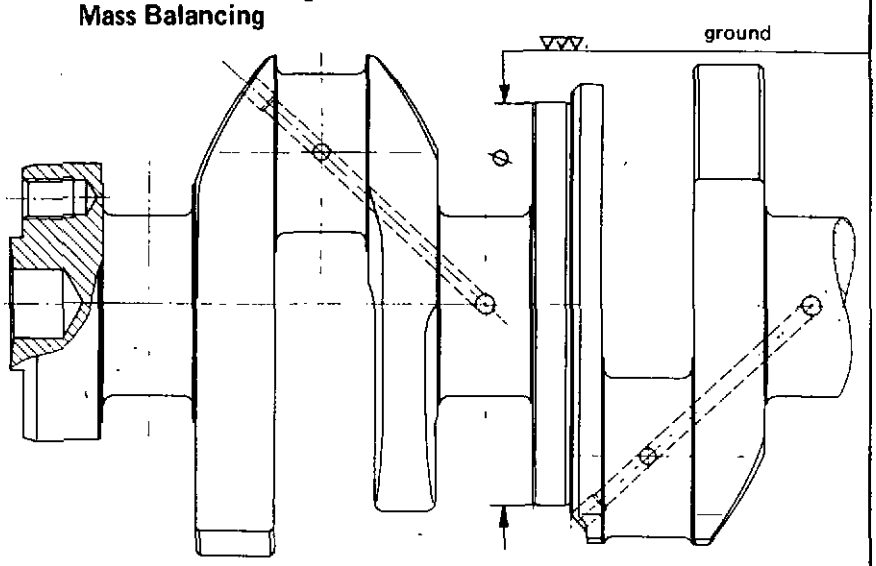
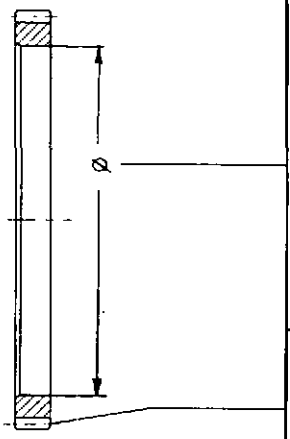
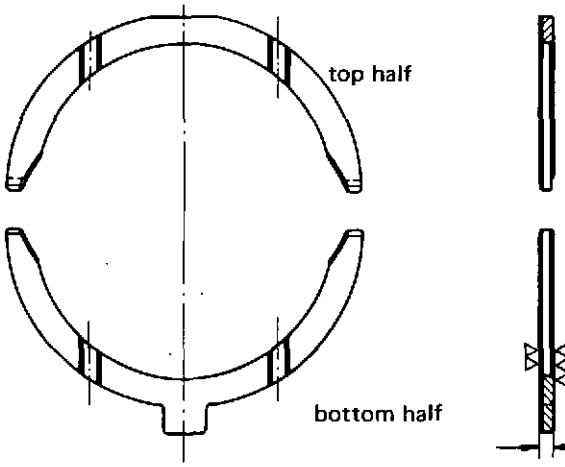
5.2 Go/no go wear part dimensions 5.2.1 – 5.2.2

Item No.	Nr. Part, Designation / Figure	Measures New max. mm	New min. mm	No go limits max. mm
1	Crankshaft			
		60,039 (58,039)	60,020 (58,020)	60,000 (58,000) ★
		69,970 (64,970)	69,951 (64,951)	69,940 (64,940) ★
		110,00	109,946	109,920
		51,955	51,925	51,900
		36,050	36,000	36,070
		35,100	35,000	35,150
		36,100	36,000	36,150
		62,970 (57,970)	62,951 (57,951)	62,940 (57,940) ★
		31,500	31,300	31,600
	Refurbishing dimensions see 5.3.1			
2	Gearwheel			
		60,019 (58,019)	60,000 (58,000) ★	Tooth edges smooth *no scoring and wear* pressed onto crankshaft

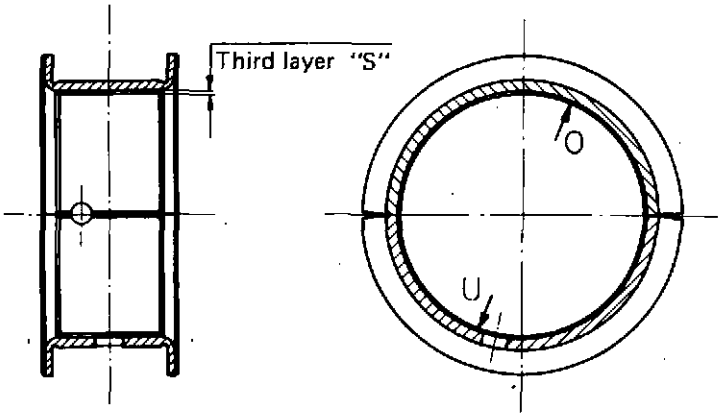
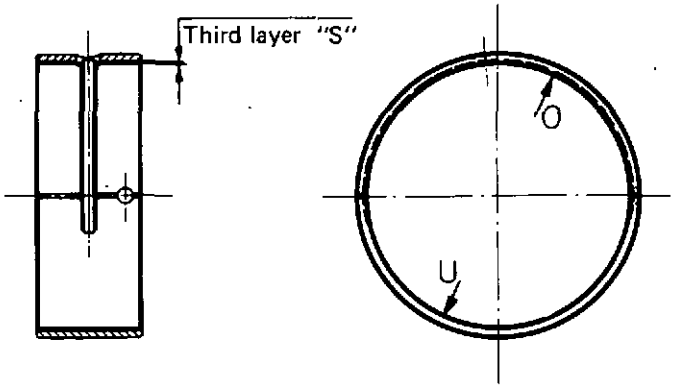
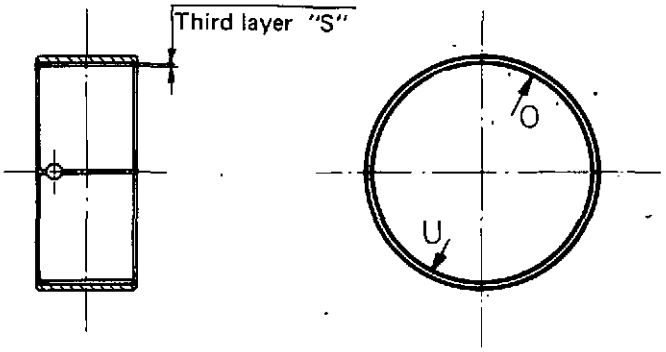
Dimensions apply to engines with 10-digit engine Nos., e.g. 327.62.01000

★ The dimensions in brackets apply to engines with 9-digit engine Nos., e.g. 327.6.01000.

Go/no go wear part dimensions

Nr. / Item No.	Part, Designation / Figure	Measures: New max. mm	Measures: New min. mm	Measures: No go limits max. mm
3	Crankshaft for Engine Mass Balancing 	160,225	160,200	
4	Gear Ring f. Mass Balancing 	160,029	160,000	Heat gear to max. 250° C to obtain shrink-fit
		Tooth edges smooth no scoring and wear.		
5	Ring Halves (Crankshaft) 	3,425	3,420	3,415

Go/no go wear part dimensions

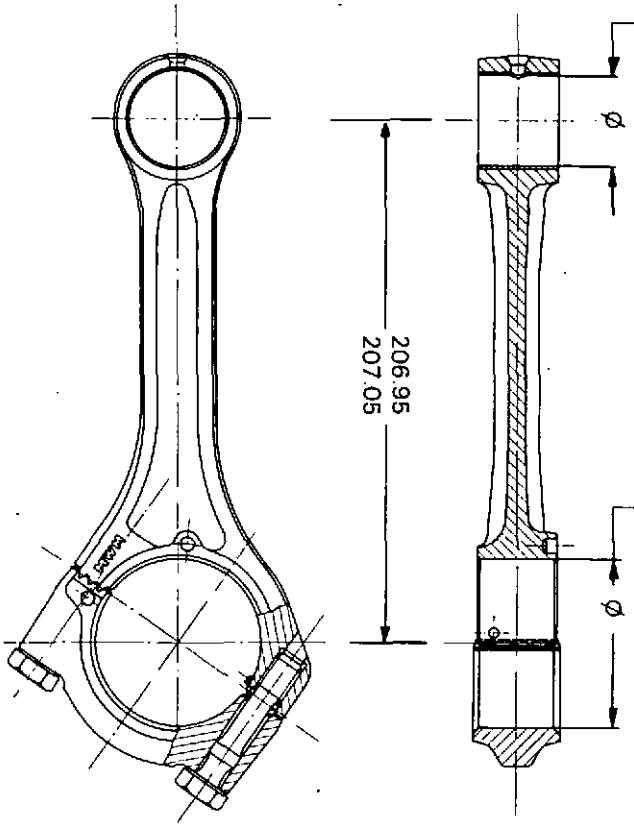
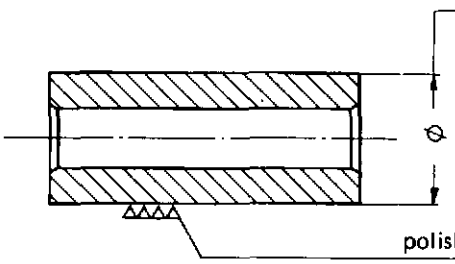
Nr. Item No.	Part, Designation Figure	Abmessungen / Measures New max. mm	New min. mm	No go limits max. mm
6	**Thrust Shell Bearing** ★ 			
7	**Main Bearing Bush** 			
8	**Big- end Bearing** 			

Both shell bearings will have to be renewed when the galvanically applied third coat "S" wears off (indicated by shiny bronze/gold contact pattern at points O and U, and/or when scoring appears around entire circumference.

Important: There is no point in fitting new shell bearings on shaft journals with no go dimensions.

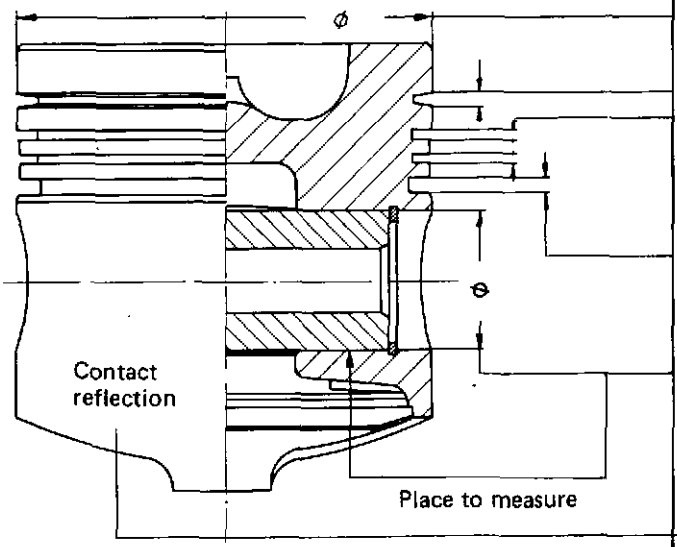
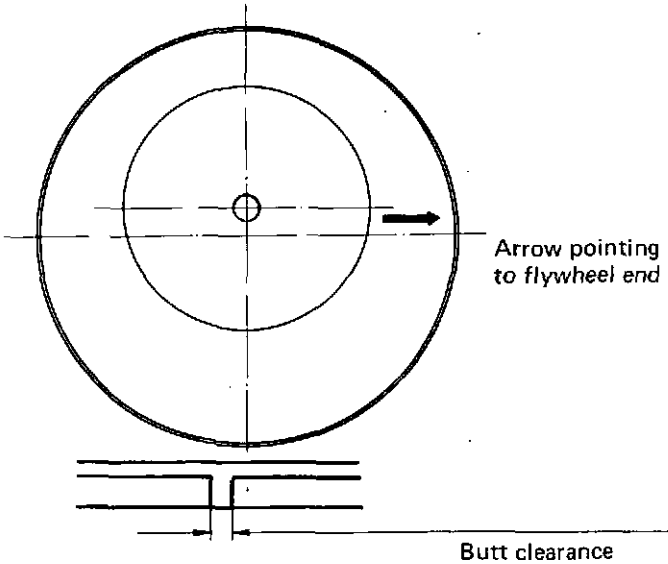
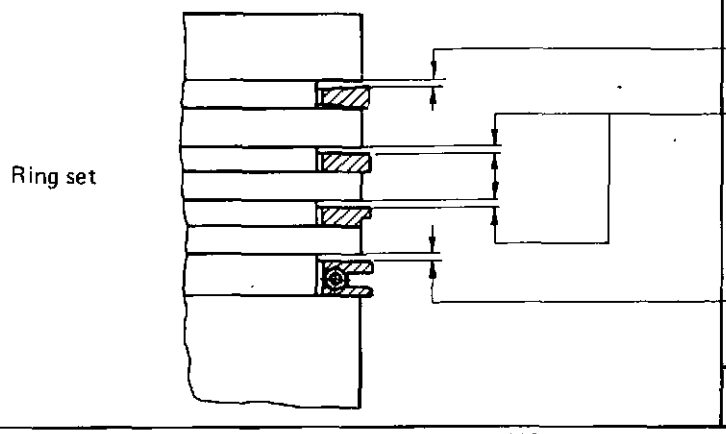
Dimensions apply to engines with 10- digit engine Nos., e.g. 327.62.01000
★ The dimensions in brackets apply to engines with 9- digit engine Nos., e.g. 327.6.01000.

Go/no go wear part dimensions

Item No.	Nr. Part, Designation / Figure	Measures: New max. mm	New min. mm	No go limits max. mm
9	**Connecting Rod**			
		35,080 (32,080)	35,030 (32,030)	35,150 (32.131) ★
		67,019 (62,019)	67,000 (62,000)★	
10	**Wrist Pins**			
		35,000 (32,000)	34,994 (31,994)	34,990 (31,990) ★
				renew if scored

Dimensions apply to engines with 10- digit engine Nos., e.g. 327.62.01000
★ The dimensions in brackets apply to engines with 9- digit engine Nos., e.g. 327.6.01000.

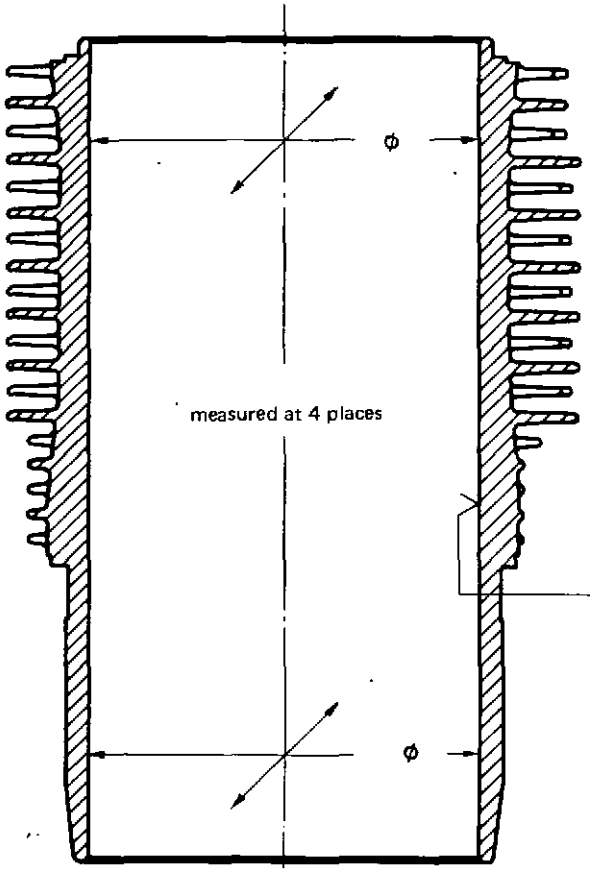
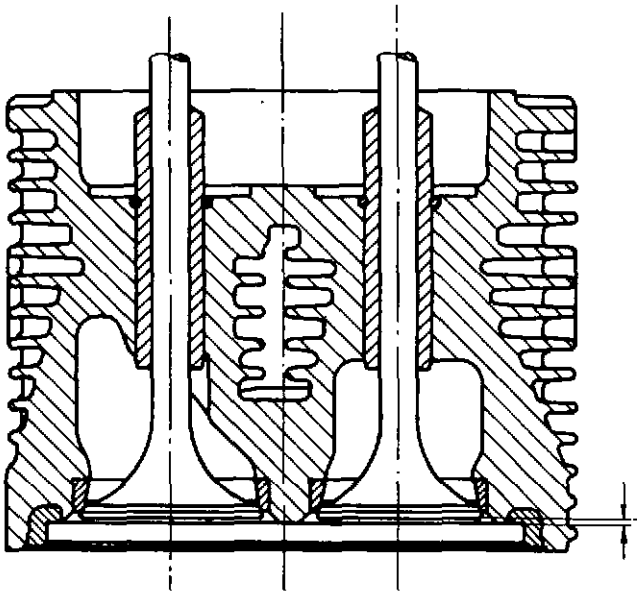
Go/no go wear part dimensions

Nr. Item No.	Part, Designation Figure	Measures New max. mm	New min. mm	No go limits max. mm
11	Piston, compl.			
		99,470 3,050 2,080 4,060 35,009 (32,009)	99,450 3,030 2,060 4,040 35,003 (32,003)	99,400 3,080 2,120 4,100 35,014 (32,014)★
				Renew if longitudinally scored
	Butt clearance *on all rings*			2 mm
				0,25 0.20 0,15
				Butt clearance caused by piston ring wear and wear of finned cylinder surface.

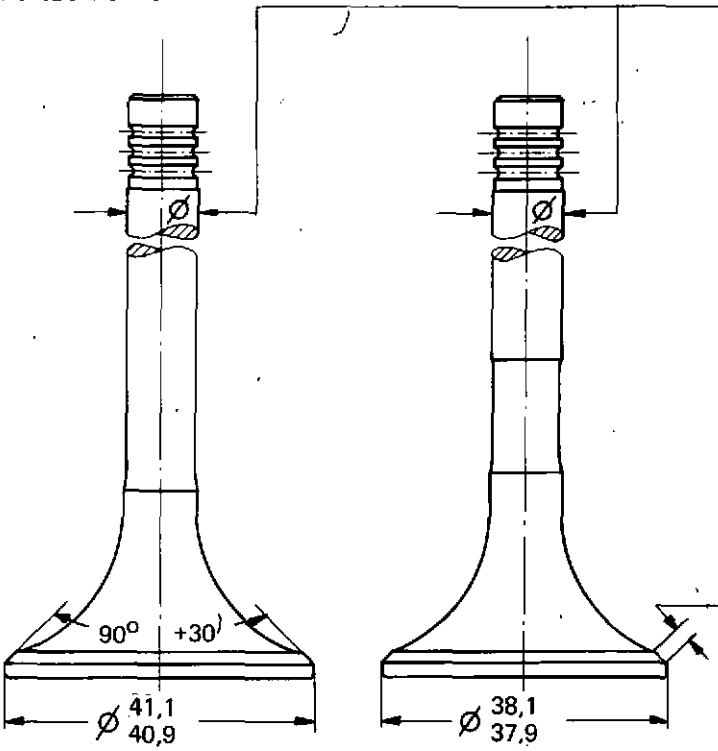
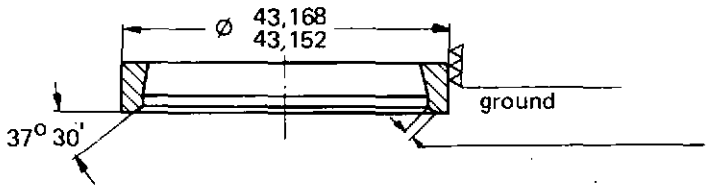
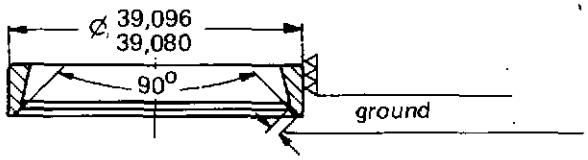
Dimensions apply to engines with 10-digit engine Nos., e.g. 327.62.01000

★ The dimensions in brackets apply to engines with 9-digit engine Nos., e.g. 327.6.01000.

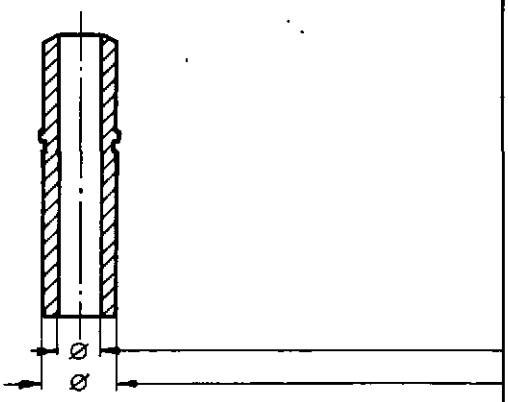
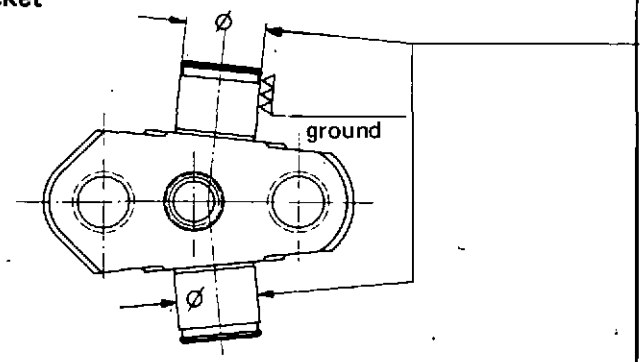
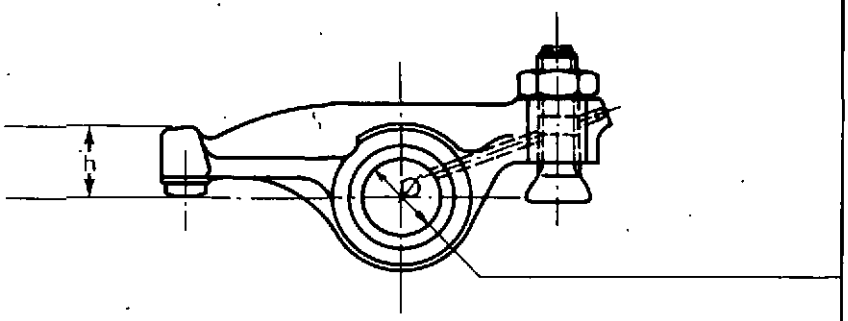
Go/no go wear part dimensions

Nr. / Item No.	Part, Designation / Figure	Measures		
		New		No go limits
		max. mm	min. mm	max. mm
12	Finned Cylinder			
		100,022	100,000	100,250
				rehone if scored: longitudinal scores exceeding 0,05 mm in deth
		Refurbishing grade see 5.3.4		
13	Amount of Valve Depression			
		1,42	1,03	1,80

Go/no go wear part dimensions

Nr. Item No.	Part, Designation / Figure	Measures		
		New		No go limits
		max. mm	min. mm	max. mm
14	**Inlet Valve** **Exhaust Valve**	8,970	8,952	8,949
				Regrinding tolerance
		2,450	2,100	3,100
15	**Valve Seating insert, Inlet**			
		1,8	1,35	2,5
	Valve Seating insert, Exhaust			
		1,8	1,35	2,5
		Refurbishing grade see 5.3.5		

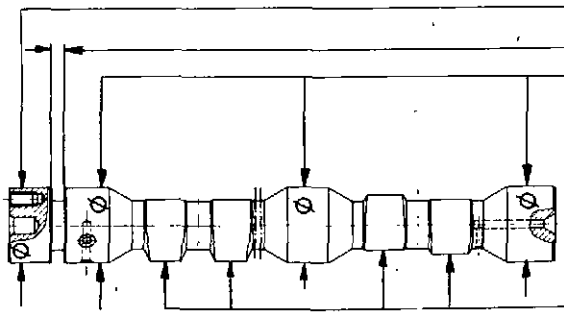
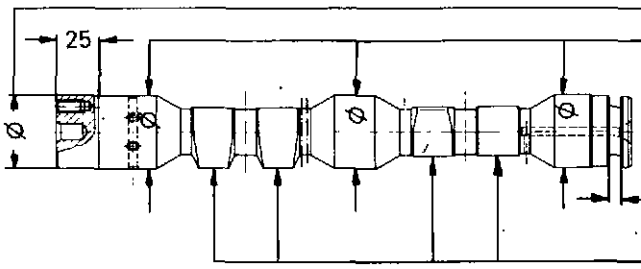
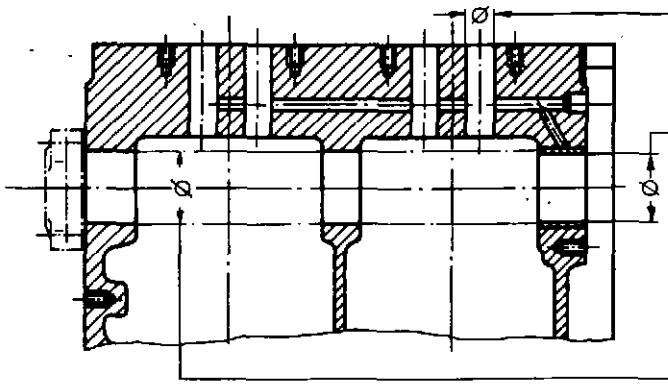
Go/no go wear part dimensions

Nr. / Item No.	Part, Designation / Figure	Measures		
		New		No go limits
		max. mm	min. mm	max. mm
16	**Valve Guide** 	9,028 15,047	9,013 15.032	9,060 Press fit
		Refurbishing grade see		5.3.5
17	**Rocker Bracket** 	15,984	15,966	15,950
18	**Rocker** 	16,018	16,000	16,030

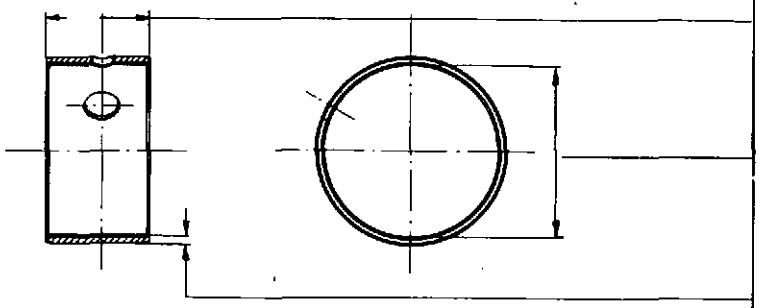
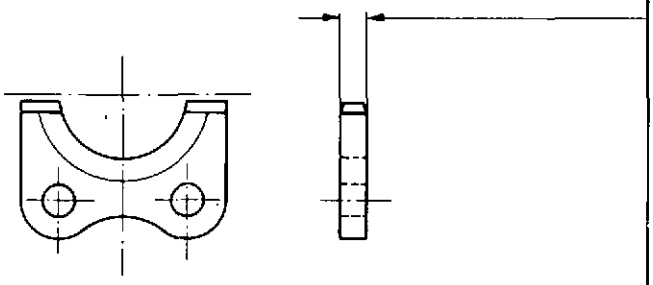
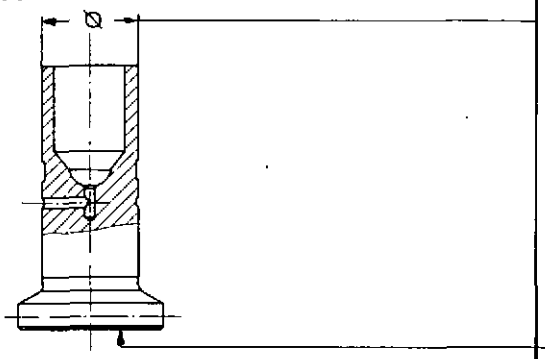
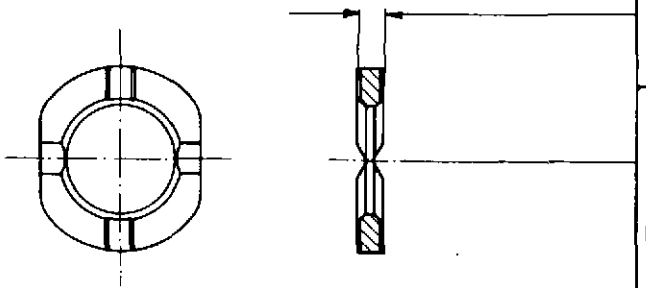
h = 14.5 mm (.571") cast standard

h = 12.0 mm (.472") machined for compression release (intake rocker only)

Go/no go wear part dimensions

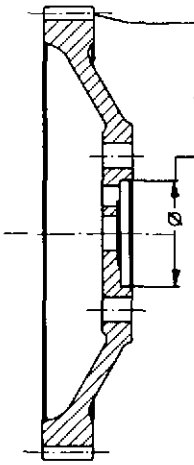
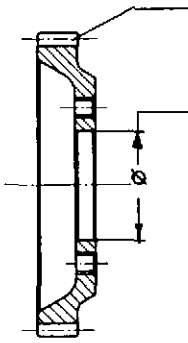
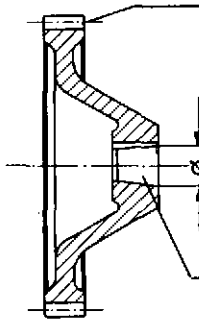
Nr. / Item No.	Part, Designation / Figure	Measures: New max. mm	New min. mm	No go limits max. mm
19	**Camshaft 2, 3, 4 and 6 Cylinder**			
		42,991	42,975	
		7,190	7,100	7,220
		42,960	42,940	42,920
				renew if scored
	Refurbishing grade see 5.3.2			
	Camshaft only 6 Cylinder			
		42,991	42,975	
		42,960	42,940	42,920
		7,190	7,100	7,220
				renew if scored
	Refurbishing grade see 5.3.2			
20	**Camshaft Bore in Crankcase**			
		18,015	18,000	18,020
		43,039	43,000	43,060
		43,025	43,000	43,040
	Refurbishing grade see 5.3.3			

Go/no go wear part dimensions

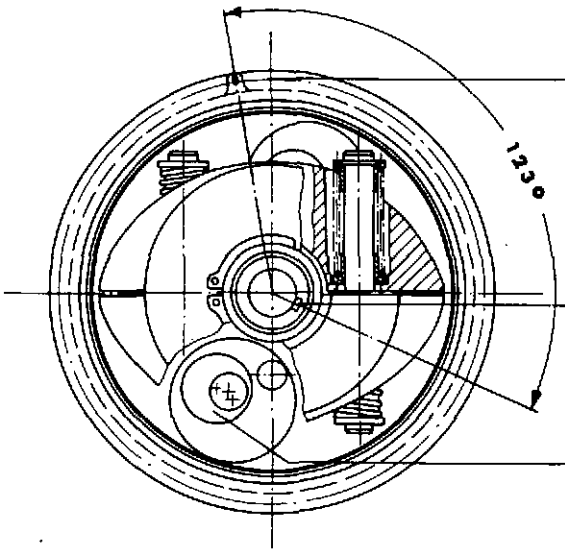
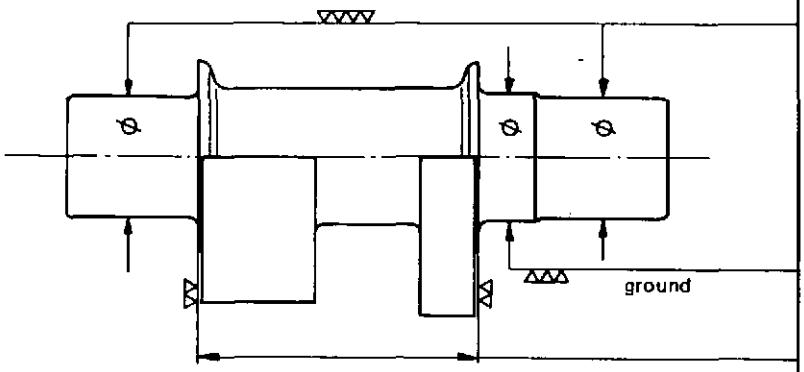
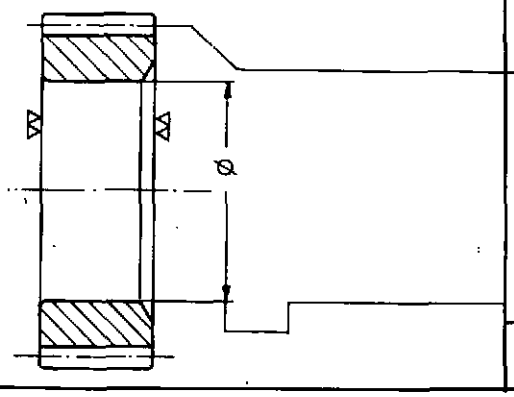
Nr. Item No.	Part, Designation / Figure	Measures		
		New		No go limits
		max. mm	min. mm	max. mm
21	Camshaft bearing bush 	26,000	25,700	
		43,039	43,000	43,060
		2,005	1,990	1,960
22	Key to fix Camshaft 	7,050	6,850	6,750
23	Mushroom- Head Tappet 	17,994	17,983	17,975
				renew if scored
24	Washer to fix Camshaft, only 6 Cylinder 	7,0	6,9	6,8

Break washer in half to fit. Use both halves in one Engine.

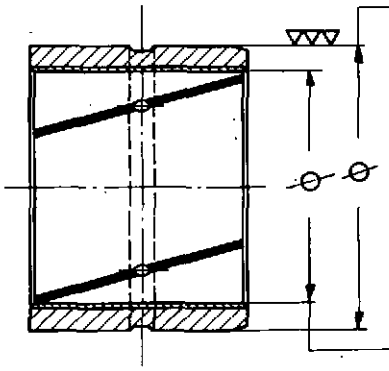
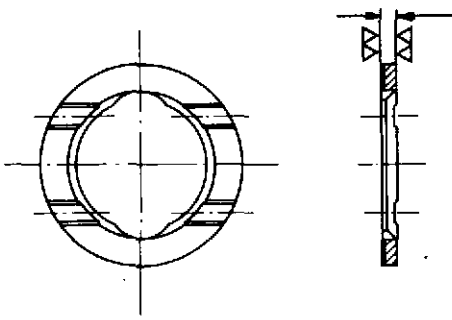
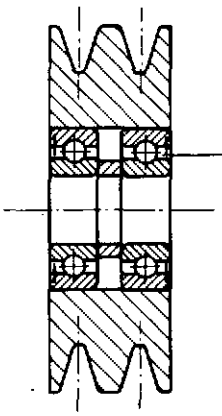
Go/no go wear part dimensions

Nr. / Item No.	Part, Designation / Figure	Measures: New max. mm	Measures: New min. mm	Measures: No go limits max. mm
25	**Spur Gear for Camshaft**  See page 56	43,025	43,000	renew if scored
26	**Spur Gear for Injection Pump Drive**  See page 56	43,025	43,000	renew if scored
27	**Spur Gear for Injection Pump**  See page 56	17,027	17,000	renew if scored

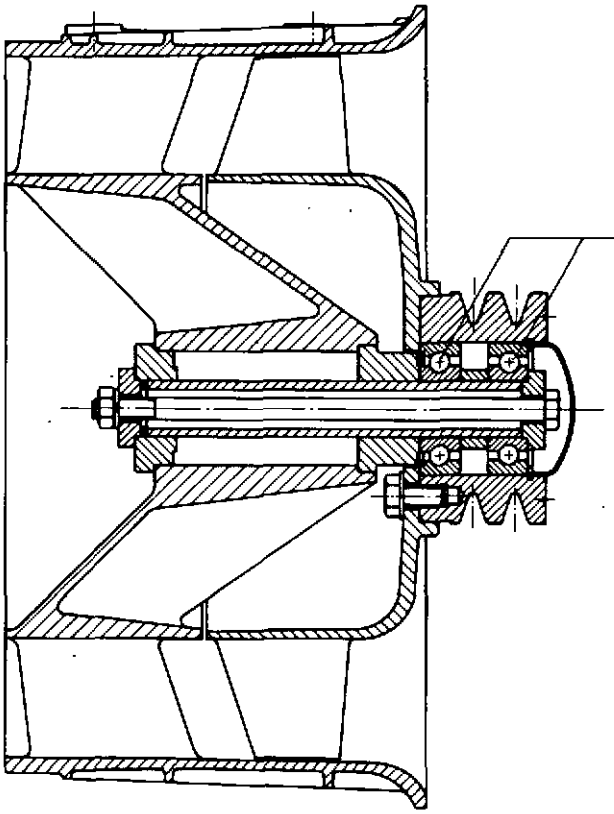
Go/no go wear part dimensions

Nr. Item No.	Part, Designation Figure	Measures New max. mm	New min. mm	No go limits max. mm
28	**Injection Timing Device**  See page 56			renew if scored renew if groove or taper damaed renew if eccentric worn
29	**Mass Balancing Shaft** 	31,975 34,065 74,9	31,950 34,049 74,8	31,940 34,040
30	**Mass Balancing Gearwheel** 	34,016	34,000	renew if scored Press fit Heat gear to approx. 220° C for shrink - fit.

Go/no go wear part dimensions

Nr. / Item No.	Part, Designation / Figure	Measures		
		New		No go limits
		max. mm	min. mm	max. mm
31	Bearing Bush for Balance Weight 	38,050	38,034	
		32,030	32,005	32,060
32	Bearing Ring for Balance Weight 	3,50	2,95	2,90
33	Pulley with Ball Bearing 			renew if tangible bearing play present.

Go/no go wear part dimensions

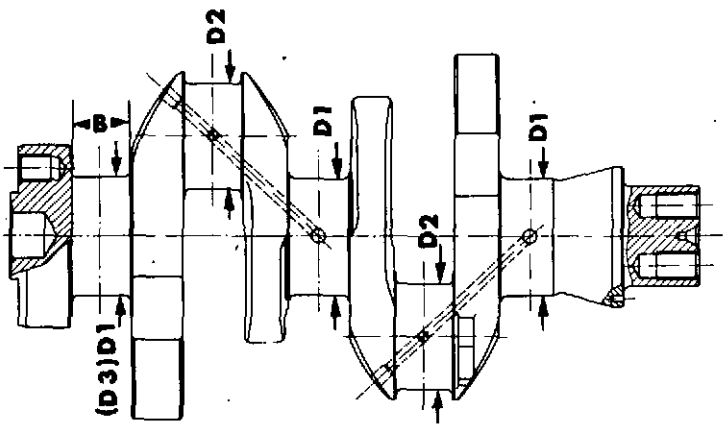
Nr. / Item No.	Part, Designation / Figure	Measures: New max. mm	Measures: New min. mm	Measures: No go limits max. mm
34	Cooling Air Blower			
				renew ball bearing if showing appreciable play

See page 57 for sealed bearing information.

5.3 Refurbishing Grades

A few engine components which have already reached the no go dimensions can be refurbished for further use.
Refurbishing must be in accordance with the following tabulated dimensions, the necessary items being listed according to the corresponding refurbishing grade.

5.3.1 Crankshaft



If crankshaft bearings show signs of irregular wear they are to be uniformly reground to the repair stage dimension at which most wear is measured.

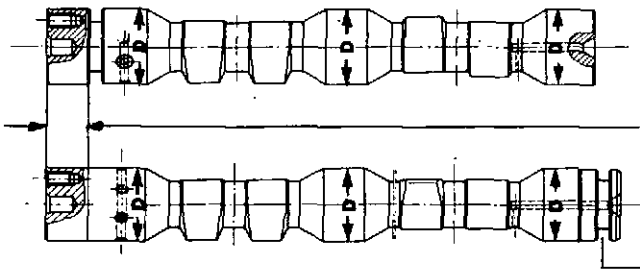
Grade	D1	corresponding Main bearing
new	69,97 - 69,951 (64,97-64,951)	6.228.0.430.001.7 (6.305.0.430.001.7)★
1	69,72 - 69,701 (64,72-64,701)	6.228.8.430.003.7 (6.305.8.430.003.7)★
2	69,47 - 69,451 (64,47-64,451)	6.228.8.430.005.7 (6.305.8.430.005.7)★
3	69,22 - 69,201 (64,22- 64,201)	6.228.8.430.007.7 (6.305.8.430.007.7)★
4	68,97 - 68,951 (63,97-63,951)	6.228.8.430.009.7 (6.305.8.430.009.7)★

Grade	D2	corresponding Big-end bearing
new	62,97 - 62,951 (57,97-57,951)	6.228.0.430.011.7 (6.327.0.430.001.7)★
1	62,72 - 62,701 (57,72-57,701)	6.228.8.430.013.7 (6.327.8.430.003.7)★
2	62,47 - 62,451 (57,47-57,451)	6.228.8.430.015.7 (6.327.8.430.005.7)★
3	62,22 - 62,201 (57,22-57,201)	6.228.8.430.017.7 (6.327.8.430.007.7)★
4	61,97 - 61,951 (56,97-56,951)	6.228.8.430.019.7 (6.327.3.430.009.7)★

Grade	B	corresponding ring halves
new	36,00 - 36,05	6.228.0.340.001.7
1	37,00 - 37,05	6.228.8.340.003.7

Grade	(D3)	corresponding fitting bearing
new	(64,97-64,951)	(6.305.0.430.400.7)★
1	(64,72-64,701)	(6.305.8.430.410.7)★
2	(64,47-64,451)	(6.305.8.430.412.7)★
3	(64,22-64,201)	(6.305.8.430.414.7)★
4	(63,97-63,951)	(6.305.8.430.416.7)★

5.3.2 Camshaft



Grade	D	see 5.3.3 for housing
new	42,96 - 42,94	
1	42,66 - 42,64	

Do not grind here because diameter is to be maintained as seating for camshaft and injection pump drive gears.

Camshaft thrust (flywheel end) for some 6-cylinder engines only.

Dimensions apply to engines with 10- digit engine Nos., e.g. 327.62.01000
★ The dimensions in brackets apply to engines with 9- digit engine Nos., e.g. 327.6.01000.

5.3.3 Camshaft Bore in Crankcase

Repair instructions

1. Remove bearing bush at timing gear end.
2. Camshaft bores at flywheel end and in partitions are to be rebored to 47 + 0.025 to accept new bearing bushes.
3. Fit new bearing bushes (note 4 mm installation dimension at flywheel end for part 2; fit part 3 flush). Make sure that bearing bushes still allow oil to pass freely through oil drillings from crankcase.
4. Finish all bearing bushes to $43^{+0.025}$ or $42.7^{+0.025}$ to match camshaft (original part or undersize stage). Parallel misalignment between camshaft bore and crankshaft axis is not to exceed 0.05 mm relative to crankcase length.
5. Carefully clean interior after finishing so that no remains are left in oil drillings.

On 2, 3, 4 and 6-cylinder engines having the camshaft located at the timing wheel end use new cover 6.305.0.787.011.4 and oval gasket 6.305.0.852.011.4 (see Fig. 1) to seal camshaft bore after applying the bushes.

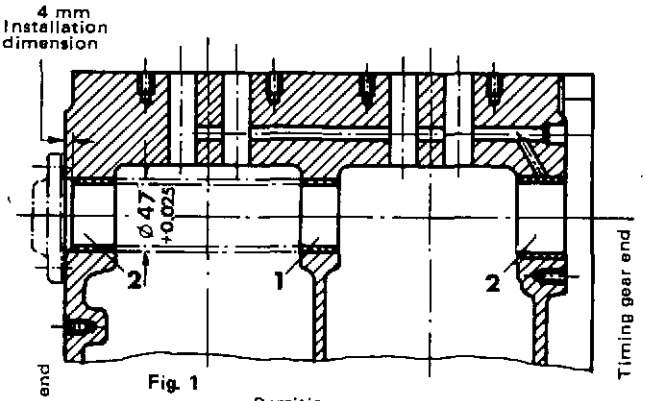


Fig. 1

On 6-cylinder engines with the camshaft located at the flywheel end the existing cover is reused, merely the O-ring (47x3) requiring replacement (see Fig. 2).

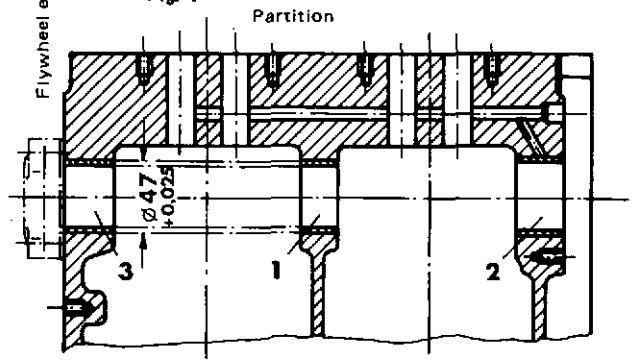
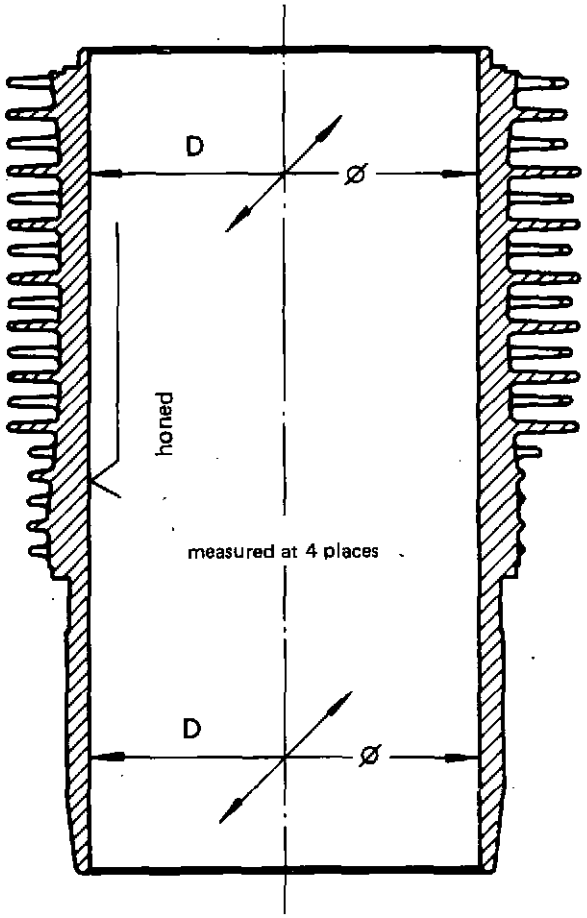


Fig. 2

Pos.	2 Cyl.	3 Cyl.	4 Cyl.	6 Cyl.	6 Cyl.	corresponding bearing bushes
1	1	2	3	5	5	6.305.8.432.003.2
2	2	2	2	2	1	6.305.8.432.002.2
3	–	–	–	–	1	6.327.8.432.001.2
	Quantity					

5.3.4 Finned Cylinder



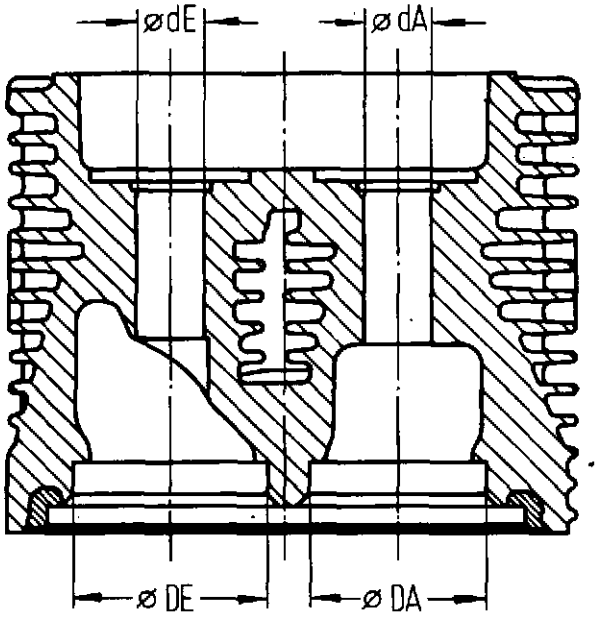
Stage	D	corresponding pistons compl.
new	100-100,022	6.327.0.160.101.7 (6.327.0.160.009.7)★
1	100,5-100,522	6.327.8.160.111.7 (6.327.8.160.091.7)★
2	101-101,022	6.327.8.160.112.7 (6.327.8.160.092.7)★

new		corresponding pistons rings
I	100/91,6x3	6.0503.35.1.0001
II	100/91,6x2	6.0503.19.0.1004
III	100/91,6x2	6.0503.65.0.1002
IV	100/91,4x4	6.0503.92.1.1001

Stage 1		
I	100,5/92,1x3	6.0503.35.1.0051
II	100,5/92,1x2	6.0503.19.0.1002
III	100,5/92,1x2	6.0503.65.0.1004
IV	100,5/91,9x4	6.0503.92.1.1002

Stage 2		
I	101/92,6x3	6.0503.35.1.0101
II	101/92,6x2	6.0503.19.0.1011
III	101/92,6x2	6.0503.65.0.1012
IV	101/92,4x4	6.0503.92.1.1011

5.3.5 Cylinder Head
Valve Seating inserts for Valve Guides



Stage	d E	d A	corresponding valve guides
new	14,995-15,005	14,985-14,995	6.305.0.332.003.4
1	15,095-15,105	15,085-15,095	6.305.8.332.031.4
2	15,195-15,205	15,185-15,195	6.305.8.332.032.4

Stage	DE	corresponding valve seating inserts Inlet
new	43,03-43,046	6.226.0.345.302.3
2	43,23-43,246	6.226.8.345.322.3

Stage	DA	corresponding valve seating inserts Exhaust
new	38,96-38,976	6.327.0.345.003.3
2	39,16-39,176	6.327.8.345.032.3

Dimensions apply to engines with 10- digit engine Nos., e.g. 327.62.01000
★ *The dimensions in brackets apply to engines with 9- digit engine Nos., e.g. 327.6.01000.*

6. Engine Assembly

6.1 General

- Replace worn parts, referring to spare parts list for order numbers (spare part numbers).
- Take care to ensure maximum cleanliness when assembling.
- Lubricate all sliding surfaces on bearings, shafts, gears, levers, as well as pistons and finned cylinders (inside) with clean engine oil.
- Assembly is carried out in the reverse sequence to that of dismantling.
- Following procedures are described in more detail in the following.

6.2 Screw and bolt tightening torques

6.3 Checking bearing play

6.4 Checking backlash

6.5 Setting timing

6.6 Adjust nozzle for piston cooling

6.7 Checking piston clearance

6.8 Fitting cylinder heads

6.9 Lead wire check

6.10 Checking compression pressure

6.11 Checking start of delivery

6.12 Renewing shaft seal.

6.2 Special Torque Specifications

The following bolted joints can only exhibit the necessary strength capability when tightened to correct torque, it therefore being mandatory, that they be tightened in accordance with the following torque requirements.

Note: For standard torque values, see page 70.

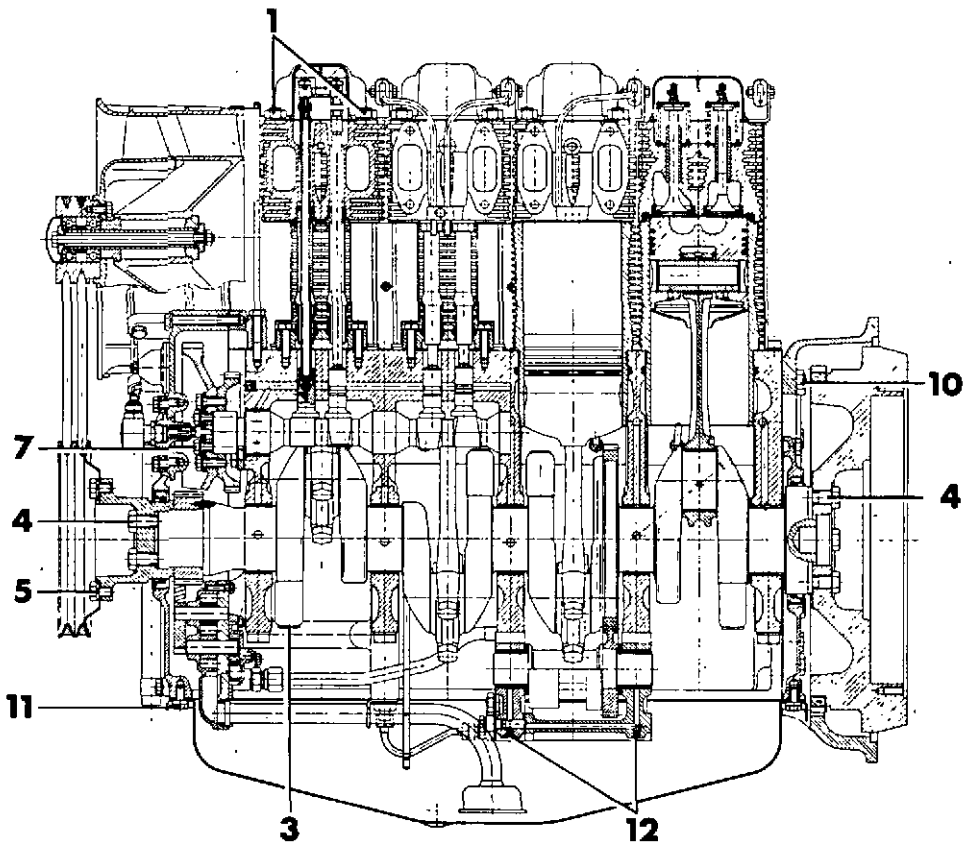
Item	Bolted joints	Thread/Material	Tightening torque Nm (lb-ft) min.	max.
1	Cylinder head nuts (see below)	M12-8.8	50 (37)	55 (40)
2	Main bearing cap bolts	M14-10.9	130 (96) 160 (118)*	140 (103) 170 (125)*
3	Counterweight bolts	(M14-10.9)	140 (104)	150 (110)
4	Flywheel fastening bolts and hub to crankshaft bolts	M16-10.9 (M12x1.5-12.9) (M12x1.5-10.9)	285 (211)* 150 (111) 120 (89)	295 (217)* 155 (114) 125 (92)
5	Hub to V-belt pulley bolts	M10-8.8	45 (34)	50 (36)
6	Hub to vibration damper bolts	M10-10.9	65 (48)	70 (51)
7	Gear to camshaft bolts, camshaft and injection pump drive gear bolts	Durlok M8-12.9 (M8-10.9)	60 (45) 30 (23)	70 (51) 35 (25)
8	Bosch injection pump shaft nuts	M12	60 (45)	70 (51)
9	Connecting rod bolts	M12x1.5-12.9 (M12x1.5-10.9)	95 (70) 75 (56)	100 (73) 80 (59)
10	Flywheel housing bolts	M12-12.9 M10-12.9 (M12-10.9) (M10-10.9)	140 (104) 80 (59) 110 (82) 60 (45)	145 (106) 85 (62) 120 (88) 65 (47)
11	Oil pan bolts	M8	20 (15)	25 (18)
12	Balance weight bolts	M10-8.8	35 (26)	40 (29)
13	Oil pump mounting bolts	Durlok M8-12.9	30 (23)	40 (29)
14	Rocker bracket bolts	M10-8.8	35 (26)	40 (29)
15	Cylinder head tie-rod studs	M12	30 (23)	40 (29)
16	Fuel delivery line nuts (counter movement using an open-ended spanner on the injection valve pressure connection)	M12x1.5 M14x1.5	20 (15) 20 (15)	25 (18) 25 (18)
17	Injector nozzle hold-down nuts	M8x1.25	10 (8)	15 (11)

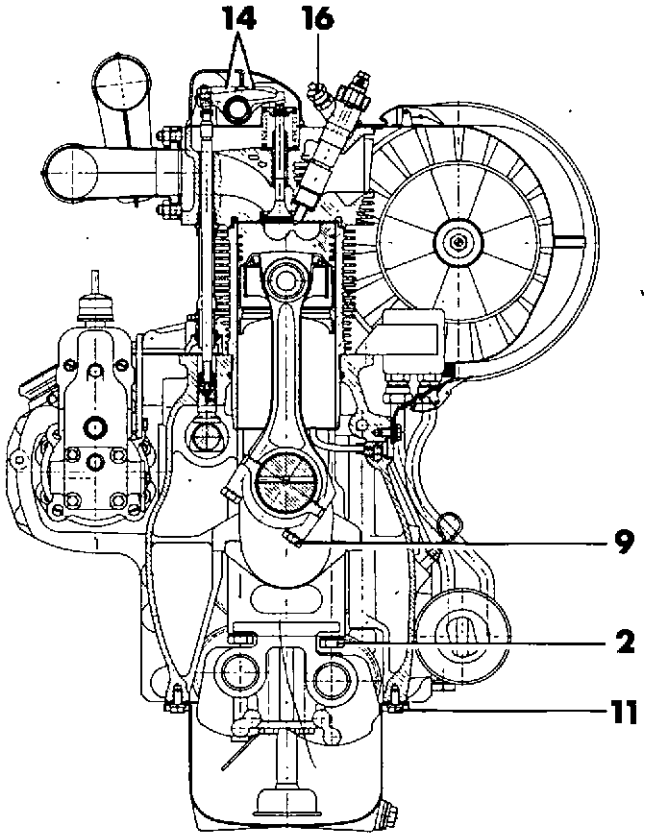
*These torque requirements apply to engines with 10-digit serial numbers. e.g: E327.62.01000 (big crank engines).

CYLINDER HEAD INSTALLATION PROCEDURES

1.) Check torque on cylinder head tie rod studs. 30-40 Nm (23-29 lb.-ft.)
2.) Make sure head gasket contact surfaces are clean on the cylinder head and finned cylinder.
3.) Install a new compression gasket.
4.) Install cylinder head and washers (4 per head).
5.) Lubricate the bottom of the hold-down nuts, nut threads and corresponding tie rod threads with Molykote type "G-n" past or it's equivalent.
6.) Install the nuts and tighten equally by hand.
7.) Using an accurate straight edge, align all of the machined surfaces of the intake and exhaust ports on the cylinder heads (multi-cylinder engines).
8.) Using a criss-cross pattern, tighten the cylinder head hold-down nuts equally in small increments to 45-50 Nm (34-36 lb.-ft.)
9.) Adjust Valve Clearance .2 mm (.0078").
10.) After a test run, approximately ½ hour, loosen all cylinder head nuts ¼ turn and retighten the nuts equally, in small increments to 50-55 Nm. (37-40 lb.-ft.)
11.) Recheck Valve Clearance.

6.2.1 Locations of Screws and Bolts





6.3 Checking Bearing Play (using dial and feeler gauges) Clearance mm (inches)

Bearing play	Radial min.	Radial max.	Axial min.	Axial max.
Main bearings	.08 (.0031)	.11 (.0043)		
Ring halves (big-crank only)			.04 (.0016)	.25 (.0098)
Thrust bearings (rear small crank)	.09 (.0035)	.12 (.0047)	.12 (.0047)	.21 (.0083)
Connecting rod bearings	.07 (.0027)	.10 (.0039)	.30 (.0118)	.50 (.0197)
Piston pin bushing	.03 (.0012)	.08 (.0031)		
Camshaft bearings	.04 (.0016)	.08 (.0031)	.10 (.0039)	.29 (.0114)
Mass balancing bearings (4 cyl.)	*.03 (.0012)*	*.07 (.0027)*	*.20 (.0079)*	*.40 (.0157)*

Fig. 1

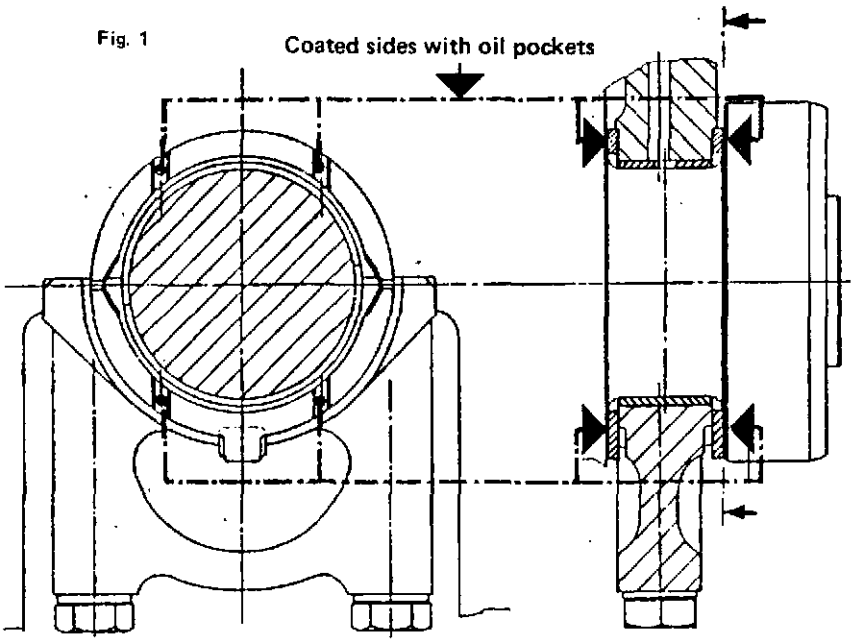


Fig. 1

1) Ring halves are to be fitted in such a way that coated sides with oil pockets always point in direction of crank web or crankshaft flange.

6.4 Checking Adjusting Backlash

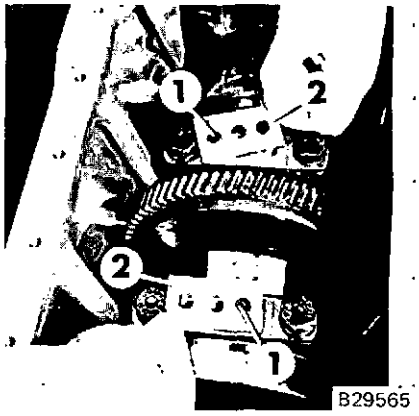
Fig. 2

Fig. 2 Using feeler gauge, adjust backlash at oil pump gear. To do so, release fixing bolts and tighten after setting correct backlash.

Gear pairs		Backlash mm	(inches)
Oil pump/crankshaft			
Working position		0.2	(.008)
Engine on its head		0.3	(.012)
Camshaft/crankshaft	1)	0.12-0.28	(.005-.011)
Camshaft/injection pump	1)	0.12-0.28	(.005-.011)
Camshaft/hydraulic pump		0,11-0,27	(.004-.010)
Balance weight/crankshaft gear			
Working position		0.2	(.008)
Engine on its head		0.3	(.012)

1) Reference size only, not adjustable

6.4.1 Adjusting Backlash at Balance Weight



Sequence:

1. Screw 2 M10x110 studs into tapping 1 diagonally so that the spacers do not shift.
2. Apply 3 0.1 mm thick spacers 2 at both ends.
3. Apply the balance weight in the gear markings.
4. Tighten with 2 hexagon bolts.
5. Establish backlash. Removing the spacers will reduce the backlash and vice versa.
   When the backlash is as required, remove the studs.

Assembly instruction:
Tighten all bolts to torque requirements of section 6.2

6.5 Adjust gears

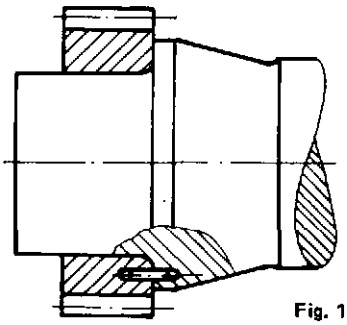


Fig. 1

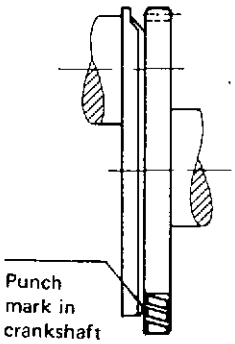


Fig. 2

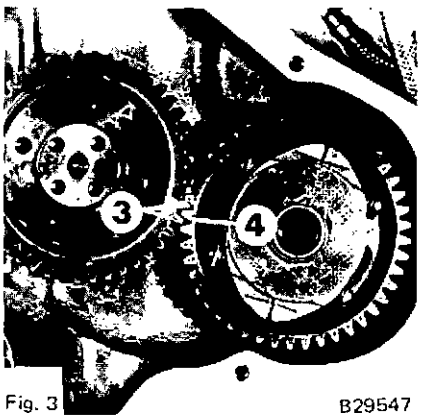


Fig. 3

Engine can only run properly when the gears are set correctly.

The gears are in proper location when they are fitted to the corresponding shaft in the required location with the markings on the gears agreeing.

Please observe the following on gear assembly:

1. The crankshaft gear is pinned axially to the crankshaft flange (Fig. 1) which must be observed on assembly.
2. The gear for driving the balance weight on the crankshaft is identified 0-0 on two teeth. The gap between the two markings must line up with the punch mark on the periphery of the crankshaft (Fig. 2).
3. The spur gear for driving the injection pump on the camshaft is flanged behind the camshaft gear (Fig. 3).
4. The camshaft gear has a circle of holes of unequal spacing for flanging to the camshaft, thus ensuring proper flange connection.

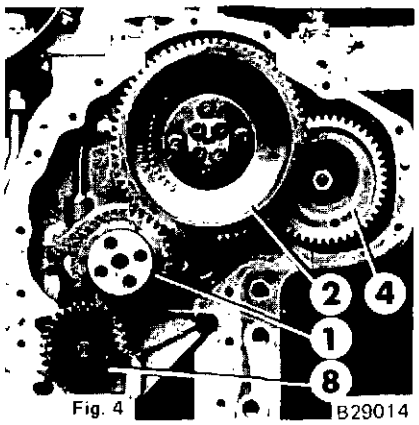


Fig. 4 B29014

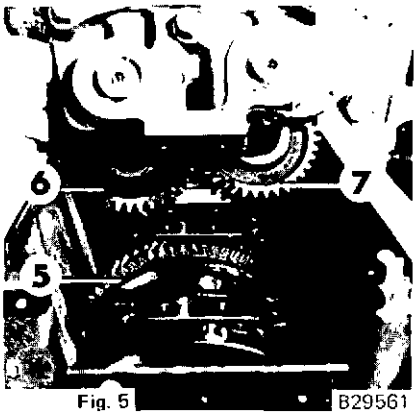


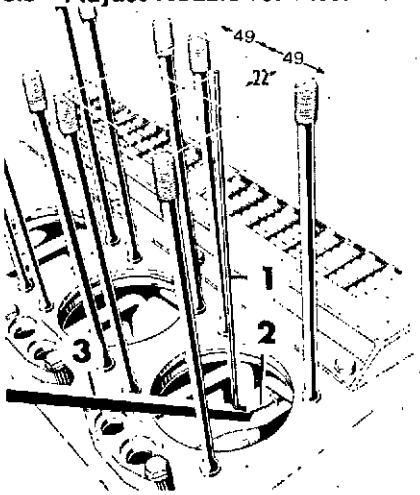
Fig. 5 B29561

5. The following tooth markings must agree:
   - Zero marking of the injection timing device 4 or of the injection pump gear with the 0-0 mark on the drive gear 3 on the camshaft (Fig.3)
   - Zero marking on the crankshaft gear 1 with the 0-0 mark on the camshaft gear 2 (Fig.4)
   - 0-0 marking on the balance weight drive gear 5 on the crankshaft with the zero mark on the compensating shaft gear 6 (Fig. 5)
   - 1-1 marking on the compensating shaft gear 6 with the 1 mark on the compensating shaft gear 7 (Fig. 5)

   The oil pump gear 8 can be in any position (Fig. 4).

See page 56 for more gear timing information.

6.6 Adjust Nozzle for Piston cooling



Sequence:

1. Insert 2 mm dia. steel wire 1 into opening of nozzle tube 2.
2. Check dimensions at top edge of tiebolts as shown in adjacent drawing.
3. Correct with straightening tube 3 or pliers if deviation is excessive.

6.7 Checking Piston Clearance

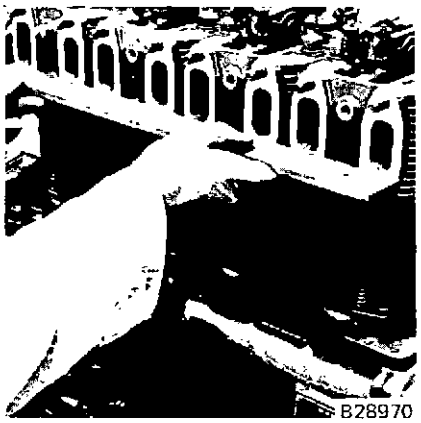

B28996

The piston clearance is the space between the flat surface of the finned cylinder and the top piston surface. This clearance must be established with the dial gauge to be:

min. 4.57 mm (.180")
max. 4.67 mm (.184")

At spacing under finned cylinder if piston clearance is too small, and vice versa. This will require lifting the finned cylinder.
(See section 4.12).

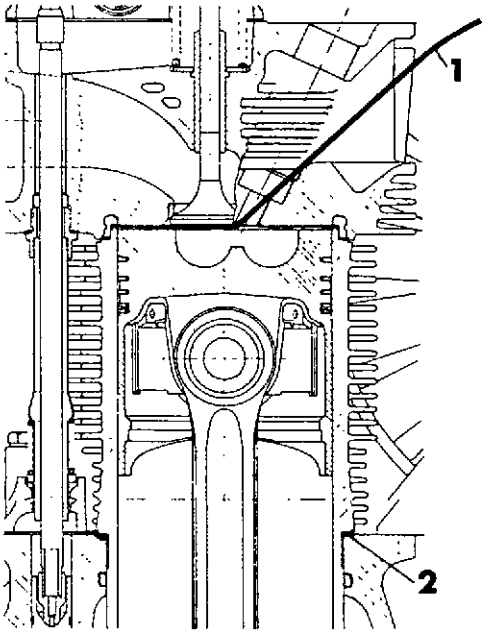
6.8 Fitting Cylinder Heads



Sequence:

1. Place new cylinder head gasket on finned cylinder.
2. Fit compression spring, compression ring and O-ring on protective pipe (see section 4.10.1).
3. Locate cylinder heads and lightly tighten the nuts.
4. Orient the cylinder heads in agreement with the surface of the intake and exhaust ducts.
5. Tighten all cylinder head nuts to torque requirements of 6.2. Also see page 57.

6.9 Lead Wire Check

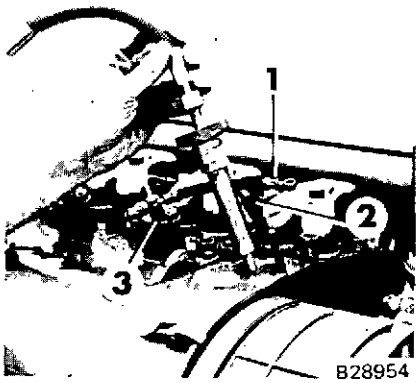


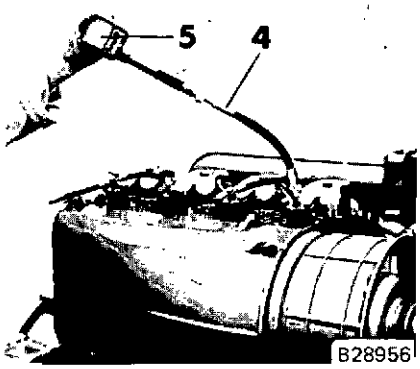
Check the compression clearance with the cylinder head fitted as follows:

1. Remove injection valve (Fig. 4.4).
2. Remove cooling air housing (section 4.2).
3. Set piston to more or less TDC.
4. Insert 2 mm dia. lead wire 1 into the cylinder head opening (not under the valve disk).
5. Slowly crank the engine (by hand) until the piston passes top dead center.
6. Remove the lead wire and check the thickness of the flattened portion.
7. Thick thickness must be
   min. 0.9 mm (.036")
   max. 1.1 mm (.043")
8. If the max. requirement is exceeded at spacer 2 under the finned cylinder. If the min. requirement is not attained remove the spacers, this necessitating removal of the cylinder head and lifting the finned cylinder.
   (See sections 4.10 and 4.12).

6.10 Check compression pressure

Compression is checked by means of the compression tester (see special tools 1.7) to establish whether adequate compression pressure is available. The tester is connected to the opening for the injection valve in the cylinder head as shown in the adjacent Figs.





Sequence:

1. Remove leakage oil line 1.
2. Remove fuel delivery line 2 at injection valve.
3. Remove mounting bracket 3.
4. Remove injection valve.
5. Apply compression tester 4.
6. Insert chart 5.
7. Press injection pump to stop.
8. Crank engine cold with starter (3 to 5 turns).
9. Compression pressure must be at least 25 to 27 bar (kp/cm^2).
10. Causes of inadequate compression pressure:
    - Valves leaky
    - Piston leaky
    - Finned cylinder heavily scored
    - Lead wire dimension excessive
11. Remedy causes as applicable.

6.11 Check Start of Delivery

Correct start of delivery is important for smokeless, optimum combustion, i.e. proper temperature loading and output of the engine.

1. Set engine to ignition TDC on the cylinder at the timing gear end (intake and exhaust valve closed).
2. Remove rocker arm bracket (section 4.7).
3. Remove valve spring on inlet valve, so that the valve cone stands on the piston. Safeguard valve against dropping in (e.g. rubber ring 3).
4. Apply depth gauge 1 or dial gauge to inlet valve stem 2 at top (Fig. 1).

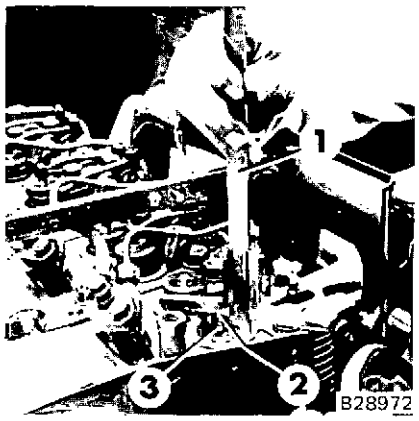


Fig. 1

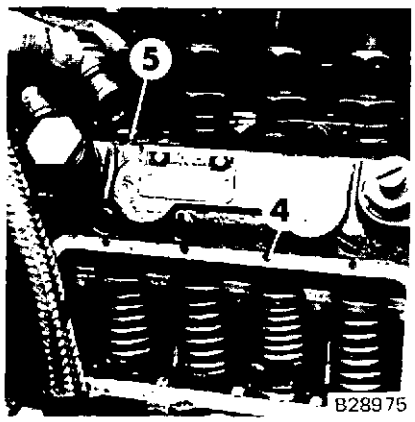


Fig 2

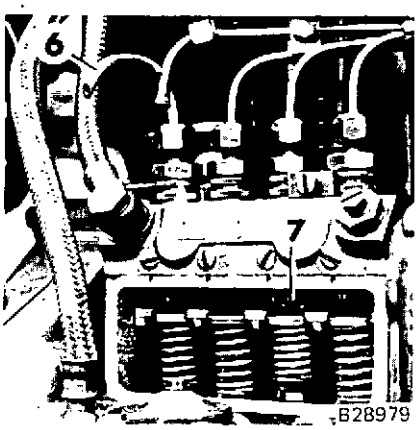


Fig 3

5. Turn crankshaft in both directions until the depth gauge or dial gauge indicate a maximum value. In this position the piston is exactly at top dead center. Note indication (dimension A).
6. Slowly turn the crankshaft against the operating sense of rotation until the inlet valve has not been lowered by more than approx. 15 mm.
7. Remove cover 4 from injection pump, delivery valve 5 (Fig. 2) and apply testing tube 6 (Fig. 3).
8. Set control lag 7 to center position, ensuring that the injection timing device is closed (section 6.5, Fig. 3).
9. Operate the priming lever on the pump until bubble-free fuel emerges from the testing tube.
10. Slowly crank the engine in the operating sense of rotation until fuel emerges from the testing tube in drops (4 ... 5 seconds between each drop).
11. Establish and note dimension B using depth gauge or dial gauge.
12. The difference between dimension A and dimension B corresponds to the piston travel ahead of top dead center. Setting values are shown in the table of section 6.11.1.
13. Minor deviations from the required piston travel (up to approx. 1.5 mm) can be corrected by tilting the injection pump, i.e.
    - Crank engine back and then in the operating sense of direction until the piston travel dimension is attained.

At time of this printing, new pump timing procedures were being drawn up. The procedures will be published in service bulletin number D435. Please contact the factory for a copy.

- Loosen the nuts on the injection pump flange.
- Tilt the injection pump (slots in flange) and prime pump until 4 to 5 drops per second emerge from the testing tube. (To tilt the injection pump, loosen the fuel delivery lines).
- Retighten the nuts.
- Repeat item 6 to 12 operations.

14. If it is not possible to adjust start of delivery by tilting the injection pump, remove front wall cover and loosen the front drive gear on the camshaft, turn according (slots) and tighten. Then carry out adjustment in accordance with description under section 13.

15. When start of delivery has been correctly adjusted, remove testing tube, fit delivery valve, connect all lines and fit front wall cover as necessary. Tighten bolts and nuts on the following:
    - drive gear
    - injection pump flange
    - delivery lines
    - front wall cover
    - V-belt pulley

    Observe torque requirements as per 6.2.

16. Fit valve spring and rocker arm bracket.

6.11.1 Port-closing adjustment table

Port-closing adjustment with Bosch in-line pump for all engines except hand starting:

		with injection timing device		without injection timing device		
Number of cylinders ↓	Working speed min^{-1} →	2401 - 2800	variable up to 3000	1500 - 1800	1801 - 2400	constant 3000
2	1)	6,36 - 6,90	6,90 - 7,46	8,64 - 9,26	9,90 - 10,55	8,64 - 9,26
	2)	(24° ± 30')	(25° ± 30')	(28° ± 30')	(30° ± 30')	(28° ± 30')
3	1)	8,64 - 9,26	6,90 - 7,46	8,64 - 9,26	9,90 - 10,55	8,64 - 9,26
	2)	(28° ± 30')	(25° ± 30')	(28° ± 30')	(30° ± 30')	(28° ± 30')
4 and 6	1)	8,64 - 9,26	6,90 - 7,46	8,64 - 9,26	9,90 - 10,55	8,64 - 9,26
	2)	(28° ± 30')	(25° ± 30')	(28° ± 30')	(30° ± 30')	(28° ± 30')

Hand starting engines:

		with injection timing device			without injection timing device
Number of cylinders ↓	Working speed min^{-1} →	1801 - 2400	2401 - 2800	variable up to 3000	1500 - 1800
2 and 3	1)	7,18 - 7,75	7,18 - 7,75	7,18 - 7,75	7,18 - 7,75
	2)	(25°30' ± 30')	(25°30' ± 30')	(25°30' ± 30')	(25°30' ± 30')

1) Piston stroke in mm from TDC
2) *Degree values-crank angle*

CAUTION!
For engines with acceptance conditions, please refer to the production test document.

For port-closing adjustment, place the control rod on central position.

PUMP TIMING

The following information will be helpful when timing the fuel injection pumps on the 'D' Series Engines.

NOTE: The following positions are viewed from the **front** of the engine.

NOTE: All timing is in reference to crankshaft degrees.

1. PUMP MOUNTING SLOTS: These slots will allow approximately 7° total adjustment in pump timing. Moving the top of the pump towards the engine will **advance** the timing, while moving it away will **retard** it.

2. CAM GEAR SLOTS: These slots will allow approximately 26° total adjustment in pump timing. Remember, after loosening the pump drive gear to cam gear attaching bolts, moving the bolts in a counter-clockwise direction in the cam gear slots will **advance** the timing while moving them clockwise will **retard** the timing.

3. PUMP **DRIVEN** GEAR TEETH: Each tooth change from the standard timing mark will alter injection timing by 16°. Rotating the pump driven gear clockwise from the standard timing mark will **advance** the timing, while rotating the gear counter-clockwise will **retard** the timing.

4. SHUT-DOWN LEVER ON PUMP: This lever will retard injection timing 9° when placed in the "Run" position during engine start-up. When using the drip tube method for adjusting pump timing, this lever must be placed in the **midrange** position. If left in the **max** "Run" position during adjustment, timing will be 9° advanced. If placed in the "stop" position, timing cannot be accomplished.

5. INJECTION TIMING DEVICE: Is used on variable speed application to **advance** injection timing 8° over a speed range of 3000 R.P.M. When servicing this device, it is important that it is assembled according to figure 1. It is possible to install the eccentric discs opposite of what figure 1 illustrates, which will **retard** injection timing 11° (static) and retard an additional 8° as the engine speed is increased to 3000 R.P.M. NEVER INSTALL THEM IMPROPERLY.

Injection Timing Device

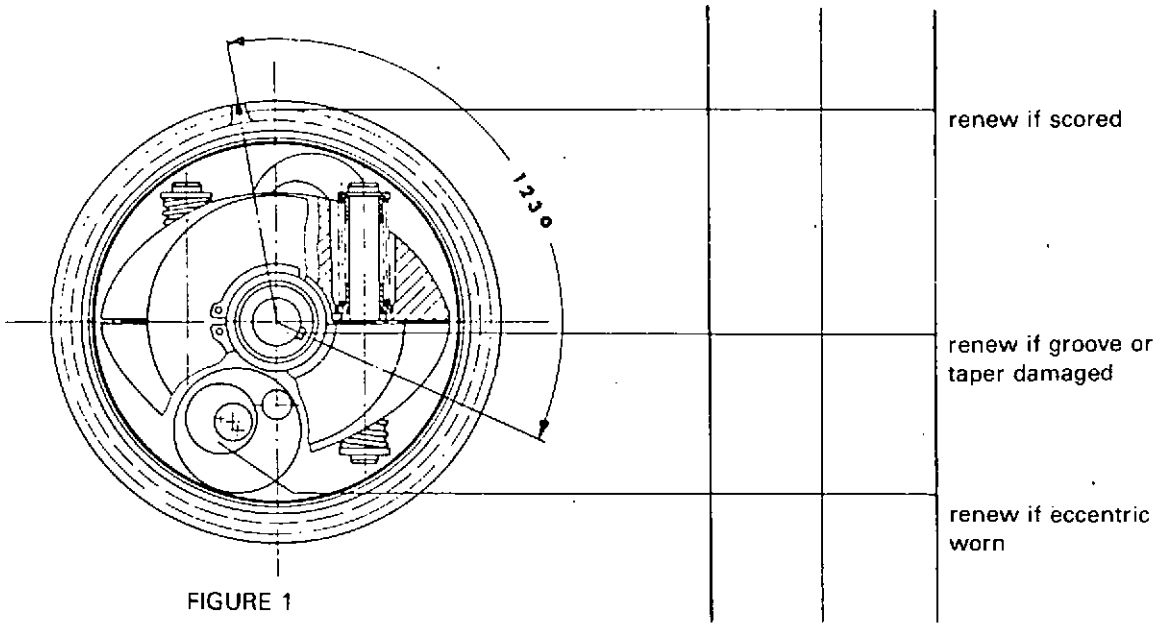


FIGURE 1

ROBERT BOSCH FUEL INJECTION PUMPS, D327 ENGINES

D327 engines come equipped with the following Robert Bosch Fuel Injection Pump with Governors.

MWM-MURPHY PART NUMBERS	ROBERT BOSCH PART NUMBERS
2 cylinder 6.0520.05.2.8008	0 400 462 047
3 cylinder 6.0520.05.3.8009	0 400 463 115
4 cylinder 6.0520.05.4.8019	0 400 464 105
6 cylinder 6.0520.05.6.8015	0 400 466 080

Injection pumps are non-engine lubricated and have non-ducted barrel and plungers. It is recommended in our operation manuals that the oil be changed in the injection pump housing every 750 hours and oil level be checked at the oil level plug every 125 hours. It is normal with non-ducted barrel and plungers to have a small percentage of fuel leak past the barrel and plungers, thus raising the oil level in the injection pump housing. Since the percentage of leakage is directly related to the amount of fuel the injector plungers inject, this leakage in the injection pump housing will be higher on engines that run continous loads such as marine and pump applications. We recommend on each new engine you deliver to have the customer check the oil level at the injection pump level plug periodically, in some cases the oil level check interval may have to be lower than 125 hours. As long as fuel is drained off at the oil level check plug, no damage will occur to the injection pump or governor between the 750 hour oil change interval.

When you have Robert Bosch injection pumps reconditioned or if the oil level checking (somewhere below 125 hours) is too much of a problem for the customer, we recommend that the injection pumps be converted over to ducted barrel and plungers. (This will only reduce the leak by fuel, not eliminate the service intervals). They are available under MWM-Murphy part number 6.0690.560.0284. (Robert Bosch part number 1 418 425 099).

PROCEDURES FOR CHANGING ENGINE RPM

NOTE: Before changing engine r.p.m., check engine spec. to ensure no damage to engine will result. (e.g., air cleaners and vibration dampers.)

NOTE: The governor part number is stamped on a tag which is located on the back of the governor. This number must be known before attempting adjustments.

The two (2) governors that will be found are:

EP/RSV 325 . . . 1500 A2B 505 DR. This governor will achieve a minimum of 650 engine r.p.m. to a maximum of 3000 engine r.p.m. with an average speed droop (speed regulation) of 5 to 7%.

EP/RSV 300 . . . 1000 A7B 505 DR. This governor will achieve a minimum of 600 engine r.p.m. to a maximum of 2000 engine r.p.m. with an average speed droop of 2 to 3%.

The following procedures are used to change the maximum speed of the engine. In some cases, a change in the maximum operating speed may result in a change in speed droop, governor instability, power or smoke. This will require additional adjustments which may not prove successful without the aid of a pump test bench. In this event it is recommended that the pump be taken to an authorized Robert Bosch service center along with the specifications from page 48.

1. To increase maximum engine speed, back out external throttle lever stop screw. This will increase the throttle lever angle which in turn will decrease droop. If a surge developes or maximum r.p.m. cannot be reached, an additional adjustment will be required on the main spring adjusting screw. See step #3.

2. To decrease maximum engine speed, turn in external throttle lever stop screw. This will decrease the throttle lever angle which in turn will increase droop. If the droop is excessive, an additional adjustment will be required on the main spring adjusting screw. See step #3.

3. Main Spring Adjustment
   A. Remove oil filler plug located on top of the governor. Some governors will have a breather and adapter at this location.
   B. Back out the idle stop screw and bumper spring located on the back of the governor. Figure 1.
   C. Ensure the throttle lever in the shutoff position. This will gain access to the main spring adjusting screw (See figure 1).
   D. Turn the main spring adjusting screw clockwise until it bottoms. (This screw has a square shank in conjunction with a spring clip. 1/4 turn will therefore yield a "click").
   E. On **A2B governors**, back out the main spring adjusting screw 2 turns (or 8 clicks).

      On **A7B governors**, back out the main spring adjusting screw according to the chart.

Engine RPM	Droop	# Turns On M.S.A. Screw
1000-1200	1.5-2.5%	2 (8 clicks)
1200-1600	1.5-3%	3 (12 clicks)
1600-2000	1.5-3%	4 (16 clicks)

   F. Start engine and adjust idle stop to approximately 50 r.p.m. below idle speed.
   G. Adjust Bumper Spring to idle speed.
   H. With engine running, position throttle lever to desired speed.
      CAUTION: Take notice not to overspeed the engine.

      Turn in external throttle lever stop screw until it contacts the throttle lever and lock it with the jam nut.

4. With new maximum speed-setting, check pump timing specs and adjust if necessary.

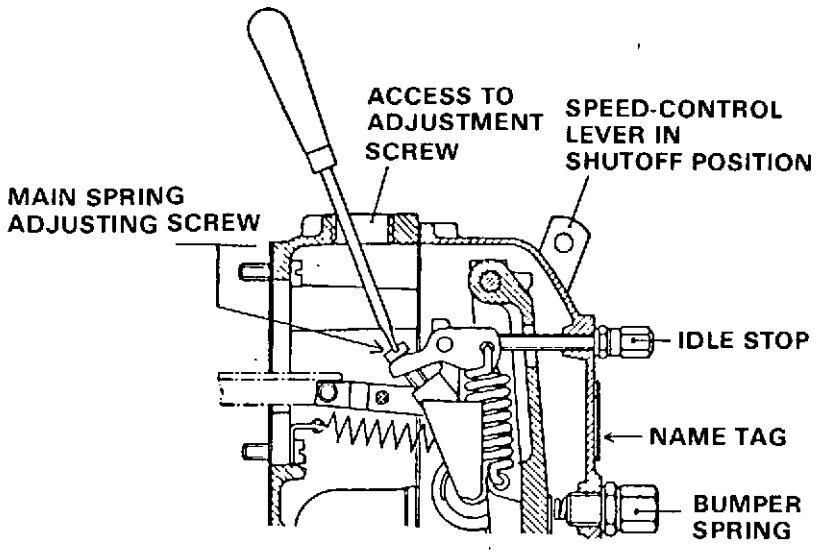


Figure 1.

INTERCHANGABILITY

The two governor assemblies are completely interchangeable on the same pump. When converting an A2B governor to an A7B governor, refer to the parts list below. The pump and governor assembly must be taken to an authorized Robert Bosch service center when replacement of the governor assembly or any of its internal parts is needed. Failure to do this can result in serious engine damage.

Governor	Description	Robert Bosch Part Number
A2B	Flyweight Assy.	1 428 194 003
A2B	Governor Spring	1 424 650 005
A7B	Flyweight Assy.	1 428 194 000
A7B	Governor Spring	1 424 650 007

FUEL STOP SETTINGS — ROBERT BOSCH INJECTION PUMPS D327 ENGINES

Over fueling can result in damage to the engine. The Distributor, Service Dealer or engine rebuilder has to make sure whenever an injection pump with governor is sent over to a Robert Bosch Service Station for repairs, that they calibrate and seal the fuel stop to the correct cubic millimeters (MM^3). If the seal is broken on the governor cover over the *fuelstop, warranty will not cover engine damage due to over fueling.*

Engine RPM	Pump RPM	D327-2 MM^3	D327-3 MM^3	D327-4 MM^3	D327-6 MM^3
2500	1250	43	50.5	47	51.5
2300	1150	50.5	49.5	47	52.5
2000	1000	49	48.5	46.5	48
1800	900	49	47.5	45.5	48
1500	750	47	46	45.5	48

The standard setting for breakaway is 10%.

Currently D225, D327 and D916 engines use the same Robert Bosch injection pump with governor. If your spare stock injection pump was calibrated and sealed to lets say a D225-6 engine and you now want to install it on a D327-6 engine, the injection pump with governor must be sent over to a Robert Bosch Service Station to be reset and sealed to the correct cubic millimeters (MM^3) above. New injection pumps with governors come unsealed unless you specify for which engine and RPM.

6.12 Renewing Shaft Seals (Crankshaft)

The sealing rings in the crankshaft seals need lubricating to make them last. Although slight, a certain amount of oil leakage always results from this lubrication but as long as there are only a few drops, there is no need for repair.

Heavy oil leakage at the crankshaft seals may be a sign of excessive pressure in the crankcase.

Therefoce clean engine breather first.

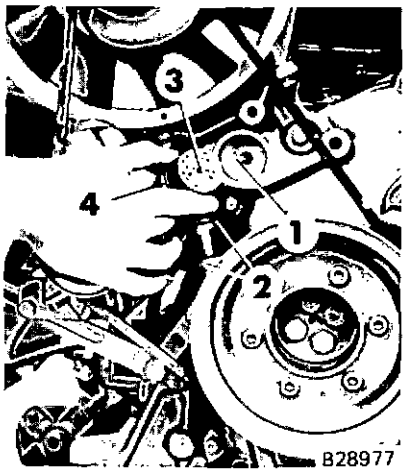


Fig. 1

Sequence:

1. Unscrew hexagon nut 1.
2. Release clip 2.
3. Remove breather housing 3.
4. Note O-ring 4.
5. Rinse breather housing in diesel fuel.
6. Attach breather housing, fitting new O-seal 4 if necessary.
7. Tighten clip 2.
8. Tighten hexagon nut 1.

6.12.1 General

The shaft seals will need renewing (see 6.12.2), if lubricating oil still continues to leak through the crankshaft seals (inside pressure not excessive).

IMPORTANT: Replacement shaft seals must bear the stamped marking

B A F.

The sealing lips of these silicone rings are of very low impact resistance and must therefore be fitted with extreme care and caution.

Another source of leakage is constituted by damaged shaft seal seating in the end covers.

The end covers themselves will need replacing under these circumstances (with fitted sealing rings).

Necessary tools and fixtures

- Installation plate for normal installation (see 1.9).
- Installation plate for offset installation (see 1.10).
- Installer (see 1.12).
- Drift press
- Torque wrench
- Emery cloth, very fine.

6.12.2 Renewing Seal in Front Wall Cover (flywheel end)

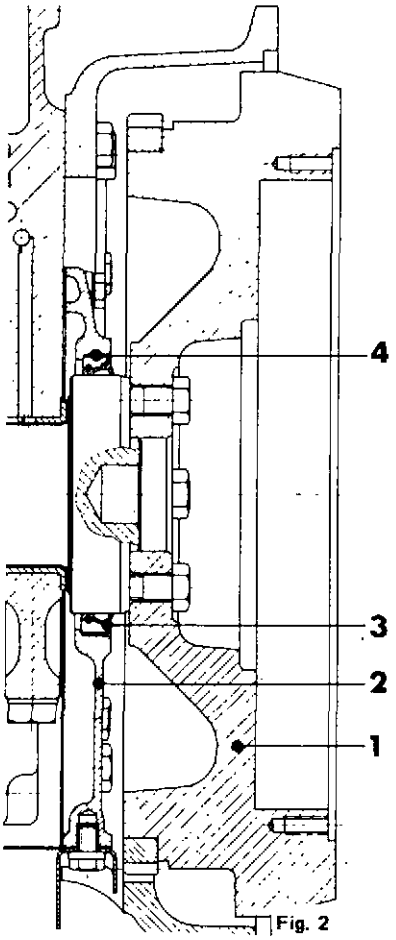


Fig. 2

Fig. 2

1 Flywheel
2 Front wall cover
3 Shaft seal
4 Seat in cover

Removal

- Unscrew flywheel (Fig. 2/1).
- Unscrew front wall cover with sealing ring (Fig. 2/2).
- Press shaft seal out (Fig. 2/3), making sure not to damage seal seat in cover (Fig. 2/4).

Checking

Examining crankshaft flange for wear :

Test result A	Action
No appreciable wear (finger-nail check) less than 1 mm wide	Clean running surface of crankshaft flange and polish with very fine emery cloth to remove rifling.
Test result B	
appreciable wear (finger-nail check) above 1 mm wide	Clean running surface of crankshaft flange and polish with very fine emery cloth to remove rifling. Fit shaft seal offset from previous position.

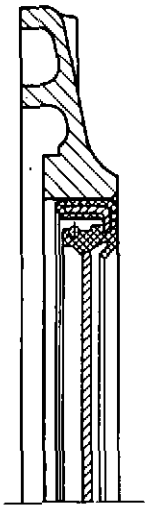


Fig. 3

Normal installation

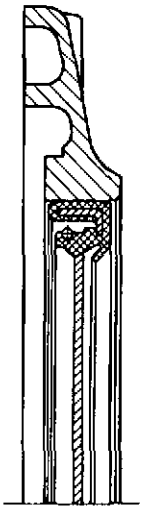


Fig. 4

Offset installation

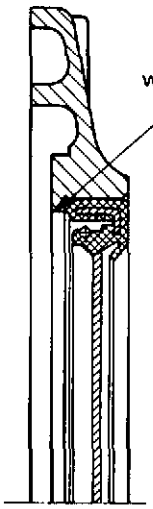


Fig. 5

Normal installation

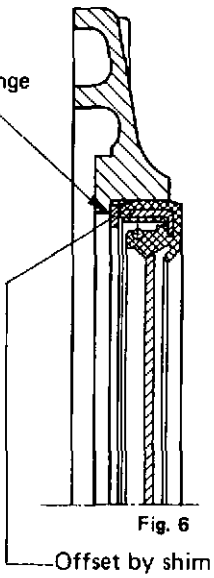


Fig. 6

Installation of new seal in front wall cover (flywheel end)

- Before beginning, apply thin film of grease to outside of seal and to sealing lip.

Action for test result A

Front wall cover with inner flange or without

- Using installation plate 6.206.0.690.005.4 with drift press, force seal fully home (Fig. 3 and 5).

Action for test result B

Front wall cover with inner flange

- Introduce shim 6.000.0.340.004.4, pressing seal fully home against shim with installation plate 6.206.0.690.008.4 (Fig. 6).

Front wall cover without inner flange

- Using installation plate 6.206.0.690.008.4 with drift press, install seal offset by 2 mm inwards so that contact surface of sealing lip is axially displaced (Fig. 4).

Apply thin film of grease to crankshaft flange around entire circumference.

Front wall cover

- Fit with extreme caution.
- **IMPORTANT**: Be sure not to damage sensitive sealing lip,
- Bolt front wall cover on.
- Attach flywheel, noting correct tightening torques (see 6.2).

6.12.3 *Renewing Seal in Front Wall Cover (timing gear end)*

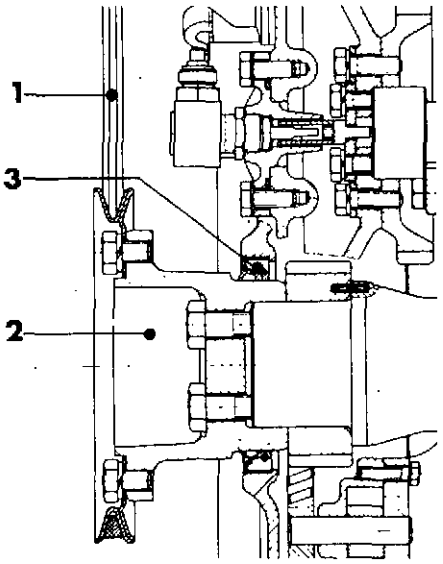


Fig. 7

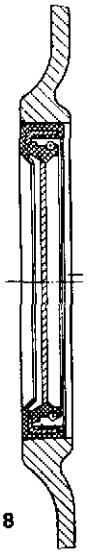


Fig. 8
without inner flange

Fig. 9
with inner flange

Removal

- Release and remove V-belt (Fig. 7/1).
- Unscrew hub together with pulley or vibration damper (Fig. 7/2).
- Force shaft seal (Fig. 7/3) out of front wall cover using screwdriver or lever.
- **IMPORTANT:** Be sure not to damage seat in front wall cover.

Checking hub for wear:

Test result A	**Action**
No appreciable wear (finger-nail check) less than 1 mm wide	Clean hub running surfaces and polish with very fine emery cloth to remove rifling.
Test result B	**Action**
Appreciable wear (finger-nail check) above 1 mm wide	Install new hub.

Installation of new seal

- Before beginning, apply thin film of grease to outside of seal and to sealing lip.
- Use installer (see 1.12) to fit the shaft seal.

Action for test result A

Front wall cover with or without inner flange:

- Press seal fully in or flush with outside, as the case may be (Fig. 8 or 9).

Action for test result B

Always fit new hub (Fig. 7, item 2).
Front wall cover with or without inner flange:

- Press seal fully in or flush with outside, as the case may be (Fig. 8 or 9).

Apply thin film of grease to hub around entire circumference. Fit hub with extreme caution.

IMPORTANT: Be sure not to damage sensitive sealing lip.

Bolt hub on, noting correct tightening torques (see 6.2).

7. Engine Data, Test Data

7.1 General Engine Data

Engine data		D 327-2	D 327-3	D 327-4	D 327-6
Technical data					
Number of cylinders		2	3	4	6
System		4-stroke			
Combustion method		direct injection			
Bore/stroke	mm	100/120			
Cylinder capacity	cm^3	1884	2826	3768	5652
Compression ratio		1 : 18			
Sense of rotation		counter-clockwise viewed at flywheel end			
Firing sequence		1-2	1-3-2	1-3-4-2	1-5-3-6-2-4
Performance data (full load)					
Operating speed, max.	min^{-1}	3000			
Idle speed, min.	min^{-1}	650			
Continuous output B at n = 3000	kW (HP)	23.5(32)	35.3(48)	47(64)	70.6(96)
Ignition pressure, max.	bar	85			
Injection pressure	bar	180			
Compression pressure (established with engine cold)	bar	30(new)	25(lower limit)		
Valve clearance (established with engine cold)	mm	0.2			
Fuel consumption	approx. Liter/h	7.8	11	15	22
Lube oil consumption	approx.g/h	40 ... 50	65 ... 75	90 ... 100	140 ... 150
Cooling air requirement, max.	m^3/h	2000	2200	3600	4100
Engine inclination in operation		see table, operating instruction D 327			
Operating temperatures					
Lube oil, max.	deg.	115°C			
Exhaust manifold temperature, max.	deg.	600°C			
Temperature difference of individual cylinders, max.	deg.	30°C			
Capacity (lube oil)		see table, operating instruction D 327			
Weights					
Engine (dry) without flywheel and flywheel housing	kg/approx.	150	190	235	335
Flywheels of 28 to 86 kg					
Housing flange of 18 to 31 kg					

7.2 Valve Timing

		opens	closes
Valve timing with gears correctly set is as follows: (measured in deg.(°) crank angle at 1 mm valve clearance)	Intake	0° ahead of TDC	30° after BDC
	Exhaust	30° ahead of BDC	0° after TDC

permissible tolerance ± 3°

Then reset valve clearance to 0.2 mm

7.3 Valve Leakage

When closed, intake and exhaust valves must only pass little or no fuel enter into the intake or exhaust duct (in the cylinder head).
Max. permissible flow 2 to 3 drops per minute.
Regrind leaky valves, observing the requirements of sections 5.2.13-15 and 5.3.5.

See "Operating Conditions" for additional information.

"D" SERIES LUBE AND FUEL OIL FILTERS

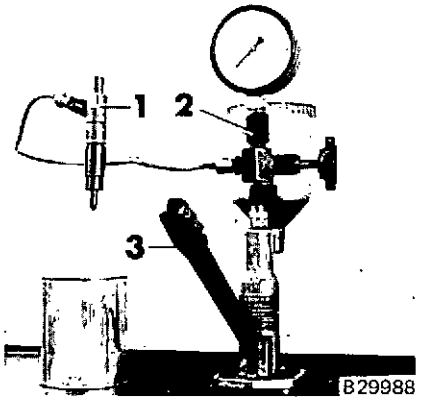
WARNING: Due to the high lubricating oil flow rates and pressures of Murphy "D" Series Engines, specially engineered filters with high pressure relief valves, check valves, and flow capability are required for safe operation and ultimate durability.

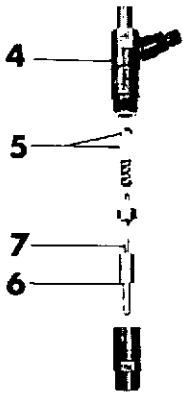
Genuine Murphy replacement filters and spare parts are required in all Murphy Diesel Engines to insure continued long life and maintain "In Warrantee" coverage.

MWM-MURPHY LUBE OIL FILTER PART #438-14
MWM-MURPHY FUEL OIL FILTER PART #438-15

7.4 Establishing Injection Pressure of Injection valve

180 bar = required value (also see 4.5)





Sequence:

1. Connect injection valve 1 to tester 2 using fuel delivery line.
2. Operate pump lever 3. Pressure gauge must indicate 180 bar on injection.
3. Injection pressure can be altered by exchanging shims 5 after removal of nozzle holder 4.
   Insert shims to raise pressure.
   Remove shims to reduce pressure.
   0.1 mm = approx. 10 bar
4. Injection valve must inject an evenly atomized spray through the four holes without dribbling.
5. If not, clean injection nozzle 6.
   Rinse off nozzle body 6 and needle valve 7 in clean fuel, making sure to use a soft brush only (brass).
   Needle valve must hava a polished finish and fit snugly into nozzle body.
   If not, renew injection nozzle (parts 6 and 7 together).

7.5 Fuel Consumption

at n = 3000 rpm, full-load

Number of cylinder	2	3	4	6
Liter/h approx.	7,8	11	15	22
cm^3/min. approx.	130-135	180-185	250-260	360-370

Check following items if fuel consumption is excessive:

	see
• Injection valve	4.5
• Injection timing device	5.2.28
• Start of delivery	6.11
• Injection pump	
• Piston gap	6.9
• Compression pressure	6.10
• Piston ring condition	5.2.11
• Piston play	

7.6 Lube Oil Pressure

With engine warmed up:

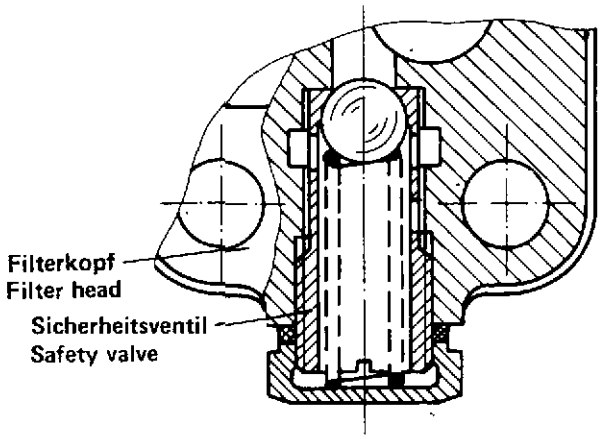
at n = 650 min^{-1} at least 0.8 . . . 1 bar

at n = 3000 min^{-1} 4.0 . . . 5 bar

Engines not incorporating oil pressure gauges are to be checked prior to delivery.

Check following points if oil pressure is inadequate:

- Oil level
- Oil grade SAE value (see Operating Instructions)
- Outdoor temperature (see Operating Instructions)
- Condition of safety valve



Lube oil Safety valve dismounted

- Is pressure gauge in good working order?
- Is oil pump working satisfactorily?
- Check bearing play on crankshaft, camshaft and balance weight.
- Are oil drillings choked?
- Are plugs in oil drillings leaking?

7.7 Lube Oil Consumption at full - load

Number of Cylinders	2	3	4	6
per hour approx.	45	70	90	140 cm^3
1 litre lube oil is then consumed in approx.	22	14	11	7 hours

Lube oil consumption is not guaranteed and depends considerably on :

- engine service (condition of pistons, piston rings and cylinders).
- Lube oil quality
- Service temperature
- Load
- Condition of shaft seals

and can thus deviate from the above values.

SEALED BEARINGS FOR D327 COOLING BLOWERS

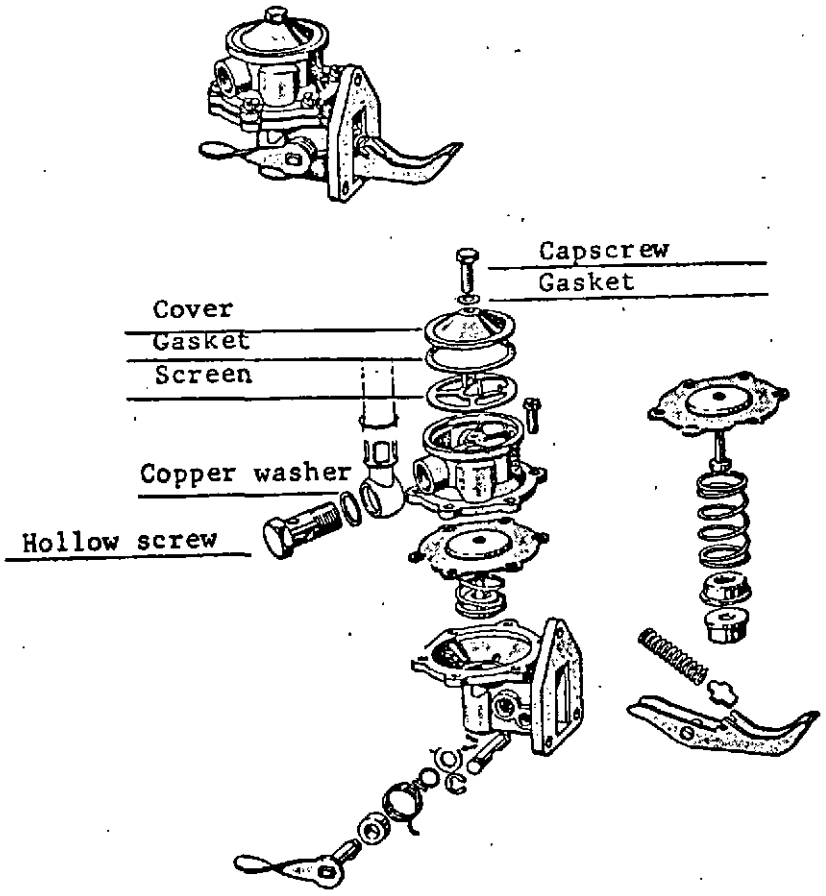
Blowers on new engines and repair part blower assemblies come equipped from Spain and Germany with 6.0320.04.5.6204 and 6.0320.07.3.6204 ball bearings, it is recommended that the bearings be checked and greased every 2,250 hours.

When bearing replacement becomes necessary, it is recommended that the 6.0320.04.5.6204 and 6.0320.07.3.6204 ball bearings be replaced with sealed bearings 463-5. It is still recommended that the bearings be checked every 2,250 hours.

"D" SERIES DIAPHRAM FUEL LIFT PUMP

A number of fuel lift pumps have been returned for possible warranty that have a dirty screen (Ref. 3), or with inlet port threads stripped or the wall cracked. There will be no warranty on these.

A dirty tank is the customer's responsibility, the screen can be cleaned. The Distributor, Service Dealer and customer should carry spare 6.0492.01.0.1420 copper gaskets (Ref. 32). Copper works hard from tightening and retightening. New gaskets that are soft take less torque to seal.



Raising low oil pressure signal on "D" Series Engines equipped with semi-automatic shutdown.

There are two (2) normally closed oil pressure switches available for the "D" Series Engines equipped with the small indicator light panel.

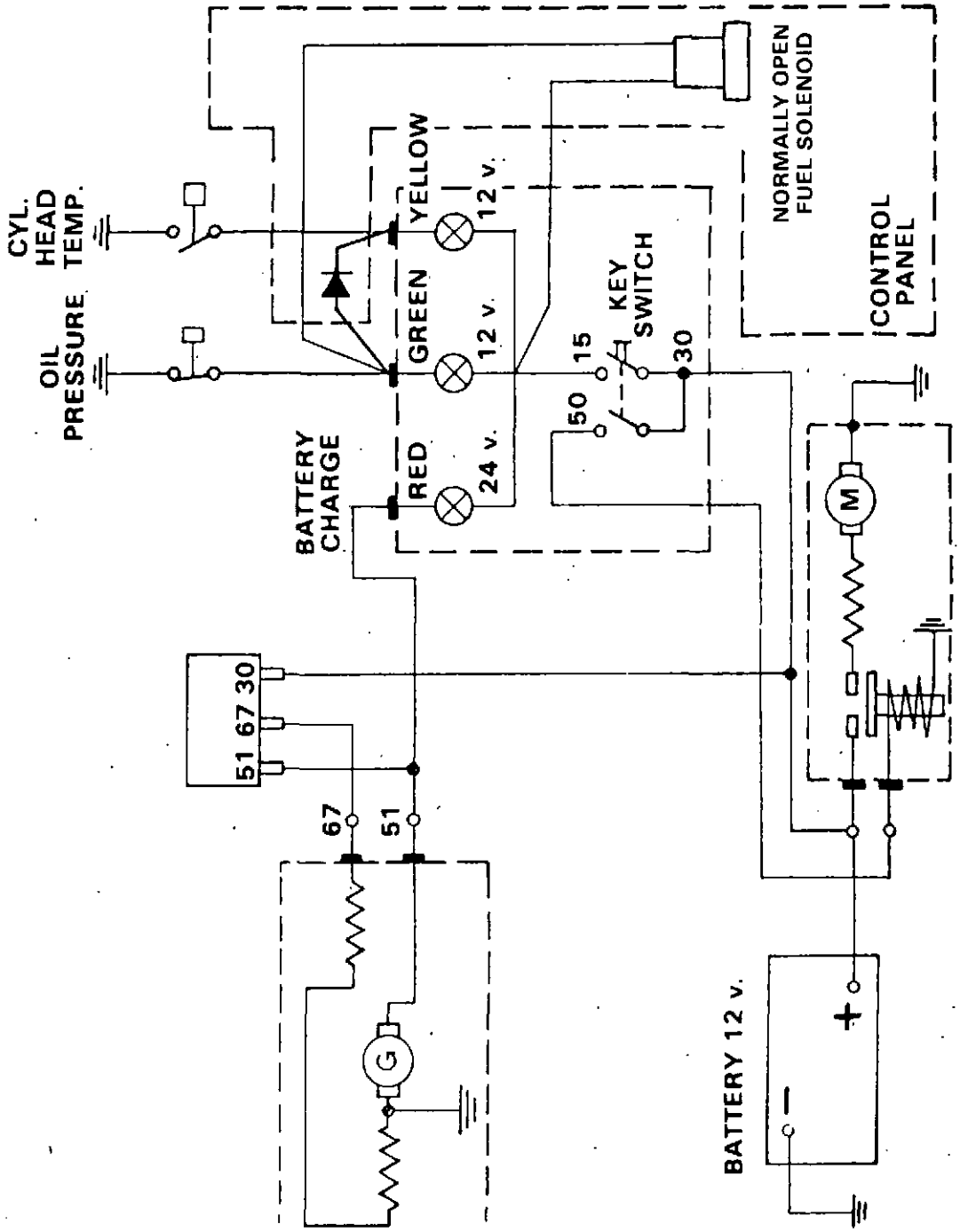
PART NUMBER	IDENTIFICATION ON SWITCH*	OPENING PRESSURE
6.0578.20.0.5080	D80151 or D81121	8 - 12 p.s.i.
6.0578.20.1.0005	D81124	28 - 34 p.s.i.

*The number shown is for U.S.A. made switches. This number is stamped on the bottom of the switch.

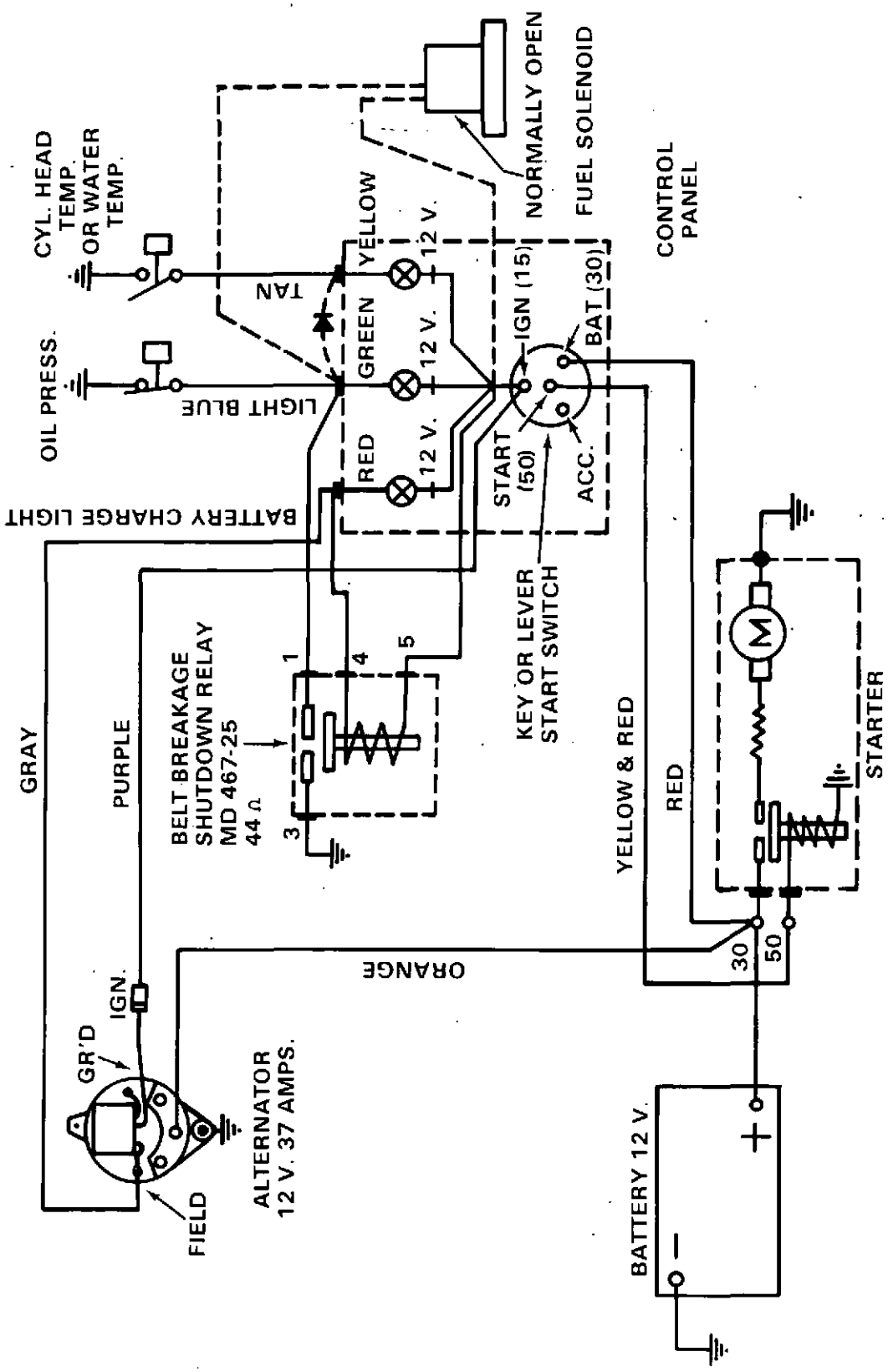
The standard switch used with this panel is the 8 - 12 p.s.i. switch. For applications where the engine is unattended or an engine that operates at a constant speed, it is recommended that the 8 - 12 p.s.i. switch be replaced with the 28 - 34 p.s.i. switch.

For engines equipped with the Frank W. Murphy switch gauge panel, insert a 1/16" allen wrench into the adjusting screw on the face of the oil pressure gauge and readjust so that the needle will read 30 p.s.i.

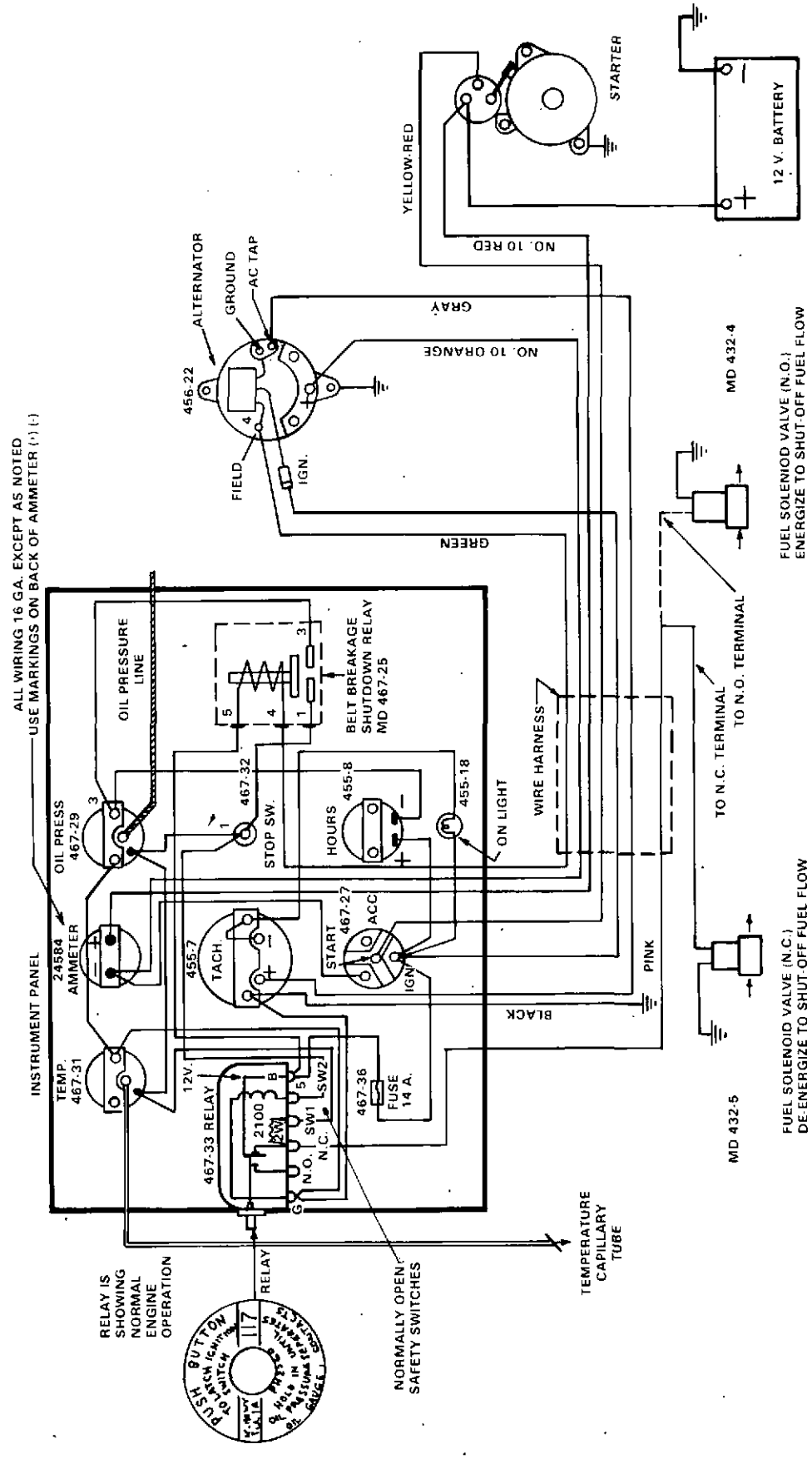
WIRING DIAGRAM FOR D SERIES ENGINE LKS, D302-1, 302-2 WITH FEMSA GENERATOR



WIRING DIAGRAM WITH MOTOROLA ALTERNATOR, SMALL PANEL WITH INDICATOR LIGHTS.
FUEL SOLENOID SHUT DOWN OPTIONAL.
BELT BREAKAGE RELAY OPTIONAL.



WIRING DIAGRAM WITH MOTOROLA ALTERNATOR, SEMI AUTOMATIC SWITCH GAUGE PANEL WITH BELT BREAKAGE RELAY (OPTIONAL)



OPERATING CONDITIONS

ELECTRICAL SYSTEM

STARTING SYSTEMS

ELECTRIC: — (12 volt D.C.)

D327-2	D327-3	D327-4	D327-6
DELCO-REMY	DELCO-REMY	DELCO-REMY	DELCO-REMY
MODEL 10 MT	MODEL 20 MT	MODEL 27 MT	MODEL 27 MT

Bosch 12 and 24 volt optional.

MANUAL:
Two and three cylinder with optional hand crank device and manual decompression lever — consult the factory. (Optional high WR^2 flywheel required).

AIR:
Three, four, and six cylinder with Dusterloh DLA 1.5 air starter.

RECOMMENDED BATTERY SIZE:

	D327-2	D327-3	D327-4	D327-6
ABOVE 10° F	65 AH	85 AH	85 AH	110 AH
BELOW 10°F	85 AH	105 AH	105 AH	135 AH

TEMPERATURE LIMITS:

	D327-2	D327-3	D327-4	D327-6
ELECTRIC START	5°F	5°F	5°F	5°F
MANUAL START	20°F	20°F	N/A	N/A
ELECTRIC w/COLD START AID	-15°F	-15°F	-15°F	-15°F

CHARGING SYSTEMS

Motorola 37 amp., 12 volt D.C. with self contained solid state voltage regualtor.

Motorola 55 amp., 12 volt D.C. with solid state regulator attached.

Motorola 37 amp., 12 volt D.C. with enclosed brushes U.L. approved for marine (also for adverse industrial applications) with solid state regulator attached.

Motorola 35 amp., 24 volt D.C.

LUBE OIL TEMPERATURE:

(Continuous output)

ALL MODELS	1500 RPM	2500 RPM
MAX.	212° F	250° F
NORMAL	185° F	220° F

LUBE OIL PRESSURE (AT 212° F)

ALL MODELS	1500 RPM	2500 RPM
NORMAL	35-70 PSI	35-70 PSI
MIN.	20 PSI	20 PSI

LUBE OIL VISCOSITY AND SERVICE CLASS:

Use a good quality oil having an API service class CC/SF, CD/SF, CC, or CD, according to the following viscosities. API classifications CD/SF or CD must be used when sulfur content in the fuel exceeds 0.5%. Use of multi viscosity oils in MWM diesel engines must meet an API classification of CD/SF or CD.

AVERAGE OUTSIDE TEMPERATURE	SAE STRAIGHT WEIGHT	SAE MULTI/VISCOSITY
Above 85°F (30°C)	40*	—
32° to 85°F (0° to 32°C)	30*	15W-40
14° to 50°F (–10° to 10°C)	20W-20*	15W-40
Permanently Below 32°F (0°C)	10W	10W-30* or 5W-20*

* Preferred

NOTE: Use the same oil in the injection pump/governor as required in the engine's crankcase.

CAUTION: Using any quality oils other than those recommended could cause engine damage. For example, do not use oil labeled **ONLY** SA, SB, SC, SD, SE, SF, CA or CB.

MAXIMUM CRANKCASE PRESSURE:

1 (In — H_2O)

LUBE OIL CONSUMPTION — APPROXIMATE (LBS/HR)

2 Cyl.	3 Cyl.	4 Cyl.	6 Cyl.
.06/.12	.1/.2	.14/.27	.2/.4

STANDARD SUMP

	D327-2		D327-3		D327-4		D327-6	
	CONT. DUTY	INT. DUTY	CONT. DUTY	INT. DUTY	CONT. DUTY	INT. DUTY	CONT. DUTY	INT. DUTY
LONGITUDINAL	15°	35°	15°	27°	15°	18°	15°	16°
TRANSVERSE	15°	35°	15°	35°	15°	35°	15°	45°

(INTERMITTENT DUTY — MAX. 15 MIN.)

LUBE OIL CAPACITY (U.S. QUARTS)	D327-2	D327-3	D327-4	D327-6
	5.0	7.0	9.5	12.0

DRY SUMP (INTERMITTENT DUTY)

	D327-2	D327-3	D327-4	D327-6
LONGITUDINAL	—	45°	45°	45°
TRANSVERSE	—	45°	45°	45°

LUBE OIL CAPACITY (U.S. QUARTS)	D327-2	D327-3	D327-4	D327-6
	—	7.5	7.5	9.5

DEEP SUMP (INTERMITTENT DUTY)

	D327-2	D327-3	D327-4	D327-6
LONGITUDINAL	—	27°	20°	20°
TRANSVERSE	—	35°	35°	45°

LUBE OIL CAPACITY (U.S. QUARTS)	D327-2	D327-3	D327-4	D327-6
	—	23	32	46

BLOWER INLET VOLUME [IN (CFM) at 68° F]

RPM/MODEL	D327-2	D327-3	D327-4	D327-6
1500	590	650	1060	1175
1800	700	800	1300	1400
2400	950	1050	1700	1900
3000	1175	1300	2100	2400

ALLOWABLE RESTRICTION 0.6 (IN—H_2O) MAX.

DISCHARGE AIR TEMPERATURE IN (° F)*

CONDITION	RPM	D327-2	D327-3	D327-4	D327-6
NORMAL	1800	175	185	160	150
MAX.	1800	212	220	185	175
NORMAL	2400	185	185	170	160
MAX.	2400	220	212	195	185

*Measured 25 mm (1") from push rod tube centers.

DISCHARGE AIR MASS HEAT REJECTION

[In (Btu/Min) at "A" rating — (not including engine oil cooler)]

RPM/MODEL	D327-2	D327-3	D327-4	D327-6
1500	675	1000	1300	1950
1800	820	1200	1550	2320
2400	1045	1550	2040	3060
3000	1100	1600	2100	3160

AVERAGE SPECIFIC HEAT REJECTION IN (BTU/HP/HR)

D327-2	D327-3	D327-4	D327-6
2162	2100	2040	2040

COMBUSTION AIR VOLUME

In (CFM) @ 68° F and 29 (Inch-Hg)

RPM/MODEL	D327-2	D327-3	D327-4	D327-6
1500	45	68	90	135
1800	53	80	105	160
2400	65	95	125	190
3000	76	115	150	230

ALLOWABLE RESTRICTION OF INTAKE SYSTEM

In (IN-H_20)

RPM/MODEL	D327-2	D327-3	D327-4	D327-6
1500	4.0	4.0	5.5	6.7
1800	4.0	4.7	7.5	9.4
2400	4.2	6.0	8.0	8.0
3000	4.7	7.8	10.0	7.0

MAXIMUM RESTRICTION ($IN-H_20$)	D327-2	D327-3	D327-4	D327-6
	12	12	12	12

COMPRESSION PRESSURE

Average for new engine: 30 bar (435 psi)
minimum: 22 bar (319 psi)

Maximum compression pressure
difference between cylinders: 3 bar (43.5 psi)

(Compression pressure measured at cranking speed)

EXHAUST VOLUME IN (CFM) AT "A" RATING

RPM/MODEL	D327-2	D327-3	D327-4	D327-6
1500	105	162	220	315
1800	125	195	260	380
2400	165	260	347	506
3000	204	300	410	612

EXHAUST TEMPERATURE IN (°C)

RATING	RPM	D327-2	D327-3	D327-4	D327-6
"A" RATING	1500	420	430	450	420
	1800	420	445	450	440
	2400				
	3000	520	500	520	520
"B" RATING	1500	450	490	490	470
	1800	470	490	490	490
	2400				
	3000	590	540	550	550

MAXIMUM TEMPERATURE DIFFERENCE BETWEEN CYLINDERS

30° C (86° F)

MAXIMUM ALLOWABLE EXHAUST BACK PRESSURE:

5.5 (In-Hg)

FUEL SYSTEM

MAX. FUEL FEED PUMP LIFT
5 (ft. fuel)

MAX. FUEL FEED PUMP SUCTION
4.4 (In-Hg) measured at pump inlet.

FUEL FEED PUMP PRESSURE
11-14 (p.s.i.) measured at pump outlet.

INJECTION PUMP PRESSURE
2610-2680 (p.s.i.) same as nozzle opening pressure.

STANDARD TORQUE VALUES

GRADE	5.6		6.9		8.8		10.9		12.9	
DIAMETER	MKP	LB./FT.	MKP	LB./FT.	MKP	LB./FT.	MKP	LB./FT.	MKP	LB./FT.
M4	0,13	1	0,24	2	0,29	2	0,4	3	0,5	3
M5	0,25	2	0,48	3	0,57	4	0,8	5,8	0,95,6	
M6	0,4	3	0,8	5	1	7	1,4	10	1,6	11
M7	0,7	5	1,3	9	1,6	11	2,3	16	2,7	19
M8	1	7	2	14	2,5	18	3,5	25	4	28
M10	2	14	4	28	4,5	32	6,5	47	8	57
M12	3,4	24	7	50	8	57	11,5	83	14	101
M14	5,5	39	11	79	13	94	18,5	133	22	159
M16	8,4	60	17	123	20	144	27,2	196	32,6	235
M18	11,6	83	23,5	170	26,5	191	37,3	267	44,8	324
M20	16,6	120	33	238	38	274	53,5	387	64	462
M22	23,5	162	44	318	51	368	72,5	524	87	629
M24	28,7	207	57	412	65	470	92	665	110	796
M27	43	311	84	607	98	708	138	998	167	1208
M30	58	419	113	817	134	969	188	1360	226	1635
M33	80	578	154	1114	183	1324	258	1866	308	2228

For special torque specifications, see page 36.

Metric Conversion Chart

TO CONVERT	MULTIPLY BY	TO OBTAIN
BAR (kp/cm²)	14.5	POUNDS PER SQ. IN. (PSI)
CENTIGRADE (°C)	1.8 THEN ADD 32	FAHRENHEIT (°F)
GRAMS (gr)	.03527	OUNCES (oz)
INCHES (in)	25.4	MILLIMETERS (mm)
KILOGRAMS (kg)	2.2046	POUNDS (lb)
KILOMETER (km)	.6214	MILES (STATUTE)
KILOWATTS (kw)	1.341	HORSE POWER (HP)
LITER (dm³)	61.02	CUBIC INCH (C.I.)
LITER (dm³)	1.057	QUART (QT.)
LITER (dm³)	.2642	GALLONS (U.S.)
METER (m)	3.281	FEET (FT.)
METERS-KILOGRAM (mkp) OR (mkg)	7.233	POUND-FEET (lb-ft)
MILLIMETERS (mm)	.03937	INCHES (in)
NEWTON METER (Nm)	.7376	POUND-FEET (lb-ft)

The multiplying SI prefixes

The multiples and sub-multiples of the basic and derived units are not unrelated to the units as is usual in the UK and US systems (e.g., yard, foot, inch and pound, grain, ounce). They are formed by means of prefixes which are the same, no matter to which unit they are applied.

Prefix	*Symbol*	*Factor by which the unit is multiplied*	
tera	T	10^{12} =	1000000000000
giga	G	10^{9} =	1000000000
mega	M	10^{6} =	1000000
kilo	k	10^{3} =	1000
hecto	h	10^{2} =	100
deca	da	10^{1} =	10
deci	d	10^{-1} =	0.1
centi	c	10^{-2} =	0.01
milli	m	10^{-3} =	0.001
micro	μ	10^{-6} =	0.000001
nano	n	10^{-9} =	0.000000001
pico	p	10^{-12} =	0.000000000001
femto	f	10^{-15} =	0.000000000000001
atto	a	10^{-18} =	0.000000000000000001

The Metric System of Weights and Measures

Linear Measure

10 millimetres (mm)	= 1 centimetre (cm)
10 centimetres	= 1 decimetre (dm)
10 decimetres	= 1 metre (m)
10 metres	= decametres (dam)
10 decametres	= hectometre (hm)
10 hectometres	= kilometre (km)

Square Measure

100 square millimetres (mm²)	= 1 square centimetre (cm²)
100 square centimetres	= 1 square decimetre (dm²)
100 square decimetres	= 1 square metre (m²)
100 square metres	= 1 are (1 square decametre)
100 ares	= hectare (ha) (1 square hectometre)
100 hectares	= square kiolmetre (km²)

Cubic Measure

1000 cubic millimetres (mm³)	= 1 cubic centimetre (cm³)
1000 cubic centimetres	= cubic decimetre (dm³)
1000 cubic decimetres	= cubic metre (m³)