



SUN-E-E1-E2 series

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GENERAL UPDATE			ISSUE n° - 3 DATE LAST ISSUE - 06/2007
Chap ter	Date issue	Issue n°	DESCRIPTION
0	01/08/00	0	FOREWORD
1	06/2007	1	IDENTIFICATION
2	06/2007	3	TECHNICAL SPECIFICATIONS
3	06/2007	2	MAINTENANCE
4	09/2007	3	SYSTEM DIAGRAMS
5	01/08/00	0	DISASSEMBLY
6	06/2007	2	CHECKS AND REPAIRS
7	06/2007	2	ASSEMBLY
8	20/02/03	1	TABLES
9	20/02/03	1	RUNNING TESTS AND ADJUSTMENTS
10	14/09/07	1	APPLICATIONS
11	20/02/03	1	SPECIAL TOOLS
12	20/02/03	1	LABOR TIME GUIDE

CHAPTER UPDATES					CHAPTER n° - 0 FOREWORD ISSUE n° - 0 / 01/08/00
Date issue	Issue n°	Prepared by:	Verified by:	Approved by:	DESCRIPTION
01/08/00	0	Giroto P.	Bianchetti R.	Baroncini F.	

CHAPTER UPDATES					CHAPTER n° - 1 IDENTIFICATION ISSUE n° - 1 - 25/06/07
Date issue	Issue n°	Prepared by:	Verified by:	Approved by:	DESCRIPTION
01/08/00	0	Giroto P.	Bianchetti R.	Baroncini F.	
25/06/07	1	Luciani	Bianchetti R.	Baroncini F.	New pictures to identify the engine s/n and engine plate. Engine code for new engine family SUN E2

CHAPTER UPDATES					CHAPTER n° - 2 TECHNICAL SPECIFICATIONS ISSUE n° - 3 - 06-2007
Date issue	Issue n°	Prepared by:	Verified by:	Approved by:	DESCRIPTION
20/02/03	1	Giroto P.	Bianchetti R.	Baroncini F.	Attached inclination max for engine. Injection pump tables updated.
25/09/03	2	Giroto P.	Bianchetti R.	Baroncini F.	1) Substitute old schedules ""TECHNICAL DATA"" with news. 2) Attached injection pump schedule setting.
06/2007	3	Luciani S.	Bianchetti R.	Baroncini F.	1) Updated dimensions, tech data, electrical power output, for new engine SUN E2 2) Deleted injection pump charts because all charts are not available for every engine model

CHAPTER UPDATES					CHAPTER n° - 3 MAINTENANCE ISSUE n° - 2 - 06/2007
Date issue	Issue n°	Prepared by:	Verified by:	Approved by:	DESCRIPTION
20/02/03	1	Giroto P.	Bianchetti R.	Baroncini F.	Overhaul paragraphs 3.2 and 3.3 has been made by remaking up pages.
06/2007	2	Luciani S..	Bianchetti R.	Baroncini F.	Updated Oil Castrol instead of Mobil for extend storage for injection system protection. New lube engine oil, Q8 with new specifications API/ ACEA. New fuel specifications, with introduction biodiesel mixed with fuel.

CHAPTER UPDATES					CHAPTER n° - 4 / SYSTEM DIAGRAMS ISSUE n° - 3 - 09/2007
Date issue	Issue n°	Prepared by:	Verified by:	Approved by:	DESCRIPTION
20/02/03	1	Giroto P.	Bianchetti R.	Baroncini F.	Deleted values of injection pressure because they are into chapter 2.
06/2007	2	Luciani S..	Bianchetti R.	Baroncini F.	Paragraph 4.3.11: inserted new electrical circuit "starter motore does not engage when the engine is running"
09/2007	3	Luciani S..	Bianchetti R.	Baroncini F.	Paragraph 4.3.3: inserted new electrical circuit about SUN4105TE2 - "control panel" Paragraph 4.3.11: inserted new electrical circuit about SUN4105TE2 - "engine wiring"

CHAPTER UPDATES					CHAPTER n° - 5 DISASSEMBLY ISSUE n° - 0 - 01/08/00
Date issue	Issue n°	Prepared by:	Verified by:	Approved by:	DESCRIPTION
01/08/00	0	Giroto P.	Bianchetti R.	Baroncini F.	

CHAPTER UPDATES					CHAPTER n° - 6 CHECKS AND REPAIRS ISSUE n° - 2 - 06/2007
Date issue	Issue n°	Prepared by:	Verified by:	Approved by:	DESCRIPTION
20/02/03	1	Giroto P.	Bianchetti R.	Baroncini F. pictures.	Updating of some specifications and addition of the missing
06/2007	2	Luciani S..	Bianchetti R.	Baroncini F.	Inserted new injection timing advance for engine model SUN E2

CHAPTER UPDATES					CHAPTER n° - 7 ASSEMBLY ISSUE n° - 2 - 06/2007
Date issue	Issue n°	Prepared by:	Verified by:	Approved by:	DESCRIPTION
20/02/03	1	Giroto P.	Bianchetti R.	Baroncini F.	Addition of the driving torque in the pictures and updating of some mounting procedures according to the current ones.
06/2007	2	Luciani S..	Bianchetti R.	Baroncini F.	Updated depth of internal injection pump value to carry out the correct thickness for engine model SUN2015-3105 E2

CHAPTER UPDATES					CHAPTER n° - 8 TABLES ISSUE n° - 1 - 20/02/03
Date issue	Issue n°	Prepared by:	Verified by:	Approved by:	DESCRIPTION
20/02/03	1	Giroto P.	Bianchetti R.	Baroncini F.	Elimination of the specific driving torque because they are indicated directly in the applications; standards left unchanged. Elimination of the checks that were already described in the specific chapters.

CHAPTER UPDATES					CHAPTER n° - 9 RUNNING TEST AND ADJUSTEMENTS ISSUE n° - 1 - 20/02/03
Date issue	Issue n°	Prepared by:	Verified by:	Approved by:	DESCRIPTION
20/02/03	1	Giroto P.	Bianchetti R.	Baroncini F.	Elimination of the test methods already existing in other chapters and updating of the troubleshooting index.

CHAPTER UPDATES					CHAPTER n° - 10 APPLICATIONS ISSUE n° - 1 - 14/09/07
Date issue	Issue n°	Prepared by:	Verified by:	Approved by:	DESCRIPTION
01/08/00	0	Giroto P.	Bianchetti R.	Baroncini F.	Indications how to support the exhaust system (turbocharger and muffler) on engine block
14/09/07	1	Luciani S.	Bianchetti R.	Baroncini F.	

CHAPTER UPDATES					CHAPTER n° - 11 SPECIAL TOOLS ISSUE n° - 1 - 20/02/03
Date issue	Issue n°	Prepared by:	Verified by:	Approved by:	DESCRIPTION
20/02/03	1	Giroto P.	Bianchetti R.	Baroncini F.	Attached adaptor for injector extracting tool.



Updates / Index U/I-16

CHAPTER UPDATES					CHAPTER n° - 12 LABOR TIME GUIDE ISSUE n° - 1 - 20/02/03
Date issue	Issue n°	Prepared by:	Verified by:	Approved by:	DESCRIPTION
20/02/03	1	Giroto P.	Bianchetti R.	Baroncini F.	Attached new codes.

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IDENTIFICATION

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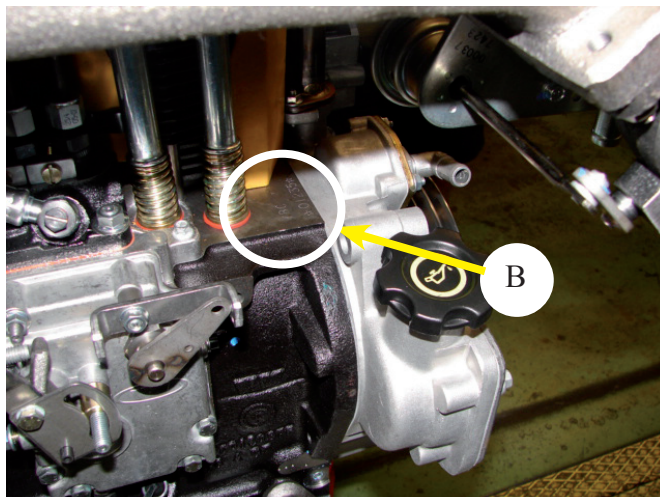
1.1 IDENTIFICATION DATA

The engine identification data can be found in the following positions:

- engine nameplate showing identification data



- serial number stamped on the engine crankcase



1.2 ENGINE TYPE IDENTIFICATION

DESIGNATION	CODE
SUN 2105	67A
SUN 2105 E1	87A
SUN 3105	68A
SUN 3105 E1	88B
SUN 3105 T	24B
SUN 3105 TE1	89B
SUN 4105 E	10B
SUN 4105 TE	11B
SUN 4105 TE1	84B
SUN 4105 IE	19B
SUN 6105 E	12B
SUN 6105 TE	13B
SUN 6105 TE1	83B
SUN 6105 IE	14B
SUN4105TE2	81C
SUN3105TE2	78C
SUN3105E2	67C
SUN2105E2	66C

EXAMPLE SUN 4105TE1

SUN = Engine Family

4 = 4 cylinders

105 = 105 mm bore

T = Turbocharged - I = Intercooled

E, E1, E2 = EPA homologation (exhaust emissions)

1.3 MANUFACTURER IDENTIFICATION

MANUFACTURER: VM MOTORI S.p.A.

Via Ferrarese, 29

44042 CENTO (FERRARA) ITALIA

TEL. (+39) - 051 - 6837511

FAX. (+39) - 051 - 6837517 / 6837584

TECHNICAL SPECIFICATIONS

2

2.1 ENGINE DIMENSIONS (FIG. 2.1)

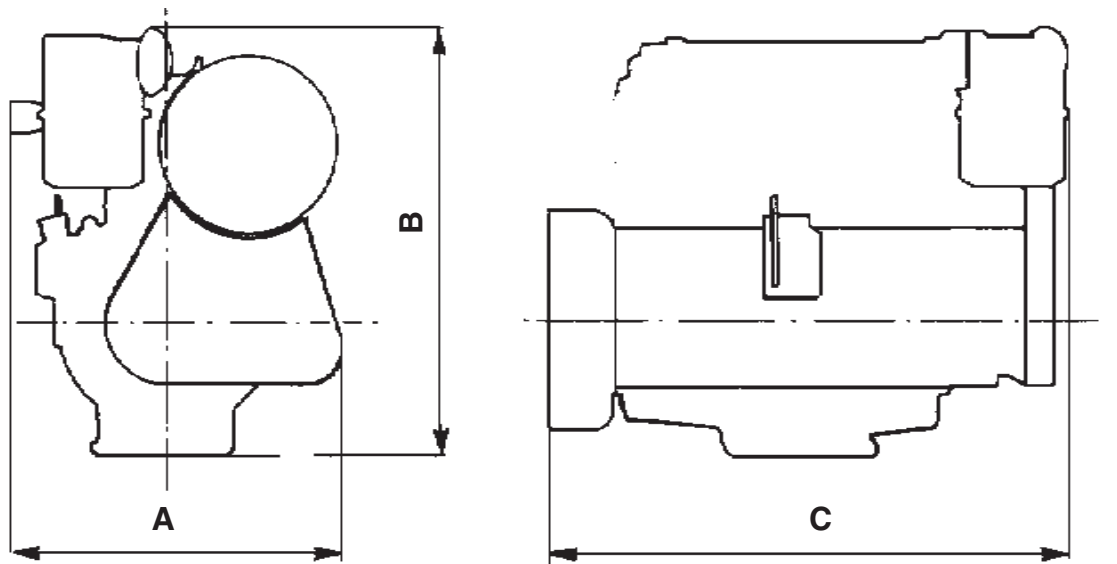


Fig. 2.1

Engine Type		A	B	C
2105	mm.	540	770	627
3105	mm.	651	762	806
3105 T	mm.	556	789	744
4105 E	mm.	631	798	961
4105 TE	mm.	707	777	929
4105 IE	mm.	765	808	1045
6105 E	mm.	694	856	1272
6105 TE	mm.	743	856	1272
6105 IE	mm.	743	858	1398

Engine Type		A	B	C
2105 E1	mm.	551	760	666
3105 E1	mm.	556	750	821
3105 TE1	mm.	565	750	841
4105 TE1	mm.	618	777	1014
6105 TE1	mm.	743	856	1350

Engine Type		A	B	C
2105 E2	mm.	540	770	671
3105 E2	mm.	551	770	806
3105 TE2	mm.	556	760	744
4105 TE2	mm.	670	787	929

2.1.1 INCLINATION MAX (FIG. 2.2)

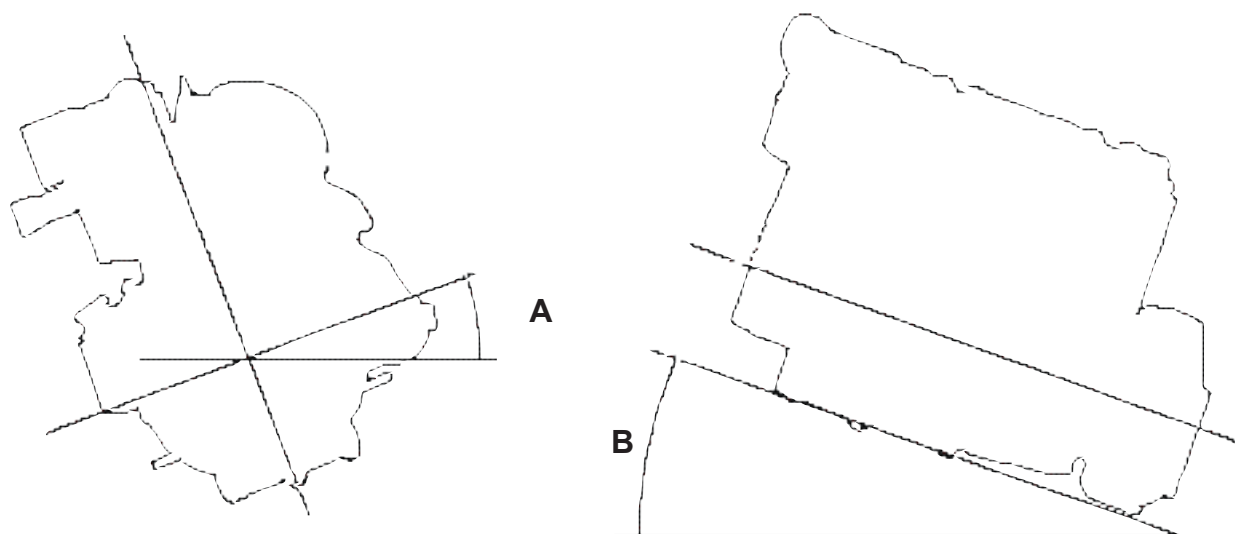


Fig. 2.2

MOTORE	A = Transverse in both directions	B = Longitudinal flywheel up	B = Longitudinal flywheel down
2105	38°	23°	42°
3105	42°	42°	23°
4105	50°	20°	23°
6105	40°	24°	24°

2.2 TECHNICAL DATA "SUN" ENGINES

ENGINE TYPE	MEASURE	2105	3105	3105 T
NUMBER CYLINDERS	N°	2	3	3
BORE	m m	105	105	105
STROKE	m m	115	115	115
TOTAL DISPLACEMENT	cm ³	1992	2987	2987
MAXIMUM ENGINE SPEED	rpm	2600	2600	2600
POWER EXPRESSED "B" DIN 6271	KW (CV)	30.8 (42)	46.3 (63)	54.4 (74)
MIN. OIL PRESSURE (WITH ENGINE HOT) AT IDLING	KPa bar	150 1.5	150 1.5	150 1.5
INJECTORS PRESSURE OPENING	bar	270-278	270-278	270-278
FIRING/INJECTION ORDER		1-2	1-3-2	1-3-2
IDLE SPEED	rpm	700	700	700
COMPRESSION RATIO		17 : 1	17 : 1	17 : 1
INJECTION TYPE		direct	direct	direct
VALVE CLERANCE (ENG. COLD)	m m	0.30	0.30	0.30
QUANTITY OF OIL IN SUMP	Kg.	5.5	6.9	6.9
ASPIRATION TYPE		natural	natural	turbocharged
COOLING		by air	by air	by air
DIRECTION OF ROTATION VIEWED FROM FLYWHEEL		counter clockwise	counter clockwise	counter clockwise
DRY WEIGHT	Kg.	245	312	322

2.2.1 TECHNICAL DATA "SUN-E" ENGINES

ENGINE TYPE	UNITS OF MEASURE	4105-E	4105-TE	4105-IE	6105-E	6105-TE	6105-IE
NUMBER CYLINDERS	N°	4	4	4	6	6	6
BORE	m m	105	105	105	105	105	105
STROKE	m m	115	115	115	115	115	115
TOTAL DISPLACEMENT	cm³	3983	3983	3983	5975	5975	5975
MAXIMUM ENGINE SPEED	rpm	2400	2400	1500	2400	2400	2300
POWER EXPRESSED "B" DIN 6271	KW (CV)	58 (79)	77.3 (105)	75 (102)	88.3 (120)	116.3 (158)	125 (170)
MIN. OIL PRESSURE (WITH ENGINE HOT) AT IDLING	KPa bar	150 1.5	150 1.5	150 1.5	150 1.5	150 1.5	150 1.5
INJECTORS PRESSURE OPENING	bar	270-278	270-278	270-278	270-278	270-278	270-278
FIRING/INJECTION ORDER		1-3-4-2	1-3-4-2	1-3-4-2	1-5-3-6-2-4	1-5-3-6-2-4	1-5-3-6-2-4
IDLE SPEED	rpm	700	700	700	700	700	700
COMPRESSION RATIO		17 : 1	17 : 1	17 : 1	17 : 1	17 : 1	17 : 1
INJECTION TYPE		direct	direct	direct	direct	direct	direct
VALVE CLERANCE (ENG. COLD)	m m	0.30	0.30	0.30	0.30	0.30	0.30
QUANTITY OF OIL IN SUMP	Kg.	9.4	9.4	9.4	15.5	15.5	15.5
ASPIRATION TYPE		natural	turbocharged	turbocharged intercooler	natural	turbocharged	turbocharged intercooler
COOLING		by air	by air	by air	by air	by air	by air
DIRECTION OF ROTATION VIEWED FROM FLYWHEEL		counter clockwise	counter clockwise	counter clockwise	counter clockwise	counter clockwise	counter clockwise
DRY WEIGHT	Kg.	385	398	431	567	580	613

2.2.2 TECHNICAL DATA "SUN-E1" ENGINES

ENGINE TYPE	MEASURE	2105-E1	3105-E1	3105-TE1	4105-TE1	6105-TE1
NUMBER CYLINDERS	N°	2	3	3	4	6
BORE	m m	105	105	105	105	105
STROKE	m m	115	115	115	115	115
TOTAL DISPLACEMENT	cm ³	1992	2987	2987	3983	5975
MAXIMUM ENGINE SPEED	rpm	2300	2300	2300	2300	2300
POWER EXPRESSED SAE J 1995	KW (CV)	31 (42)	37 (50)	45 (61)	75 (102)	106 (144)
MIN. OIL PRESSURE (WITH ENGINE HOT) AT IDLING	KPa bar	150 1.5	150 1.5	150 1.5	150 1.5	150 1.5
INJECTORS PRESSURE OPENING - NEW INJECTOR	bar	220-230	220-230	220-230	220-230	220-230
INJECTORS PRESSURE OPENING - WORKING	bar	195-205	195-205	195-205	195-205	195-205
FIRING/INJECTION ORDER		1-2	1-3-2	1-3-2	1-3-4-2	1-5-3-6-2-4
IDLE SPEED	rpm	700	700	700	700	700
COMPRESSION RATIO		17 : 1	17 : 1	17 : 1	17 : 1	17 : 1
INJECTION TYPE		direct	direct	direct	direct	direct
VALVE CLERANCE (ENG. COLD)	m m	0.30	0.30	0.30	0.30	0.30
QUANTITY OF OIL IN SUMP	Kg.	5.4	6.8	6.8	8.5	14
ASPIRATION TYPE		natural	natural	turbocharged	turbocharged	turbocharged
COOLING		by air	by air	by air	by air	by air
DIRECTION OF ROTATION VIEWED FROM FLYWHEEL		counter clockwise	counter clockwise	counter clockwise	counter clockwise	counter clockwise
DRY WEIGHT	Kg.	245	330	340	425	607

2.2.2 TECHNICAL DATA "SUN-E2" ENGINES

TIPO MOTORE	MISURA	2105-E2	3105-E2	3105-TE2	4105-TE2
NUMBER CYLINDERS	N°	2	3	3	4
	m m	105	105	105	105
STROKE	m m	115	115	115	115
TOTAL DISPLACEMENT	cm ³	1992	2987	2987	3983
MAXIMUM ENGINE SPEED	rpm	2300	2300	2300	2100
POWER EXPRESSED (CE 2002/88 – Stage 2)	KW (CV)	25 (34)	36 (49)	46 (62)	70 (95)
MIN. OIL PRESSURE (WITH ENGINE HOT) AT IDLING	KPa bar	150 1.5	150 1.5	150 1.5	150 1.5
INJECTORS PRESSURE OPENING	bar	270-278	270-278	270-278	270-278
FIRING/INJECTION ORDER		1-2	1-3-2	1-3-2	1-3-4-2
IDLE SPEED	rpm	700	700	700	700
COMPRESSION RATIO		17 : 1	17 : 1	17 : 1	17 : 1
INJECTION TYPE		direct	direct	direct	direct
VALVE CLERANCE (ENG. COLD)	m m	0.30	0.30	0.30	0.30
QUANTITY OF OIL IN SUMP	Kg.	5.4	6.8	6.8	8.5
ASPIRATION TYPE		natural	natural	turbocharged.	turbocharged.
COOLING		air	air	air	air
DIRECTION OF ROTATION VIEWED FROM FLYWHEEL		counter clockwise	counter clockwise	counter clockwise	counter clockwise
DRY WEIGHT	Kg.	245	330	340	425

ELECTRICAL POWER OBTAINABLE AT 1500 RPM						ELECTRICAL POWER OBTAINABLE AT 1800 RPM					
	Electrical power						Electrical power				
	Emergency		Continuos		*		Emergency		Continuos		*
	KVA	KW	KVA	KW	%		KVA	KW	KVA	KW	%
2105	22	17	20	16	85	2105	26	21	24	19	86
3105	33	27	30	24	86.5	3105	40	32	37	29	87.5
3105 T	47	37	43	34	88	3105 T	53	43	48	39	89
4105 E	45	36	41	33	88	4105 E	53	43	48	38	89
4105 TE	66	53	60	48	88.5	4105 TE	80	64	73	58	89.5
4105 IE	83	66	75	60	88.5	4105 IE					
6105 E						6105 E					
6105 TE	100	80	91	73	91	6105 TE	116	92	105	84	90.5
6105 IE	110	88	100	80	91	6105 IE	129	103	117	94	91

- a) Power ratings are expressed in accordance with DIN 6271 and refer to the engine after running.
b) Production tolerances on the indicated power ratings: $\pm 5\%$
c) New engines perform 4% less power.
d) Continuous duty power ratings can be overloaded by 10%.
e) Emergency duty power ratings cannot be overloaded.
f *) The alternator output values given are those stated by the manufacturer.

ELECTRICAL POWER OBTAINABLE AT 1500 RPM						ELECTRICAL POWER OBTAINABLE AT 1800 RPM					
	Electrical power						Electrical power				
	Emergency		Continuos		*		Emergency		Continuos		*
	KVA	KW	KVA	KW	%		KVA	KW	KVA	KW	%
2105E1	-	-	-	-	-	2105E1	22	17	20	16	85
3105E1	-	-	28	23	86.5	3105E1	33	27	30	24	86.5
3105 TE1	-	-	43	34	88	3105 TE1	47	37	43	34	88
4105 TE1	-	-	70	56	88.5	4105 TE1	45	36	41	33	88
6105 TE1	-	-	99	79	91	6105 TE1	66	53	60	48	88.5

- a) Power ratings are expressed in accordance with SAE J1995 and refer to the engine after running.
b) Production tolerances on the indicated power ratings: $\pm 5\%$
c) New engines perform 4% less power.
d) Continuous duty power ratings can be overloaded by 10%.
e) Emergency duty power ratings cannot be overloaded.
f *) The alternator output values given are those stated by the manufacturer.

ELECTRICAL POWER OBTAINABLE AT 1500 RPM						ELECTRICAL POWER OBTAINABLE AT 1800 RPM					
Electrical power						Electrical power					
Emergency		Continuos		*		Emergency		Continuos		*	
KVA	KW	KVA	KW	%			KWe		KWe	%	
2105E2	20	17	18	25	-	2105E2	19	17			
3105E2	30	25	27	23		3105E2	28	25			
3105 TE2	40	33	36	30		3105 TE2	37	33			
4105 TE2	64	52	58	47		4105 TE2	58	52			

a) Power ratings are expressed in accordance with **ISO 3046/1**, **ISO 8528/1**, **BS 5514/1** and refer to the engine after running.

b) Production tolerances on the indicated power ratings: $\pm 5\%$

c) New engines perform 4% less power.

d) Continuous duty power ratings can be overloaded by 10%.

e) Emergency duty power ratings cannot be overloaded.

f *) The alternator output values given are those stated by the manufacturer.

2105 EQUIPMENT

MANUFACTURER Code

injection pump: STANADYNE PFR 2K 85/7060

Injector: STANADYNE NHM 780722

Injection advance: See page. 6-23

Injection pump calibration: Delivery $70 \pm 3 \text{ mm}^3$ at 1000 rpm

3105 EQUIPMENT

MANUFACTURER Code

injection pump: STANADYNE PFR 3K 85/7061

Injector: STANADYNE NHM 780722

Injection advance: See page 6-23

Injection pump calibration: Delivery $70 \pm 3 \text{ mm}^3$ at 1000 rpm

3105 T EQUIPMENT

MANUFACTURER Code

Injection pump: STANADYNE PFR 3K 85/7061

Injector: STANADYNE NHM 780722

Injection advance: See page 6-23

Injection pump calibration: Delivery $70 \pm 3 \text{ mm}^3$ at 1000 rpm

MAINTENANCE

3

3.1 STORAGE



WARNING:

ALL ENGINES WHICH REMAIN IDLE ARE SUBJECT TO RUST AND CORROSION OF MACHINED SURFACES WHICH ARE NOT PROTECTED BY PAINT. THE DEGREE OF CORROSION DEPENDS ON THE CLIMATIC CONDITIONS TO WHICH THE ENGINE IS EXPOSED. THE INDICATIONS BELOW ARE THEREFORE INTENDED TO PROTECTING THE ENGINE FROM CORROSION.

3.2 TEMPORARY PROTECTION



- 1) Prepare a container with a mixture of 10% (**Castrol Safecoat DW30X, Rustilo 181, Rustilo DWX31**) and diesel fuel, disconnect the fuel feed and diesel fuel return lines from the fuel tank and connect them to this container.
- 2) Run the engine at low speed for a few minutes.
- 3) Run the engine for about 10 minutes at a speed between $\frac{1}{2}$ and $\frac{3}{4}$ of nominal rpm so that the pipelines, nozzles, pumps and filters are completely filled with the protective mixture.
- 4) Stop the engine and wait for it to cool down.
- 5) Reconnect the pipelines to the fuel tank.
- 6) Completely refill the diesel fuel service tank.
- 7) Spray the specific protective oil for electrical contacts into the non-protected contact points.

For disposal of used oils contact an authorised disposal company.

3.3 PERMANENT PROTECTION (six months or longer)



- 1) Drain the oil from the sump and refill with new oil.
- 2) Prepare a container with a 10% mixture of (**Castrol Safecoat DW30X, Rustilo 181, Rustilo DWX31**) and diesel fuel, disconnect the fuel feed and diesel fuel return lines from the fuel tank and connect them to this container.
- 3) Run the engine at low speed for a few minutes.
- 4) Run the engine for about 10 minutes at a speed between $\frac{1}{2}$ and $\frac{3}{4}$ of nominal rpm so that the pipelines, nozzles, pumps and filters are completely filled with the protective mixture.
- 5) Stop the engine and wait for it to cool down.
- 6) Reconnect the pipelines to the fuel tank.
- 7) Completely refill the service diesel fuel tank.
- 8) Loosen the trapezoidal belt driving the alternator.
- 9) Spray the specific protective oil for electrical contacts into the non-protected contact points.

3.4 THREAD-LOCKING COMPOUNDS AND/OR

SEALANTS

VM recommends use of the products indicated below:

BRAND	For Europe	For USA
Loctite	510	510
Loctite	573	510
Loctite	601	603
Loctite	986	586/620
Dow Corning	791	

3.5 LUBRICANT**Specifications****API CF, CG-4, CH-4, CI-4****ACEA A3/B4**

VM prefers

Q8 Oils**FORMULA ADVANCED DIESEL**

NOTE DISPOSAL OF WASTE MATERIAL MUST BE CARRIED OUT IN CONFORMITY WITH ESTABLISHED LEGISLATION IN THE COUNTRY OF INSTALLATION.

IDENTIFICATION OF DANGERS

EFFECTS OF OVEREXPOSURE: No relevant effects expected.

FIRST AID MEASURES

CONTACT WITH EYES: Rinse immediately with copious amount of water and seek medical advice.

CONTACT WITH SKIN: Wash with soap and water.

INHALATION: No problems expected.

INGESTION: Not considered to be a problem.

DISPOSAL

The product can be incinerated, according to standard regulations.

Wear protective gloves when handling the product.

Operate according to standard regulations in the country of use and in relation to the characteristics of the product at the moment of disposal.

3.6 SOLVENTS

VM Motori raccomende le seguenti prodotti o equivalenti.

3.6.1 Pickling diluent

SUBSTANCE

Chemical composition

Mixture of aromatic hydrocarbons ketones, dichloropropane, isobutyl alcohol.

Commercial name

Diluente Decapaggio 15

Formula ----

Kemler number 33

ONU number 1203

CHARACTERISTICS - INGREDIENTS

Acetone mixture 15% - 25%

Isopropyl alcohol mixture 10% - 20% Xn R 20

Dichloropropane mixture 15% - 25% Xn R 20

Toluol mixture 35% - 45% Xn R 20

Component identification numbers:

	n° CEE	n° CAS
Acetone	606-001-00-8	67-64-1
Isopropyl alcohol	603-003-00-0	67-63-0
Dichloropropane	602-020-00-0	78-87-5
Toluol	601-021-00-3	108-88-3

HAZARDS

Highly inflammable.

Harmful if inhaled and in contact with skin.

Injurious to health if ingested.

R 11 - Highly inflammable

R 20 - Harmful if inhaled.

Skin irritant

Eyes irritant

Ingestion harmful

Inhalation harmful

FIRST AID

CONTACT WITH SKIN

Remove contaminated clothing. Wash affected parts of the body with cold or tepid water immediately. Use neutral soap if available.

CONTACT WITH EYES

Rinse immediately with copious amounts of fresh water for at least 15 minutes. Seek medical advice.

INHALATION

Take patient away from the sources of fumes and keep outside in fresh air. Apply artificial respiration if the patient stops breathing.

Seek medical advice.

INGESTION

Rinse out mouth with water without swallowing. Do not induce vomiting. Seek medical advice.

EXPOSURE CONTROL - PERSONAL PROTECTION

Maximum exposure limit LV mg/mc. 491

According to DPR n° 303 19/03/65 medical examinations are required every three months.

RESPIRATORY PROTECTION

Full mask facepiece respirator with filter for highly concentrated organic vapor.

HAND PROTECTION

Solvent-resistant gloves.

EYE PROTECTION

Goggles providing splash and spray protection.

SKIN PROTECTION

Overalls and apron.

Do not eat, drink or smoke in areas where solvents are used.

3.6.2 Trichloroethane

Chemical name

1,1,1 - Trichloroethane

Synonyms: Tri-Ethane 377 - Tri-Ethane 348

EEC No. 602-013-00-2

Einecs No. 200-766

Cas No. 71-55-6

Contains:

<5% Polymer stabilizer (the product does not contain significant concentrations of substances classified as hazardous for health).

HAZARDS

Major hazards

Harmful if inhaled

Specific hazards

A concentration significantly higher than that permitted in the work area could cause damage to the central nervous system and collapse.

FIRST AID

General information

Show this safety sheet to the doctor in charge.

Avoid contact with solvents and adopt protective measures whenever possible in accordance with general standards of industrial hygiene.

Inhalation

Take patient outside in fresh air. Administer oxygen.

Contact with skin

Remove all contaminated clothing, shoes, etc.. Wash immediately with plenty of water and soap. Seek medical advice.

Contact with eyes

Rinse thoroughly with copious amounts of water for at least 15 minutes while keeping the patient's eyes wide open.

Seek medical advice.

Ingestion

Drink plenty of water. Do not induce vomiting.

Seek immediate medical advice.

Do not administer any substances whatsoever if the patient loses consciousness.

Protection while administering first aid

Wear protective clothing to avoid contact with skin.

Solvents can remove natural oils from skin.

EXPOSURE CONTROL - PERSONAL PROTECTION

Work area design

Ensure that the work area is adequately ventilated, particularly if the area is enclosed.

Control parameters

OSHA PEL 8 hr - TWA = 350 ppm

OSHA STEL 15 min = 450 ppm

Personal protection

Respiratory protection

If the work area is insufficiently ventilated, use a suitable respirator.

For emergency rescue operations and when working in storage tanks, use self-contained breathing apparatus.

Hand protection

Solvent-resistant gloves.

Eye protection

Safety goggles/faceshield visor

Skin and body protection

Protective clothing, solvent-resistant apron.

Remove and wash contaminated gloves and clothing before re-use.

Hygiene

Avoid contact with eyes, skin and clothing.

Do not eat, drink or smoke during use.

3.7 FUEL

Use diesel fuel conforming to the specifications given below.

When filling the fuel tank, use a funnel fitted with a metal mesh to filter out any solid impurities which could otherwise block the injector nozzles.

Do not use diesel fuel mixed with water and/or other substances.



The engine has been designed to be powered by standard fuels available on the European market (according to specifications DIN EN 590). If it is to be powered by BIODIESEL fuels (according to specifications UNI EN 14214), it can be mixed, up to 5%, with fuel available on the European market (according to regulation DIN EN 590).

WARNING:

THE USE OF DIESEL FUEL WHICH DOES NOT MEET THE ABOVE STANDARDS WILL CAUSE DAMAGE TO THE FUEL INJECTION SYSTEM AND CONSEQUENTLY TO THE ENGINE ITSELF AND WILL INVALIDATE THE WARRANTY.

3.8 POWER ADJUSTMENT FOR VARIATION OF FUEL

PROPERTIES

FUEL PROPERTIES - Power output correction according to the properties of the fuel used.

The specified power output ratings are valid for fuel with the following properties:

Energy value

42 700 kJ/kg

Temperature before fuel supply pump: 35 (95) °C (°F)

Density

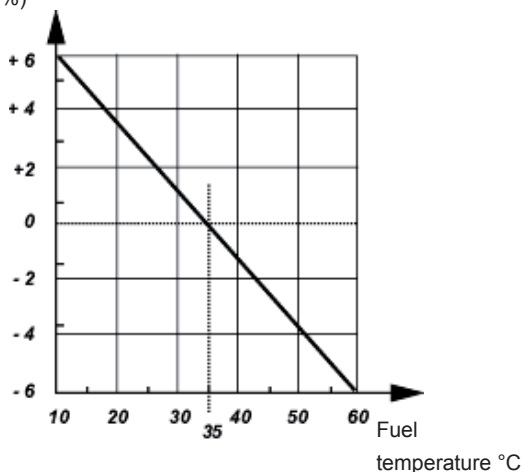
0.84 kg/dm³ at 15 (59) °C (°F)

If the fuel deviates from these values, consult the graph below to determine the power correction factor (in %).

Apply these factors to calculate engine power.

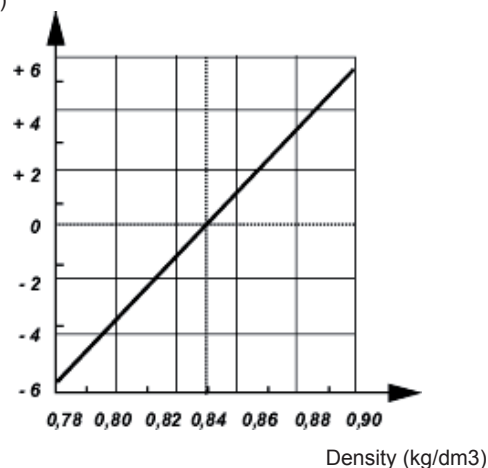
Effect of fuel temperature on engine power.
The normal temperature is +35 (95) °C (°F) (0%).

Power correction (%)



Effect of fuel density on engine power.
Normal value 0.84 kg/dm³ at +15 (59) °C (°F) (0%).

Power correction (%)



3.9 POWER ADJUSTMENT FOR VARIATION OF COMBUSTION AIR PROPERTIES

AIR PROPERTIES - Power output correction
according to air properties The specified power ratings are valid for air with following properties (as per ISO 3046):

Air pressure 100kPa (1000 mbar)

Air temperature 25 (77) °C (°F)

Humidity 30%, normally aspirated engines only (humidity is eliminated in the heat of turbochargers).

If the air deviates from these values, consult the graph below to determine the power correction factor.

Apply these factors to calculate the engine power.

Note: if the engine is used at air pressures (e.g. high altitudes) and/or temperatures exceeding the above standard values, the engine will have to be derated in order to compensate for the lower air pressure.

Reduced air density will negatively affect engine performance.

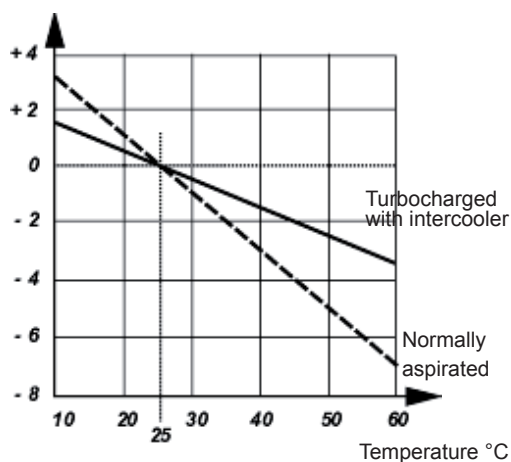
Incomplete combustion will result in black exhaust fumes and increased fuel consumption. There is also a risk of overrevving and overheating of the turbocharger.

To avoid these problems, the engine must be derated in accordance with "Derating of engine".

Effect of intake air temperature on engine performance

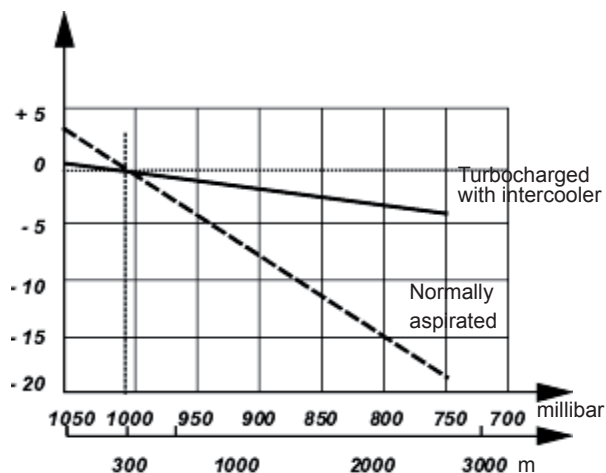
Normal value: +25 (77) °C (°F) (0%).

Power correction (%)



Effect of intake air pressure on engine power Normal value: 100 kPa (1000 mbar) (0%)

Power correction (%)



m = meters above sea level

3.10 SERVICE INTERVALS



CARRY OUT MAINTENANCE MORE FREQUENTLY WHEN THE ENGINE IS USED IN HARSH CONDITIONS (FREQUENT STOPS AND STARTS, DUSTY ENVIRONMENTS, LONG HARSH WINTERS, OPERATION UNDER NO-LOAD CONDITIONS).

IT IS STRICTLY FORBIDDEN TO CLEAN THE ENGINE WITH COMPRESSED AIR.

ADHERE SCRUPULOUSLY TO MAINTENANCE INTERVALS REPORTED BELOW.

Every 10 hours or every day

Check	Engine oil level
Check	Oil-bath air cleaner oil level
Clean	Oil bath air filter (to carry out the maintenance operation in function of the use conditions).
Clean	Dry air cleaner (to carry out the maintenance operation in function of the use conditions).
Check	Oil Radiator (the radiator must be frequently cleaned using a soft brush even daily if necessary).
Clean	Fan

After 50 hours

Change	Engine oil
Change	Oil filter cartridge
Check	Vee belt

THE ABOVE SERVICE INTERVAL FOR CHANGING THE ENGINE OIL APPLIES TO THE FIRST OIL CHANGE ONLY.

FAILURE TO PERFORM THIS OPERATION WILL INVALIDATE THE WARRANTY.

THE ABOVE SERVICE INTERVAL FOR INSPECTING THE VEE BELT APPLIES TO THE FIRST INTERVAL ONLY.

Every 100 hours

Clean	Fuel pump filter
-------	------------------

Every 150 hours

Change	Oil-bath air filter
Check	Vee belt

Every 300 hours

Change	Engine oil (must be performed at least once every 12 months in any event)
--------	---



OWING TO THE FACT THAT THE ENGINE WORKS IN HARSH CONDITIONS SUCH AS DUSTY ENVIRONMENTS AND HEAVY LOADS, MAKE SURE TO CHANGE THE ENGINE OIL EVERY 150 HOURS

Change	Oil filter cartridge
Change	Fuel filter cartridge (the fuel filter cartridge must be renewed at least once every 12 months, regardless of the hours of duty).
Check	Tightness of fuel line unions

Every 500 hours

Check	Injectors
Check	Valve clearances
Change	Dry air cleaner cartridge

Every 1000 hours

Clean	Fuel tank
Change	Alternator drive belt

Every 2000 hours

Check	Starter motor brushes
Check	Turbocharger

After 5000 hours

Overhaul	Partial engine
----------	----------------

After 9000 hours

Overhaul	Major engine
----------	--------------

SYSTEM DIAGRAMS

4

4.1 LUBRICATION SYSTEM

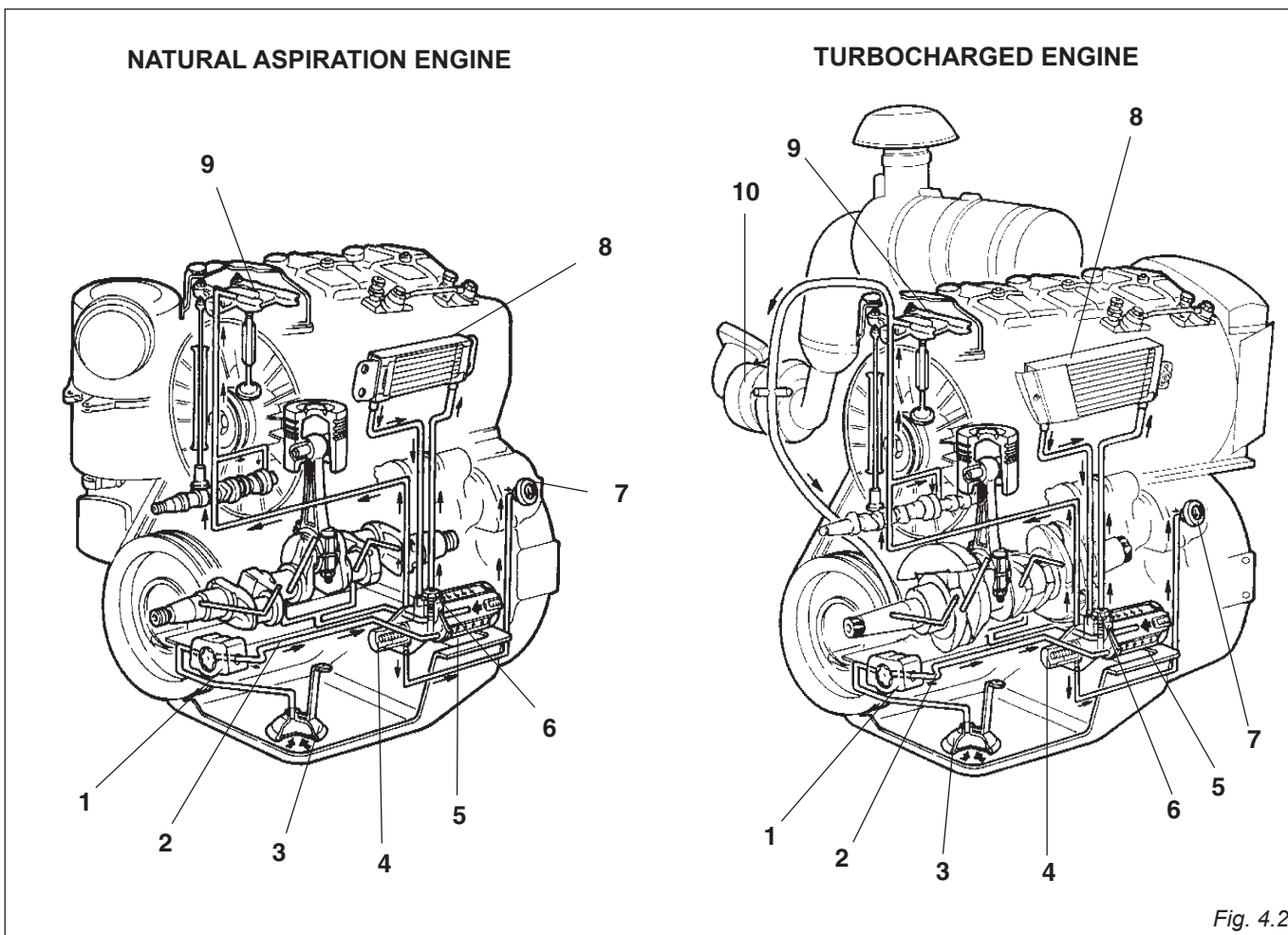


Fig. 4.2

KEY:

- | | |
|---------------------|-------------------|
| 1) Oil pump | 6) Thermostat |
| 2) Oil pipe | 7) Pressure gauge |
| 3) Oil pick-up pipe | 8) Oil radiator |
| 4) Pressure switch | 9) Rocker arms |
| 5) Filter cartridge | 10) Turbocharger |

4.2 LUBRICATING SYSTEM

The lubricating oil is forced through the system by a rotor pump and filtered before being sent to the various points requiring lubrication. The oil from the pump is sent through a pressure regulating valve to the filter and then to the crankshaft main bearings, and through external pipes to the rocker arms and the turbocharger.

When oil in the circuit reaches 80-85°C a thermostatic valve sends hot oil to the oil radiator.



WARNING! OIL, FUEL, COOLANT MIXTURES, ETC. ARE HARMFUL IF INGESTED.

Lubrication circuit pressure (with engine hot)

SUN 2105-3105-3105T-4105E-TE-IE- 6105E-TE-IE

min / 800÷900 rpm = 100 ÷ 150 kPa (1 ÷ 1.5 bar)
(14.5 ÷ 21.7 psi)

max / 2500 rpm = 300 ÷ 350 kPa (3 ÷ 3.5 bar)
(43.5 ÷ 51 psi)

SUN 2105E1-3105E1

min / 800÷900 rpm = 100 ÷ 150 kPa (1 ÷ 1.5 bar)
(14.5 ÷ 21.7 psi)

max / 2300 rpm = 450 ÷ 500 kPa (4.5 ÷ 5 bar)
(65 ÷ 72.5 psi)

SUN 3105TE1-4105TE1-6105TE1

min / 800÷900 rpm = 100 ÷ 150 kPa (1 ÷ 1.5 bar)
(14.5 ÷ 21.7 psi)

max / 2300 rpm = 350 ÷ 400 kPa (3.5 ÷ 4 bar)
(51 ÷ 58 psi)

4.2 FUEL SYSTEM

4.2.1 Internal injection pump (2105 - 2105E1-
3105- 3103E1- 3105 T - TE1)

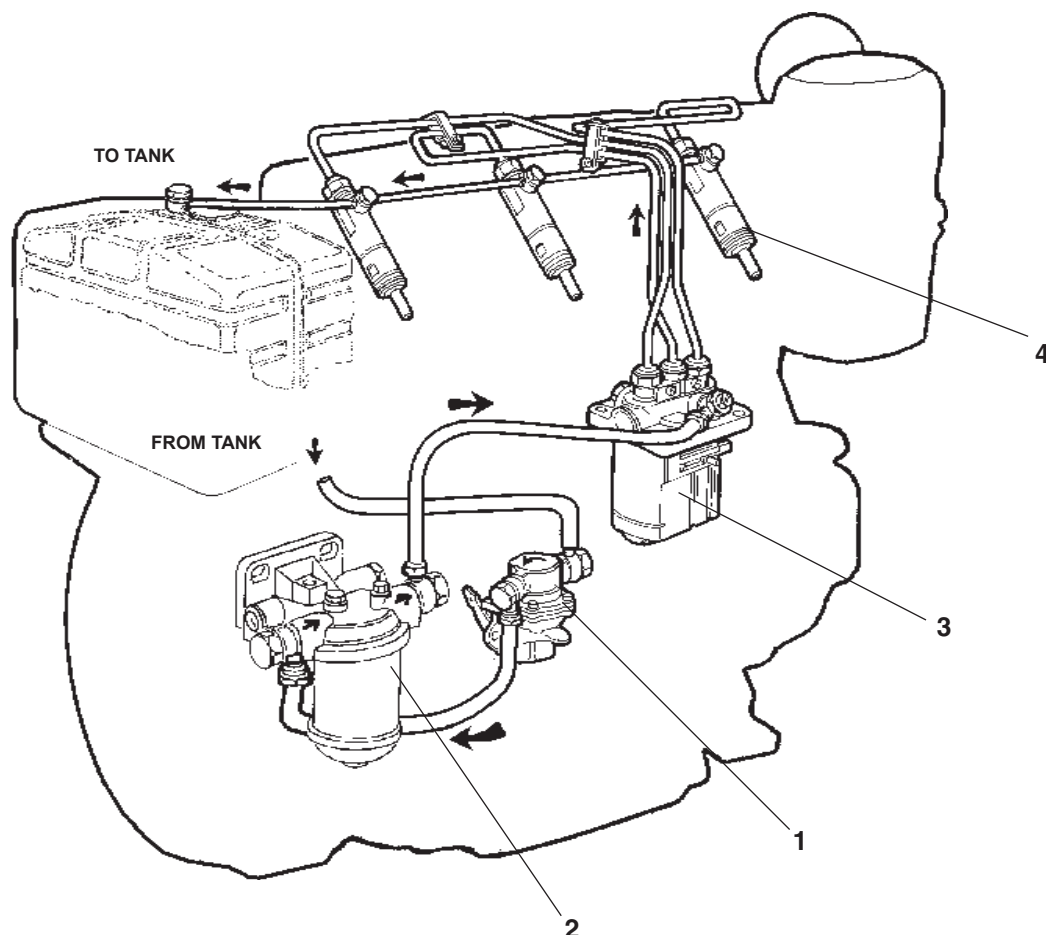


Fig. 4.3

KEY:

- 1) Fuel supply pump
- 2) Fuel filter
- 3) Injection pump
- 4) Injector

System pressure
30 - 40 kPa (0.3 - 0.4 bar)



**WARNING! OIL, FUEL, COOLANT
MIXTURES, ETC. ARE HARMFUL IF
INGESTED.**

4.2.2 Rotary pump (STANADYNE) 4105E-E1

4105TE-TE1- 4105 IE 6105E- 6105TE-TE1- 6105IE

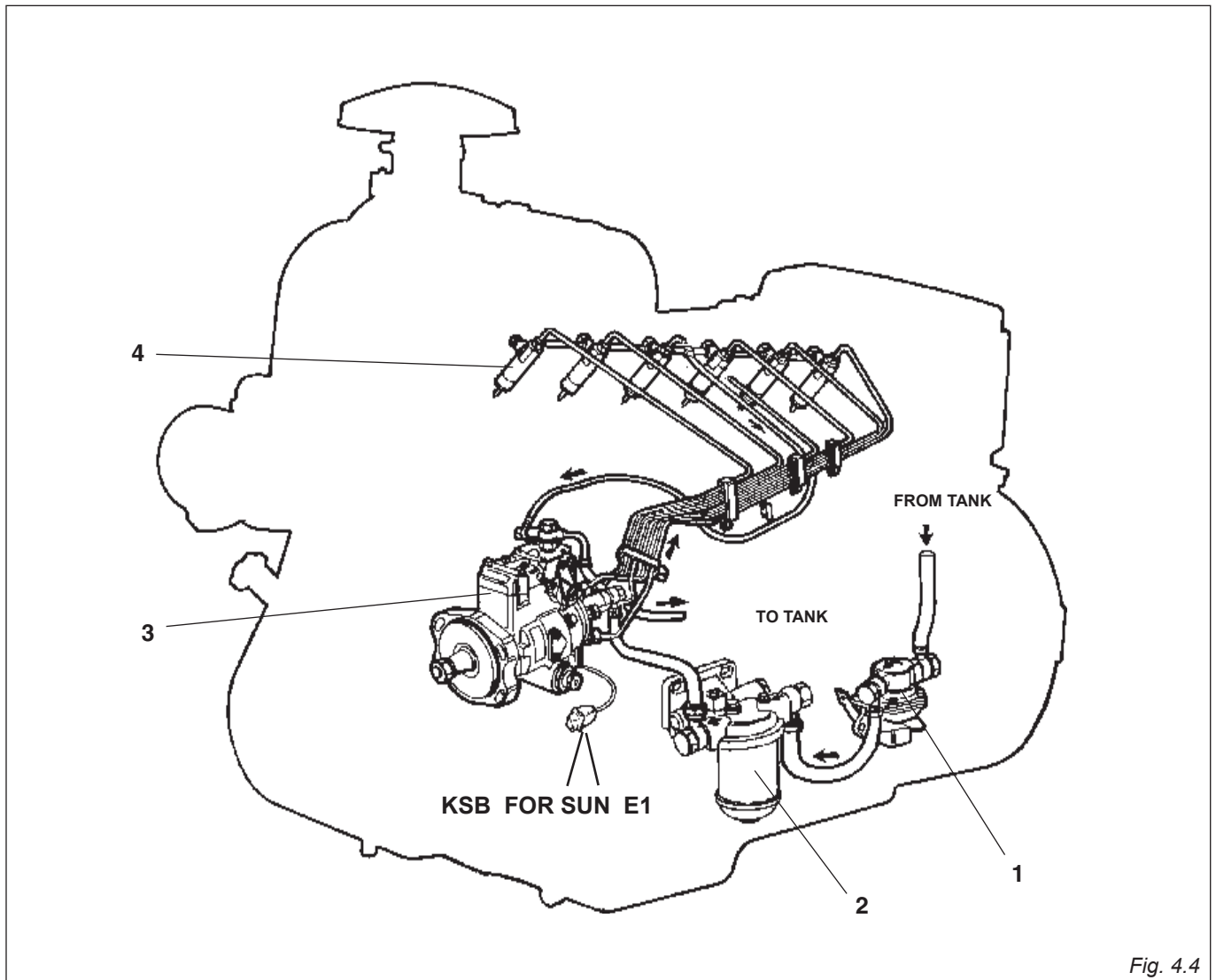


Fig. 4.4

KEY:

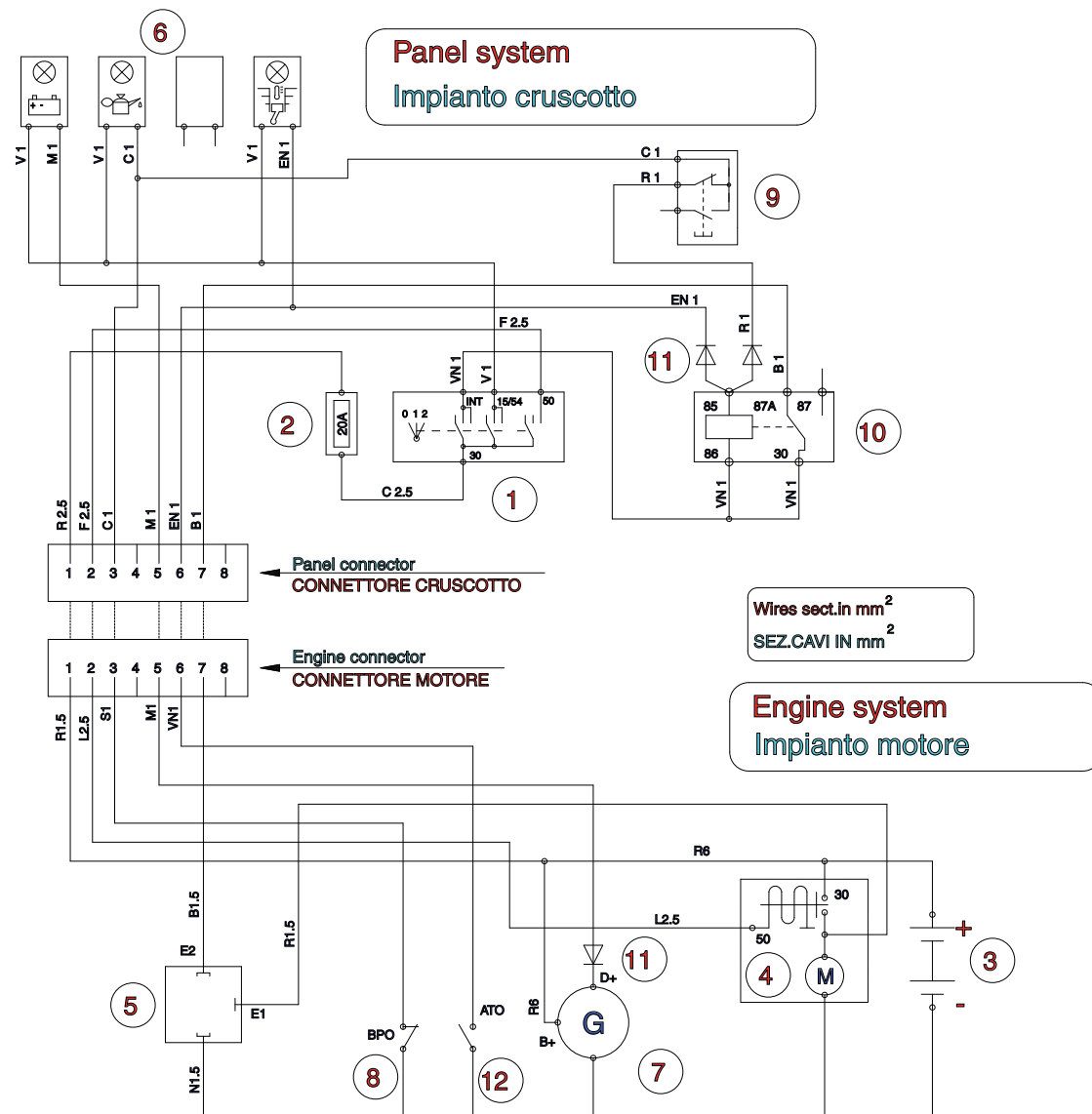
- 1) Fuel supply pump
- 2) Fuel filter
- 3) Injection pump
- 4) Injector

System pressure
30 - 40 kPa (0.3 - 0.4 bar)



**WARNING! OIL, FUEL, COOLANT
MIXTURES, ETC. ARE HARMFUL IF
INGESTED.**

STANDARD ELECTRICAL SYSTEM (2 and 3 cylinders) - 12/24V

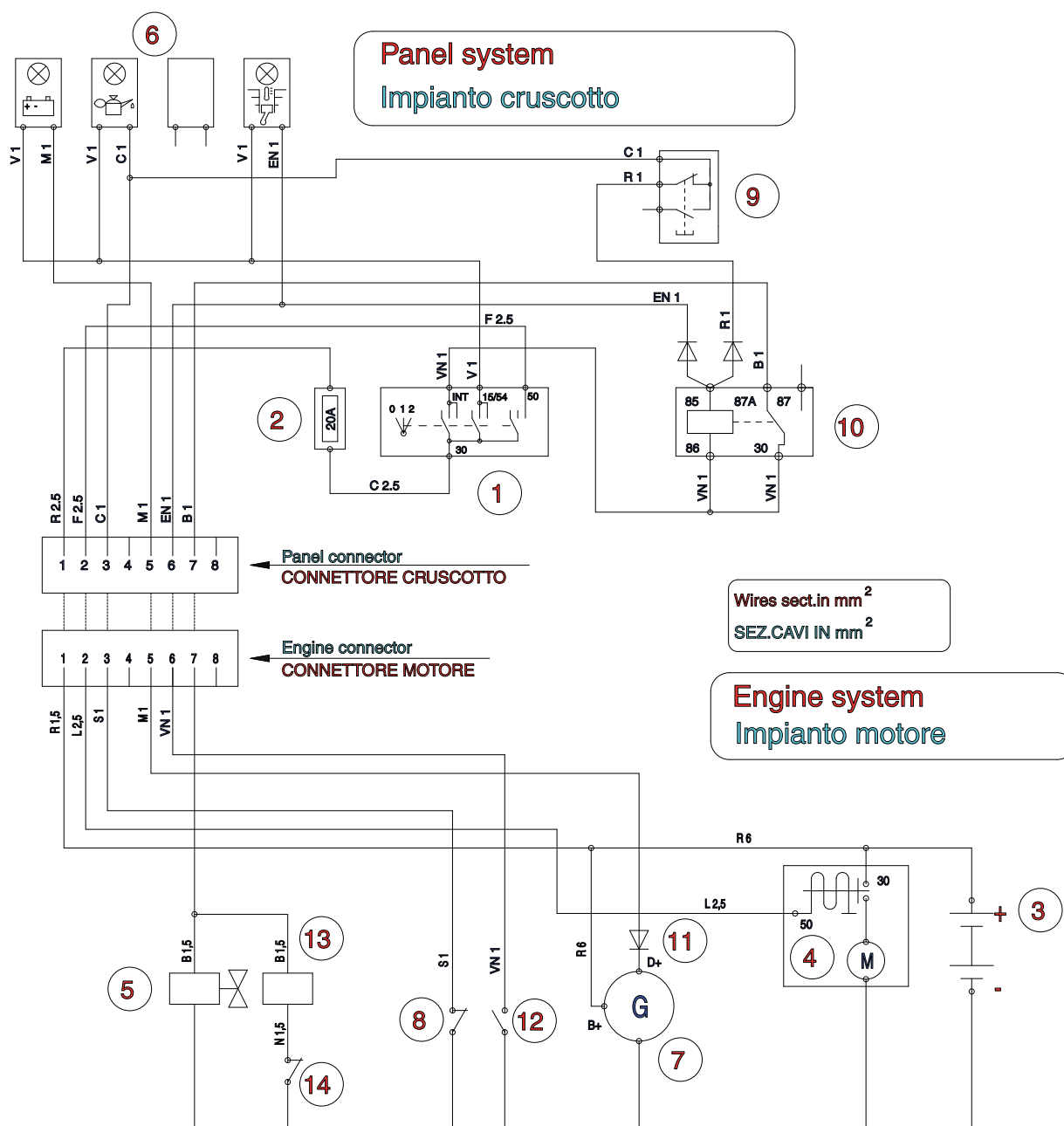


N°	DENOMINAZIONE	DESCRIPTION
1	Chiave avviamento	Switch key
2	Fusibile	Fuse
3	Batteria	Battery
4	Motorino d'avviamento	Starter
5	Elettrostop	Electrostop
6	Lampade + portalampe	Lamps + lamps holder
7	Alternatore ISKRA	ISKRA alternator
8	Manocontacto bassa pressione olio	Low oil pressure sensor

N°	DENOMINAZIONE	DESCRIPTION
9	Pulsante esclusione interv. B.P.O. all'avviam.	Release button for L.O.P. alarm at starting.
10	Servo rele'	Servo relais
11	Diode	Diode
12	Termocontacto alta temperatura olio	High oil temperature sensor

 SUN2105E1 SUN3105E1/TE1	SCHEMA IMPIANTO ELETTRICO 12V/24V 12V/24V electrical schematics			
	Data/Date	Disegn./Drawn.	Control./Ckd	TAB.N°
	03/02	Maniezzi	Paris	11.8.1B

STANDARD ELECTRICAL SYSTEM (4 and 6 cylinders) - 12/24V



N°	DENOMINAZIONE	DESCRIPTION
1	Chiave avviamento	Switch key
2	Fusibile	Fuse
3	Batteria	Battery
4	Motorino d'avviamento	Starter
5	Elettrostop	Electrostop
6	Lampade + portalampe	Lamps + lamps holder
7	Alternatore ISKRA	ISKRA alternator
8	Manocontacto bassa pressione olio	Low oil pressure sensor

N°	DENOMINAZIONE	DESCRIPTION
9	Pulsante esclusione interv. B.P.O. all'avviam.	Release button for L.O.P. alarm at starting.
10	Servo rele'	Servo relais
11	Diode	Diode
12	Termocontacto alta temperatura olio	High oil temperature sensor
13	Anticipo avviamento a freddo CSA	Cold starting device
14	Trasmittitore olio per CSA	Oil temp. for cold starting device

SUN4105E-TE-TE1
SUN6105E-TE-TE1

SCHEMA IMPIANTO ELETTRICO 12V/24V

12V/24V electrical schematics

Data/Date	Disegn./Drawn.	Control./Ckd	TAB.N°
05/02	Maniezzi	Paris	11.8.2B

4.3 ELECTRICAL SYSTEM PANEL PLANT

4.3.1 SUN 2105 - 3105 - 3105 T - 4105 - 6105 T - 12 / 24 V

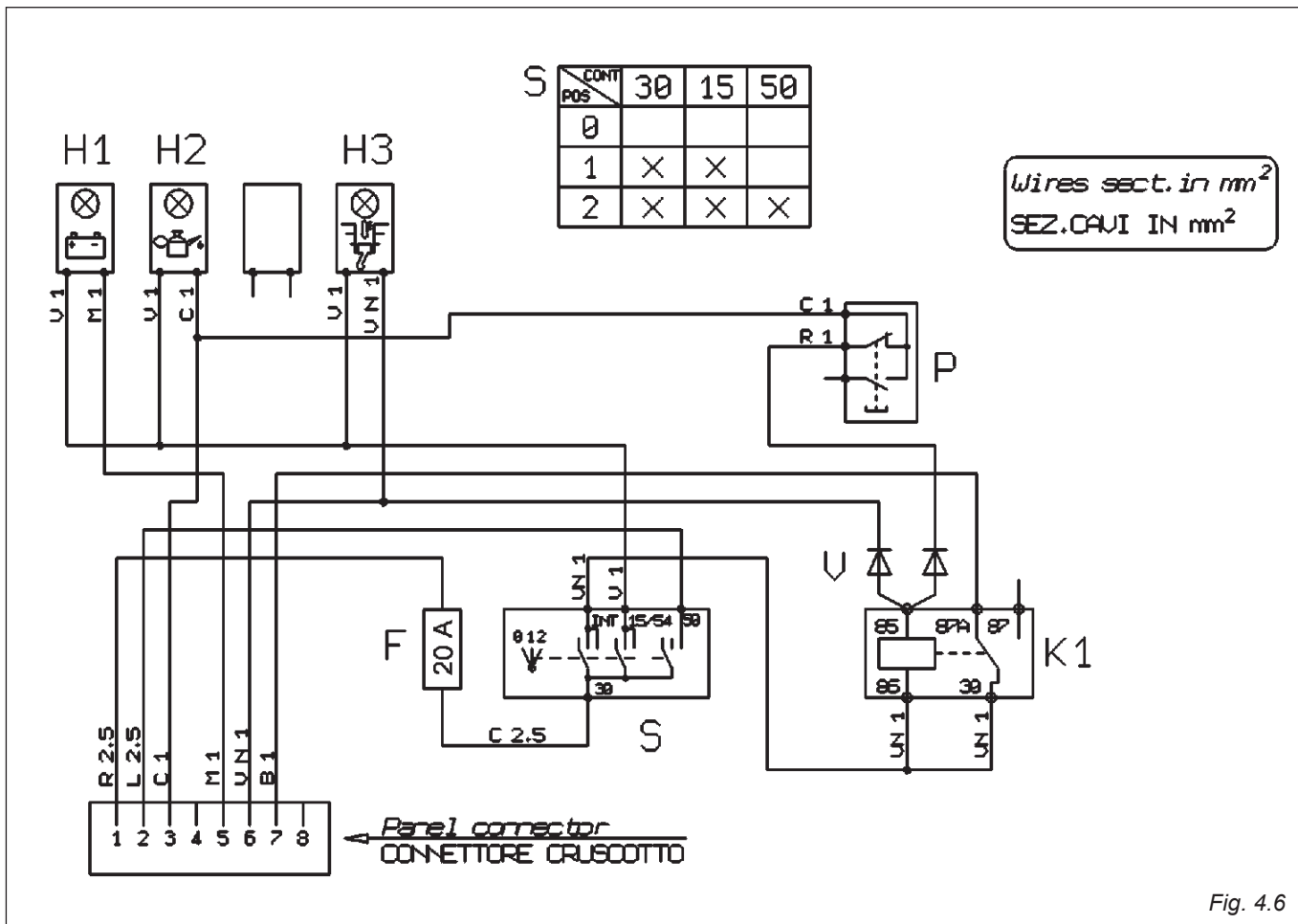


Fig. 4.6

KEY

S ignition keyswitch

P release button for low oil pressure trasmitter alarm at starting

F fuse

H1 alternator charge indicator lamp

H2 low oil pressure warning lamp

H3 high cylinder heads temperature warning lamp

K1 relay

V diode

4.3.2 SUN 2105E/E1 - 3105E/E1 - 3105 TE/TE1 - 4105E - 4105TE/TE1 - 6105E - 6106TE/TE1 **12 / 24 V**

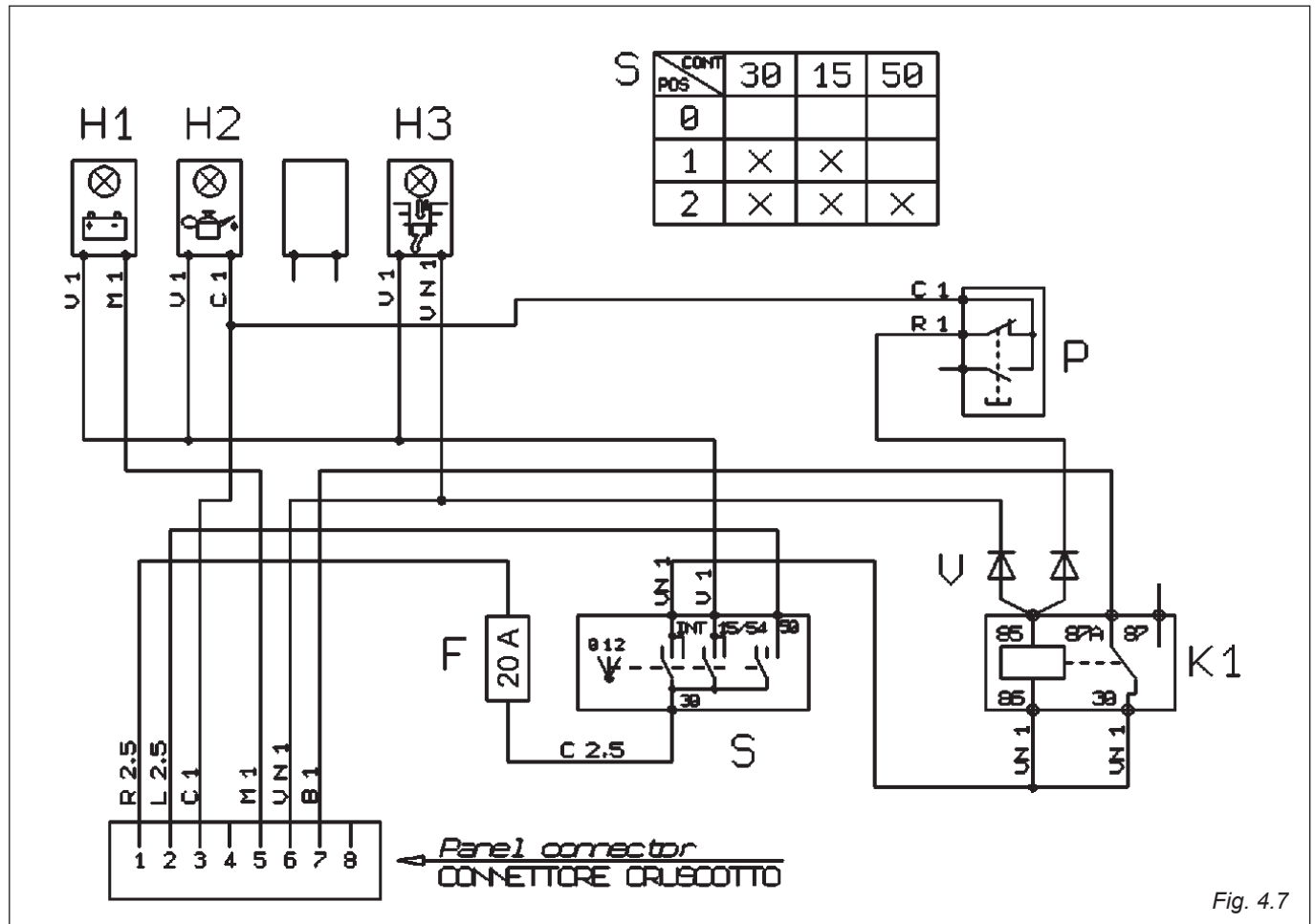


Fig. 4.7

KEY

S ignition keyswitch

P release button for low oil pressure trasmitter alarm at starting

F fuse

H1 alternator charge indicator lamp

H2 low oil pressure warning lamp

H3 high cylinder heads temperature warning lamp

K1 relay

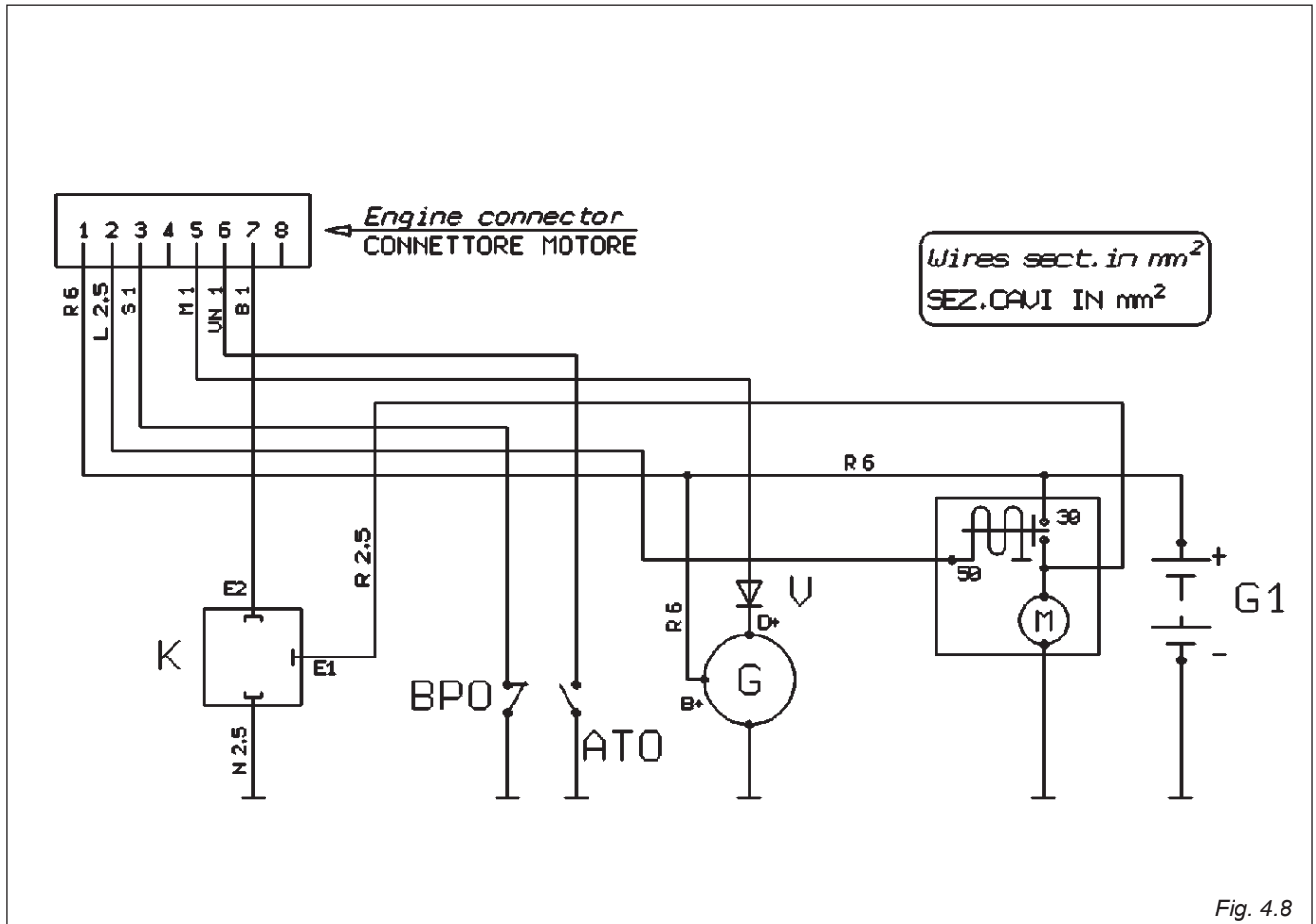
V diode

SUN 4105 TE2 12 / 24 V

4105 TE2 16662042F 01

4.4 ELECTRICAL SYSTEM ENGINE

4.3.3 SUN 2105 - 3105/T - 12 / 24V



KEY

G1 battery

G alternator

M starter motor

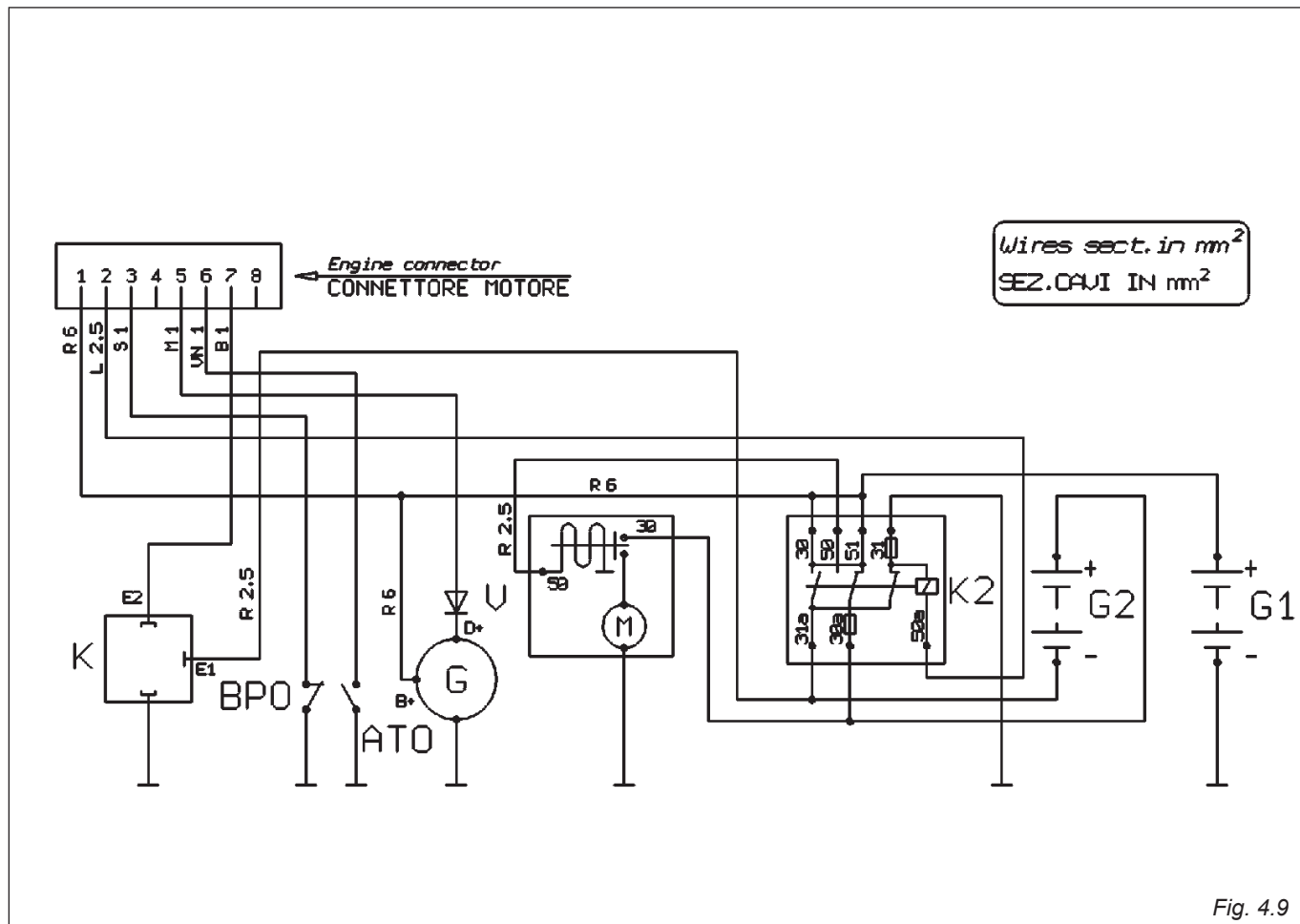
K electrovalve

BPO low oil pressure trasmitter

ATO high temperature oil thermal contact

V diode

4.3.4 SUN 2105 - 3105/T 12V and STARTER MOTOR 24V



KEY

G1 battery

G2 battery

G alternator

M starter motor

K1 electrostop

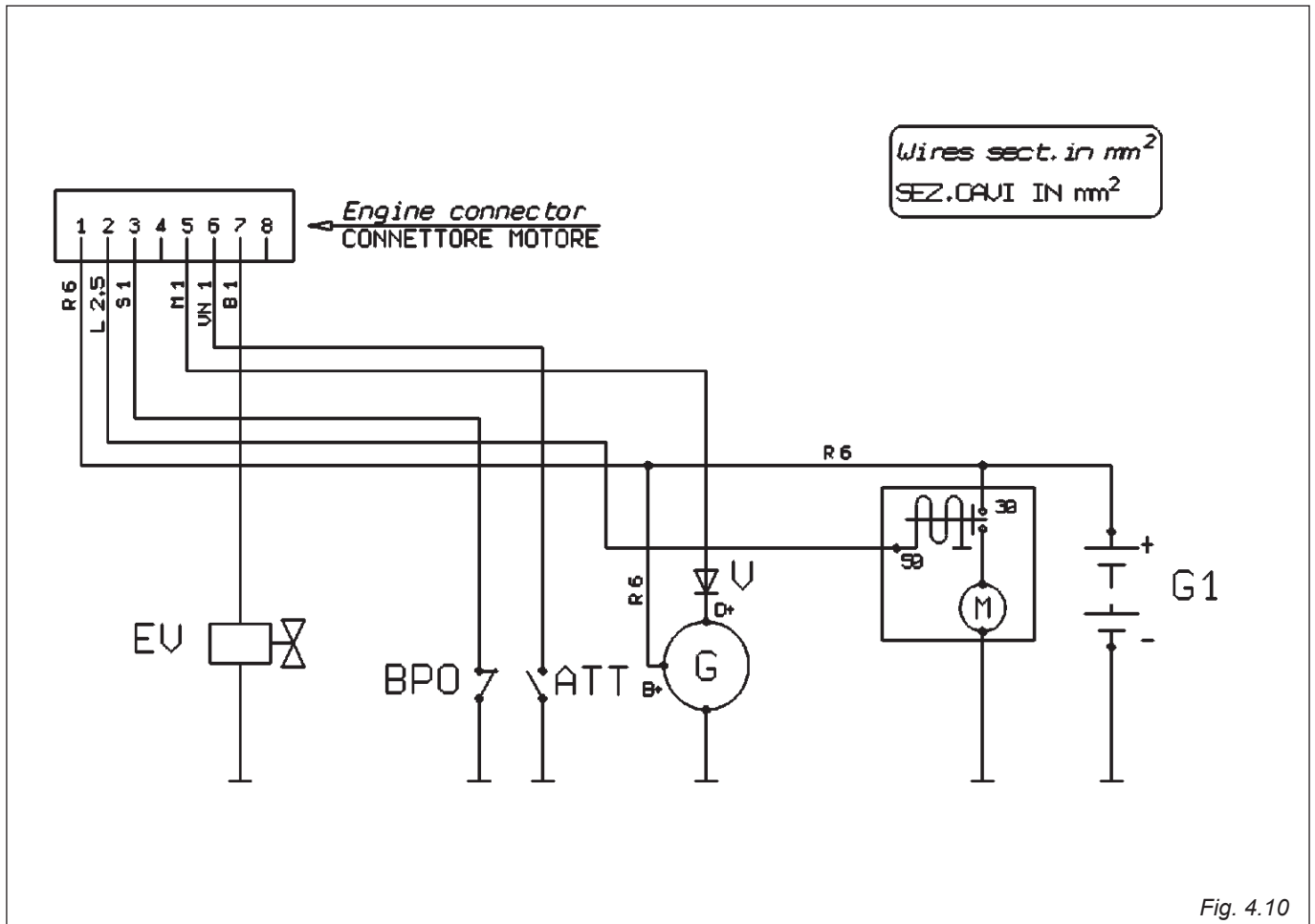
K2 multi point relay switch

BPO low oil pressure trasmitter

ATO high temperature oil thermal contact

V diode

4.3.5 SUN 4105 - 6105/T - 12V / 24V



KEY

G1 battery

G alternator

M starter motor

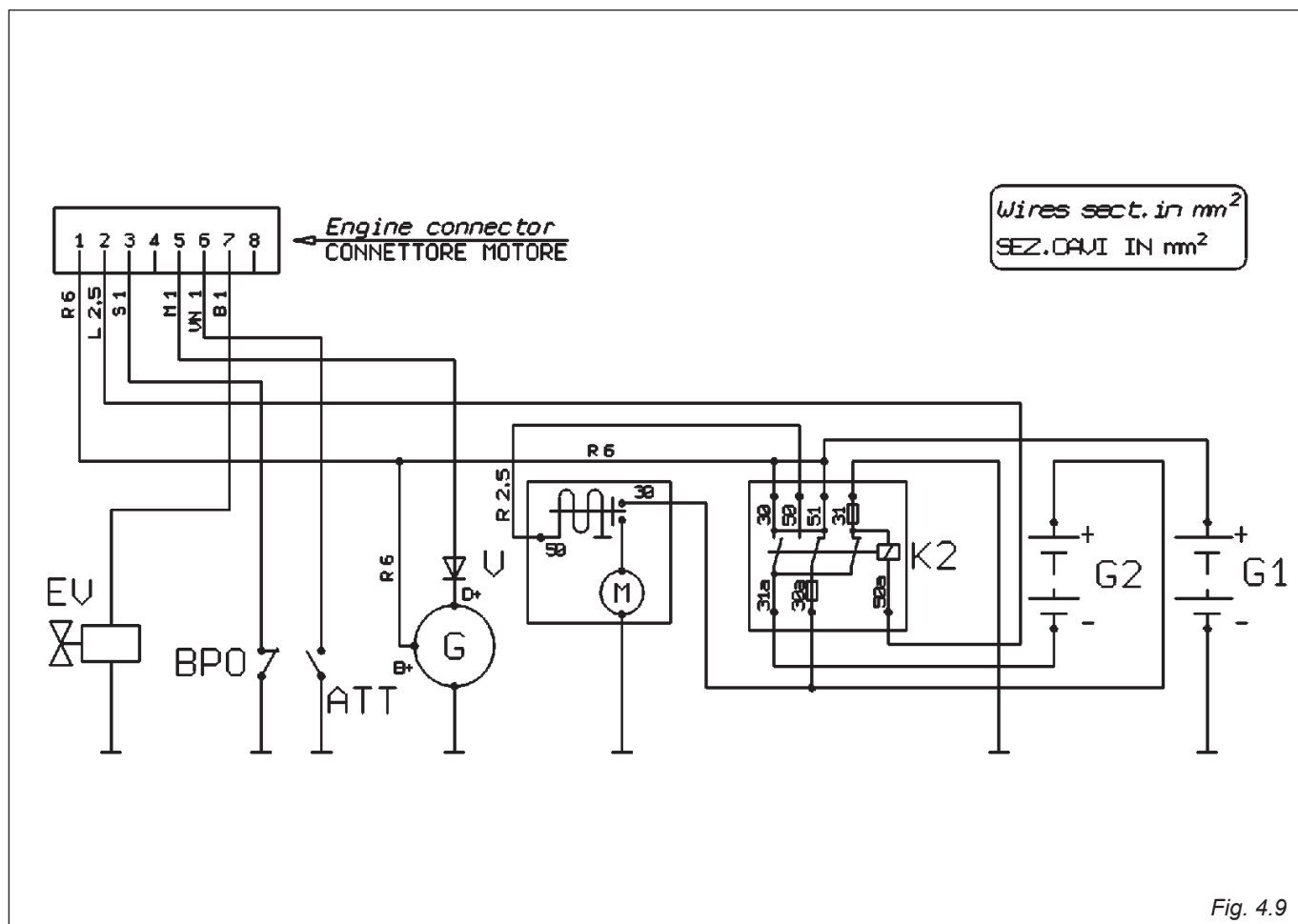
BPO low oil pressure trasmitter

ATT high cylinder heads temperature thermal contact

EV solenoid valve rotary pump

V diode

4.3.6 SUN 4105 - 6105/T 12V and STARTER MOTOR 24V



KEY

G1 battery

G2 battery

G alternator

M starter motor

K2 multi point relay switch

BPO low oil pressure trasmitter

ATT high cylinder heads temperature thermal contact

EV solenoid valve rotary pump

V diode

4.3.7 SUN 4105E/TE/TE1 - 6105E/TE/TE1 - 12V / 24V

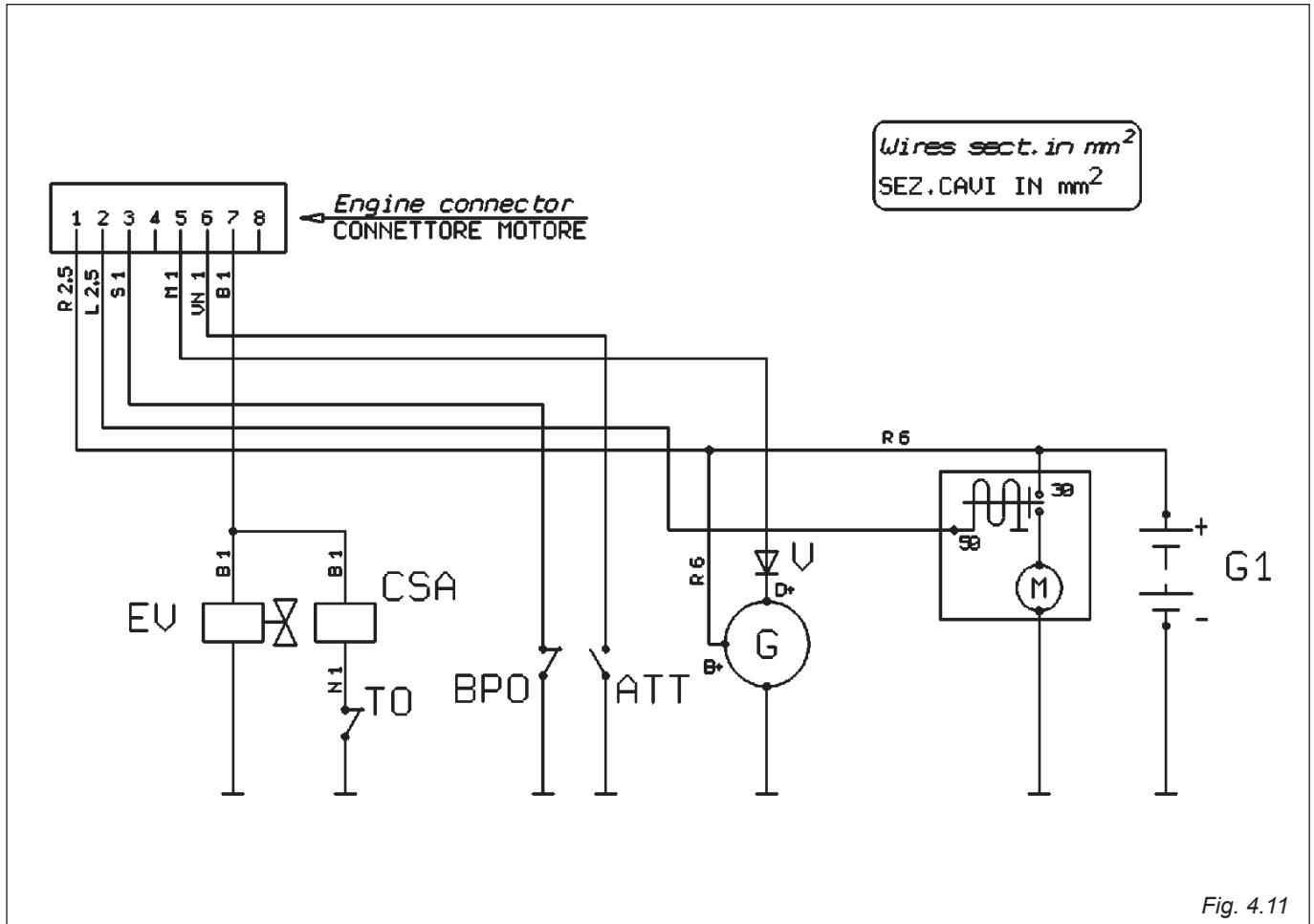


Fig. 4.11

KEY

G1 battery

G alternator

M starter motor

BPO low oil pressure trasmitter

ATT high cylinder heads temperature thermal contact

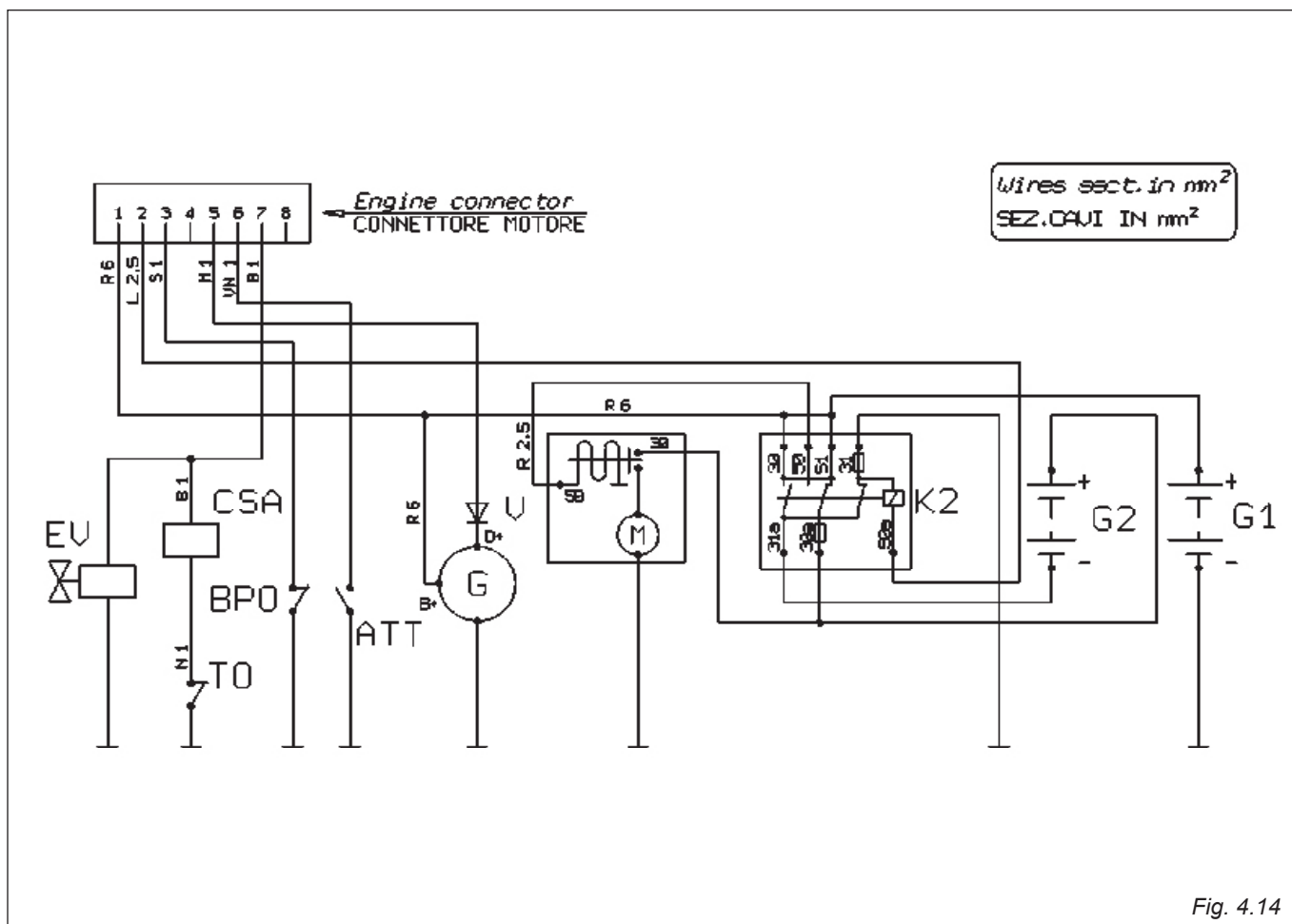
CSA mechanical accelerator staring to cold

EV solenoid valve rotary pump

TO thermostat temperature engine for CSA

V diode

4.3.10 SUN 4105E/ET/TE1 - 6105E/TE/TE1 12V and STARTER MOTOR 24V



KEY

G1 battery

G2 battery

G alternator

M starter motor

K2 multi point relay switch

BPO low oil pressure trasmitter

ATT high cylinder heads temperature thermal contact

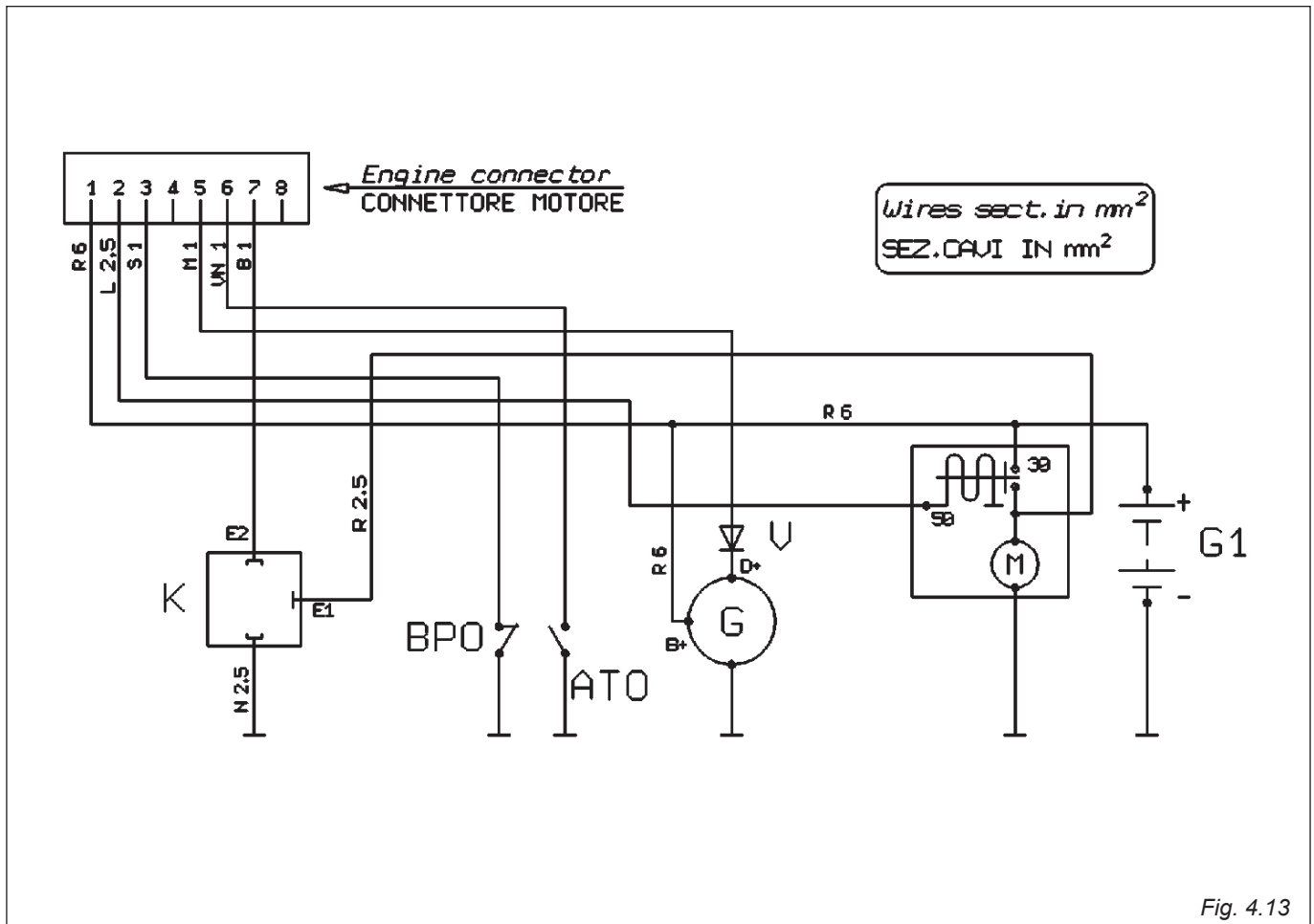
V diode

EV solenoid valve rotary pump

CSA mechanical accelerator starting to cold

TO thermostat temperature engine for CSA

4.3.9 SUN 2105E/E1 - 3105E/TE/E1/TE1 - 12V / 24V



KEY

G1 battery

G alternator

M starter motor

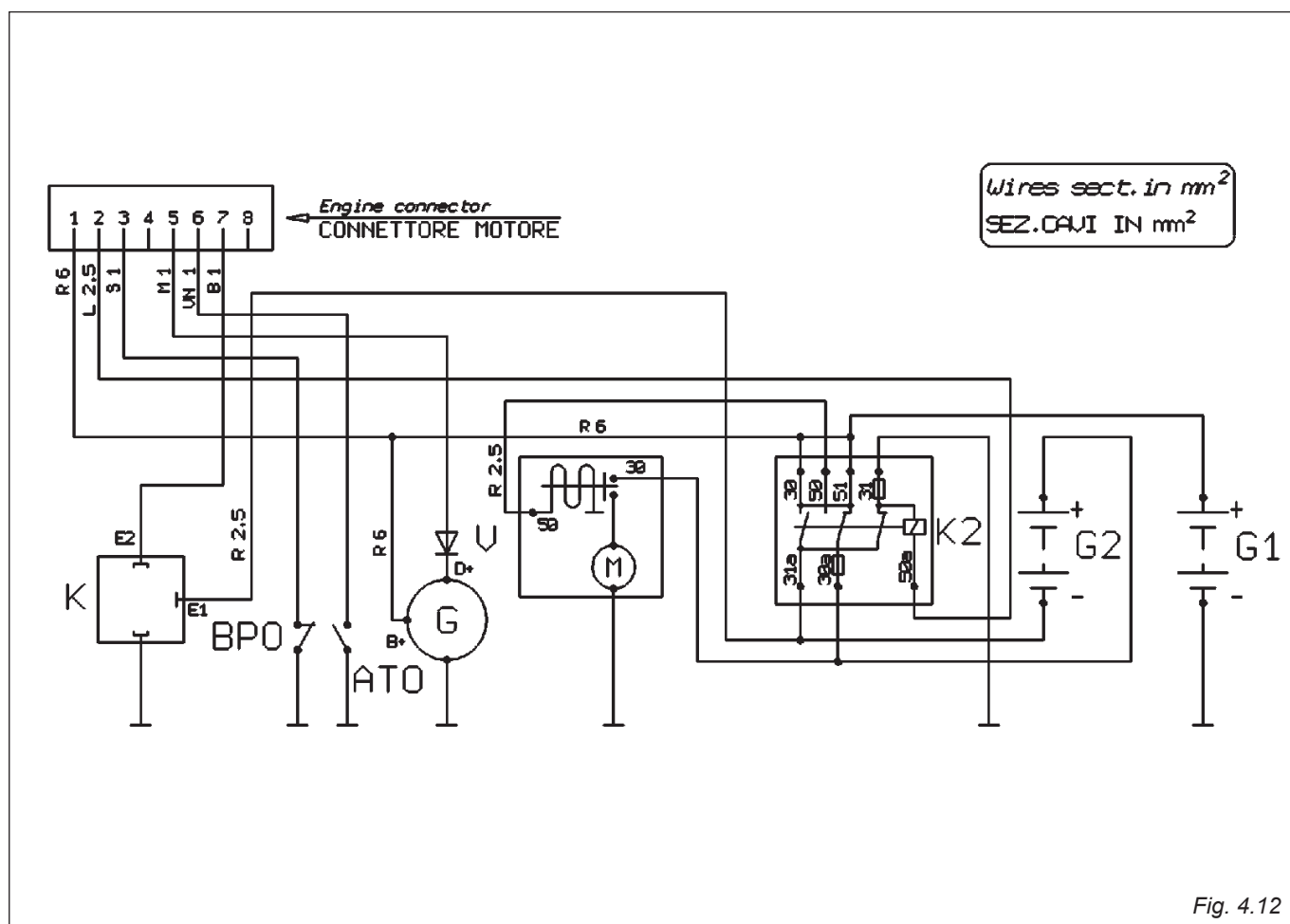
BPO low oil pressure trasmitter

ATO high temperature oil thermal contact

K connector stop solenoid

V diode

4.3.8 SUN 2105E/E1 - 3105E/TE - 3105E1/TE1 12V and STARTER MOTOR 24V



KEY

G1 battery

G2 battery

G alternator

M starter motor

K connector stop solenoid valve

K2 multi point relay switch

BPO low oil pressure trasmitter

ATO high temperature oil thermal contact

V diode

4.3.11 SUN 4105 TE2 12V / 24V

CABLAGGIO MOTORE
ENGINE WIRING HARNESS

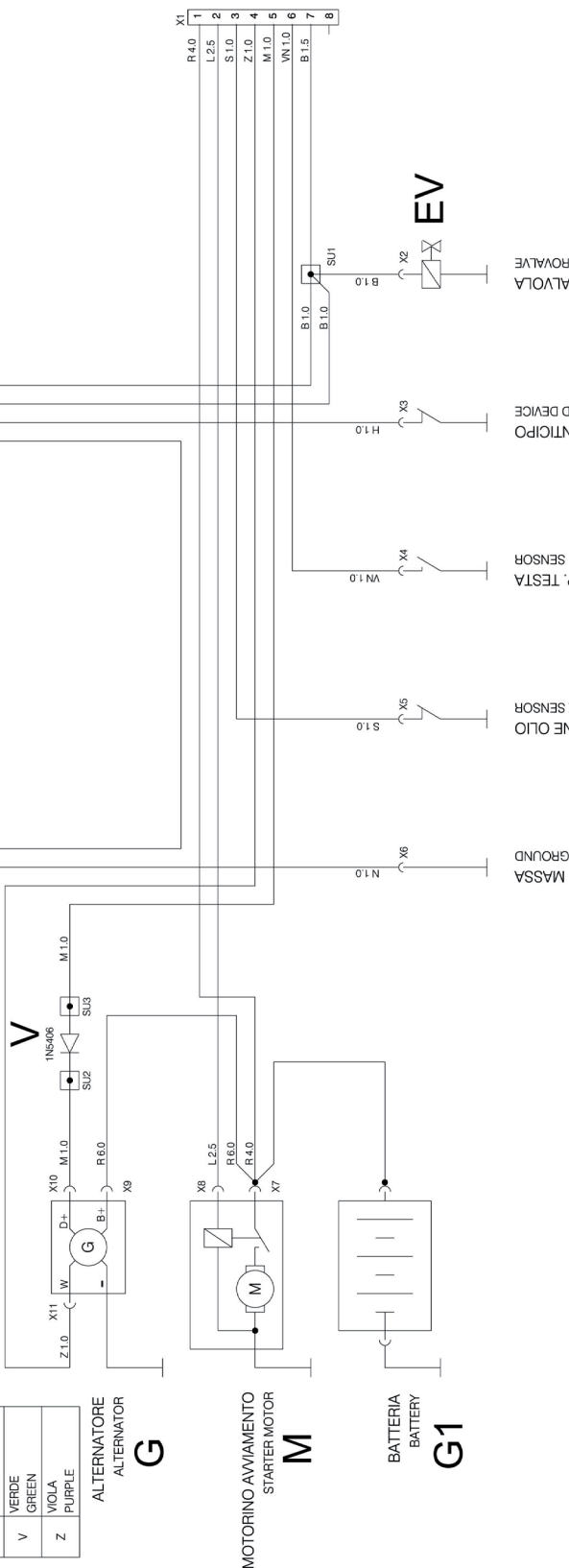
CODICE COLORI
COLOR CODE

A	AZZURRO	LIGHT BLUE
B	BIANCO	WHITE
C	ARANCIO	ORANGE
G	GIALLLO	YELLOW
H	GRIGIO	GREY
L	BLU	BLUE
M	MARRONE	BROWN
N	NERO	BLACK
R	ROSSO	RED
S	ROSA	PINK
V	VERDE	GREEN
Z	VIOLA	PURPLE

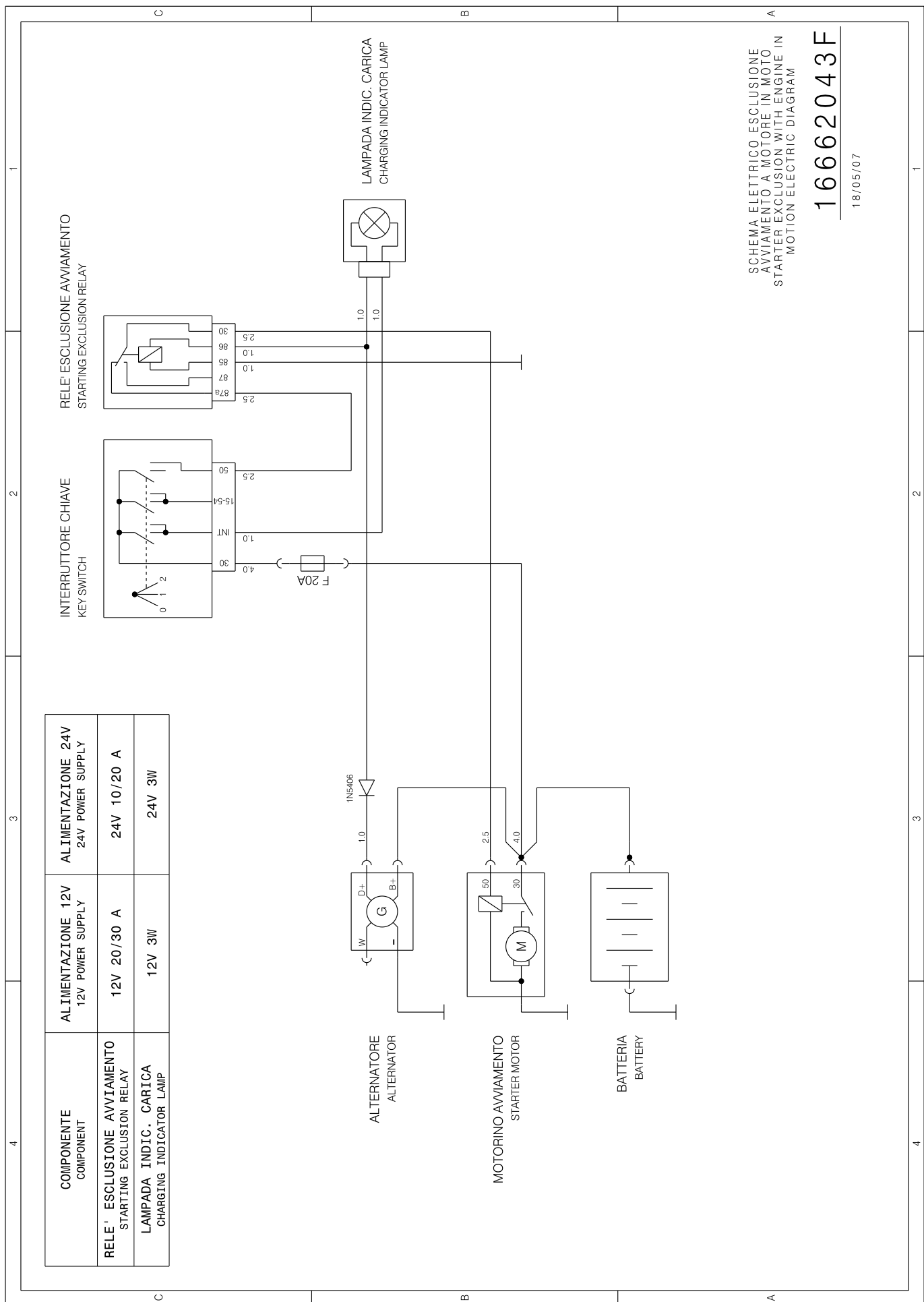
CSA

DISP. ANTICIPO AV. A FREDDO
COLD STARTING DEVICE

RELE' ANTICIPO AV. A FREDDO
COLD STARTING RELAY



4.3.12 Exclusion of the starter motor with operating engine



4.5 LEGEND OF COLORS

LIGHT BLU	A
WHITE	B
ORANGE	C
YELLOW	G
GREY	H
BLUE	L
BROWN	M
BLACK	N
LIGHT BROWN	P
RED	R
PINK	S
GREEN	V
VIOLET	Z
YELLOW/BLACK	GN
ORANGE/BLACK	CN
GREEN/BLACK	VN

[illegible]

DISASSEMBLY

5

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PAGE INTENTIONNELLEMENT BLANCHE

WEIß SEITE

PÁGINA INTENCIONALMENTE BLANCA

5.0 INTRODUCTION

The following instructions refer to engine models available at the time of publication of this manual.

Before proceeding with the complete or partial disassembling of the engine, check that the problem is not due to some external cause.



WHERE VM SPECIAL TOOLS ARE NOT SPECIFIED IN THE DISASSEMBLY PROCEDURES, USE STANDARD COMMERCIAL TOOLS OF THE TYPE ILLUSTRATED.

5.0.1 Mounting the engine on the stand

Mount the engine on a commercial stand as shown in figure 5.0.

Secure the engine by means of the assembling arms and bolts provided with the stand (or using mounting bolts of the same type).



WARNING: THE STAND MUST BE EQUIPPED WITH A REDUCTION GEAR AS SHOWN IN THE FIGURE TO SLOW DOWN ENGINE ROTATION AND CONTROL ROCKING.



WARNING: REMEMBER TO INSERT THE LOCK PIN (A) AND CHECK THAT IT EFFECTIVELY LOCKS THE ENGINE IN POSITION.



WARNING: RISK OF CRUSHING AND/OR SHEARING OF LIMBS DURING ROTATION OF ENGINE ON STAND.



NEVER INTRODUCE PARTS OF THE BODY OR FOREIGN OBJECTS IN THE AREA SHADED GREY IN FIGURE 5.0.

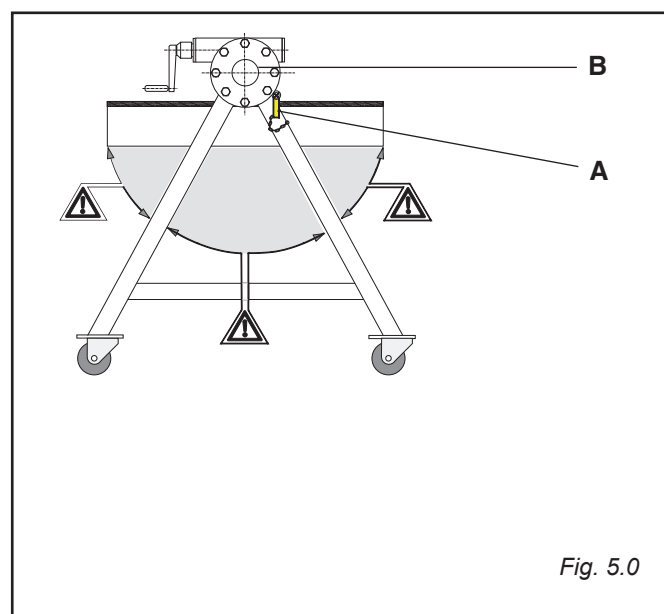


Fig. 5.0

5.1 BELT GUARD (FIG. 5.1)

Unscrew screws **A**.

5.2 FAN COVER (FIG. 5.1)

Unscrew screws **B**.

5.3 AIR FILTER (FIG. 5.1)

Loosen screw **C** and remove clamp **D**.

Loosen and open clamps **E**

Remove filter **F**

5.4 FILTER SUPPORT (FIG. 5.1)

Unscrew the 2 screws **H** and nut **G**.

Unscrew screw and locknut **I**.

Disassemble support **L**.

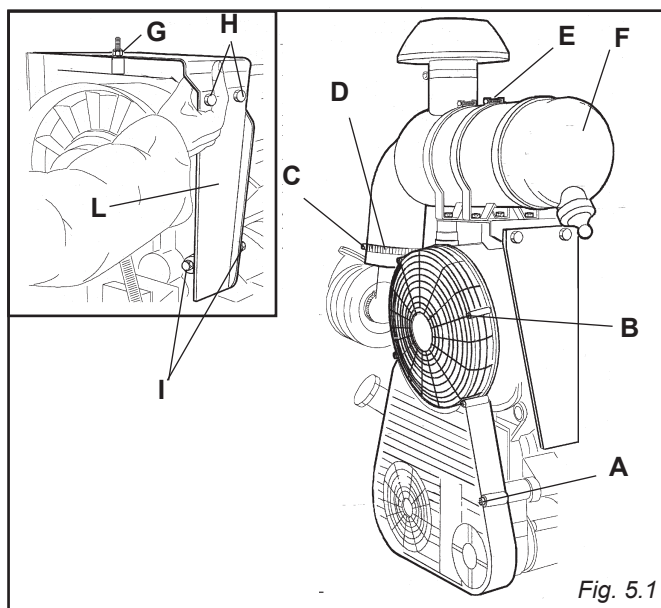


Fig. 5.1

5.5 TURBOCHARGER (FIG. 5.2)

Unscrew the oil feed pipe to turbocharger **A**, restraining the lower union with a wrench.

Unscrew nuts **B** and remove the oil return pipeline **C** complete with seal **D**.

Loosen clamp **E**.

Unscrew nuts **F** and remove turbocharger **G** with relative gasket **H**.

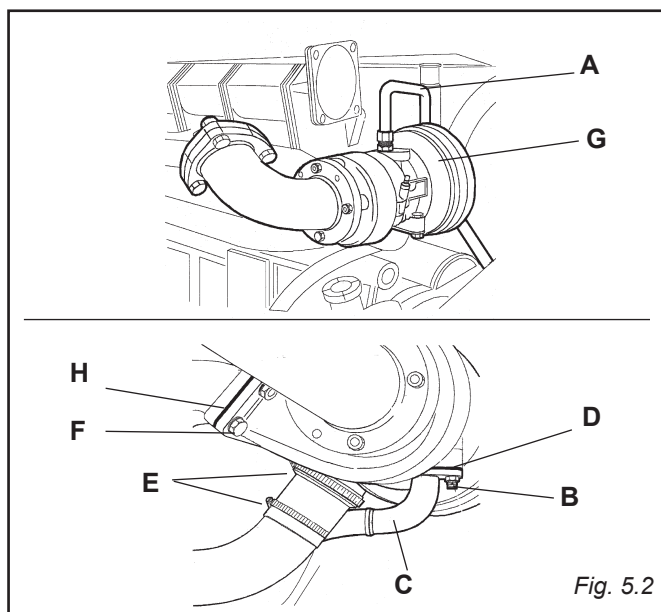


Fig. 5.2

OIL FEED PIPE TO TURBOCHARGER (FIG. 5.3)

Remove hose clamp **A**

Unscrew union **B** connected to the oil filter, holding the lower union with a wrench.

OIL RETURN PIPE FROM TURBOCHARGER TO SUMP (FIG. 5.3)

Unscrew union **A** at the bottom of the pipe and remove pipe and hose.

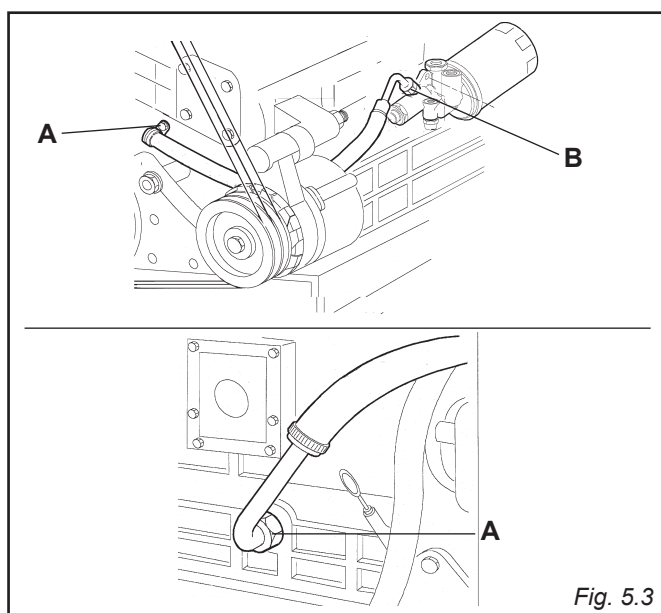


Fig. 5.3

AIR PIPELINE FROM TURBOCHARGER TO INTERCOOLER (FIG. 5.4)

Unscrew screws **A**.

Unscrew screw **B** fixing air hose **C**.

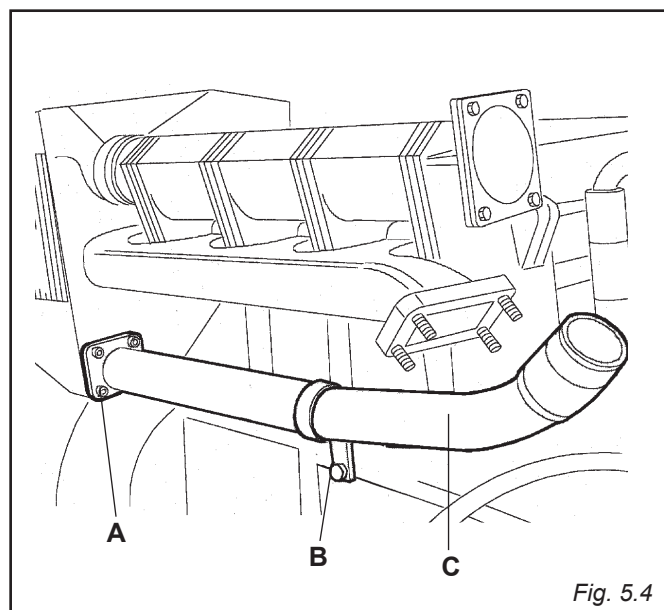


Fig. 5.4

5.6 INTERCOOLER (FIG. 5.5)

Remove shroud **A** by unscrewing screws **B**.

Unscrew screws **C**.

Loosen the two clamps **E**.

Remove intercooler **D**.



**TO REMOVE THE COMPLETE UNIT,
UNSCREW THE SUPPORT SCREWS
AND LOOSEN THE HOSE CLAMPS**

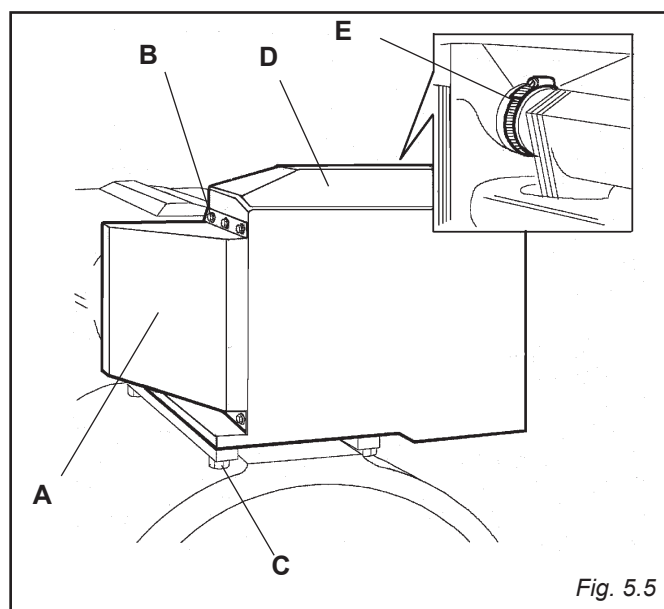


Fig. 5.5

5.7 STARTER MOTOR (FIG. 5.6)

Disconnect the battery leads.

Unscrew nuts **A**.

Remove the starter motor **B**.

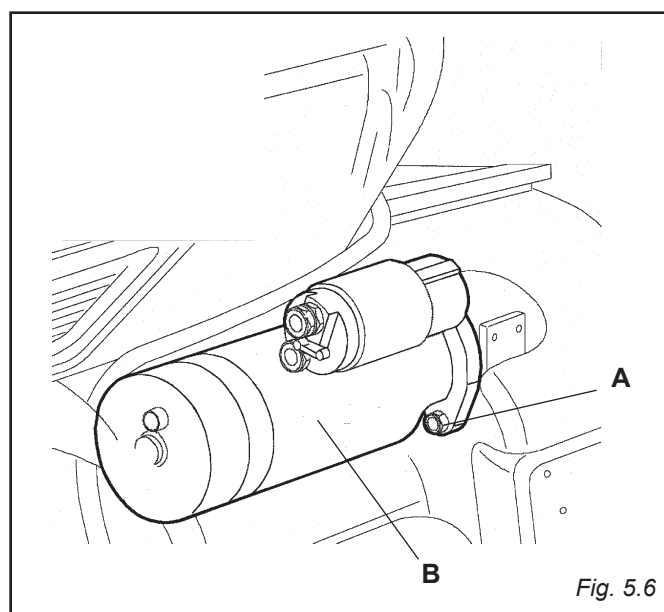
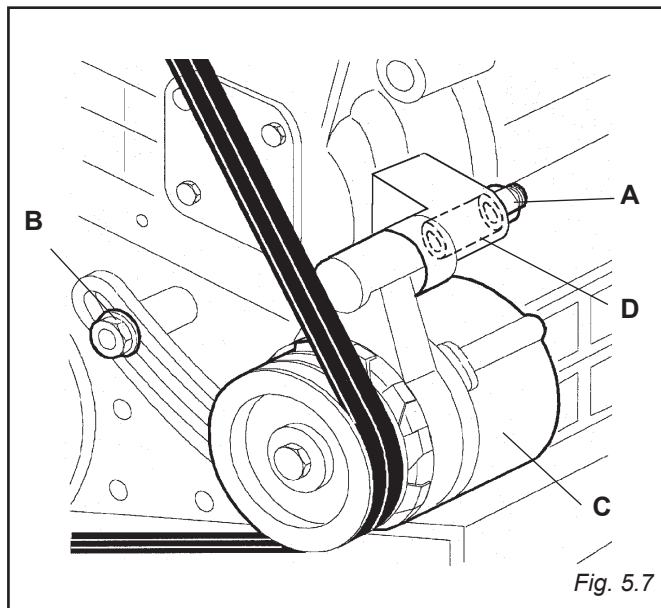


Fig. 5.6

5.8 BELTS (FIG. 5.7)

Loosen the nut of support **A** and the alternator tensioner nut **B**; allow the tensioner to slide inwards thereby loosening the belts.

Remove the belts taking care not to damage them.



5.9 ALTERNATOR (FIG. 5.7)

Unscrew nuts **A - B** to remove alternator **C** taking care not to misplace bushing **D**.

5.10 FRONT PULLEY WITH HUB (FIG. 5.8)

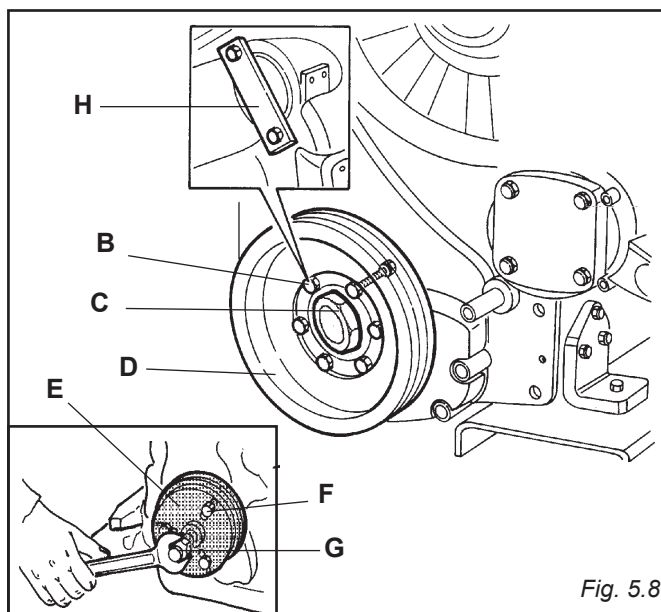
Now unscrew screws **B** and nut **C** and remove pulley **D**.

Unscrew nut **C**.

Fit the special tool (Table 11.1 ref A), fixing the body **E** to the flange by means of commercial screws **F**. Tighten screw **G** until the pulley is detached (leaving nut **C** finger tight).



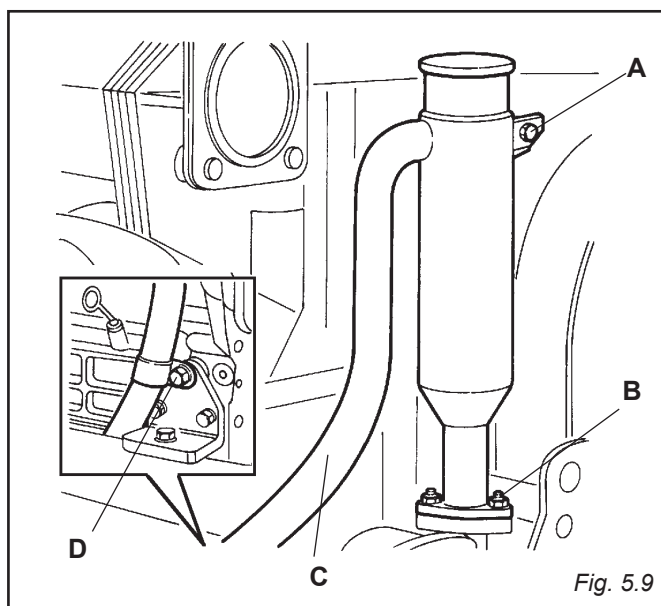
TO FACILITATE THE ABOVE PROCEDURES PREVENT THE PULLEY FROM ROTATING BY MEANS OF SPECIAL TOOL "H" (TABLE 11.1 REF. L).



5.11 OIL BREATHER HOSE (FIG. 5.9)

Unscrew screw **A** and nuts **B**.

Unscrew screw **C** and remove breather hose **D**, paying attention to the O-ring between the hose and front cover. **N.B.** Unscrew nut **D** to remove bracket **E**.



5.12 SHROUD COVER (FIG. 5.10)

Disengage the clips and remove the cover.

5.13 FAN (FIG. 5.10)

Unscrew nut **A** and nut **B** of the fan shroud clamp
Remove the entire fan **C**.

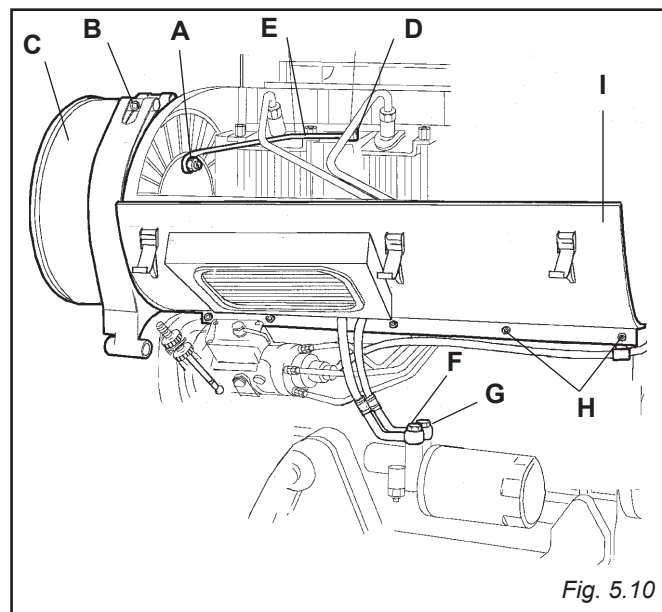


Fig. 5.10

5.14 AIR SHROUD (FIG. 5.10)

Remove connections **F** from oil filter **G**.

Unscrew flanged nuts **H**.

Remove the shroud **I**.

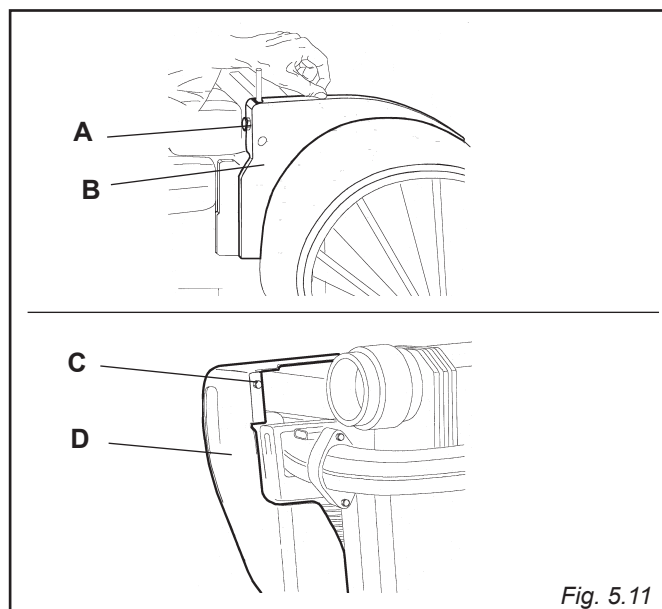


Fig. 5.11

5.15 AIR SHROUD COVER (FIG. 5.11- 5.12)

Unscrew screw **A**.

Remove guard **B**.

Unscrew screw **C**.

Remove guard **D**.

Unscrew screws **E** fixing the guard to the cylinder heads.

Remove guard **F**.

Unscrew screw **G**.

Remove guard **H**.

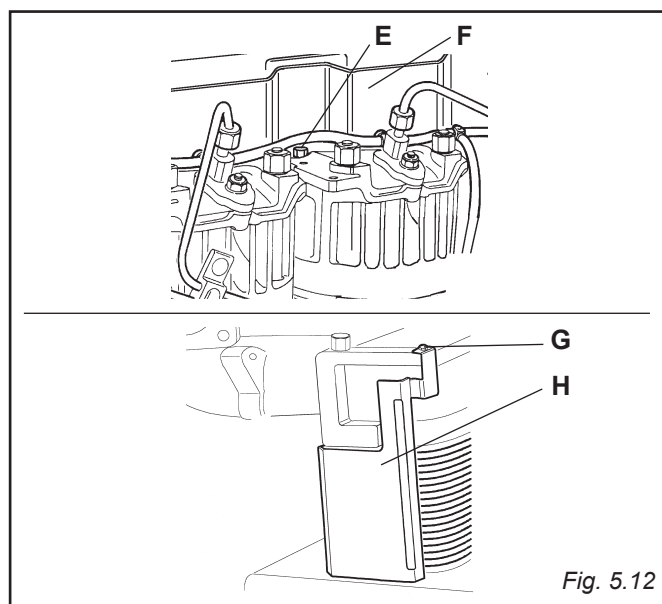


Fig. 5.12

5.16 FRONT COVER (FIG. 5.13)

Remove spacers **A** from the alternator slide.

Unscrew screws **B**, only if necessary, to remove cover **C** and relative gasket.

Remove cover **F** with its gasket by unscrewing screws **G**.

Now unscrew screw **H** located behind the cover.

Unscrew screw **I** located at the top of the cover and then unscrew and remove all the screws located around the perimeter of the front cover.

Screws **L** and **M** must be equipped with copper washers on reassembly.

Remove cover **N** by tapping with a rubber mallet.

Remove the gasket.

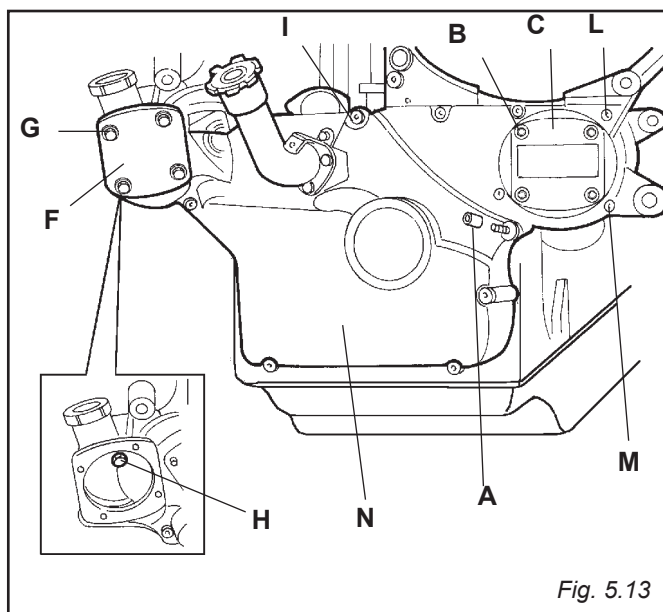


Fig. 5.13

5.17 FLYWHEEL (FIG. 5.14)

Immobilize the flywheel by means of special tool **A** (Table 11.1 Ref. L).

Loosen nut **B** without removing.

Use a drift and mallet to disengage flywheel **C** by striking the crankshaft centrally.

To assist in removing the flywheel, use two commercial screws **D** and a commercial safety support.

5.18 FLYWHEEL HOUSING (FIG. 5.14)

Unscrew and remove nuts **E** and relative washers.

Unscrew screws **F**. Remove flywheel housing **G** and O-ring **H**.

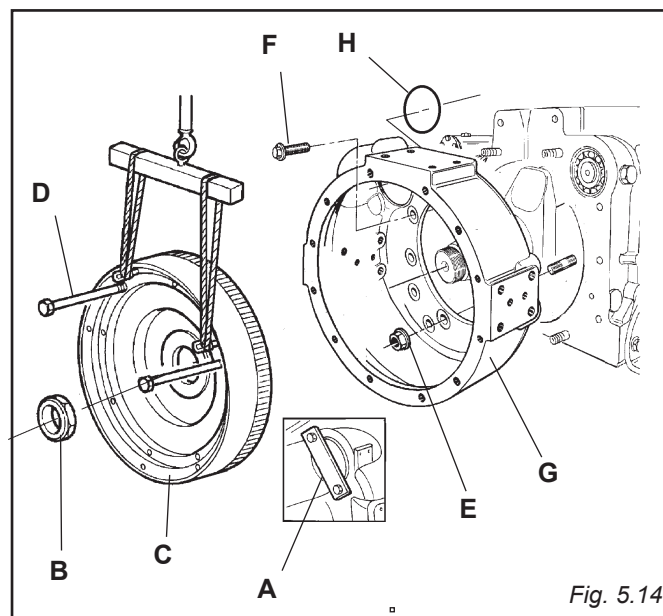


Fig. 5.14

5.19 OIL COOLER (FIG. 5.15)

Unscrew connections **A - B** using two wrenches to avoid damage to the lower unions, and remove hoses **C - D**.

Unscrew screws **F - G** and remove metal plate **H**.

If necessary, renew the two rubber seals **L**.

Remove the oil cooler.

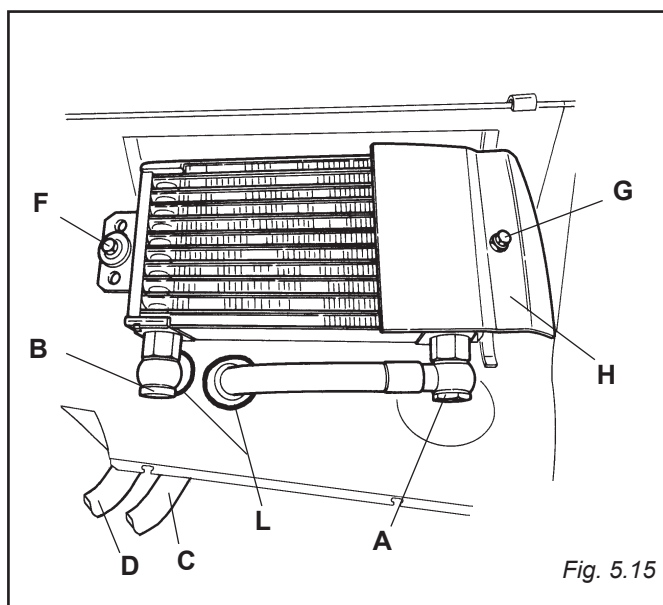


Fig. 5.15

5.20 EXHAUST MANIFOLD (FIG. 5.16)

Unscrew nuts **A**.

Remove manifold **B** by pulling outwards.

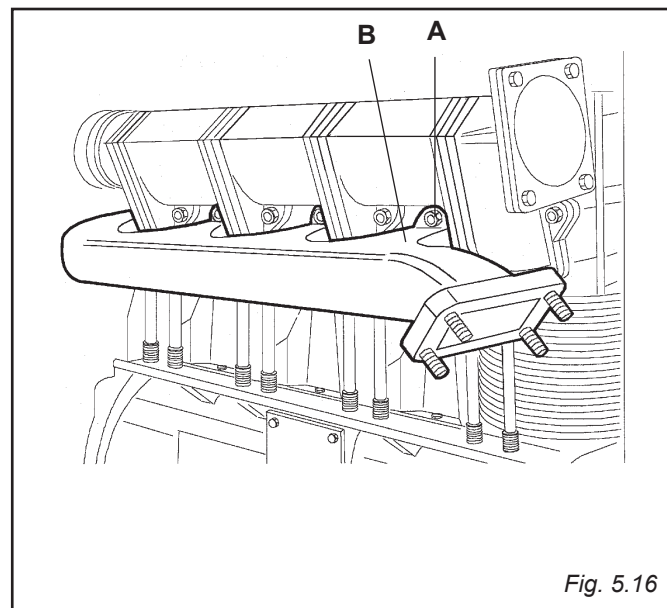


Fig. 5.16

5.21 INTAKE MANIFOLD (FIG. 5.17)

Unscrew nuts **A**.

Pull manifold **B** outwards to remove.

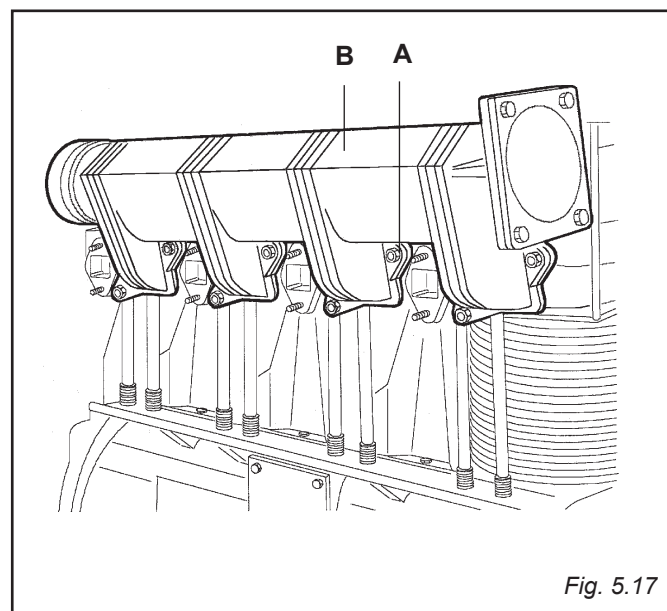


Fig. 5.17

5.22 ROCKER ARM / CAMSHAFT LUBRICATION PIPES (FIG. 5.18)

Unscrew connections **A - B** in sequence.

Cut clamp **C**, unscrew connection **D** and remove the upper pipe.

Unscrew connection **E** and remove the lower pipe.

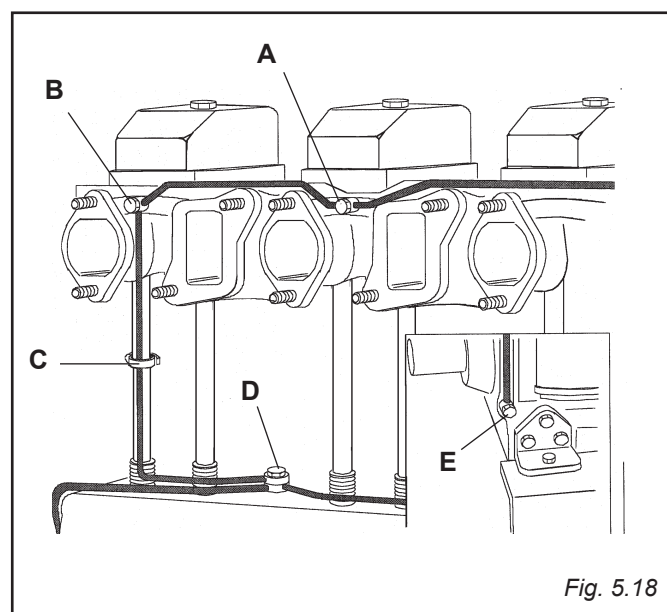


Fig. 5.18

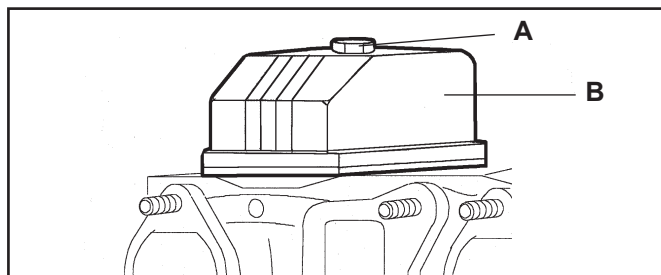
5.23 ROCKER COVER (FIG. 5.19)

Unscrew nut **A**.

Remove cover **B**.

If necessary, strike gently with a rubber mallet on one side in order to detach the cover.

This procedure must be repeated for all the rocker covers.



5.24 ROCKER ARMS (FIG. 5.19)

Unscrew nuts **C** in order to free the rocker arms from all restraints.

Disassemble the rocker arms by pulling them upwards.

Ensure you renew all O-rings at the time of reassembly.

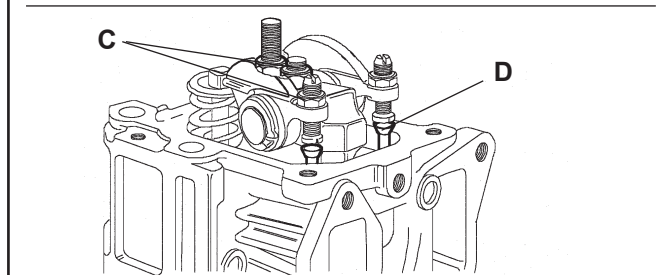


Fig. 5.19

5.25 PUSHRODS (FIG. 5.19)

Withdraw pushrods **D**.

5.26 FUEL PUMP (FIG. 5.20)

Unscrew connections **A -B** and remove pipes **C -D** from the fuel pump.

Unscrew locknuts **E**.

Withdraw pump **F**, paying attention to the **O-rings** on the mounting flange.

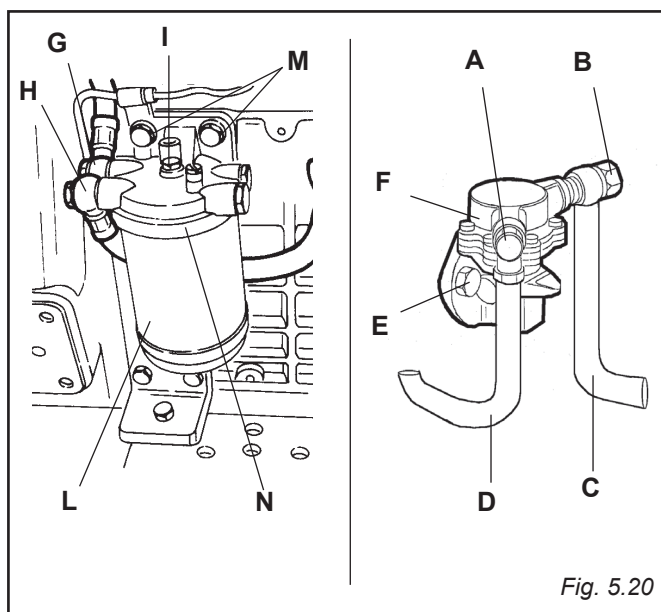


Fig. 5.20

5.27 FUEL FILTER (FIG. 5.20)

Unscrew union **G** from the filter to the injection pump, and union **H** leading from the filter to the fuel pump.

Unscrew screw **I**.

Extract cartridge **L**.

Pay attention to the two **O-rings**.

Unscrew the two screws **M**.

Remove filter support **N**.

5.28 FUEL FEED LINE FROM THE FILTER TO THE INJECTION PUMP (FIG. 5.21)

Unscrew union **A**.

Remove pipe **B**.

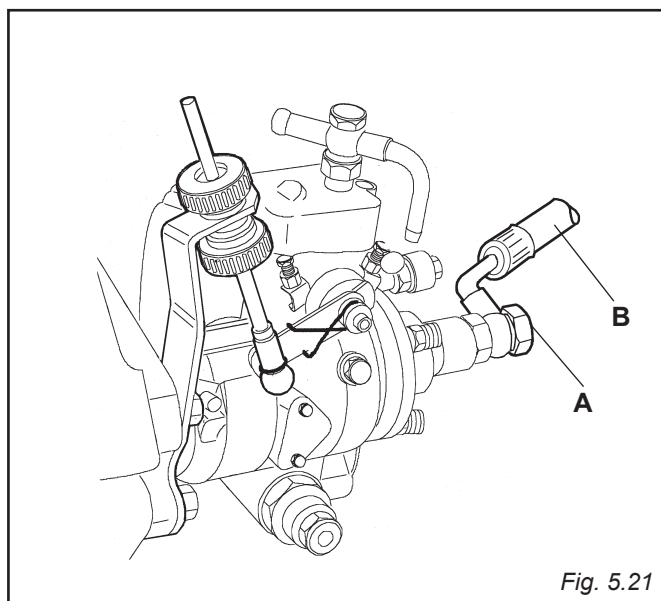


Fig. 5.21

5.29 FUEL FEED LINES TO THE INJECTORS (FIG.5.22)

Unscrew unions **A** from the injectors.
Unscrew unions **B** on the injection pump.
Remove all the unions of pipes **C**.

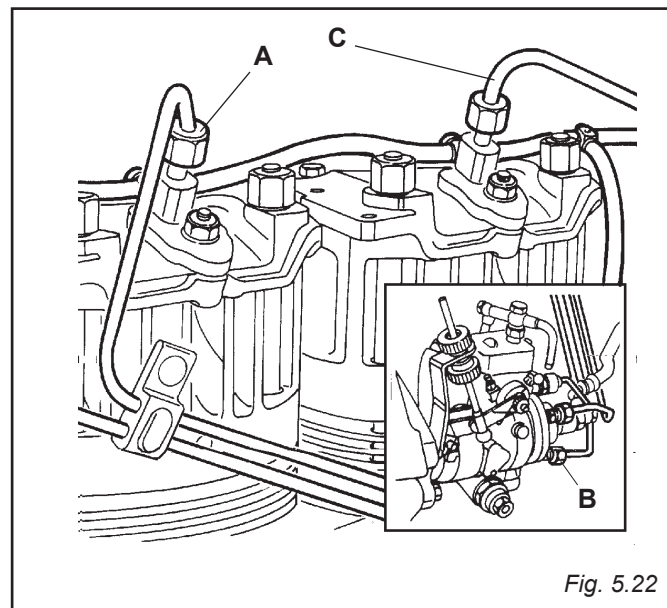


Fig. 5.22

5.30 FUEL RETURN PIPES FROM THE INJECTORS (FIG.5.23)

Unscrew unions **A** from the rear of the injectors.
Unscrew union **B** on the injection pump.
Remove pipe **C**.
Using two opposing wrenches, hold locknut **D** and unscrew screw **E**.
Remove union **F**.

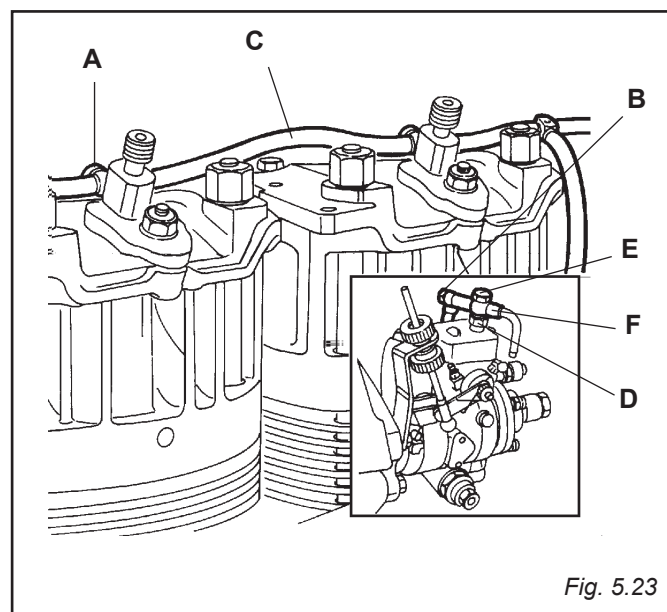


Fig. 5.23

5.31 INJECTORS (FIG. 5.24)

Unscrew nut **A** and remove the injector clamp **B**. Use special tool **E** (TABLE 11.1 ref. E), on the injector **C** as shown in the figure. Disassemble the injector by sliding striker **D** in alternate directions as shown in the figure.



TO FACILITATE DETACHMENT OF THE INJECTOR, TURN THE INJECTOR BODY CLOCKWISE-COUNTERCLOCKWISE IF NECESSARY. REPEAT THE ABOVE STEPS FOR EACH INJECTOR.

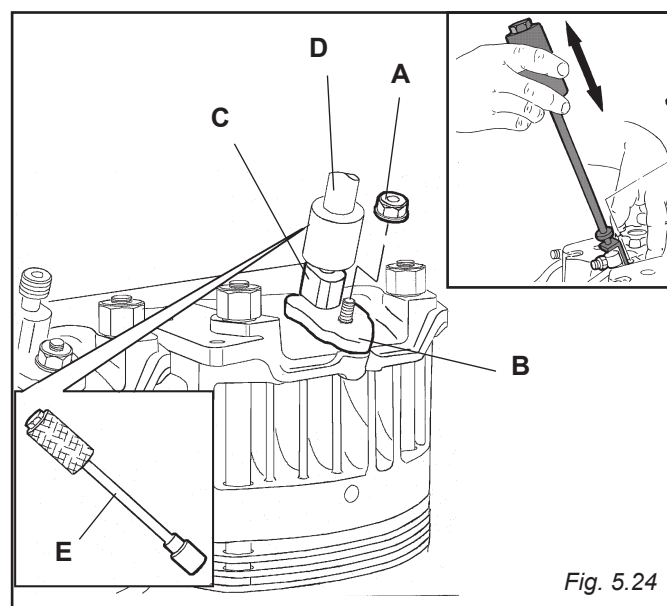


Fig. 5.24

5.32 CYLINDER HEADS (FIG. 5.25)

Unscrew nuts **A - B**.

Unscrew distance collars **C**.

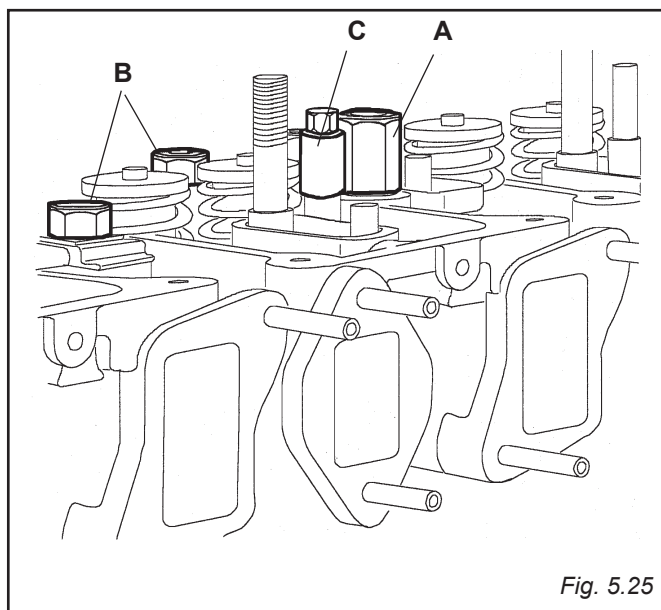


Fig. 5.25

5.33 PUSHROD PROTECTION TUBES (FIG. 5.26)

After removing cylinder head **B** extract the pushrod protection tubes **A**.



TO EXTRACT THE PUSHROD PROTECTION TUBES WITH CYLINDER HEAD ASSEMBLED, USE THE SPECIAL TOOL "C" (TABLE 11 REF. H). COMPRESS THE SPRING AND EXTRACT THE TUBE

Pay attention to the seals at the end of the tube.

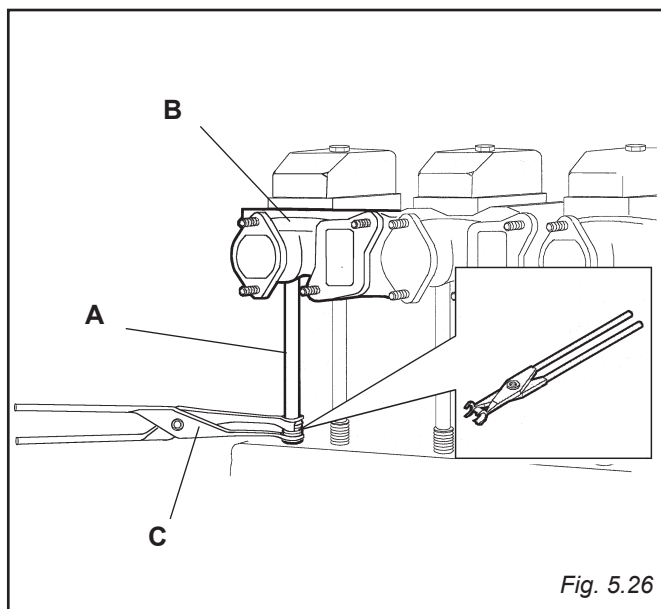


Fig. 5.26

5.34 AIR DEFLECTORS (FIG. 5.27)

Unscrew screw **A**.

Remove metal plate **B**.

Repeat these steps for all the deflectors.

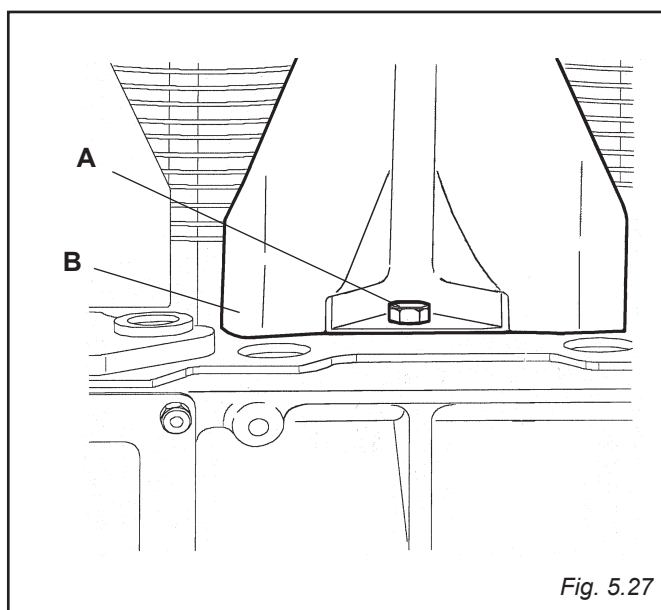


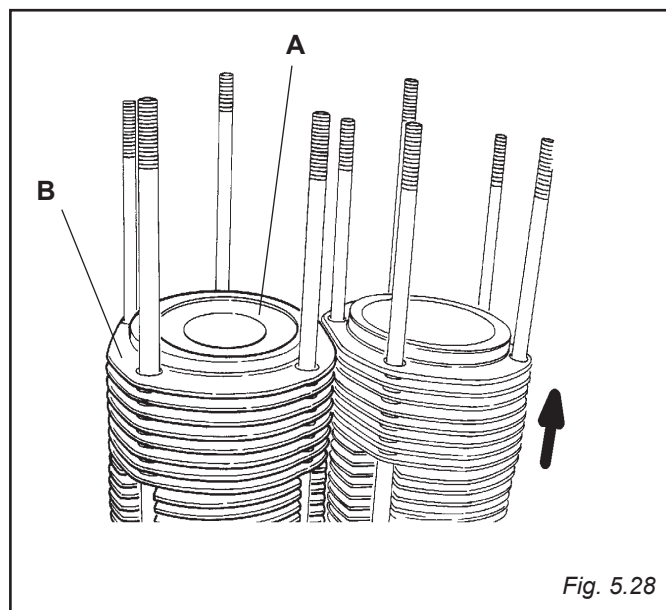
Fig. 5.27

5.35 CYLINDER (FIG. 5.28)

Turn the crankshaft until piston **A** reaches **TDC**.

Extract cylinder **B**.

Repeat the above steps for each cylinder.

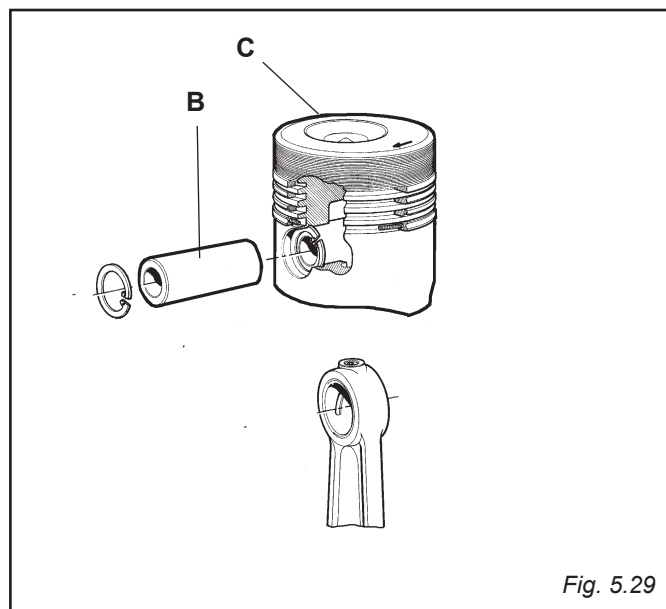


5.36 PISTON (FIG. 5.29)

Disassemble circlips **A**.

Extract gudgeon pin **B** and remove piston **C**.

Repeat the above steps for each piston.



5.37 OIL PRESSURE VALVE AND OIL FILTER SUPPORT (FIG. 5.30).

Extract valve **A**, paying attention to the relative gaskets.

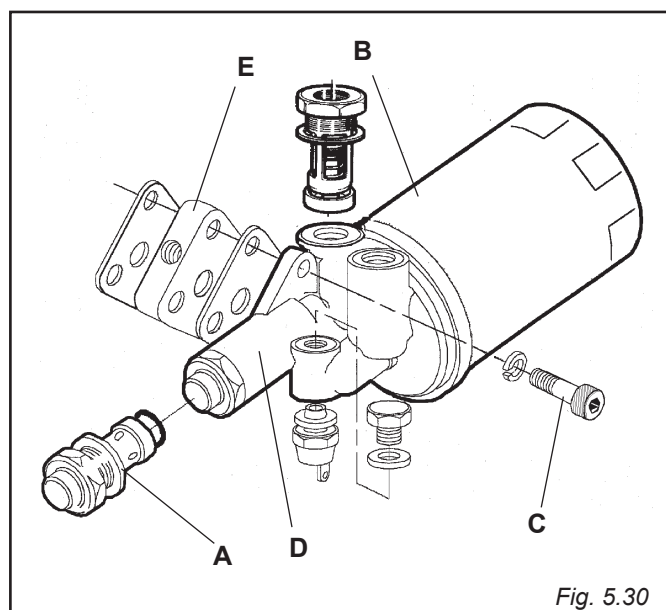
Remove cartridge **B**, using a commercial tool if necessary.



DURING THIS PROCEDURE TAKE CARE NOT TO DISTORT THE OIL CARTRIDGE ATTACHMENT BASE.

Unscrew fixing screws **C** and remove support **D**.

Note: spacer **E** is only present on turbocharged engines.



5.38 ACCELERATOR (FIG. 5.31)

Extract pin **A**, gently pulling accelerator **B** outwards slightly; use a drift if necessary.

Unscrew nut **C**.

Simultaneously extract bracket **D** and accelerator **B**.

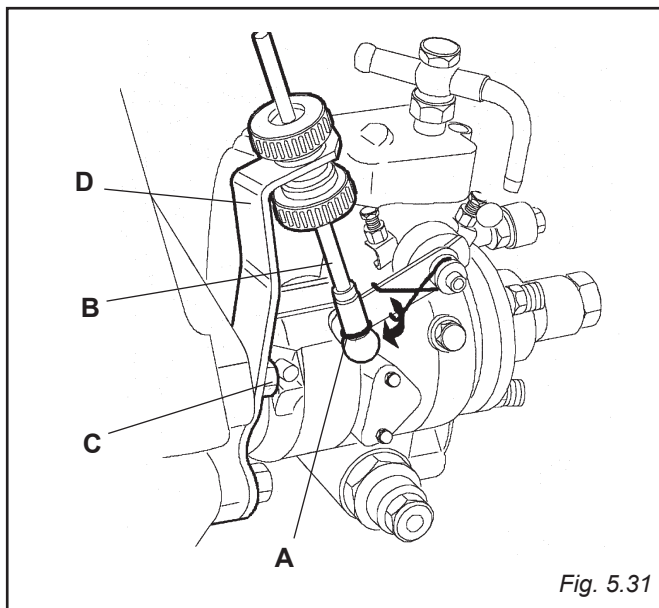


Fig. 5.31

5.39 INJECTION PUMP (FIG. 5.32)

Unscrew nuts **C**.

Unscrew nut **B**.

Use an aluminum or wooden drift to strike the front of pump **F** until it is disengaged and can be removed from the rear.

Pay attention to the **O-ring**.

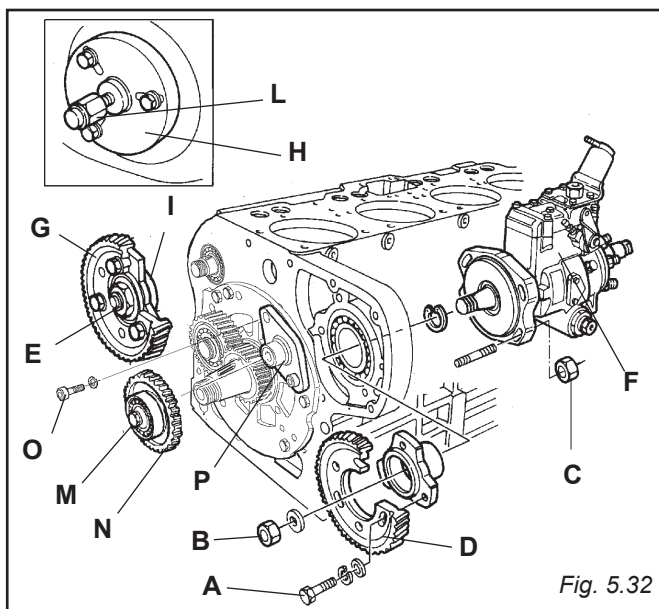


Fig. 5.32

5.40 INJECTION PUMP GEAR (FIG. 5.32)

Unscrew screws **A**.

Use a rubber mallet to press on the side of gear **D** until the gear can be removed.

5.41 CAMSHAFT GEAR (FIG. 5.32)

Unscrew nut **E**.

Fit special tool **H** (TABLE 11.1 Ref. B) by means of the 3 holes on gear **G**.

Tighten central screw **L** and extract flange **I**.

5.42 INTERMEDIATE GEAR (FIG. 5.32)

Unscrew screw **M**.

Extract gear **N** manually

5.43 INTERMEDIATE GEAR SUPPORT (FIG. 5.32)

Unscrew screws **O**.

Remove support **P**.

5.44 GOVERNOR (SUN 2105 - 3105 ENGINES) (FIG. 5.33)

Disengage tie rod **A** from the governor control fork **B**.

Turn the fork until it can be removed from lever support **C**.

Disassemble the front main bearing **D** as described in heading 5.49 page 5-16, remove circlip **E** and withdraw the governor counterweight assembly **F**.

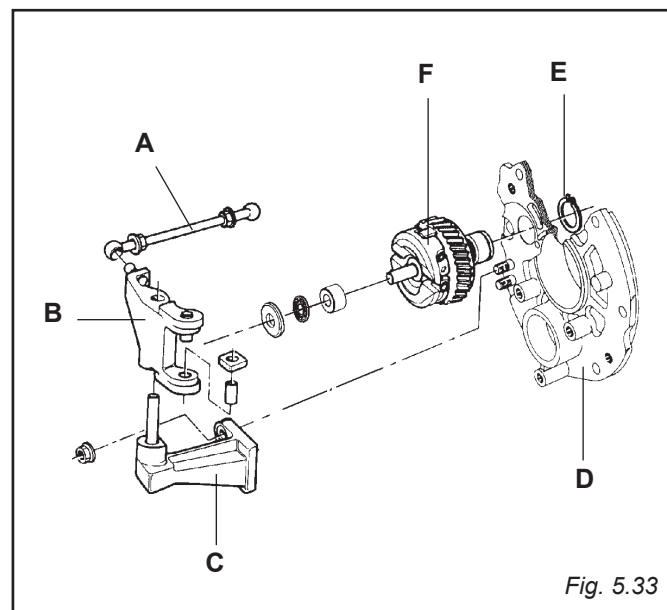


Fig. 5.33

5.45 OIL PUMP (FIG. 5.34)

Unscrew screws **A** on oil delivery pipe **B**.

Unscrew screws **C** on the oil suction pipe **D**.

Unscrew screws **E**.

Manually extract pump **F**.

Renew the **O-Rings** on the two pipes.

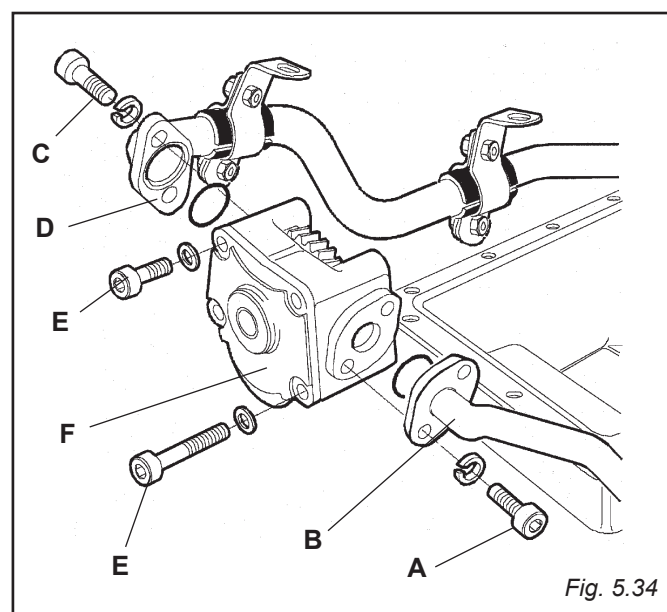


Fig. 5.34

5.46 REAR MAIN BEARING (FIG. 5.35)

Unscrew nuts **A**.

Remove bearing **B** by means of tool **C**
(TABLE. 11.1 Rif. G).

Pay attention to the gasket.

5.47 SUMP (FIG. 5.35)

Unscrew perimeter screws **D**.

Remove sump **E**.

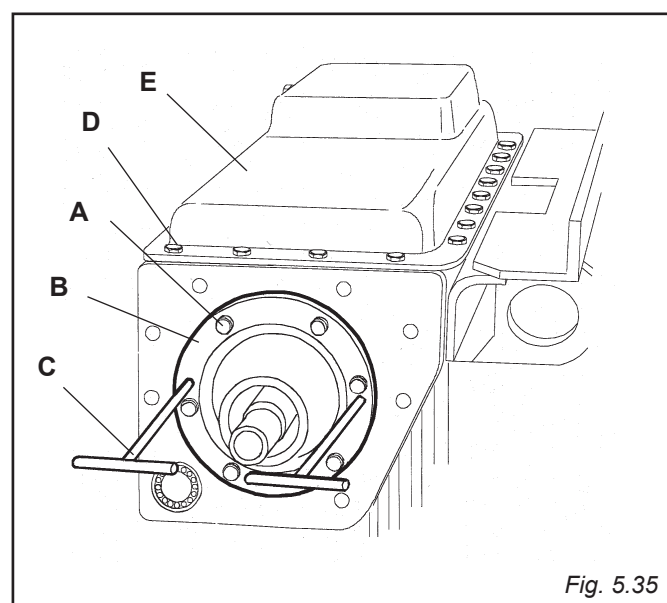


Fig. 5.35

5.48 SUMP OIL SUCTION AND DELIVERY PIPES AND OIL FEED PIPES TO MAIN BEARINGS (FIG. 5.36)

Unscrew all nuts **A**.

Remove the clamps **B** that fix the oil delivery and suction pipes, paying attention to the anti-vibration rubber.

Unscrew screws **C** that fasten the supports of the delivery pipes **D** and suction pipes **E** to the crankcase.

Unscrew nuts **F** that secure the delivery pipe supports to the oil filter.

Unscrew screws **G** that fasten the oil suction filter **H**.

Remove the discharge pipe of overpressure valve **I**. Detach the suction pipe **E** from suction filter **H**.

Remove suction pipe **E**, rotating it and removing it from the front.

Unscrew connectors **L** securing oil feed pipes **M** to the main bearings.

Unscrew nuts **N**.

Vertically withdraw all feed pipes **M** to the main bearings and to the front and rear bearings.

Remove the main oil feed pipe **D** by turning it and removing it from the front.

Note: The **O-rings** on all the pipe connections must be renewed at the time of reassembly.

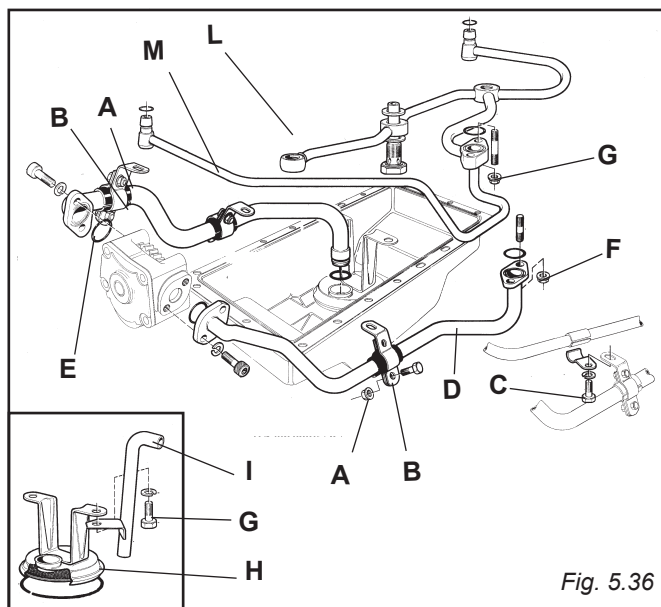


Fig. 5.36

5.49 FRONT MAIN BEARING (FIG. 5.37)

Unscrew screws **A** and **C**.

Remove the front bearing **D** with the assistance of special tool **B** (TABLE 11.1 Ref. G).



IN THE CASE OF 2 CYLINDER ENGINES, REMOVE THE COUNTERWEIGHTS BEFORE WITHDRAWING THE CRANKSHAFT.

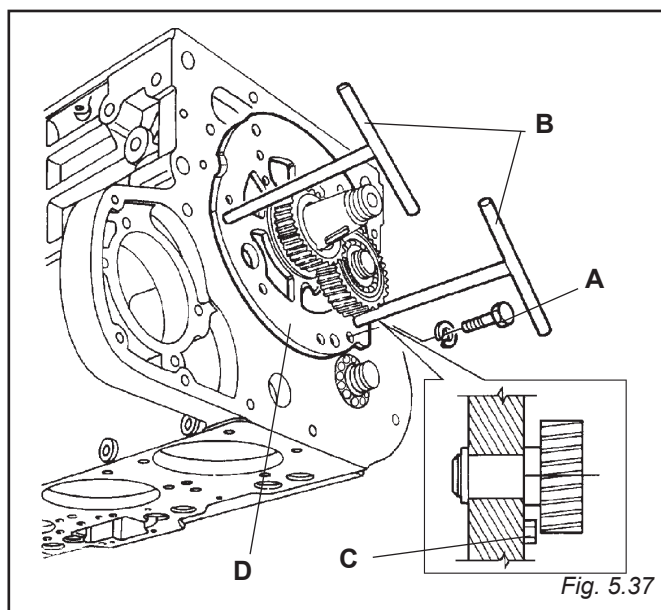


Fig. 5.37

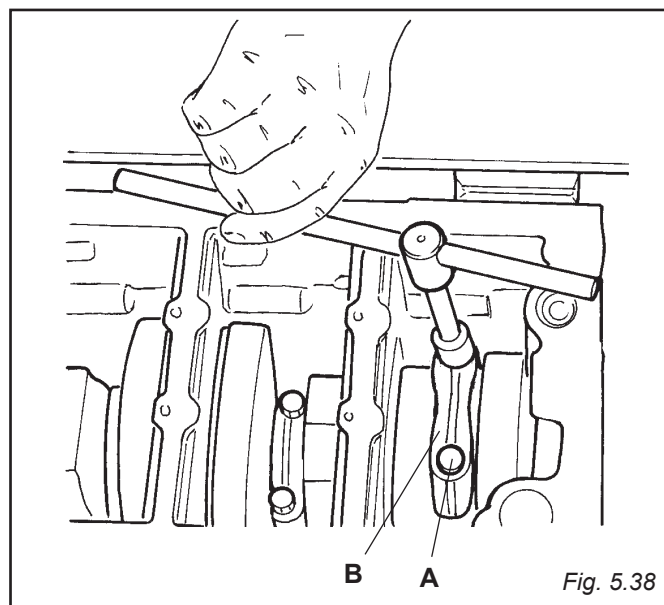
5.50 CONNECTING ROD (FIG. 5.38)

Turn the crankshaft to the **B.D.C.** position of the connecting rod on which you are working. Unscrew screws **A** and remove cap **B**. Withdraw the connecting rod. Reassemble the connecting rod cap without tightening the screws so that it does not get confused with the others.

Repeat the above procedures for each connecting rod.



WITH THE PISTON ASSEMBLED TO THE CONNECTING ROD IT IS POSSIBLE TO REMOVE THE PISTON/CONNECTING ROD ASSEMBLY FROM THE TOP AFTER HAVING REMOVED THE CONNECTING ROD CAP.



5.51 CENTRAL MAIN BEARINGS (FIG. 5.39)

Extract the crankshaft **C** until screws **A** on bearing **B** are exposed.

Unscrew screws **A**.

Extract the main bearings.

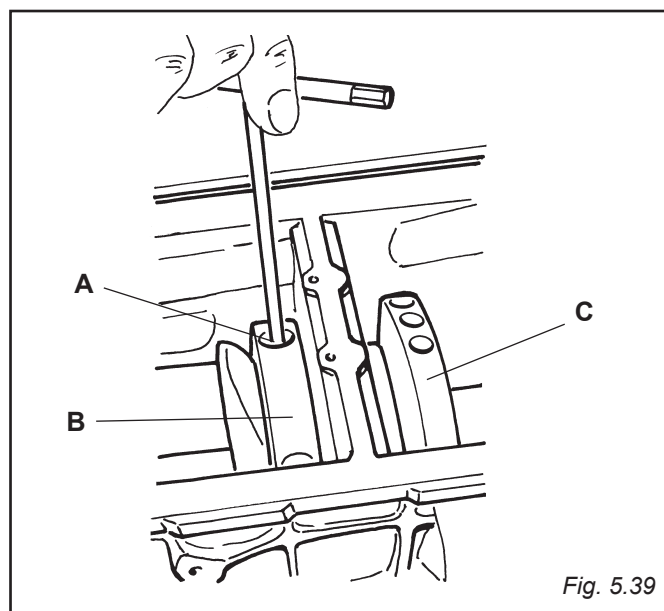
Immediately reassemble the bearing half-shells without tightening.

The numbers stamped on the half-shells must always be the same; when the shells are assembled the numbers must be facing the timing side of the engine.

Repeat this procedure for all the main bearings.



IT IS GOOD PRACTICE TO DISASSEMBLE ALL THE BEARINGS TO AVOID THE RISK OF DAMAGING THEM WHEN THE CRANKSHAFT IS BEING REMOVED.

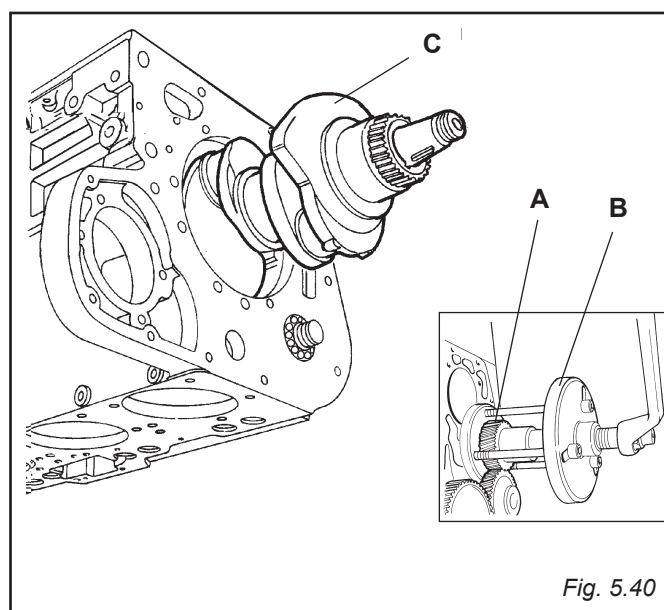


5.52 CRANKSHAFT GEAR (FIG. 5.40)

Disassemble gear **A** using puller tool **B** (Table 11.1 Ref. D).

5.53 CRANKSHAFT (FIG. 5.40)

Manually remove crankshaft **C** taking care to avoid impacts.

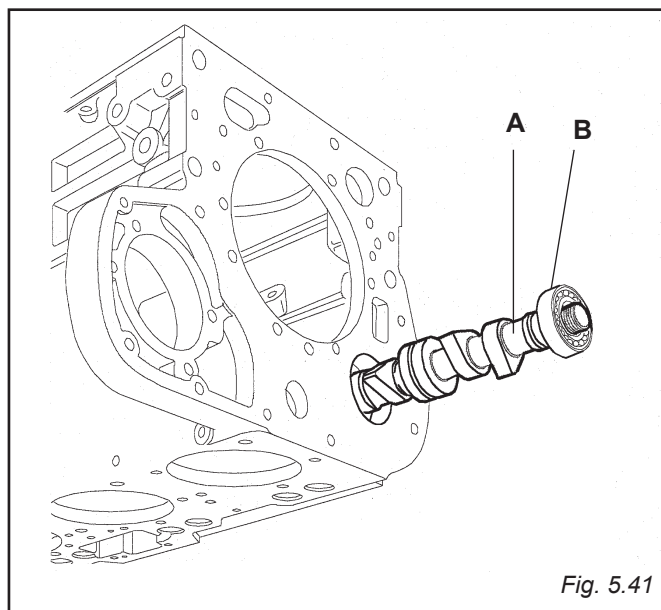


5.54 CAMSHAFT (FIG. 5.41)

Taking the maximum care not to damage the cam profiles:

Extract camshaft **A**.

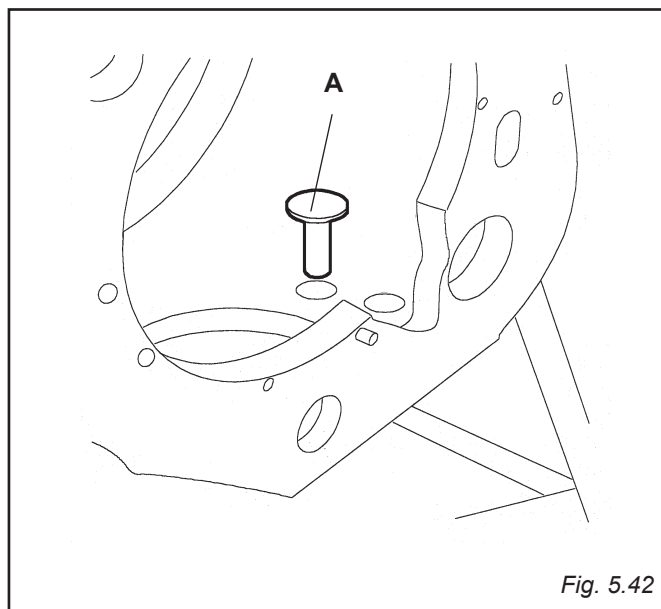
Drive bearings **B** from their seats.



5.55 TAPPETS (FIG. 5.42)

Manually remove tappet **A**.

Repeat the operation for each tappet



CHECKS AND REPAIRS

6

PAGINA INTENZIONALMENTE BIANCA

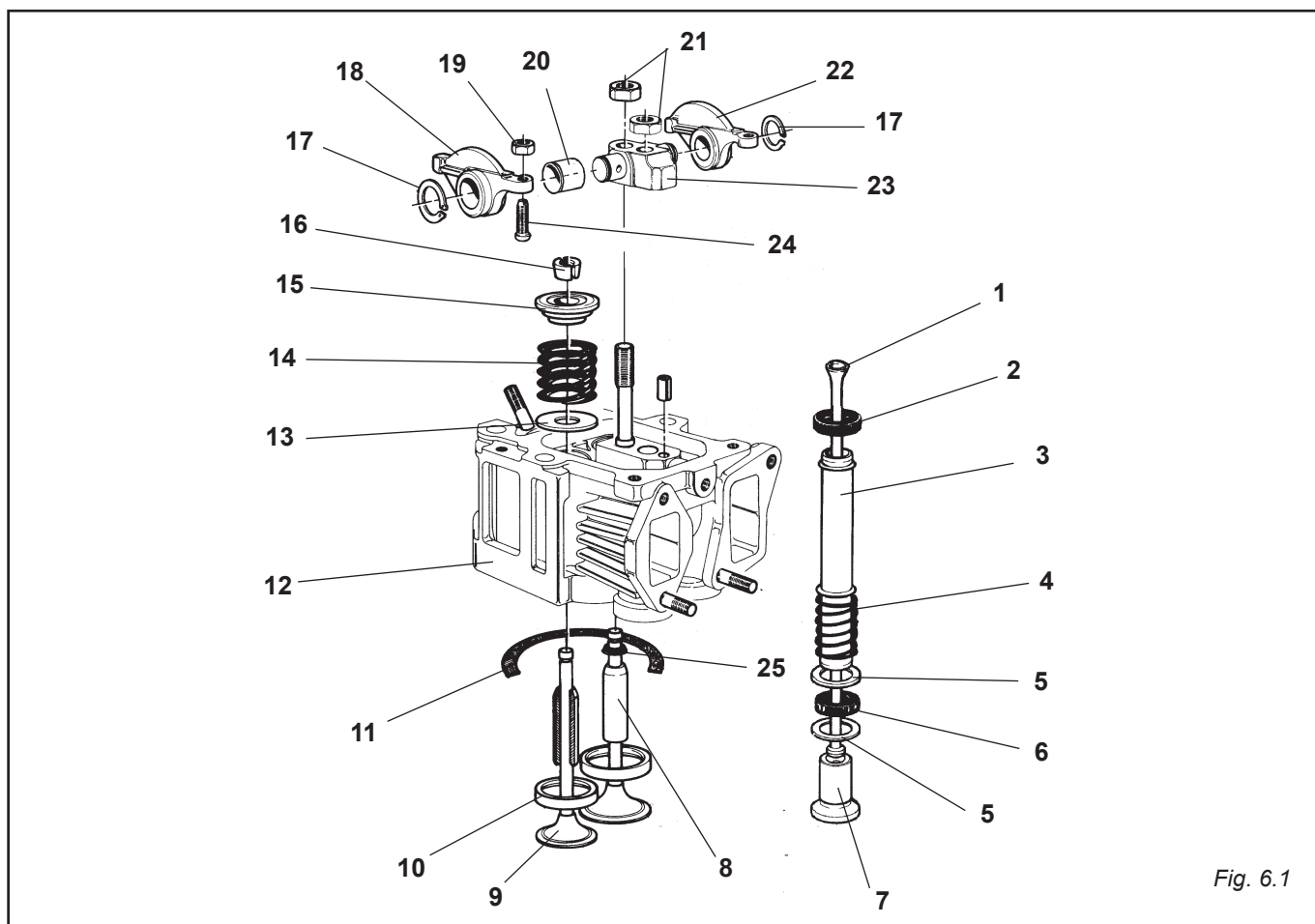
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6.1 CYLINDER HEAD (FIG. 6.1)



KEY: 1) Push rod, 2) Seal, 3) Pushrod protection tube, 4) Spring, 5) Seal washer, 6) Seal, 7) Tappet, 8) Valve guide, 9) Valve, 10) Valve seat, 11) Head gasket, 12) Cylinder head, 13) Lower disc, 14) Spring, 15) Upper disc, 16) Half cones, 17) Circlip, 18) Exhaust rocker arm, 19) Nut, 20) Bush, 21) Nut, 22) Intake rocker arm, 23) Support, 24) Rocker arm adjustment screw, 25) Gasket.

6.2 VALVES - SEATS - GUIDES (FIG. 6.2 - 6.3 - 6.4)

If necessary clean the valves with a wire brush or replace them if the heads are bent, worn or cracked.

Check the diameter of the valve stem, value **A** (fig. 6.2), and if the valve stems are worn replace the valves.

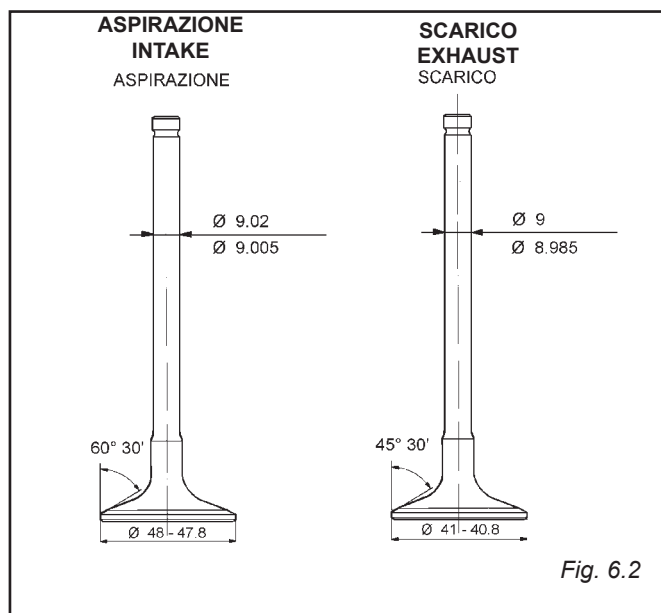
Check that the guides are not grooved inside or show signs or seizing.

To check whether the valve guides are in the right position, check value **A** (fig. 6.3).

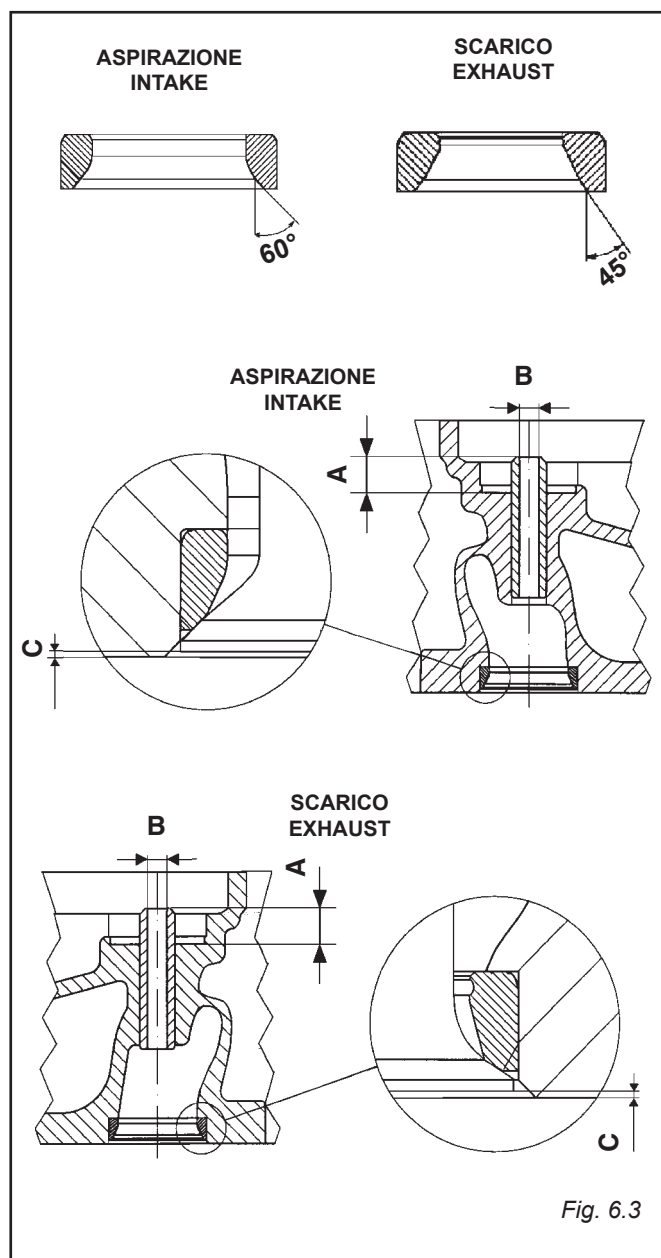
Check the internal diameter of the valve guides, value **B** (fig. 6.3).

If there is any difference in the values, replace the head.

If value **C** (fig. 6.3) is lower than normal, the valve has probably broken through the seat and you will have to replace the head.



Dimension	Assembly clearance	
	Intake mm	Exhaust mm
A - Fig. 6.3	15.000 - 15.050	15.000 - 15.050
B - Fig. 6.3	9.060 - 9.075	9.060 - 9.075
C - Fig. 6.3	0.550 - 0.850	0.710 - 1.010



6.3 VALVE SPRING (FIG. 6.5)

Check that the spring is undamaged and has not lost its elasticity.

Check the spring for traces of rust.

Check that distance **"A"** is no greater than **2.000 mm**.

Check the spring height with various loads:

L 0 = 44.000 mm (Free spring length)

L 1 = 37.000 mm **P 1** = 24 kg

L 2 = 26.610 mm **P 2** = 59.6 kg

L 0 = 44.000 mm (Free spring length)

L 1 = 38.500 mm **P 1** = 29.96 Kg

L 2 = 28.200 mm **P 2** = 64.72 Kg

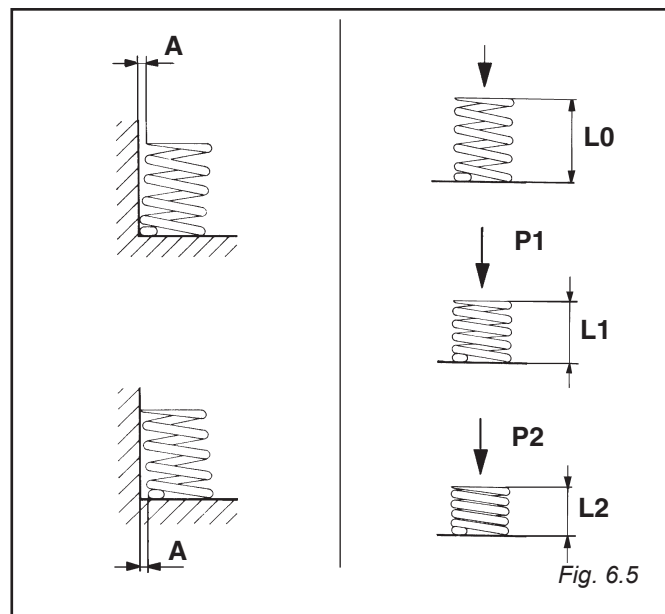


Fig. 6.5

6.4 ROCKER ARMS (FIG. 6.6)

Clean the pins and rocker arms with solvent (see chapter 3 "maintenance", heading 3.7).



REMOVE ANY SLUDGE FROM THE OILWAYS.

Check the values listed below.

If you encounter different values, renew the rocker arms.

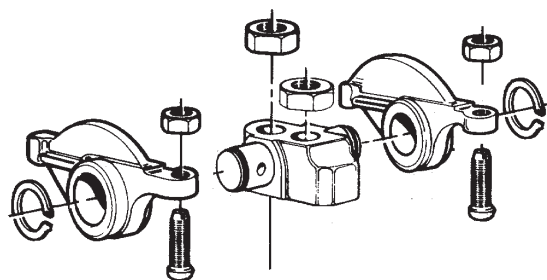


Fig. 6.6

REF.	DESCRIPTION	DIMENSIONS
A	Rocker arm support diameter mm	19.970 - 19.980
B	Bushing inside diameter (mm)	20.010 - 20.030
C	Clearance between journal and bushing (mm).	Min. 0.030 Max. 0.060

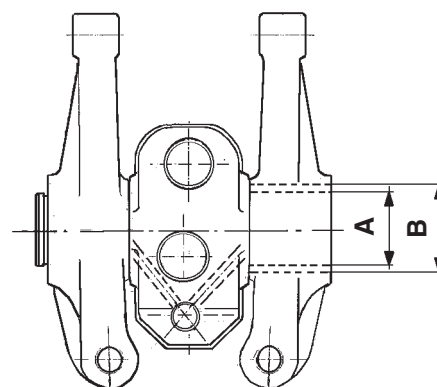


Fig. 6.6a

6.5 PUSHRODS AND TAPPETS (FIG. 6.7)

Make sure the pushrods are straight and that the spherical surfaces at the ends are in good condition.

Check flat surface **A** of the tappets. Slight impressions or scoring can be removed using a carborundum stone.

Check the values indicated below.

REF.	DESCRIPTION	DIMENSIONS
A	Outside diameter	17.985 - 17.995 mm

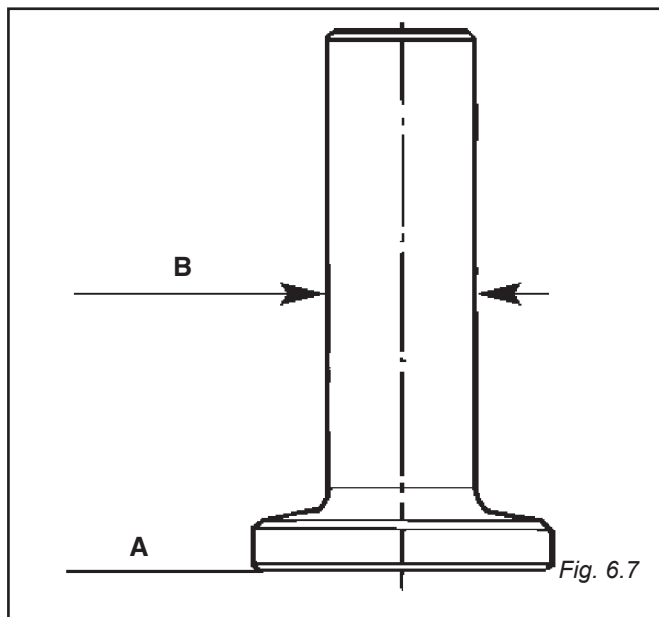


Fig. 6.7

6.6 CYLINDERS (FIG. 6.8)

Cylinder internal diameter D (mm)

Max. permissible out of round **A - B**:

0.200 mm

Max. taper error **1 - 3**:

0.200 mm

If the interior face of the cylinder is scored or worn to no more than **0.100 mm** with respect to nominal dimensions (**TABLE 8.2.4 ref. A-B**) **1-2-3**, you can restore the initial surface roughness using fine grade emery cloth soaked in naphtha and applied with spiral movements.

Surface roughness must be **0.8 - 1.2 μ** (micron). If you find scoring or wear greater than **0.100 mm**, renew the parts.

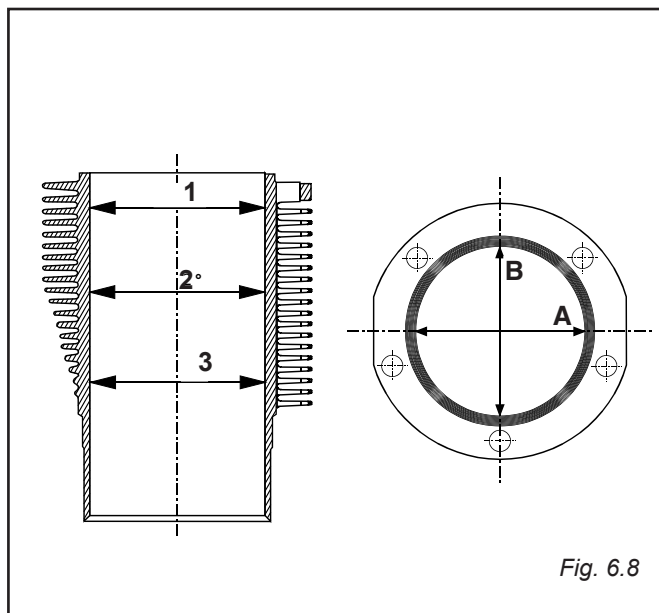


Fig. 6.8

6.7 PISTON AND PISTON RINGS (FIG. 6.9 - 6.10 - 6.11 - 6.11a)

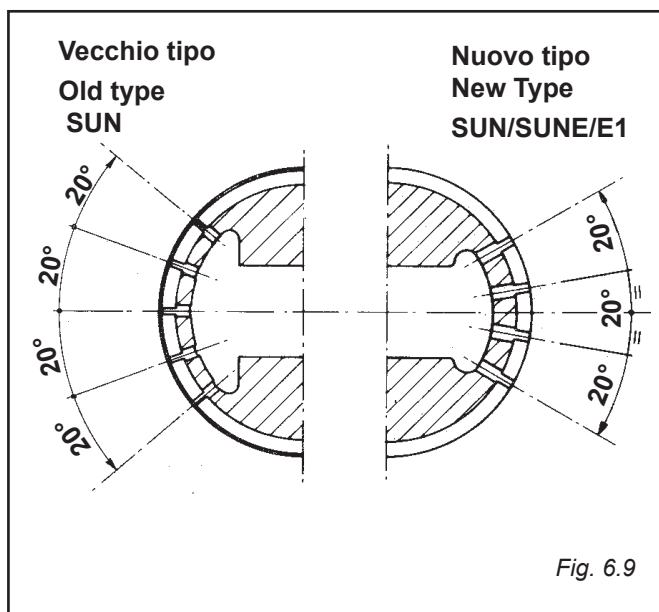


Fig. 6.9

Check that piston weights do not differ by more than **20 gr**. If cylinder and piston are replaced, it is advisable to ensure that both parts are of the same category.

Turbocharged engines are fitted with the new type pistons, although they are freely interchangeable with the original type.

New pistons fitted from:

SUN 4105T Engine - Serial number 70A 04213

SUN 6105T Engine - Serial number 72A 02738

Since January 1989 the new pistons have been fitted on the entire range of engines.

The arrow stamped on the original type piston crown (Fig. 6.10) shows the direction of insertion of the gudgeon pin. The bore has been increased to **35.200 - 35.300 mm** to facilitate insertion.



WHEN ASSEMBLING THE PISTON KEEP THE ARROW FACING TOWARDS THE FLYWHEEL (FIG. 6.10).

Check that the working surfaces are free of any anomalies, scratches, or signs of seizing, if you do find any of the above problems, replace the faulty part.

To check the play between the rings and their seats, use a precision feeler gauge and check that the play isn't over the following limits:

compression ring **A**, cannot be measured

compression ring **B** max 0.112 mm

piston ring **C** max 0.102 mm

oil scraper ring **D** max 0.075 mm.

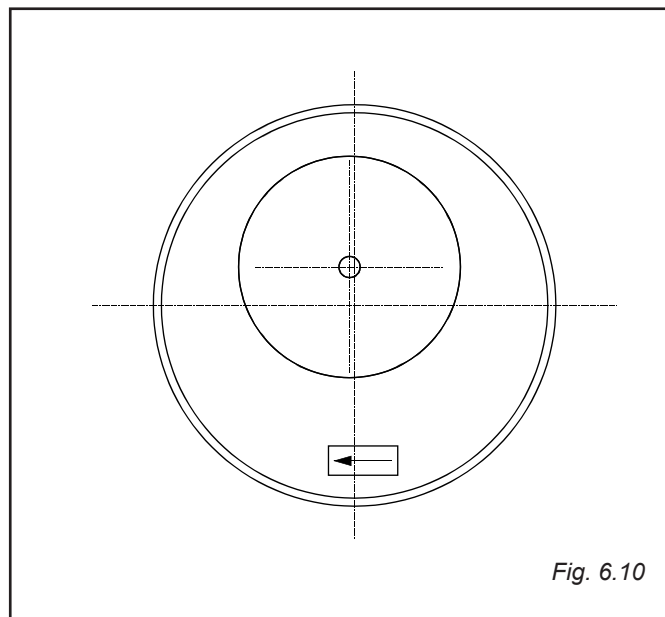


Fig. 6.10

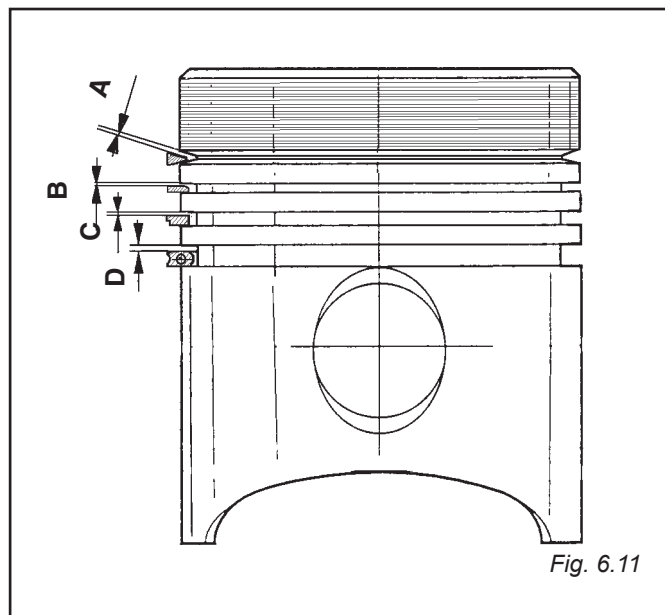


Fig. 6.11

PISTON RINGS (FIG. 6.11a)

Check that the piston rings are free to turn in their seats without any friction or blocking and that they show no signs of damage. If any anomalies are found, replace the rings.

To check the distance between the two ends of the rings, as shown in the figure, insert the ring in the cylinder, position it at a right angle to the working surface and use a precision feeler gauge.

The values measured should not exceed those indicated below:

compression ring **A** max 0.6 mm

compression ring **B** max 0.6 mm

piston ring **C** max 0.6 mm

oil scraper ring **D** max 0.6 mm

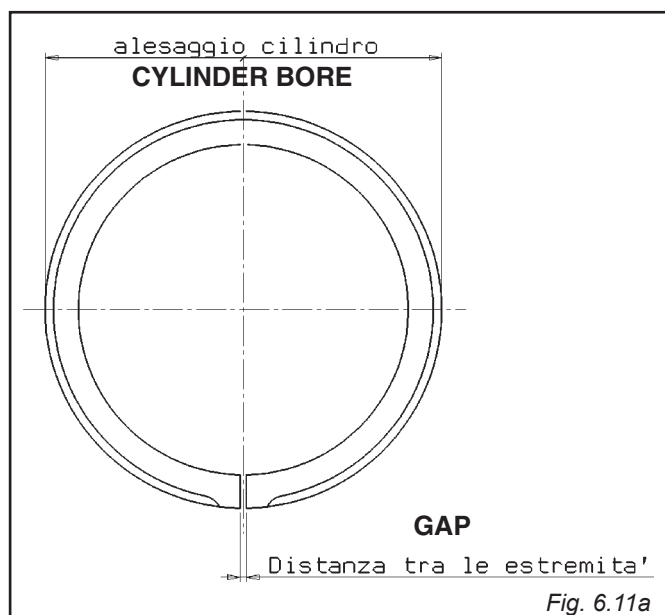


Fig. 6.11a

6.8 CRANKSHAFT (FIG. 6.12 - 6.13 - 6.14 - 6.15)

Immerse the crankshaft in a bath of solvent and remove all sludge from the oil ways. Check that the crankshaft is not cracked. Check that the spigots, mating surfaces and threads are not scored, distorted or worn. Check that the timing gear teeth are not worn or damaged. To replace the timing gear, use tool **A** (TABLE 11.1 ref. D) to disassemble (Fig. 6.12). To reassemble, heat the new gear in an oven to **180 - 200 °C** and fit, after centring the key.

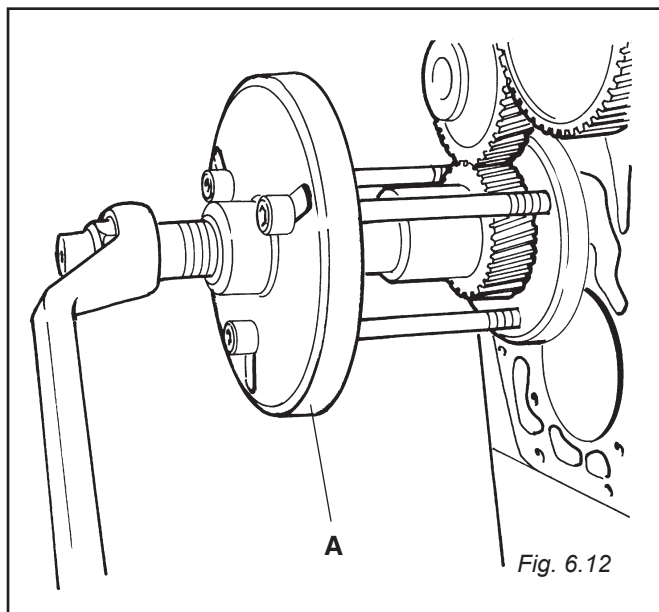


Fig. 6.12

(FIG. 6.13)

At each reassembly replace the seal rings. Check the wear and out of round of the main journals and crank journals using a dial gauge in two perpendicular directions.

If surface wear is more than **0.100 mm** or out of round is more than **0.050 mm**, grind the journals and fit undersize bearings as per the table (TABLE 8.2.1).

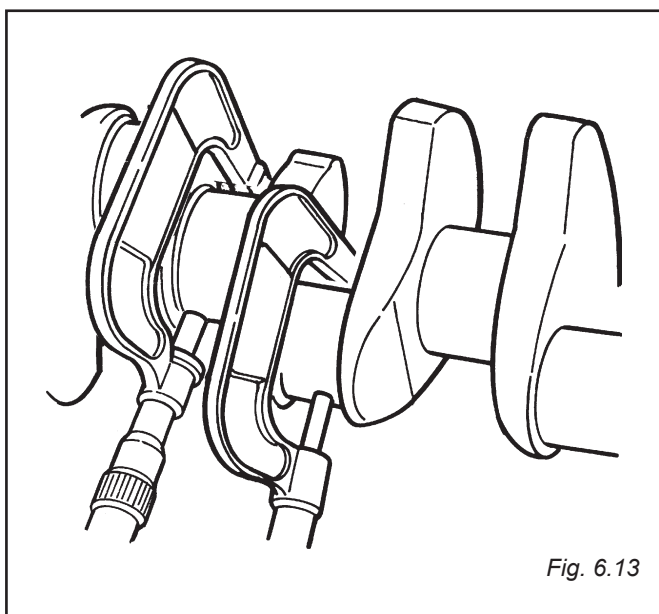


Fig. 6.13

(FIG. 6.14)

Following engine seizure, overheating or regrinding, use a Magnaflux tester to check the crankshaft for cracks. The surface roughness of main bearing journals and crank journals must be **0.12 µ** (micron). If the crankshaft needs regrinding, ensure you do not remove material from fillets **A - B**, which must be chamfered; after regrinding perform "SURSULF" surface hardening (**HRC ³ 53**)



**WHEN REGRINDING THE CRANKSHAFT
DO NOT REMOVE MATERIAL FROM THE
LATERAL CLEARANCE SURFACES**



**CRANKSHAFT ANGLES "A" MUST
COMPLY WITH THE DIMENSION:
A = 2.5 - 2.8 mm**

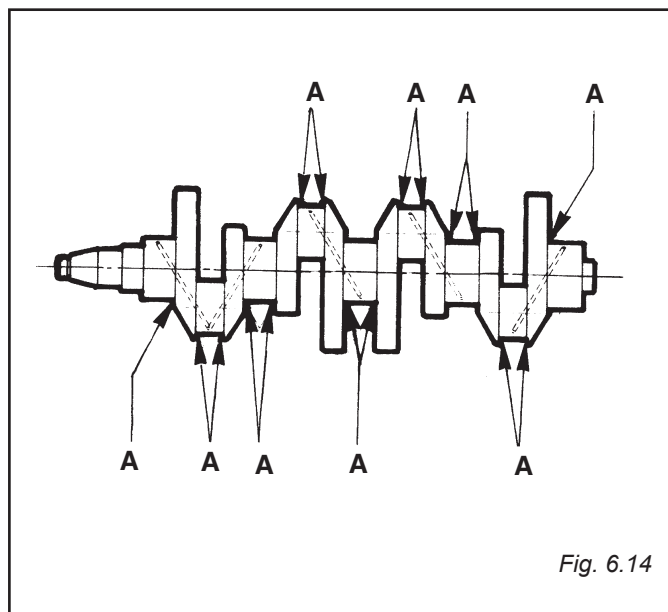


Fig. 6.14

(FIG. 6.15)

All main bearings and crank bearings, including undersize components, are supplied to measure.

Main journals and front bearings, see (TABLE 8.2.1)

For assembly and disassembly of the bearings consult a properly equipped grinding shop. When assembling the bearings, observe the following indications:

- Check that the arrow punched on the exterior of each half shell is facing the direction of assembly of the bearing (Fig. 6.15).
- Fit the bearing to a depth of **3.5 mm** with respect to the crankshaft thrust surface and align the oilways in the half shells with the respective oilways in the support (Fig. 6.15).

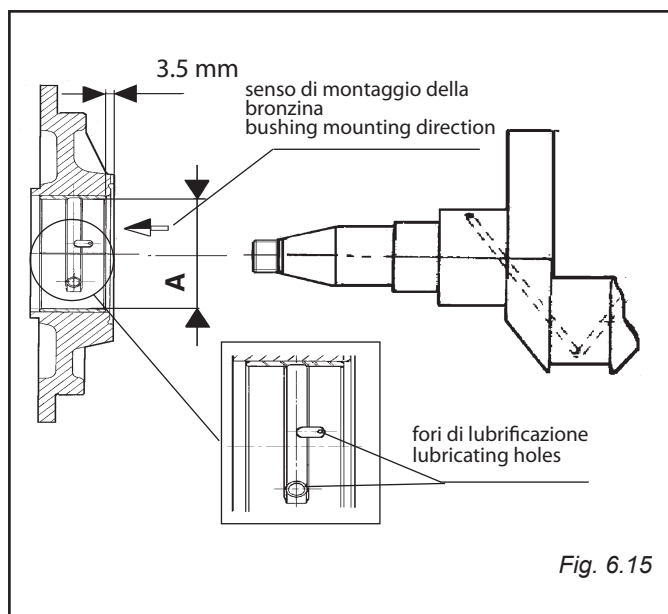


Fig. 6.15

(FIG. 6.17)

Main journals and rear bearings, see (TABLE 8.2.1)

For assembly and disassembly of the bearings consult a properly equipped grinding shop. When assembling the bearings, observe the following indications:

- Check that the arrow punched on the exterior of each half shell is facing the direction of assembly of the bearing (Fig. 6.17).
- Fit the bearing to a depth of **3.5 mm** with respect to the crankshaft thrust surface and align the oilways in the half shells with the respective oilways in the support (Fig. 6.17).

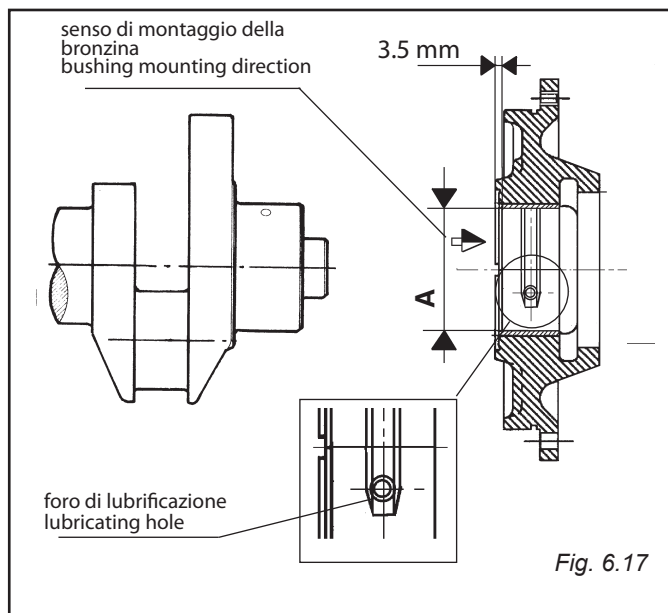
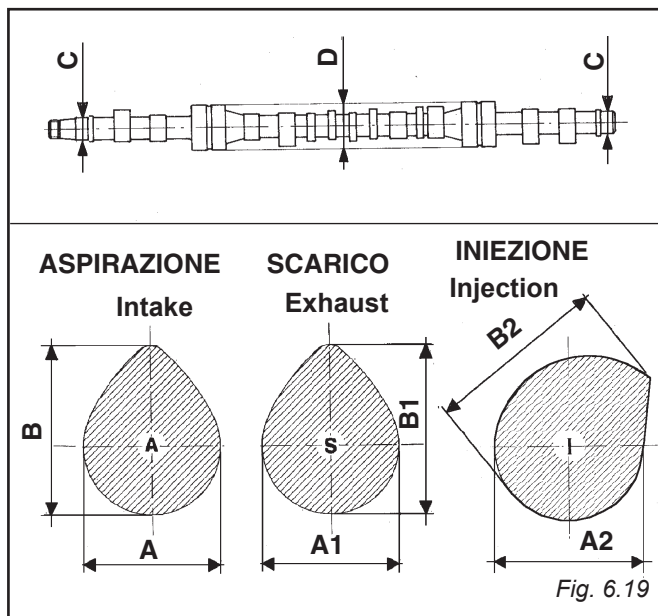


Fig. 6.17

6.9 CAMSHAFT (FIG. 6.19)

Make sure that the cams and journals are not worn. Check that the dimensions of cams **A-B-C-D** are no less than **0.05 mm** with respect to the values in (TABLE 8.2.2).



6.10 GUDGEON PINS AND CONNECTING RODS (FIG. 6.20A - 6.20B)

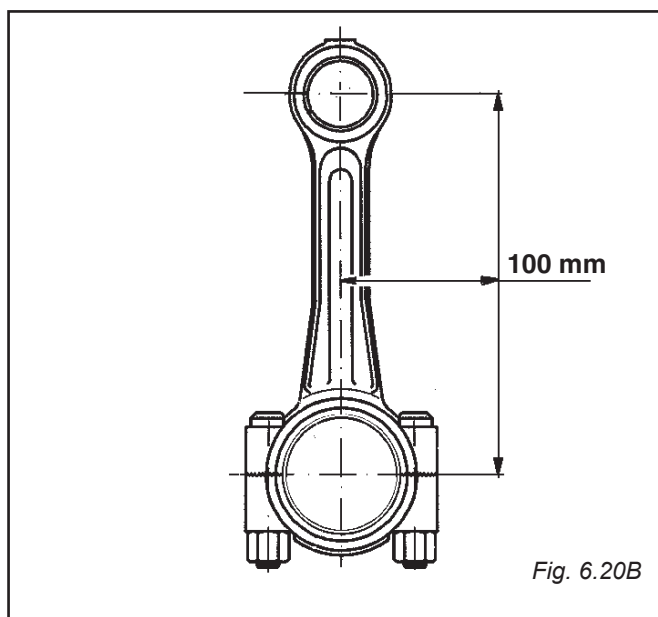
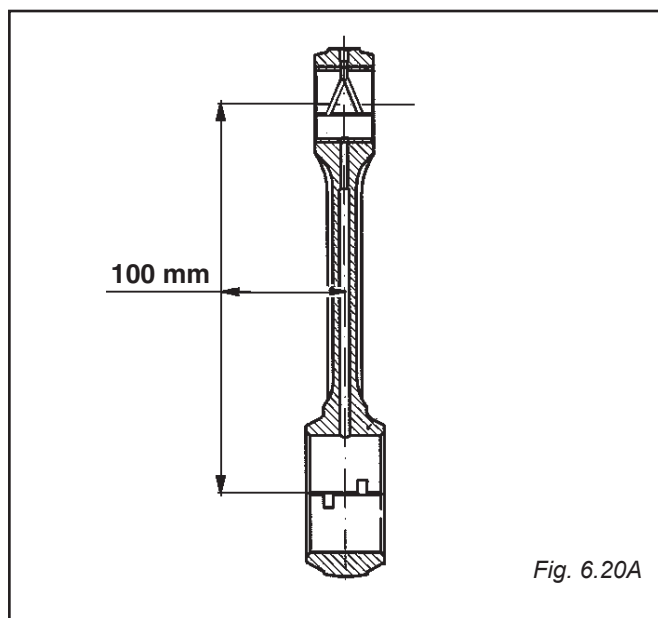
Check each connecting rod for signs of wear or cracks, perform a Magnaflux inspection if necessary. Make sure that the gudgeon pin is without scoring or signs of seizure.

Check parallelism of the connecting rod axes.

The maximum parallelism error between the small end and big end axes is **0.050 mm** at a distance of **100 mm** from the connecting rod in the direction shown in figure 6.20A.

The maximum parallelism error between the small end and big end axes is **± 0.100 mm** at **100 mm** from the connecting rod in the direction shown in figure 6.20B.

If it is necessary to renew the small end bushing, when fitting the new bushing ensure that the lubrication holes in bushing and connecting rod are properly aligned.



WARNING:
MAKE SURE THAT THE CONNECTING RODS ARE MARKED WITH THE SAME SELECTION NUMBER.

6.11 CONNECTING ROD BEARING SEAT CHECK.

Assemble cap and rod. Torque the screws to the values shown in (pag. 7-28).

Use an inside caliper gauge to check that, at three different heights, the diameter of the connecting rod

bearing **A** seat is in line with the values of:

Ø 60.833 - 60.845 mm.

If values are greater than **0.020 mm**, replace the connecting rods.

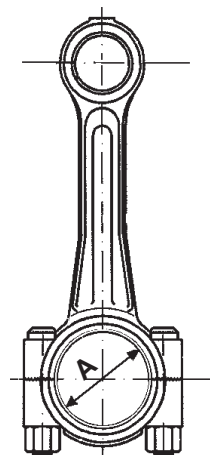


Fig. 6.20c

6.12 FLYWHEEL HOUSING (Fig. 6.21)

Check the condition of the mating surface, the holes and the bore diameters. If necessary, restore damaged threads using Helicoils.

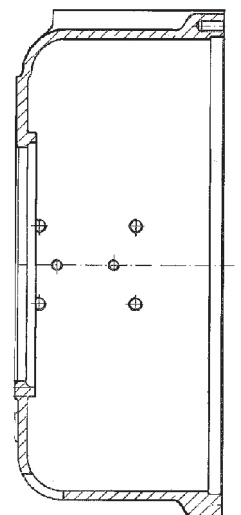


Fig. 6.21

6.13 REAR MAIN BEARING (Fig. 6.22)

Make sure that the contact surfaces with the clearance rings have no traces or irregular wear and that the orthogonality error of the crankshaft main bearing location is no greater than **0.030 mm**. Check the following diameters:

A Diameter **175.010 - 174.980 mm**

B Bushing seat diameter **72.430 - 72.405 mm**

C Oil seal seat diameter **85.000 - 84.946 mm**



AT EACH DISASSEMBLY REPLACE THE O-RING (1) (FIG. 6.22).

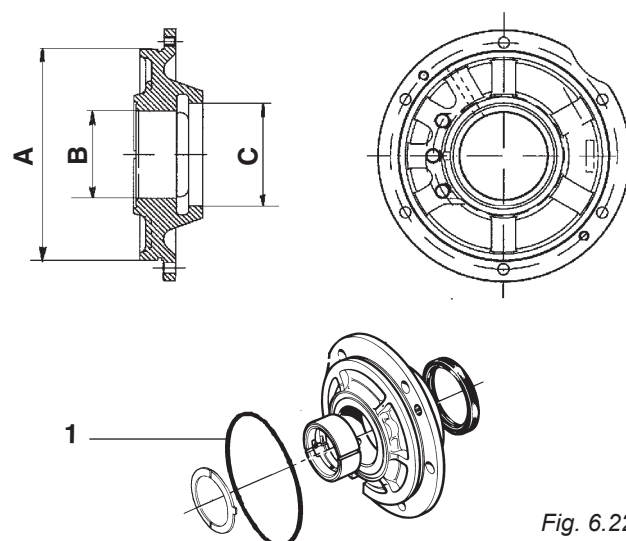


Fig. 6.22

6.14 CLEARANCE RINGS (FIG. 6.23)

For the correct end float adjustment clearance ring thicknesses are available as shown in **(TABLE 8.2.3)**.

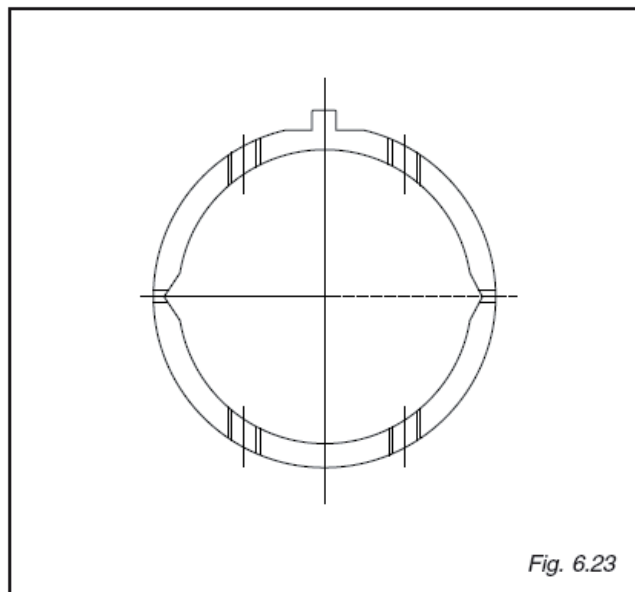


Fig. 6.23

6.15 FRONT COVER (FIG. 6.24)

Clean seat **A**. Now fit the seal ring by inserting it axially without damaging the seal.
Check the diameter of the oil seal seat.

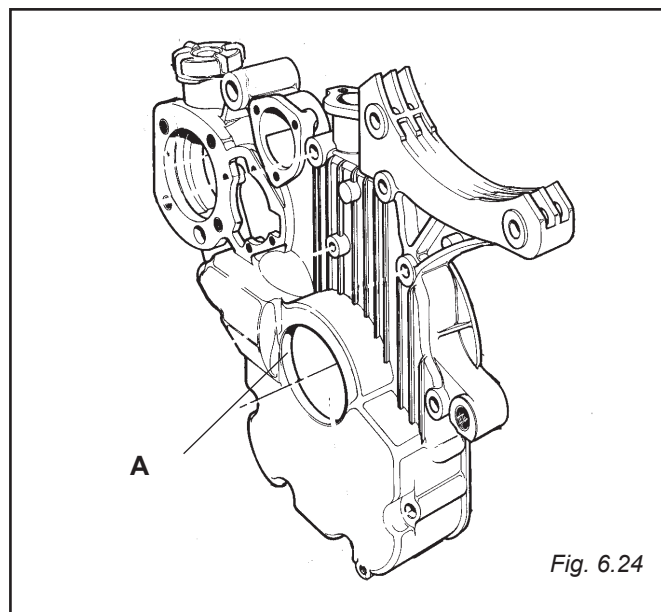


Fig. 6.24

6.16 CENTRAL MAIN BEARING (FIG. 6.25)

Tighten the bearing by torquing the screws to the value indicated to (pag. 7-24).

Measure seat **A** of the bushing across two perpendicularly opposed diameters.

Seat diameter $\varnothing 72.982 - 73.002$ mm.

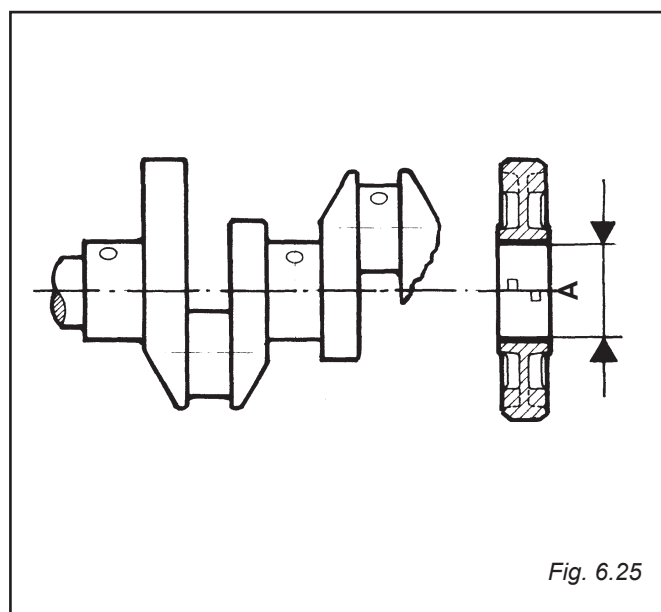


Fig. 6.25

6.17 FRONT MAIN BEARING (Fig. 6.26)

Make sure that the contact surfaces with the clearance rings have no traces or irregular wear and that the orthogonality error of the crankshaft main bearing location is no greater than **0.030 mm**. Check the following diameters:

A Diameter **175.010 - 174.980 mm**

B Bushing seat diameter **72.450 - 72.425 mm**

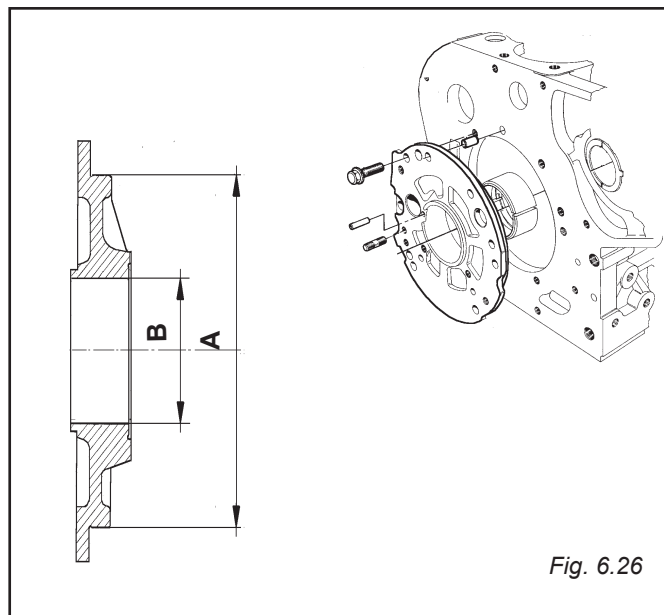


Fig. 6.26

6.18 CRANKCASE (FIG. 6.27A - 6.27B)

- Wash the crankcase with solvent as described in chapter 3 (maintenance) heading 3.7.2.
- Check the condition of the cylinder mating surface.
- Check that the threaded holes are clean and undamaged.
- Check that the oilways are not clogged.
- Check that the oil pipes are not porous or cracked.
- Check the front and rear support bore diameter.
- A = 175.080 - 175.020 mm**
- Check the injection pump bore diameter.
- B = 85.025 - 85.000 mm**
- Check the front and rear camshaft support seat diameter.
- C = 51.995 - 51.975 mm**
- Check the camshaft central support seat diameter.
- D = 52.006 - 52.004 mm**

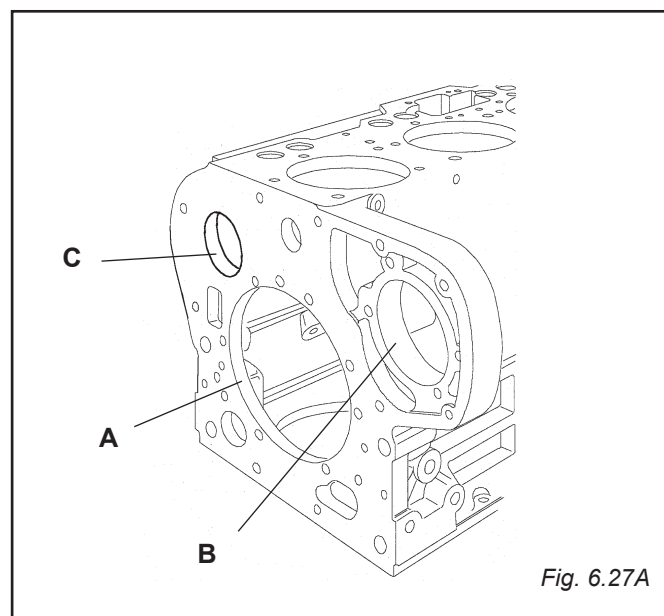


Fig. 6.27A

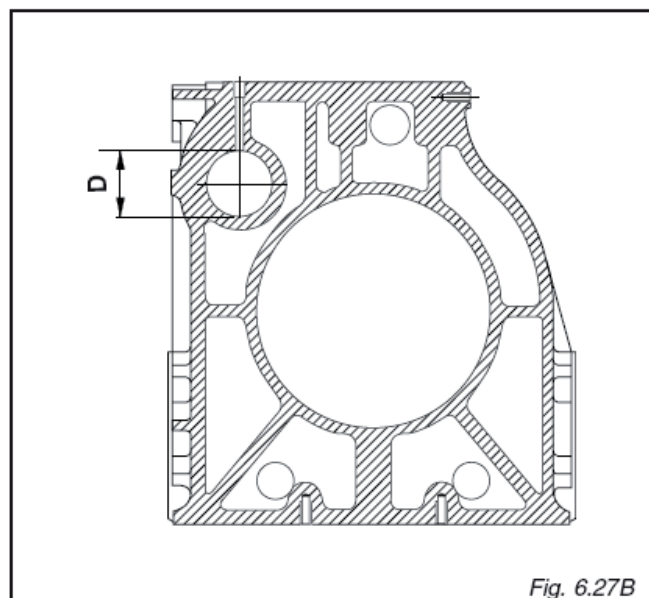


Fig. 6.27B

6.19 Governor counterweights (Fig. 6.30)

The light counterweight sets for industrial applications (11980039A) and the heavy set for generator sets (11982001A) have been replaced by an intermediate weight set (11982009F) that can be fitted to all versions of the engine provided the correct spring is used. The counterweight type can be distinguished by height **A**.

Modification applicable from:

Engine 2105 - Serial number 67A 2454

Engine 3105 - Serial number 68A 2927

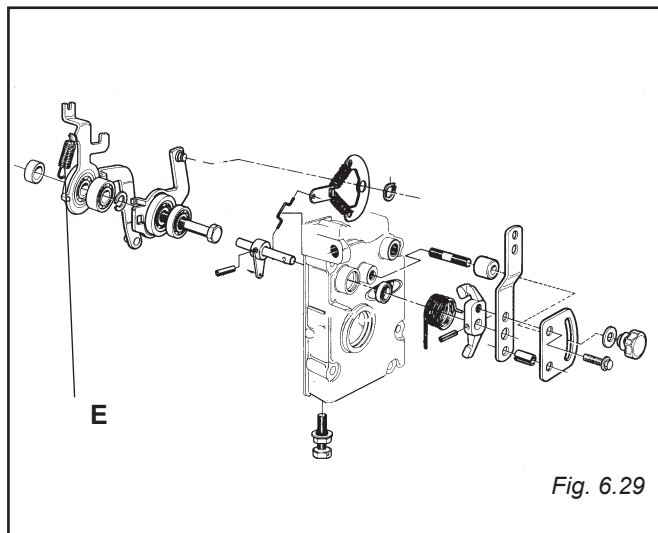


Fig. 6.29

Counterweight set	Type	A (mm)
	Light	23.5
	Heavy	28.5
	Medium	26.5

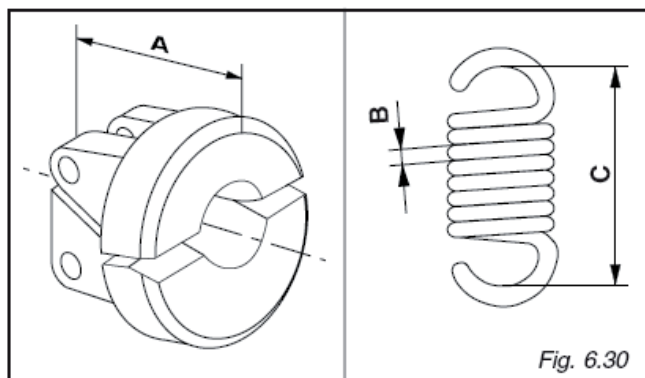


Fig. 6.30

GOVERNOR SPRINGS

Engine type	Rpm	Application	Color	C	B
2-3-4105-4105T		Industrial	Grey	22	1.8
2105E1-3105E1-TE1		Industrial	Grey	22	1.8
2-3105-3105T	1500 - 1800	Generator set	Natural	22	1.5
2105-3105	1800	Generator set	Purple	21	1.5
3105T-4105T	1500 - 1800	Generator set	Red	22	1.6
4105T	1500	Generator set	Yellow	21	1.3

6.20 Thermostatic valve and oil pressure valve (Fig. 6.31)

- If an oil cooler is fitted check that thermostatic valve **A** starts opening at **80 - 85°C** and oil is sent to the radiator.
- Check that oil pressure control valve **B** remains closed up to the pressure value shown in (Pag. 4.3).

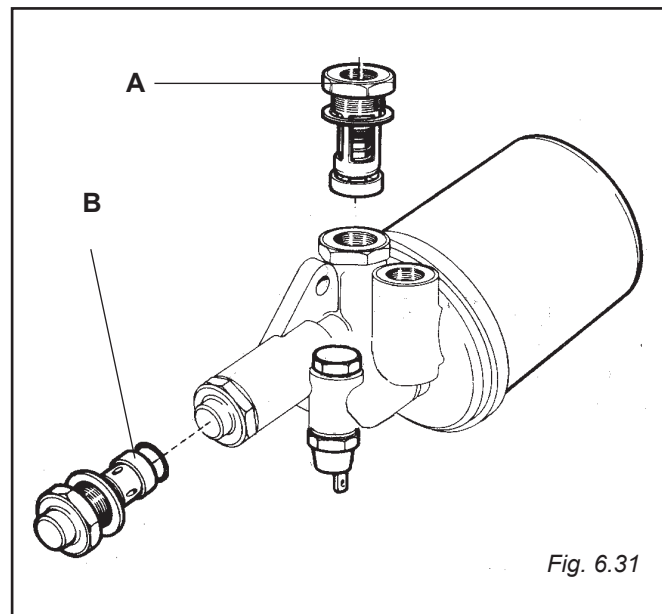


Fig. 6.31

6.21 OIL PUMP (FIG. 6.32)

Each time the pump is disassembled wash the components and check wear and general condition.

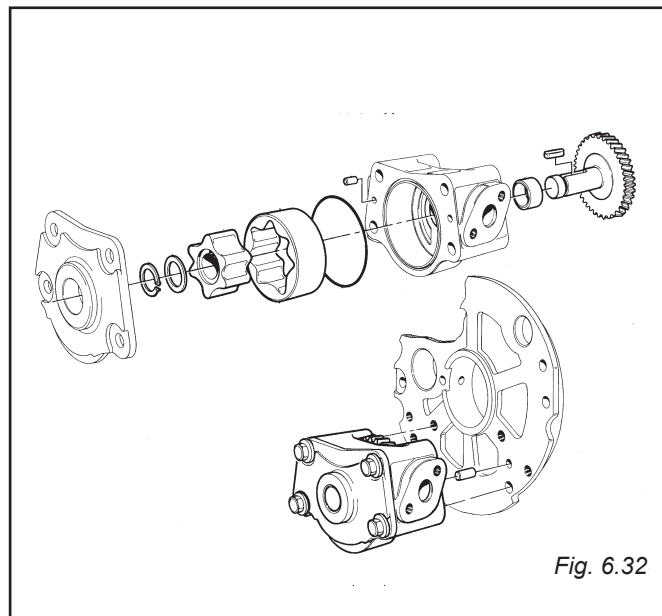


Fig. 6.32

(FIG. 6.33 - 6.34)

Dimensions and clearances:

(2-3 cylinder engines)

Rotor height (mm) **23.970 - 23.910 (C)**. Rotor

seat depth (mm): **24.000 - 23.970 (C)**.

(4-6 cylinder engines)

Rotor height (mm): **27.970 - 27.910 (C)**. Rotor

seat depth (mm): **28.000 - 27.970 (C)**.

Difference between rotor height and seat depth (mm): **0.090 - 0.040**.

External rotor diameter (mm):

69.834 - 69.764 (B).

Rotor seat diameter (mm):

69.979 - 69.954 (B).

Clearance between housing and external rotor (mm): **0.215 - 0.120**.

Clearance between rotors (mm): **0.200 - 0.07 (A)**.

Axial clearance between gear and pump body (mm): **0.050 - 0.070**.



AT THE TIME OF REASSEMBLY KEEP THE EXTERNAL ROTOR CHAMFER FACING THE GEAR.

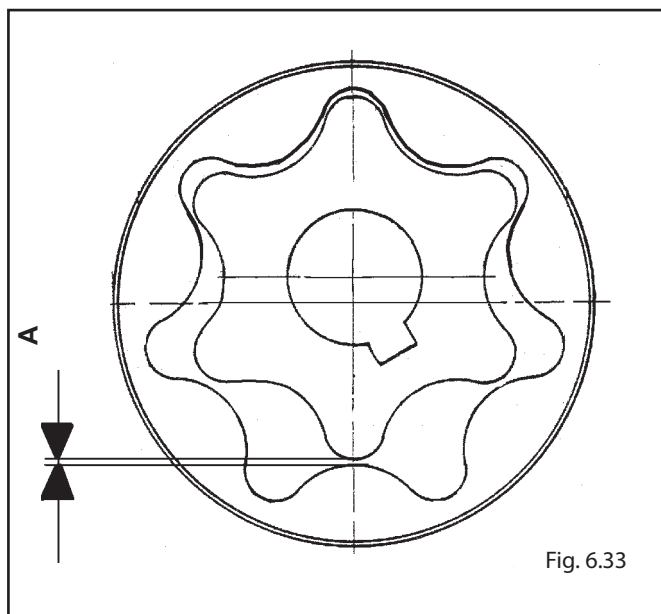


Fig. 6.33

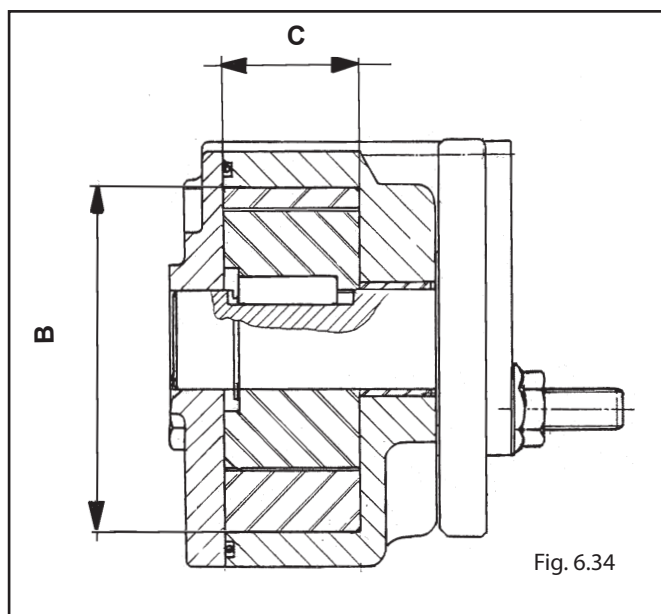


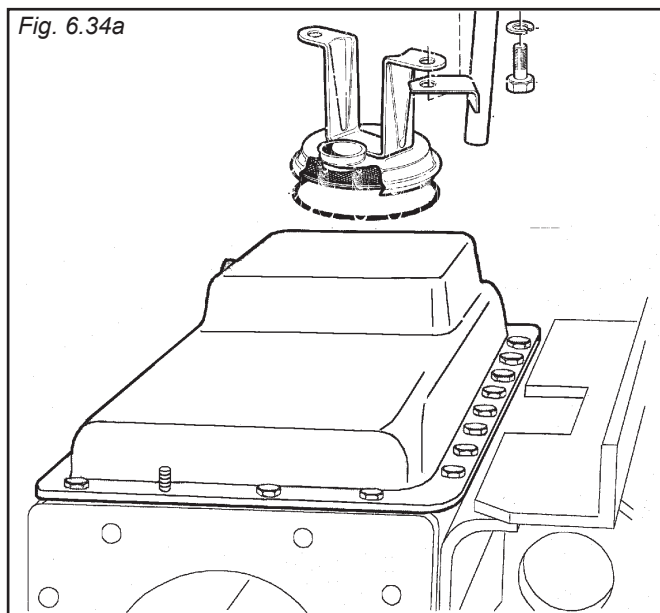
Fig. 6.34

6.22 SUMP AND OIL SUCTION PIPELINE

Check the sump for signs of cracks or other damage.

Carefully check that welded joints are perfectly oiltight and that the oil suction pipeline seals are in good condition.

Fig. 6.34a



6.23 OIL FILTER (FIG. 6.35)

Change the filter cartridge at the scheduled intervals shown in heading 3.10, chapter 3 (Maintenance).

When fitting the cartridge smear clean engine oil over the seal.

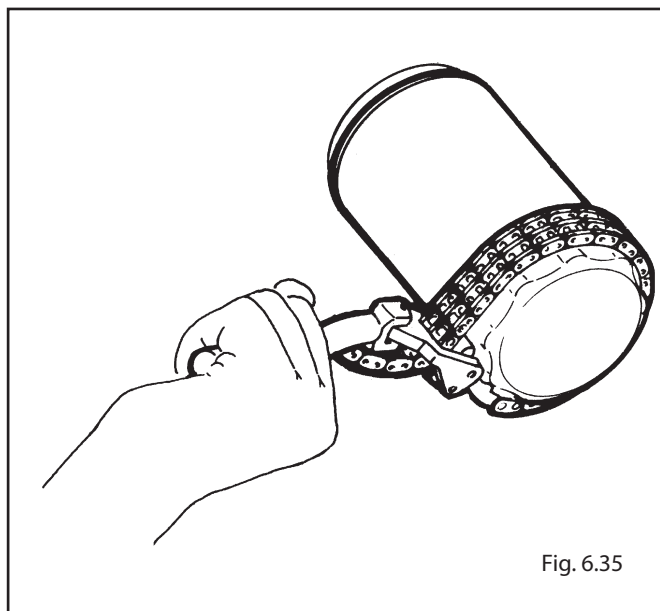


Fig. 6.35

6.24 AIR FILTER

SUN/SUNe series engines can be equipped with dry or oil bath type air filters.

6.25 DRY AIR FILTER (FIG. 6.36)

The filter is equipped with a clog indicator **A**. Clean or change the cartridge only when the indicator color is permanently red.

Maintenance:

Unscrew wingnut **B** and remove the dust debris from prefilter **C**.

Remove cover **D** and empty the container. On filters without expulsion valve **E** this operation should be performed daily.

Remove the cartridge **F** by unscrewing wingnut **G** and perform maintenance.

The safety cartridge **I** (if present) must only be removed when strictly necessary.

Replace the cartridge at the intervals shown in heading 3.10, chapter 3 (Maintenance).

Do not impact the cartridge against hard surfaces

Unscrew the lateral nut of the filter cover. Disassemble the filter element.

Check the air inlet ports and remove any debris.

Clean the internal cartridge with low pressure compressed air.

Use a worklight to check that there are no tears in the cartridge.

If the upper seal is torn and/or if the plastic fins are damaged, replace the cartridge.

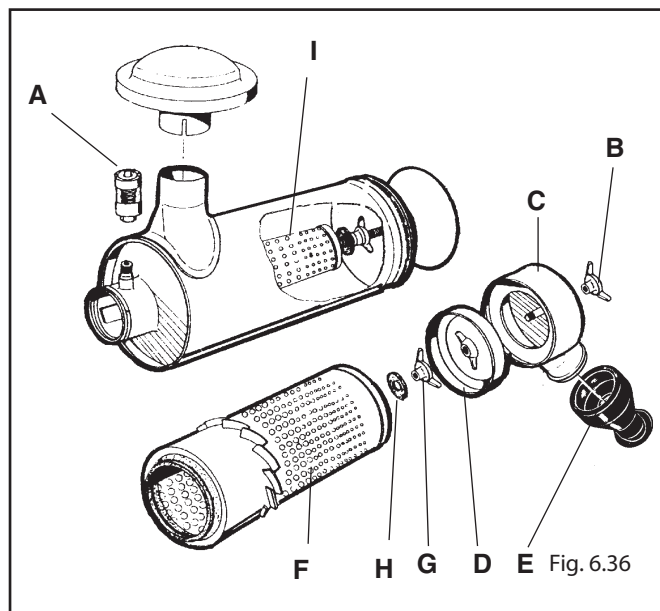
After 3 services change the main cartridge and (if present) the safety cartridge.

Refit the cartridge in the filter, placing seal **I** beneath the wingnut.

After servicing, press button **A** to reset the clog indicator.

In the event of replacement, specify the type of filter on which the indicator is fitted.

With the engine assembled, check the inlet suction at full load and max. revs. The vacuum values are shown in chapter 10 (Installation).



6.26 OIL BATH AIR FILTERS (FIG. 6.37)

- Check that the gaskets **A** between filter and manifold are in good condition. Replace if necessary.
- Remove the seal rings **B** and renew if damaged.
- Wash filter element **C** with paraffin or solvent (chapter 3, "Maintenance") and replace if the mesh is damaged. Check the air inlet ports.
- Dry the element with compressed air and refit only when perfectly dry.
- Clean the bowl and fill up to the level mark with new engine oil.
- Service the filter at the intervals specified in heading chapter 3 (Maintenance).

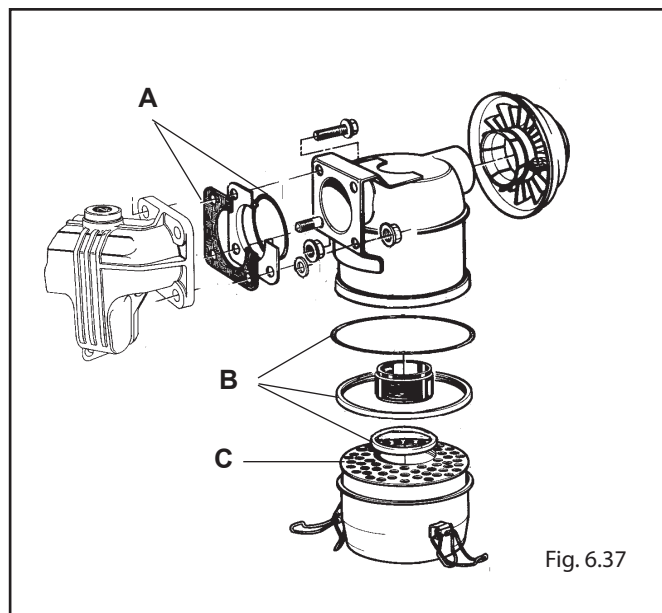


Fig. 6.37

6.27 FUEL FILTER (FIG. 6.38)

Change the filter cartridge at the intervals specified in heading (chapter 3 "Maintenance").

The filter cartridge replacement procedure is as follows:

Unscrew the screw that secures the cartridge to the filter.

Fit a new cartridge.

Bleed the fuel circuit as described on chapter 9 (Tests and adjustments with engine running).

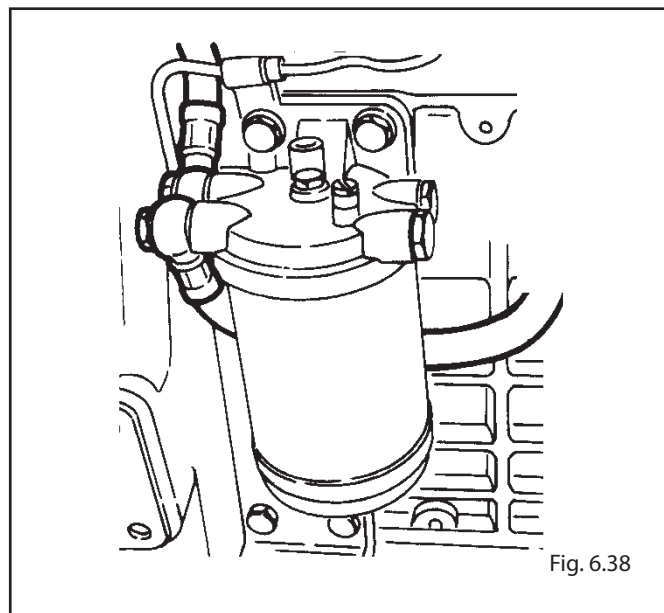


Fig. 6.38

6.28 INTERMEDIATE GEAR (FIG. 6.39)

Check the gear for damage or uneven wear.

If unevenness is detected, replace the entire unit.

At the time of reassembly make sure there is **0.100 - 0.200 mm** clearance between the gears.

Check the outside diameter of bearing journal **A**: **20.002 - 20.011 mm**.

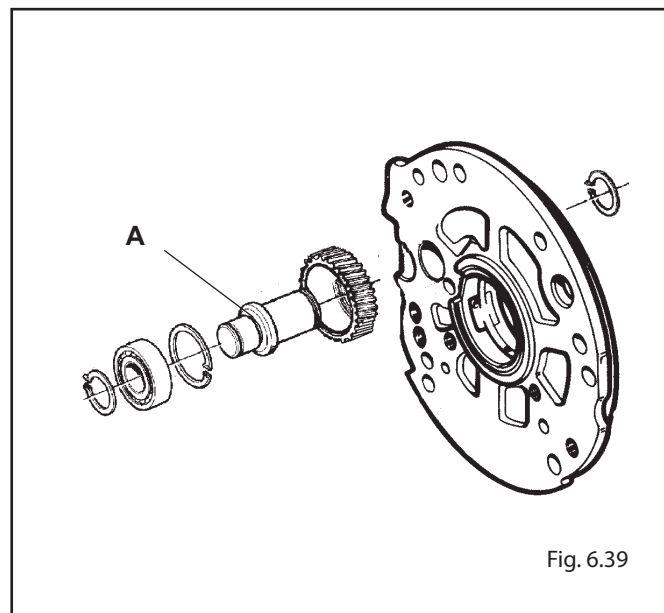


Fig. 6.39

6.29 IDLER GEAR (FIG. 6.40)

Check the gear for damage or uneven wear. If unevenness is detected, renew the entire unit. At the time of reassembly make sure there is a clearance of **0.100 - 0.200 mm** between the gears.

Check the outside diameter of bearing journal

A: 19.987 - 20.000 mm.

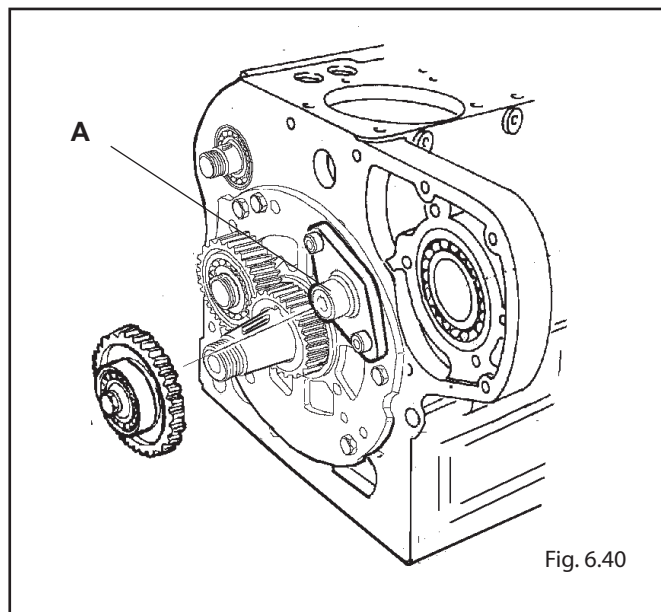


Fig. 6.40

6.30 BELT COOLING FAN (FIG. 6.41 - 6.42)

Check that the fins of shroud **A** and fan **B** are undamaged.

Check bearings **C** and renew if you detect damaged races, balls or excess internal play.

The seat diameter of ball bearings **C** in the fan shroud must be:

SUN 2105 - 3105 - 3105T- (FIG. 6.41)

Ø 47.000 - 46.975 mm

SUN 2105E1 - 3105E1 - 3105TE1- (FIG. 6.41)

Ø 47.000 - 46.975 mm

SUN 4105 E-TE-IE / 6105 E-TE-IE (FIG. 6.42)

Ø 61.979 - 61.949 mm

SUN 4105 TE1 / 6105 TE1 (FIG. 6.42)

Ø 61.979 - 61.949 mm

Replace shroud **A** (Fig. 6.41 - 6.42) if the values deviate with respect to the specified tolerances.

Check that the belts are not excessively worn or cracked.

After fitting new belts press the free length with your finger and check that deflection is not greater than **10 mm** (Fig. 6.42).

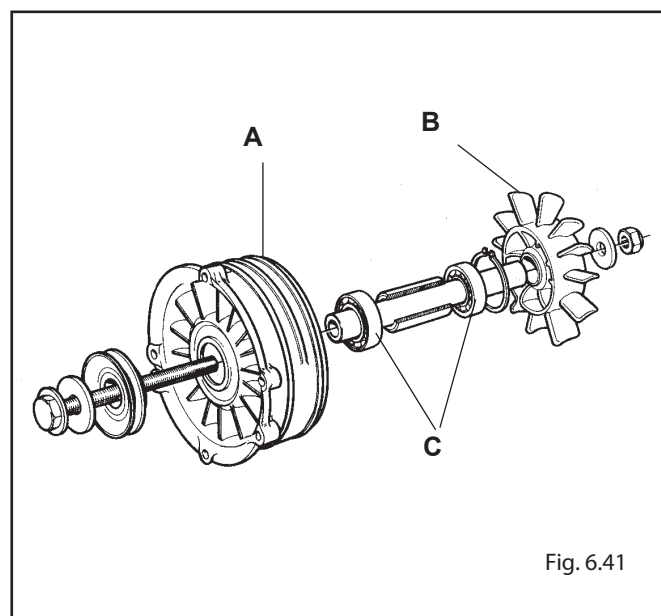


Fig. 6.41

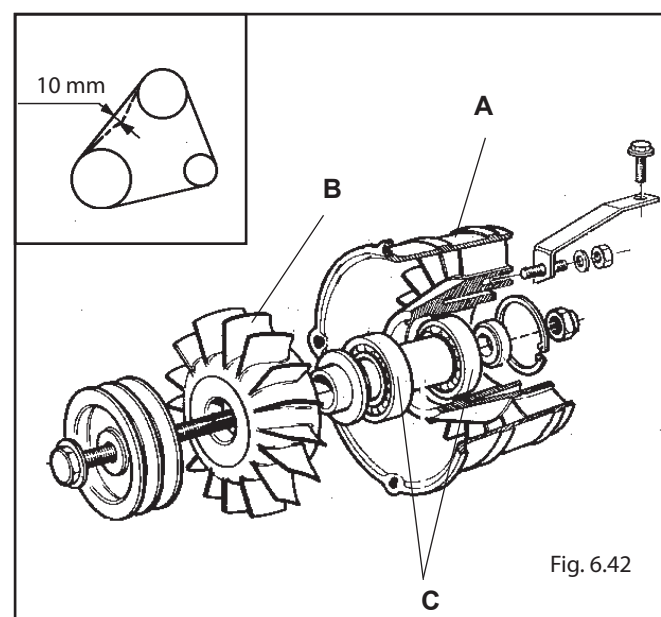


Fig. 6.42

6.31 EXHAUST MANIFOLD (FIG. 6.43)

Check the manifolds for signs of damage or cracking; renew if necessary.

Make sure the mating flanges with the cylinder head are co-planar.

Exhaust manifolds for turbocharged engines are not interchangeable with those for naturally aspirated engines. In the case of replacement consult the General Spare Parts Catalogue.

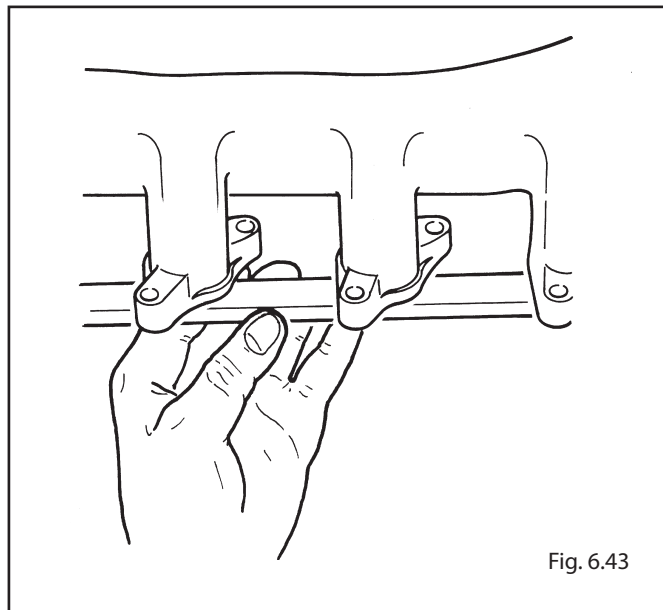


Fig. 6.43

6.32 OIL COOLER (FIG. 6.44)

The oil cooler is located at the side of the engine.

Check the oil cooler for leaks. Remove accumulated dust from the fins and clean thoroughly. Note that excessively high oil temperature can be caused by an insufficiently taut fan belt or by a faulty thermostatic valve.

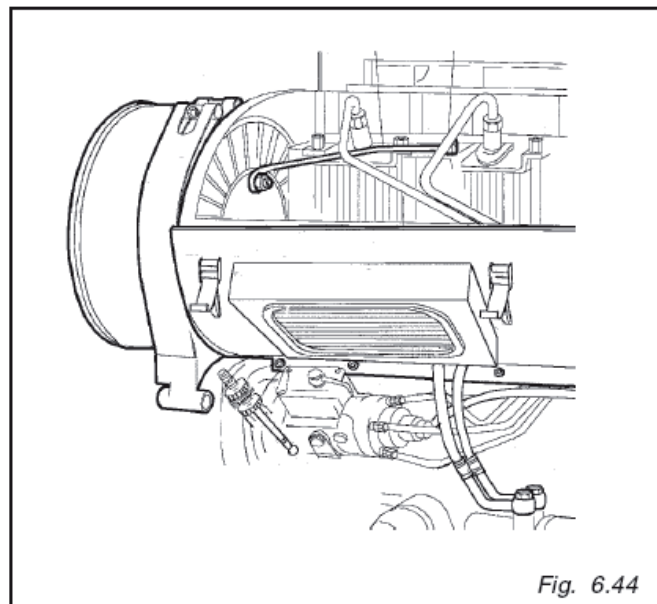


Fig. 6.44

6.33 FUEL PUMP (FIG. 6.45)

The membrane type fuel pump is mounted to the crankcase and operated by one of the cams on the camshaft; the pump is manually primed.

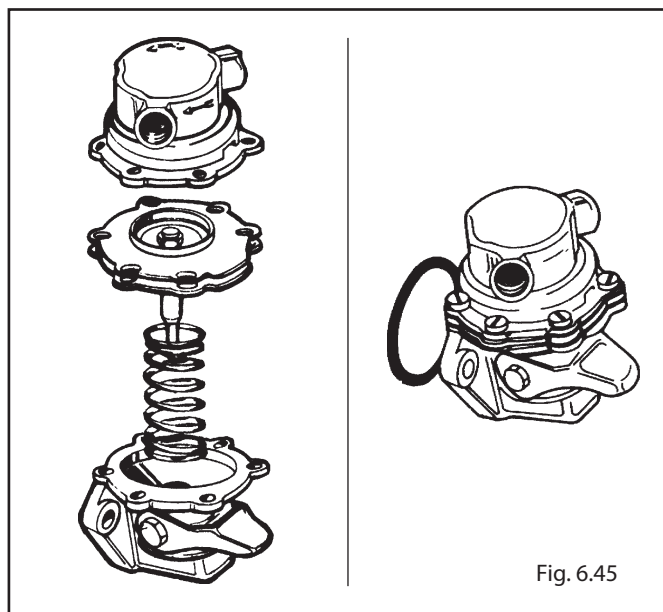


Fig. 6.45

6.34 SINGLE INJECTION PUMP

(FIG. 6.46 - 6.47 - 6.48)

Internal injection pump.

The fuel pump forces the fuel through the filters to the injection pump, which sends it under high pressure to the injectors. The injection system incorporates a single body pump with constant stroke plungers, each of which supplies one cylinder.

The piston of each plunger cylinder is driven by a dedicated cam on the engine camshaft.

Before checking the pump make sure that the fuel filter is not clogged and that the pipelines are clear.

When the plunger is at its bottom dead center position it opens the fuel transfer ports and the upper chamber is flooded with fuel. The plunger now ascends and closes the transfer ports, forcing the fuel to the injectors through the outlet valve. The end of the pump cycle occurs when the port is opened by the helical groove around the circumference of the plunger.



EACH PLUNGER IS PERFECTLY MATCHED TO ITS CORRESPONDING CYLINDER AND CANNOT BE INTERCHANGED WITH ANY OF THE OTHERS.

Disassembly

Pump disassembly operations are performed in accordance with the traditional procedures used in pumps with the camshaft and are described by following the steps in the following chapter "Assembly" in reverse sequence.

Assembly (FIG. 6.46 - 6.47)

- Equip the pump body with the cylinders **4** (without plungers), valves **3**, and springs **2** and restrain the parts by tightening the outlet unions **1**.
- Fit the rack rod **5** in a mid position.
- Fit adjustment sleeves **6** ensuring that points **C** are aligned with points **B** on the rack.
- Fit washers **7** and springs **8**.
- Insert the plungers in the cylinders with points **H** on the same side as points **G**.
- Turn the adjustment bush so that point **F** is aligned with point **D**.
- Fit washers **9** and tappets **10**. Fasten. Check the plunger timing and displacement on the test bench.

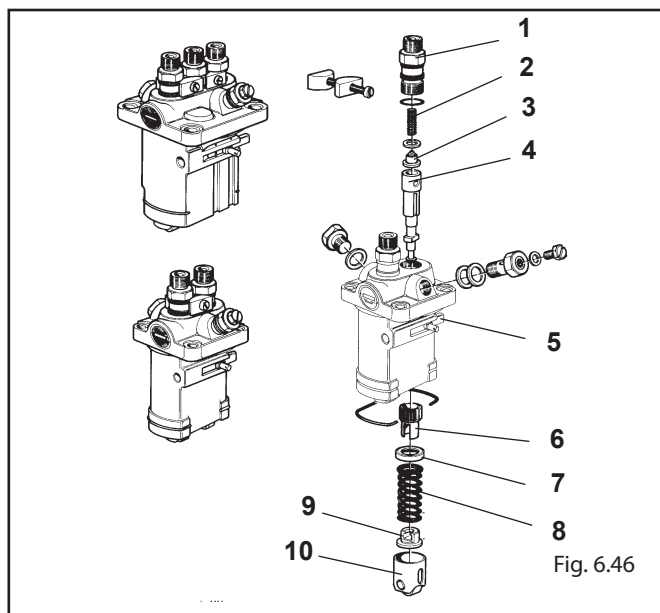


Fig. 6.46

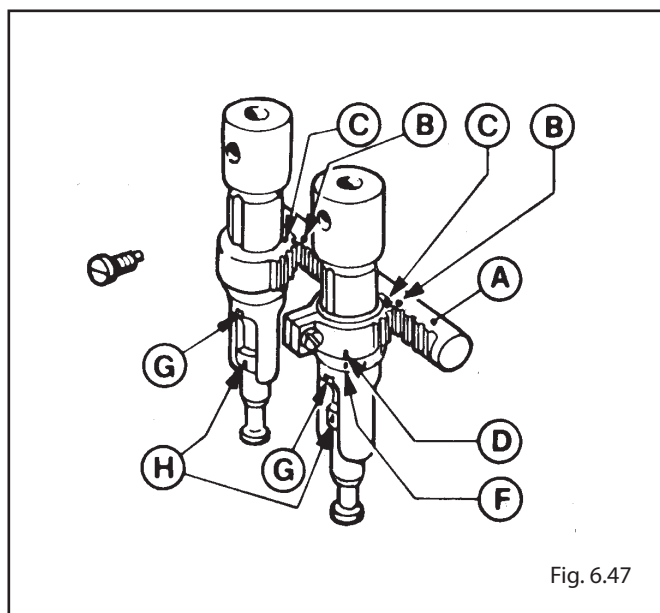


Fig. 6.47

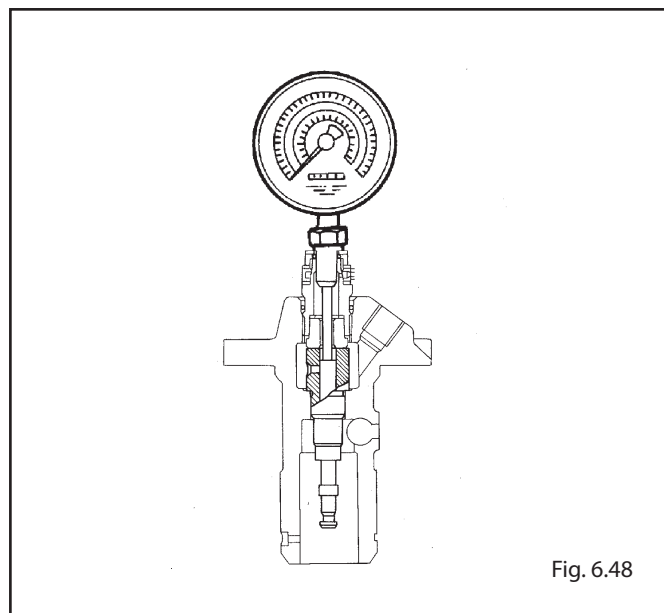
Adjustment

The pumps are supplied with a $\sim 12^\circ$ retard position on the plunger. Pump timing is performed by the manufacturer and when the plungers are substituted (with equivalent genuine replacements) the preset values are not affected. The only precaution to observe is to avoid inverting washers **7** (fig. 6.46).

Plunger seal (FIG.6.48)

This test is shown with guideline values because the pressures vary in relation to the plunger speed.

- Connect an outlet union to a **60000 kPa (600 bar)** pressure gauge with a relief valve.
- Set the rack rod in an intermediate position.
- Activate the plunger so that it performs almost the entire compression stroke. If the pressure fails to reach **30000 kPa (300 bar)** replace the plunger. Repeat the test on the other plungers.



Outlet valve seal (FIG. 6.48)

- Set up the pump as described for the previous test.
- During the test the pressure gauge reading should reach a peak followed by a sudden return to a lower value indicating that the outlet valve has closed. This sudden pressure drop should be in the region of **3000 - 4000 kPa (30 - 40 bar)**.
If the value is lower or higher, replace the outlet valve.

INTERNAL STANADYNE PUMP			
ENGINE TYPE	INJECTION ADVANCE	Internal pump depth (mm)	Selection of internal pump depth shims (mm)
2105	22°	83.400 - 83.500	0.100 - 0.250
3105	22°	83.400 - 83.500	0.100 - 0.250
3105T	22°	83.400 - 83.500	0.100 - 0.250
2105E1	15°	83.400 - 83.500	0.100 - 0.250
3105E1	15°	83.400 - 83.500	0.100 - 0.250
3105TE1	14°	83.400 - 83.500	0.100 - 0.250
3105TE1 G.E.	12°	83.400 - 83.500	0.100 - 0.250
SUN 2105E2	13°	83.700 - 83.800	0.100 - 0.250
SUN 3105E2	13°	83.400 - 83.500	0.100 - 0.250
SUN 3105TE2	11°	83.400 - 83.500	0.100 - 0.250

6.35 INJECTION PUMP (FIG. 6.49)

Stanadyne rotary pump

- Bleeding the fuel circuit.

After filling the fuel circuit by means of the fuel pump and bleeding the fuel filter, operate the fuel pump until all the air has been purged from the circuit.

- Bleeding the injector pipelines

Loosen the unions of the injector pipes. Turn over the engine using the starter motor until all the air has been expelled from the pipes and they are emitting fuel only.

Retighten the unions

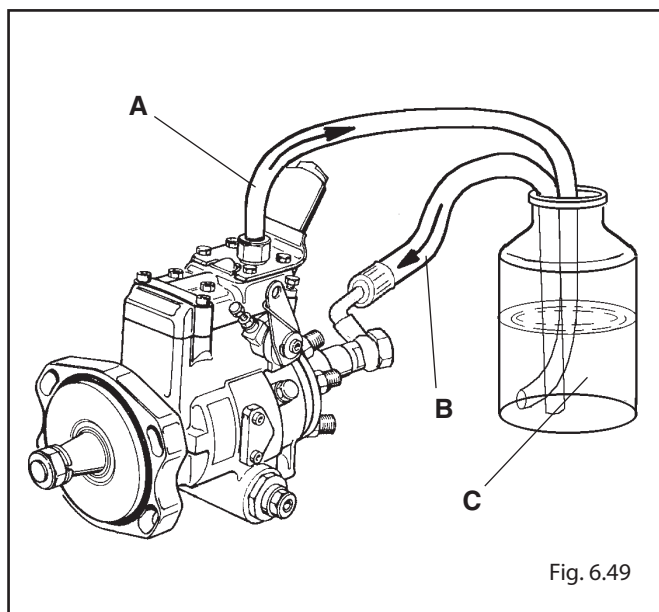


BEFORE PERFORMING THIS OPERATION CHECK THE ELECTRICAL CONNECTION OF THE SOLENOID VALVE ON THE INJECTION PUMP.

- Dynamic timing check (with strobe lamp and engine running)

Connect the Time Trac or an equivalent diagnostic unit set to 1500 rpm no load and using a strobe lamp to check the timing.

Start the engine and accelerate it to 1500 rpm no load. The engine is correctly timed when the reference on the timing cover and the T.D.C. notch on the front pulley are aligned (when viewed under the strobe) and the instrument display shows the values in degrees.



A = Return
B = Outlet
C = Totally pure fuel

STANDYNE ROTARY PUMP			
ENGINE TYPE		STANADYNE REF.	INJECTION ADVANCE
4105E		DB4427 - 5017	17°
4105E		DB4427 - 5021	15°*
4105TE		DB4427 - 5015	15°
4105TE		DB4427 - 5019	14°*
4105TE1		DB4429 - 5579	13°
4105TE1 G.E.		DB4429 - 5579	7°*
4105TE2		DB4429 - 6026	9°
4105IE		DB4427 - 5028	14°*
6105E		DB4627 - 5016	21°
6105E		DB4627 - 5022	21°*
6105E		DB4627 - 5016	21°**
6105TE		DB4627 - 5014	18°
6105TE		DB4627 - 5018	18°*
6105TE1		DB4629 - 5586	17°
6105IE		DB4627 - 5020	16°*
6105IE		DB4627 - 5012	16°
6105IE		DB4627 - 5104	21°

* GENERATOR SETS
1500/1800 rpm

** MARINE/WORK
2200 rpm

DISA PUMP			
ENGINE TYPE		DISA REF.	INJECTION ADVANCE
4105		PRN490/120E1016	22°**
4105T		PRN490/120E1016	22°•
6105-6105T-6105I		PPM6-90/253E1193/4	26°*

* INDUSTRIAL/GENERATOR SETS 1500/1800 rpm

• INDUSTRIAL/GENERATOR SETS 1500/2600 rpm

** MARINE/WORK 2200 rpm

BOSCH ROTARY PUMP			
ENGINE TYPE		BOSCH REF.	INJECTION ADVANCE
6105-6105T-6105I		PE96A90O320/3RS27852	26°

6.36 ADJUSTMENTS (FIG. 6.50 - 6.51)

Maximum speed and idle speed adjustment is not possible on the internal Stanadyne pump.

This adjustment is possible by means of the screws on the governor cover:

A) maximum speed;

B) idle speed.

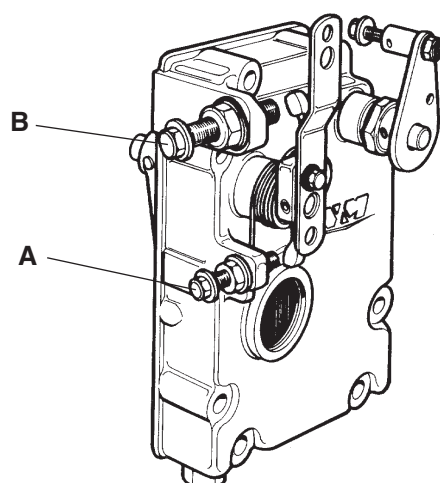


Fig. 6.50

Stanadyne rotary pump (Fig. 6.51)

Maximum speed and idle speed adjustment is possible on the Stanadyne rotary pump:

- A) maximum speed;
- B) idle speed.

Direct lever **C** towards the flywheel and use screws **A-B** to adjust Idle and or Max. engine speed.



THE QUANTITY OF FUEL IS PRESET.

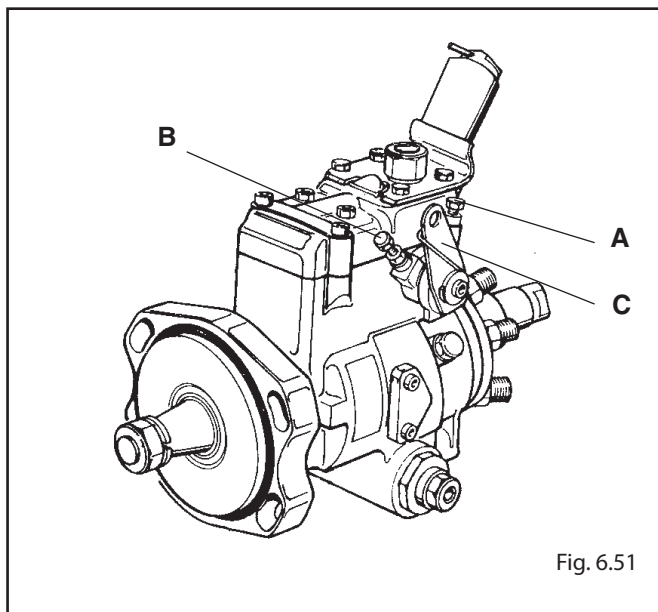


Fig. 6.51

Stabilizing uneven idle speed Stanadyne rotary pump (Fig. 6.51a)

Use a screwdriver to turn screw **A** clockwise/ counterclockwise until engine idle speed is stabilized.

THE ADJUSTMENT SCREW CAN BE TURNED UP TO A MAXIMUM OF 360° IN CLOCKWISE AND / OR COUNTER CLOCKWISE DIRECTIONS.

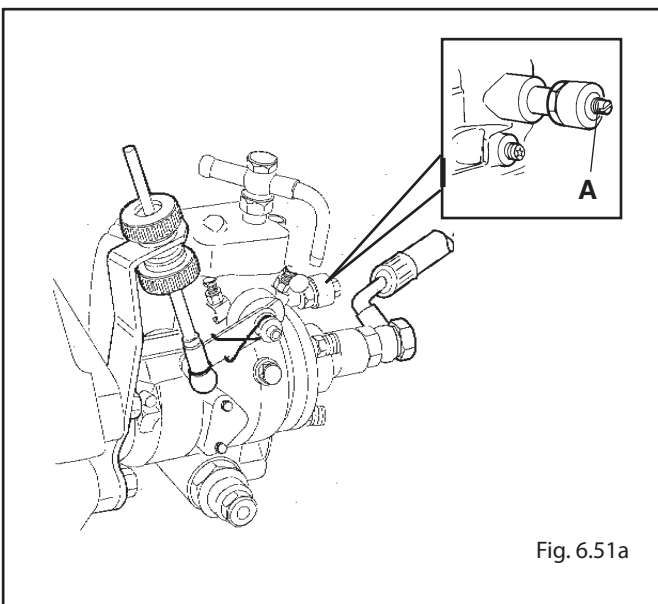


Fig. 6.51a

6.37 INJECTOR (FIG. 6.52)

Components:

- 1) Body - 2) Distance ring - 3) Spring - 4) Atomizer

To observe the atomized fuel delivered by the injector, the injector must be disassembled from the cylinder head.

Connect the injector to the fuel feed pipeline outside the engine and turn the engine over by hand slowly with the pump in the max. delivery position.

Renew the atomizer if you notice dripping fuel during the check.

Mount the injector on the test bench, activate the handpump and check that the injection pressure is as shown in heading 2.2, chapter 2 (Technical Specifications).

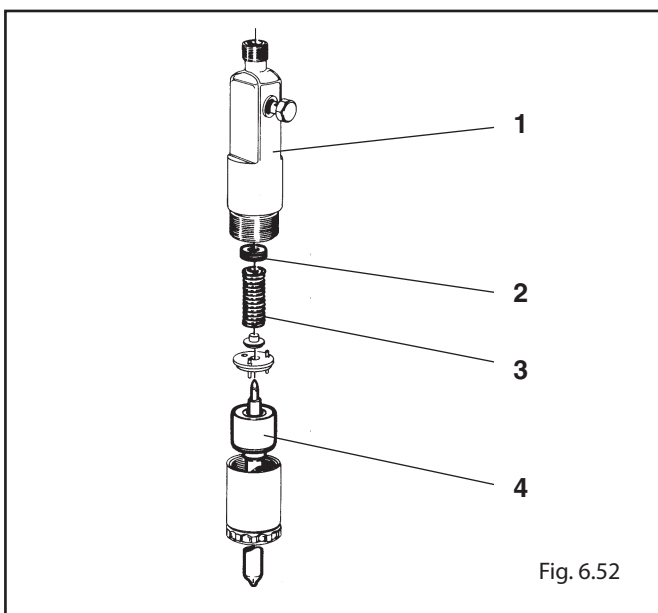


Fig. 6.52

6.38 ELECTRICAL EQUIPMENT

Warning

When the engine is running do not detach the battery leads to avoid voltage spikes that could damage the alternator diodes or other electrical equipment.

If electric welding operations must be carried out, detach the battery ground lead before starting work.

6.39 ENGINE STARTING (FIG. 6.53)

At the first turn of the key (**position 1**) the oil pressure and battery check circuits are connected, at the second turn (**position 2**) the starter motor is connected. Do not run the starter motor for more than 15 seconds at a time to avoid overheating of the engagement electromagnet.

After each engine start attempt wait for a few seconds for the battery to recover power.

When the engine is stopped leave the key in position **0** to prevent the battery from draining or indicator lights from burning out.

A - Insufficient battery recharge

B - Insufficient oil pressure

C - Cylinder head temperature

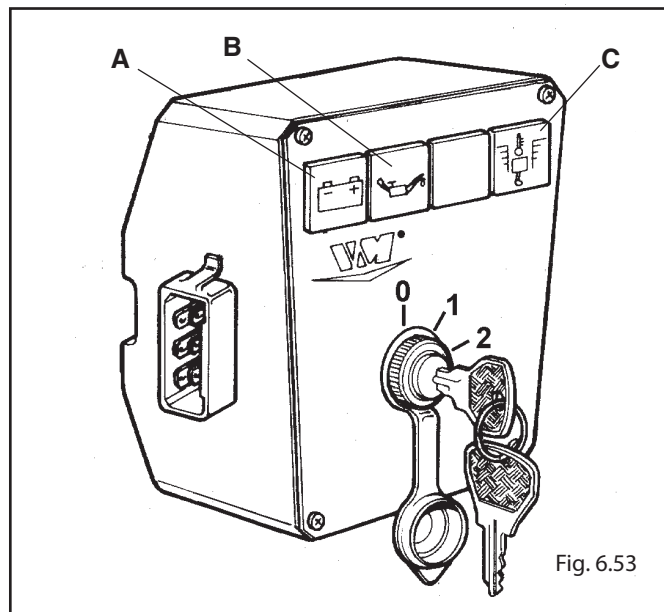


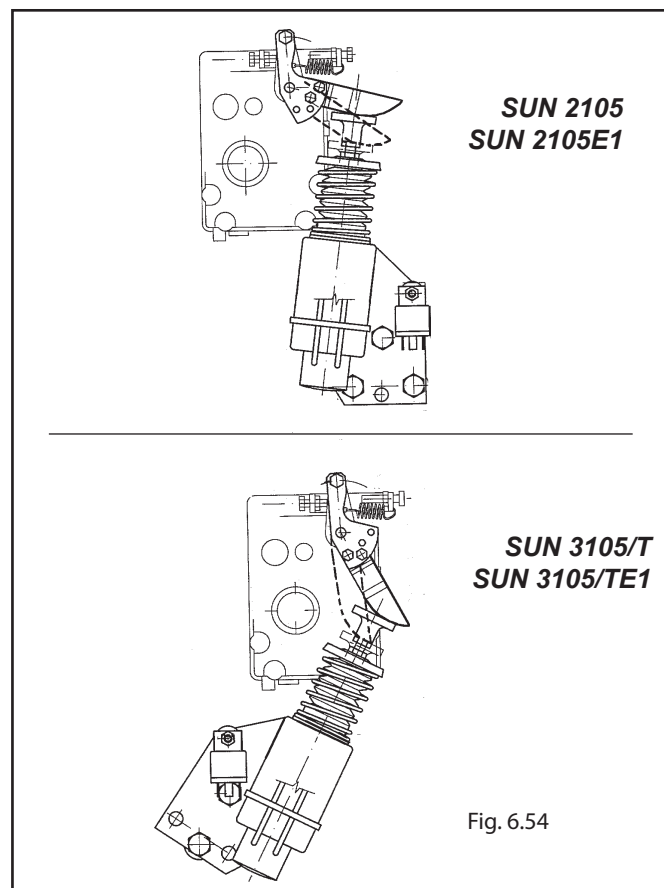
Fig. 6.53

6.40 AUTOMATIC STOPPING (FIG. 6.54)

Run the engine at medium speed for 4-5 minutes.

Turn the ignition key to "0".(Fig. 6.54).

For automatic stopping of the SUN 2105-3105 engine, fit the Elettrostop device (Fig. 6.54) 12V - 24V with the adjustments specified for manual stopping (Fig. 6.55).



**SUN 2105
SUN 2105E1**

**SUN 3105/T
SUN 3105/TE1**

Fig. 6.54

6.41 MANUAL STOPPING (FIG. 6.55)

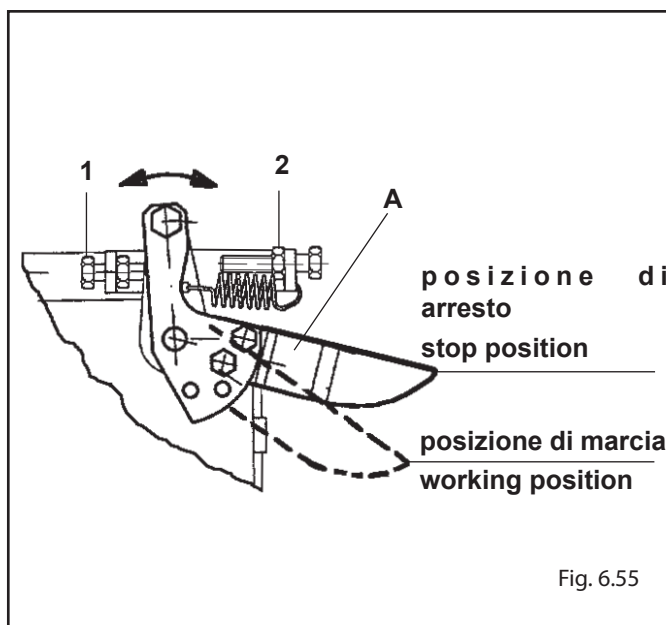
For manual stopping of the engine (SUN2105-3105) adjust the motion of lever **A** by means of screws **1-2** on the governor cover.

stopping position

Bring lever **A** to the stop position (fig.6.55) and tighten screw **1** until it locates against the lever to provide the limit position.

running position

Bring lever **A** to the running position (Fig. 6.55) and tighten screw **2** until it locates against the lever to provide the limit position; leave a minimum amount of play in the initial movement of lever **A**.



6.42 GENERAL INSPECTION OF THE ELECTRICAL SYSTEM

Check the condition of cables and insulation.

If the electrical system is not working correctly, the problems could be:

- battery - starter motor connection leads disconnected
- red lead from starter motor to alternator disconnected
- battery drained and/or battery cells disconnected
- faulty starter motor
- faulty voltage regulator
- faulty alternator diode(s)

6.43 BATTERY

Adhere to the following minimum values when selecting a battery.

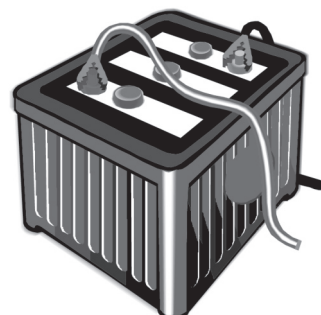


Fig. 6.55a

Temperature	-5°C	-15°C	-25°C	-32°C
Engine type	Volt / Ah	Volt / Ah	Volt / Ah	Volt / Ah
SUN 2105 - 2105 E1	12 V/92Ah	12V/110Ah	24V/2x55Ah	24V/2x66Ah
SUN 3105 -T-E1-TE1	12V/92Ah	12V/110Ah	24V/2x66Ah	24V/2x77Ah
SUN 4105E-TE-IE -TE1	12 V/92Ah	12V/110Ah	24V/2x80Ah	24V/2x92Ah
SUN 6105E-TE-IE -TE1	12V/110Ah	12V/135Ah	24V/2x92Ah	24V/2x110Ah

6.44 ALTERNATOR

The alternator is a three-phase self-excited model with incorporated diode rectifier.

Checks:

- check the wiring

For specific non-standard situations, consult VM Motori.

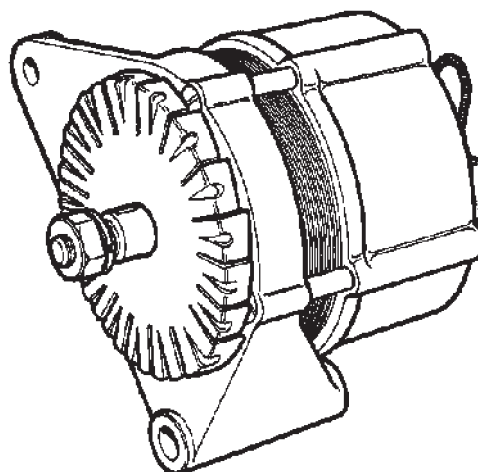


Fig. 6.55b

6.45 VOLTAGE REGULATOR

The regulator is maintenance free and does not require adjustment.

To replace the regulator consult the Spare Parts Catalogue.

6.46 STARTER MOTOR (FIG. 6.56)

Replace the brushes at the specified intervals.

During this procedure check that the armature is not scored or worn.

For specific situations, consult VM Motori.

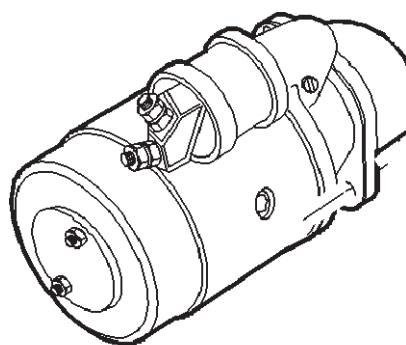


Fig. 6.56

6.47 USE AT LOW TEMPERATURE

(FIG. 6.57)

For ambient temperatures up to - 20 °C:

Fit 12V thermostart device.

12V starter motor.

For ambient temperatures between - 20 °C and

- 30 °C:

Fit 24V thermostart device.

24V starter motor.

For specific situations consult VM Motori.

Thermostart device fuel feed system

- 1 Thermostart
- 2 Thermostart fuel reservoir
- 3 Reservoir feed pipe (Injector return pipe)
- 4 Excess fuel discharge pipes
- 5 Intake manifold
- 6 Switch lead

Thermostart electrical system

F1-F2 Fuse

G1 Battery

H1 Lamp

S Ignition switch

R Thermostarter

P Thermostart activation button

K Servo-relay

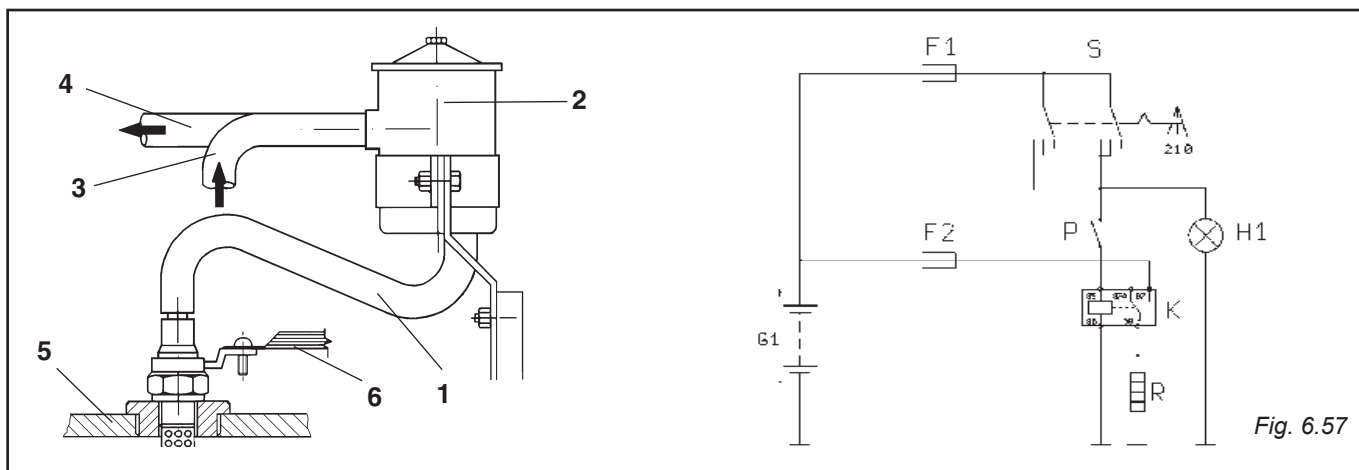


Fig. 6.57

(FIG. 6.58)

The engine can also be equipped with a fuel filter with heater.

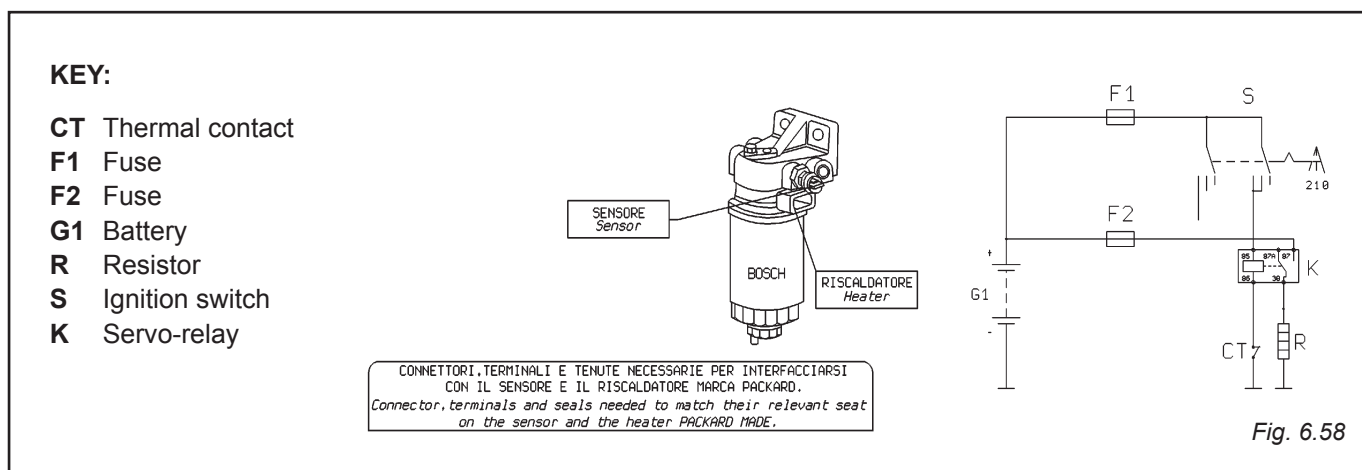
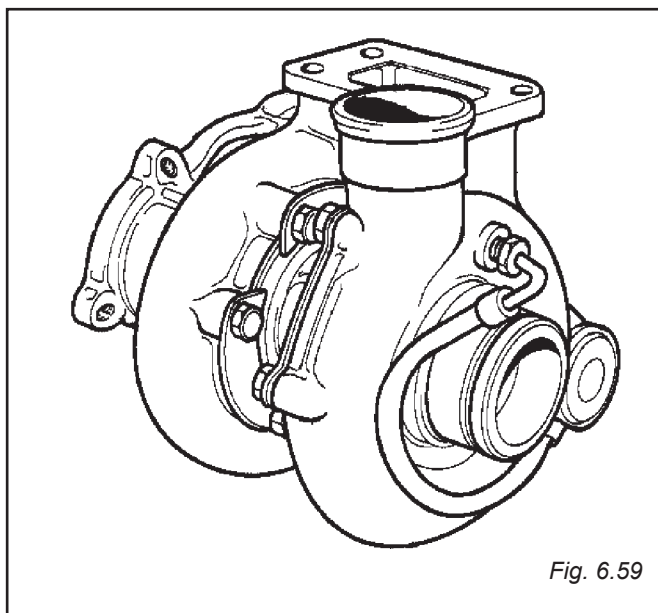


Fig. 6.58

6.48 TURBOCHARGER

**VM MOTORI EXPRESSLY PROHIBITS
ADJUSTMENT OF OR TAMPERING
WITH THE TURBOCHARGER. IF THIS
PRESCRIPTION IS DISREGARDED THE
WARRANTY WILL BE AUTOMATICALLY
INVALIDATED.**



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7.0 GENERAL WARNINGS

The following instructions refer to engine models available at the time of publication of this manual.

Assemble the engine components in the order indicated to save time and avoid damage.

Carefully check components before assembly following the instructions in chapter 6 "CHECKS AND REPAIRS".



USE TORQUE WRENCH



WARNING: WHEN THE ABOVE SYMBOLS APPEAR TOGETHER, THE OPERATIONS ARE TO BE PERFORMED IN THE SEQUENCE INDICATED IN THE FIGURE.



WARNING: PRIOR TO ASSEMBLY, CLEAN PARTS WITH A SUITABLE SOLVENT (SEE HEADING 3.7).



WARNING: IT IS STRICTLY FORBIDDEN TO CLEAN THE ENGINE WITH COMPRESSED AIR.



WARNING: WHEN USING TORQUE WRENCHES, ALWAYS REFER TO THE "TORQUE WRENCH SETTINGS" (TABLE 8.1).



WHERE THE USE OF VM SPECIAL TOOLS IS NOT SPECIFIED IN THE ASSEMBLY PROCEDURES, USE STANDARD COMMERCIAL TOOLS OF THE TYPE ILLUSTRATED.

7.0.1 Mounting the engine on the stand

Mount the engine on a commercial stand as shown in figure 7.0.

Secure the engine by means of the assembling arms and bolts provided with the stand (or using mounting bolts of the same type).



WARNING: REMEMBER TO INSERT THE LOCK PIN (A) AND CHECK THAT IT EFFECTIVELY LOCKS THE ENGINE IN POSITION.



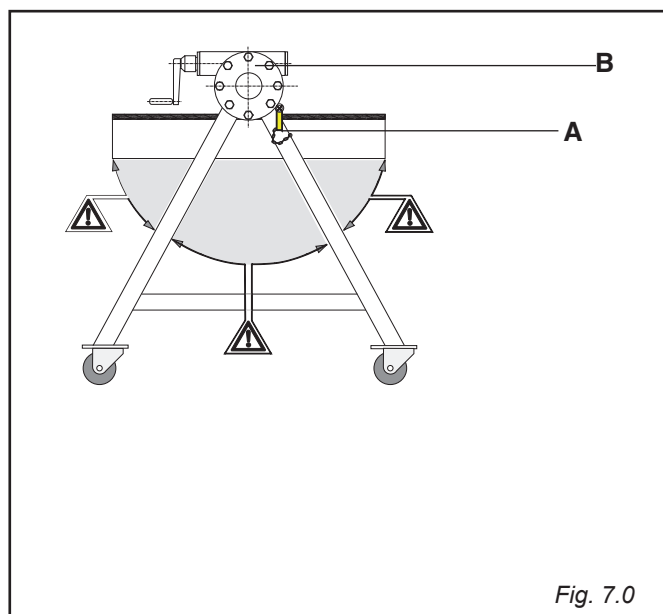
WARNING: ALWAYS USE THE REDUCTION GEAR (B) TO ROTATE THE ENGINE.



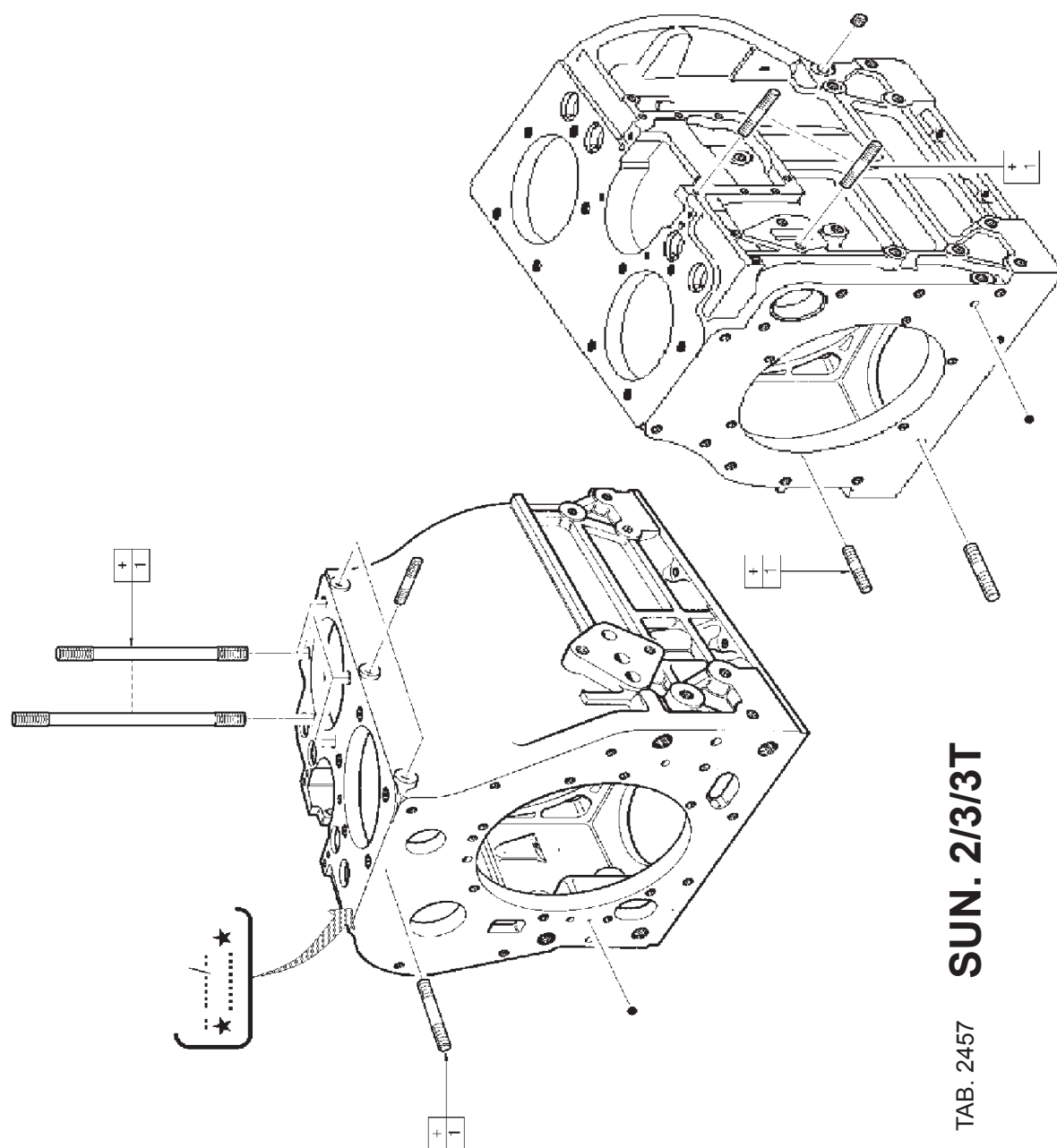
WARNING: RISK OF CRUSHING AND/OR SHEARING OF LIMBS DURING ROTATION OF ENGINE ON STAND.



NEVER INTRODUCE PARTS OF THE BODY OR FOREIGN OBJECTS IN THE AREA SHADED GREY IN FIGURE 7.0.



7.0.2 Assembly charts

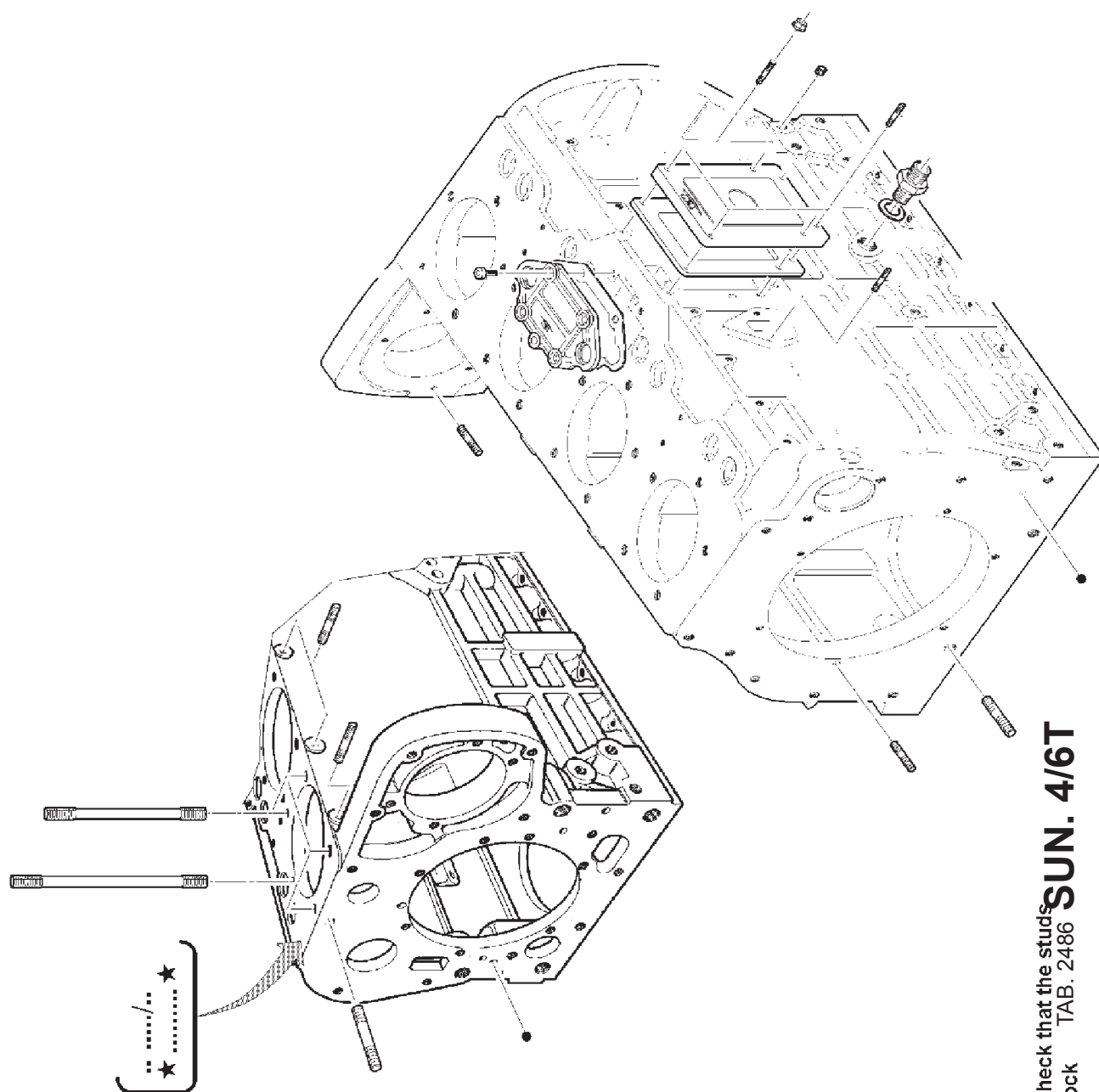


SUN. 2/3/3T

TAB. 2457

Assembly studs with LOCTITE 601 and check that the studs thread is completely screwed into the block

+	→
---	---

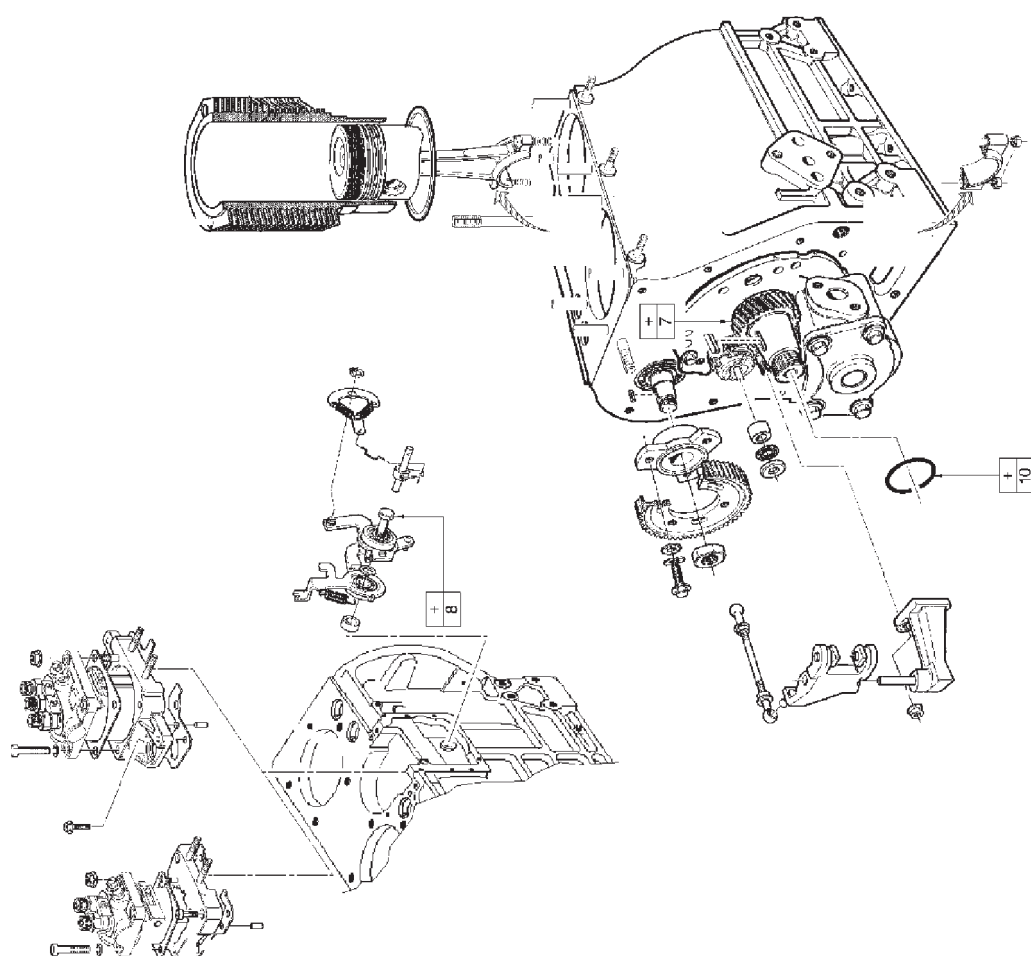


SUN. 4/6T

TAB. 2486

Assembly studs with LOCTITE 601 and check that the studs
thread is completely screwed into the block

+	1
---	---



Grease the O-Ring

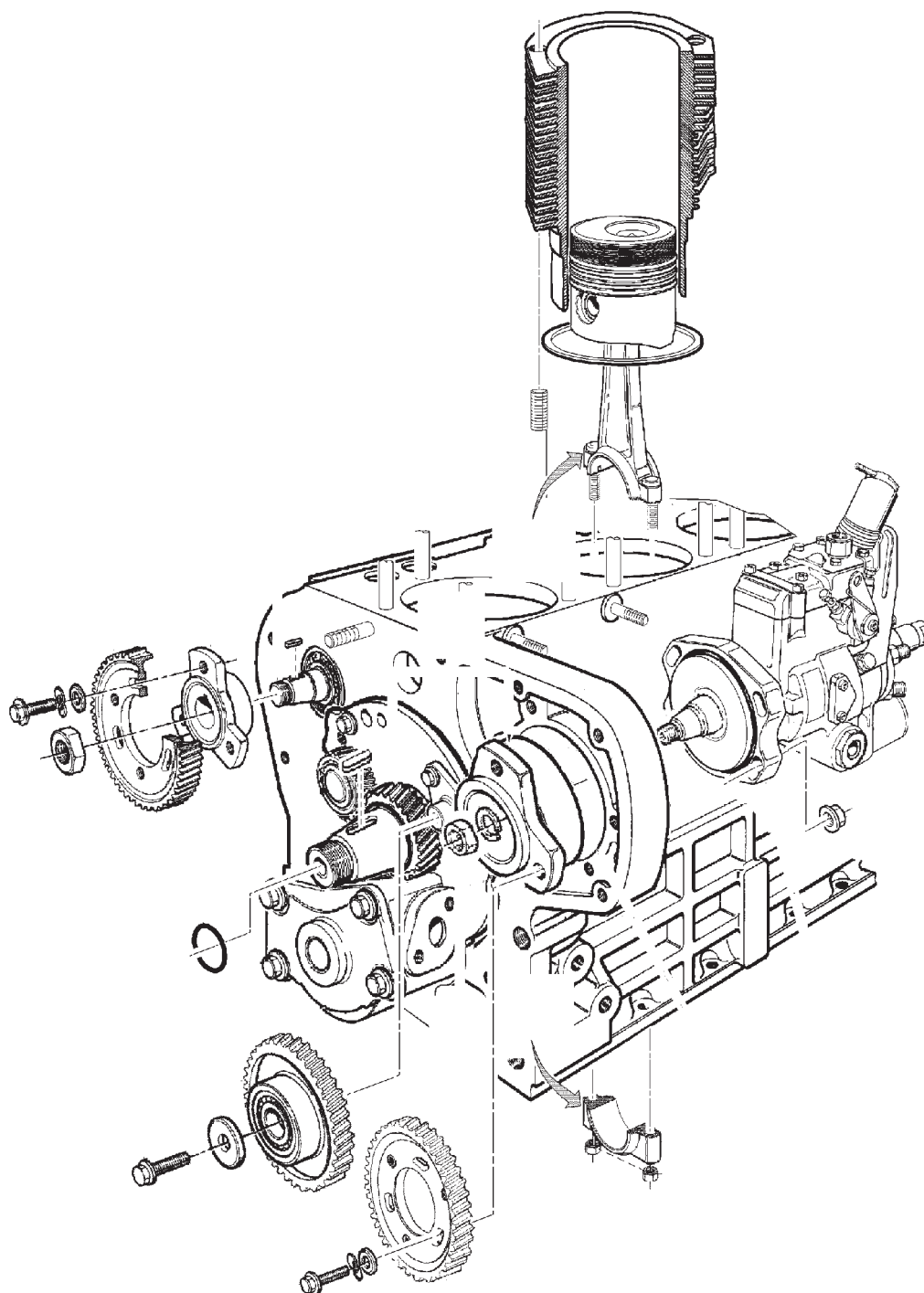
+ 10

**After tightening check that the lever
move freely**

+ 8

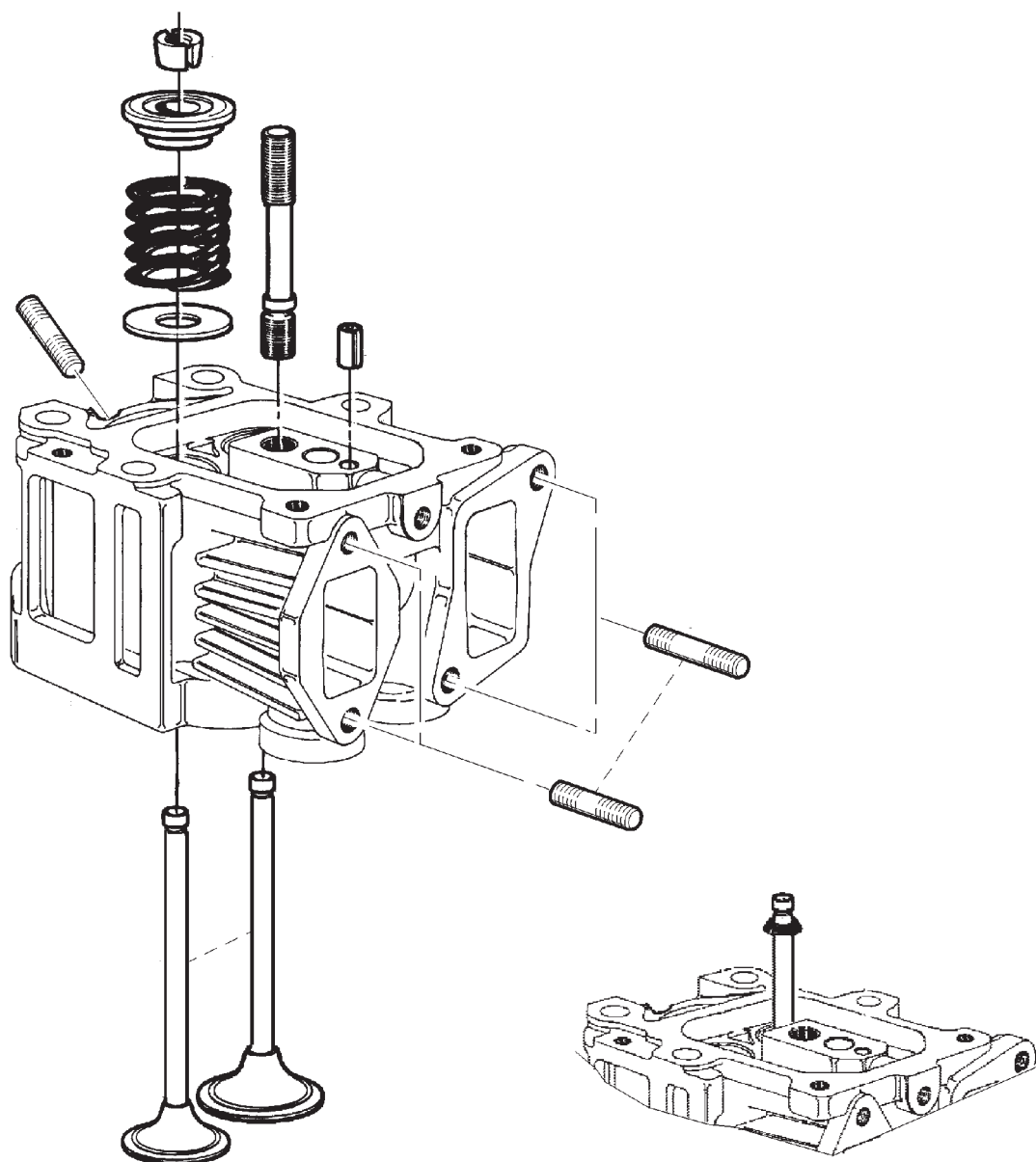
SUN. 2/3/3T

TAB. 2459



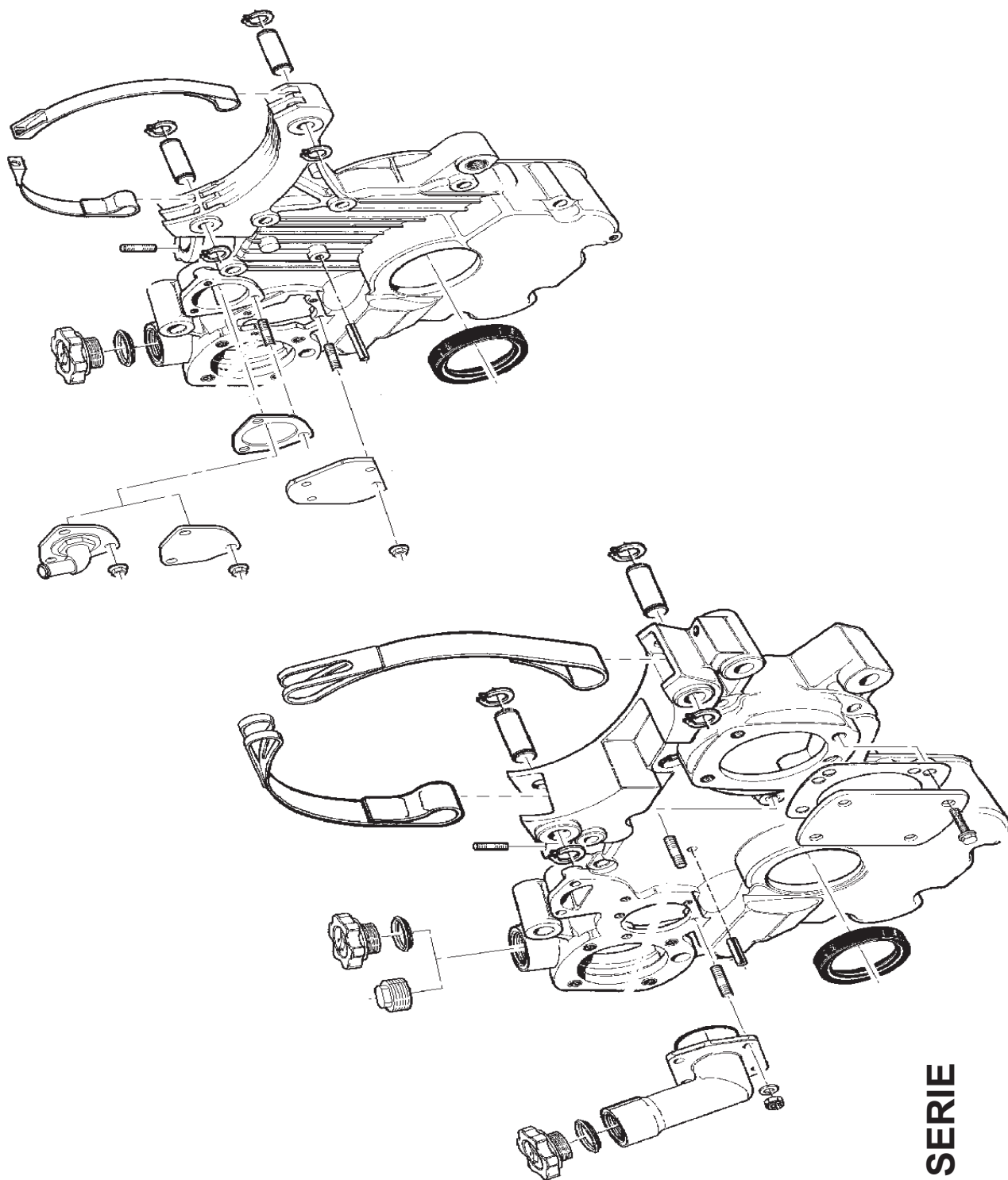
SUN. 4/6T

TAB. 2488



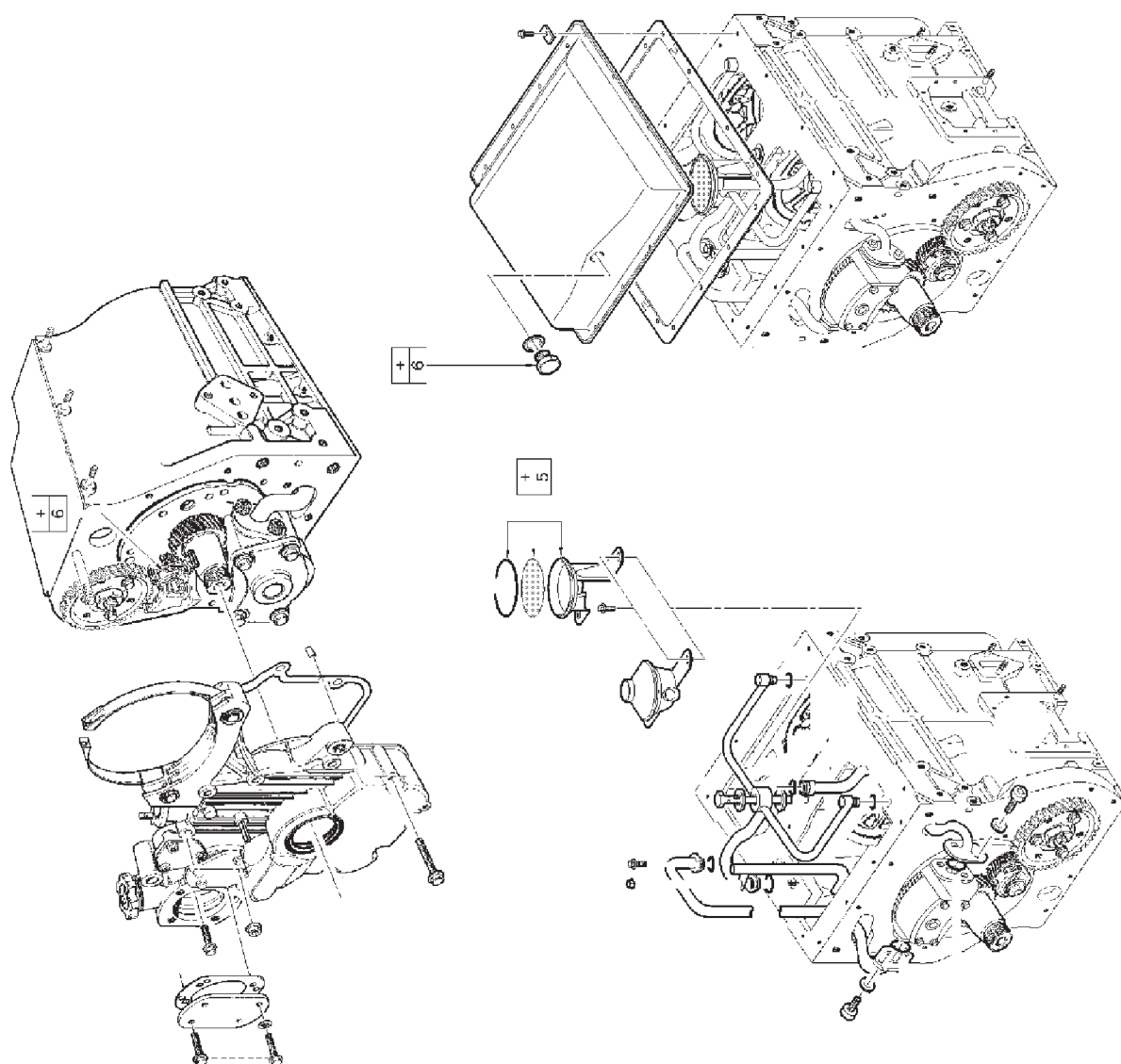
SUN. SERIE

TAB. 2446



SUN. SERIE

TAB. 2447



Lubricate with oil

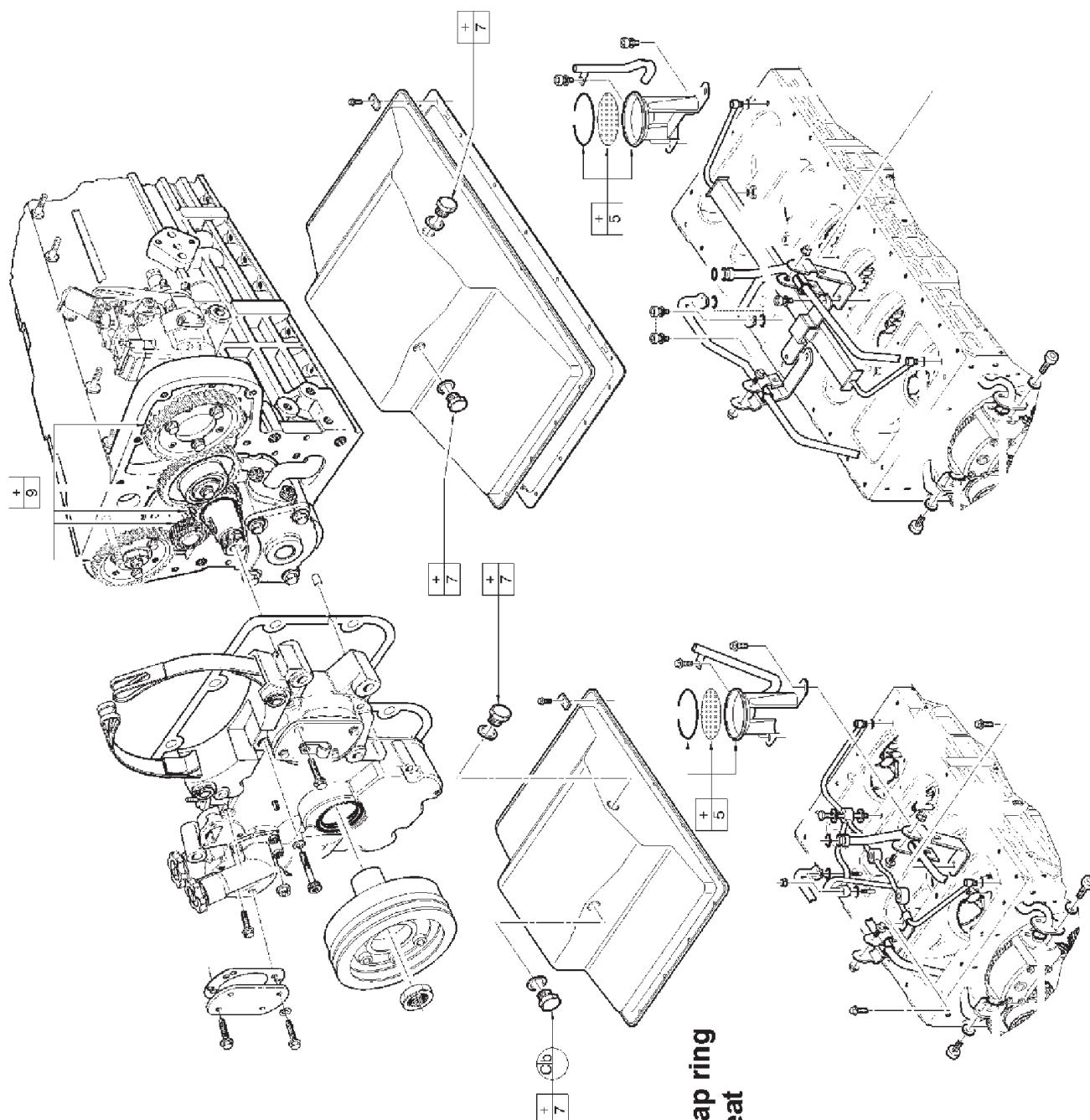
Visually inspect that the snap ring is located correctly in its seat

+ 6

+ 5

SUN. 2/3/3T

TAB. 2460



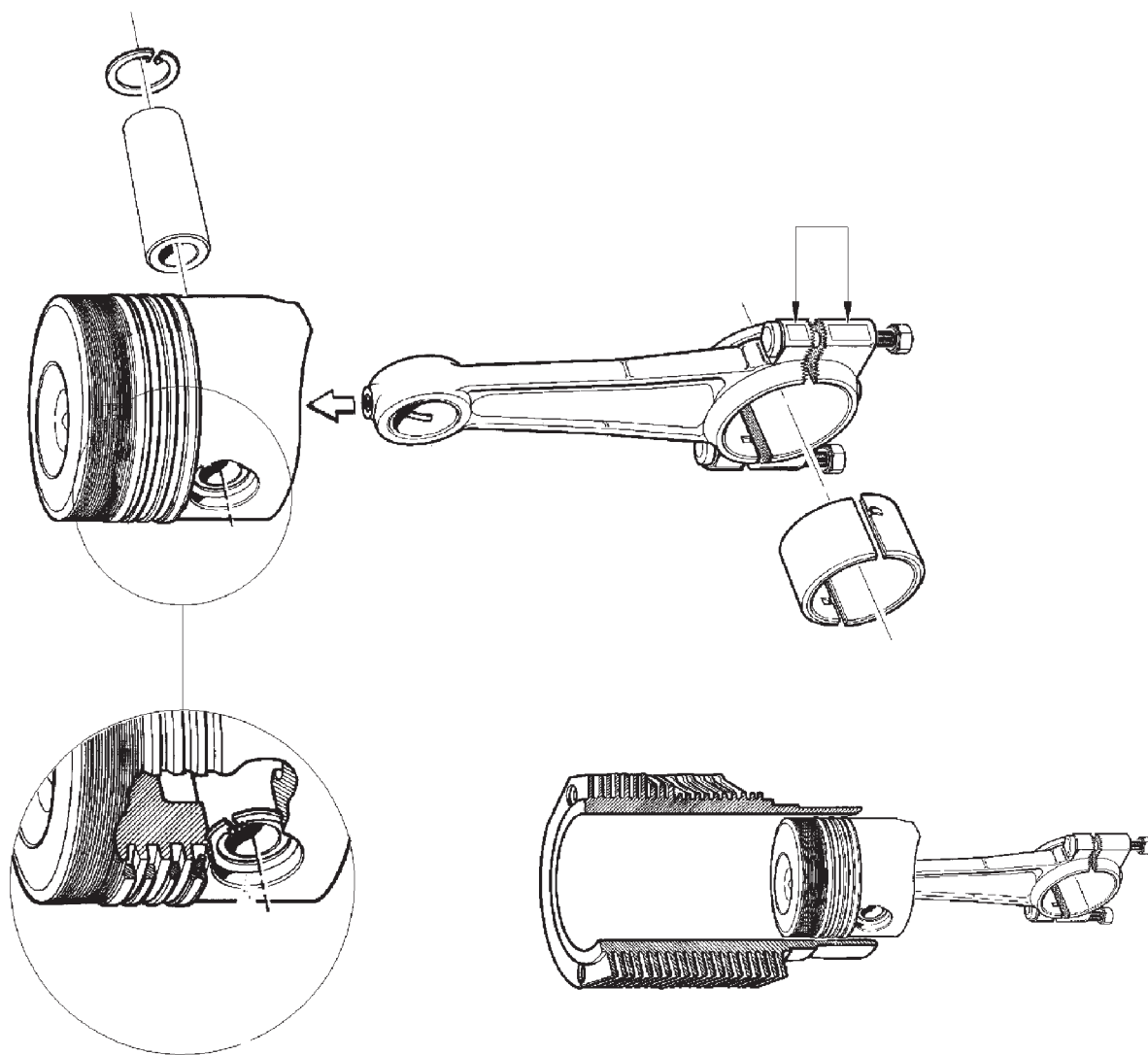
Grease the gears

Lubricate with oil

Visually inspect that the snap ring is located correctly in its seat

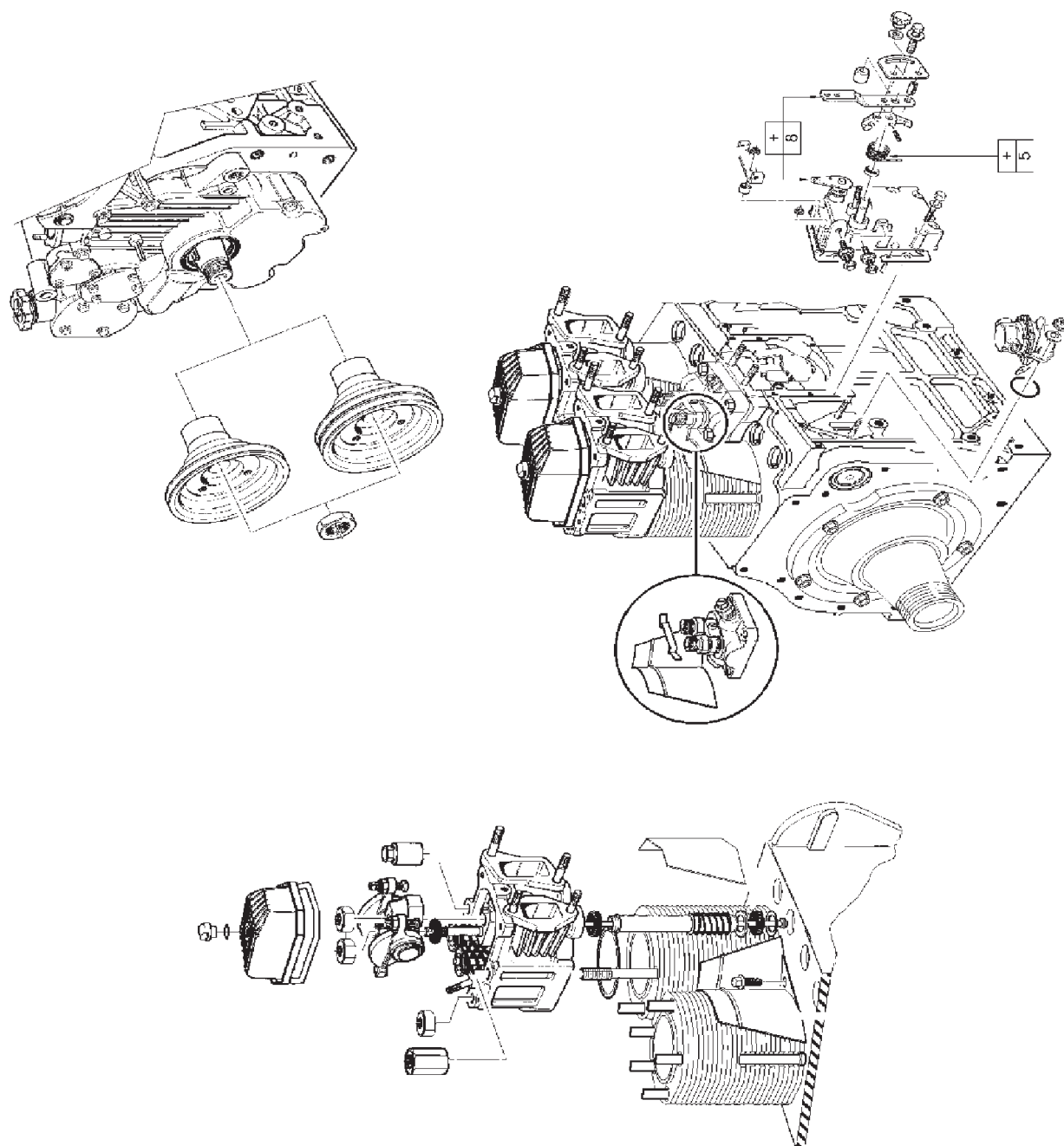
SUN. 4/6T

TAB. 2489



TAB. 2453

SUN. SERIE



After the governor cover assembly
check that the level move freely

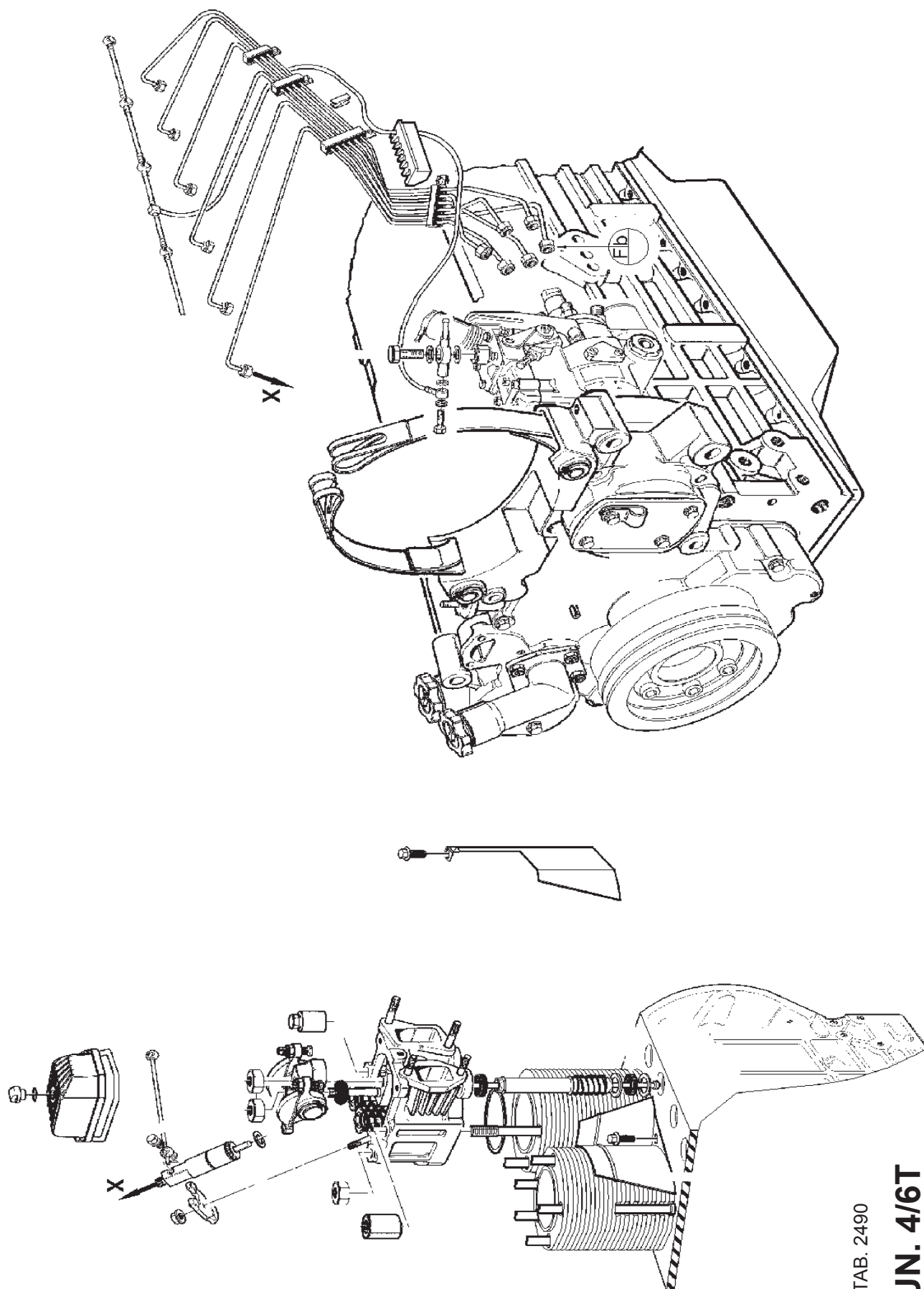
+	8
---	---

The spring must not be assembled
on GEN-SET

+	5
---	---

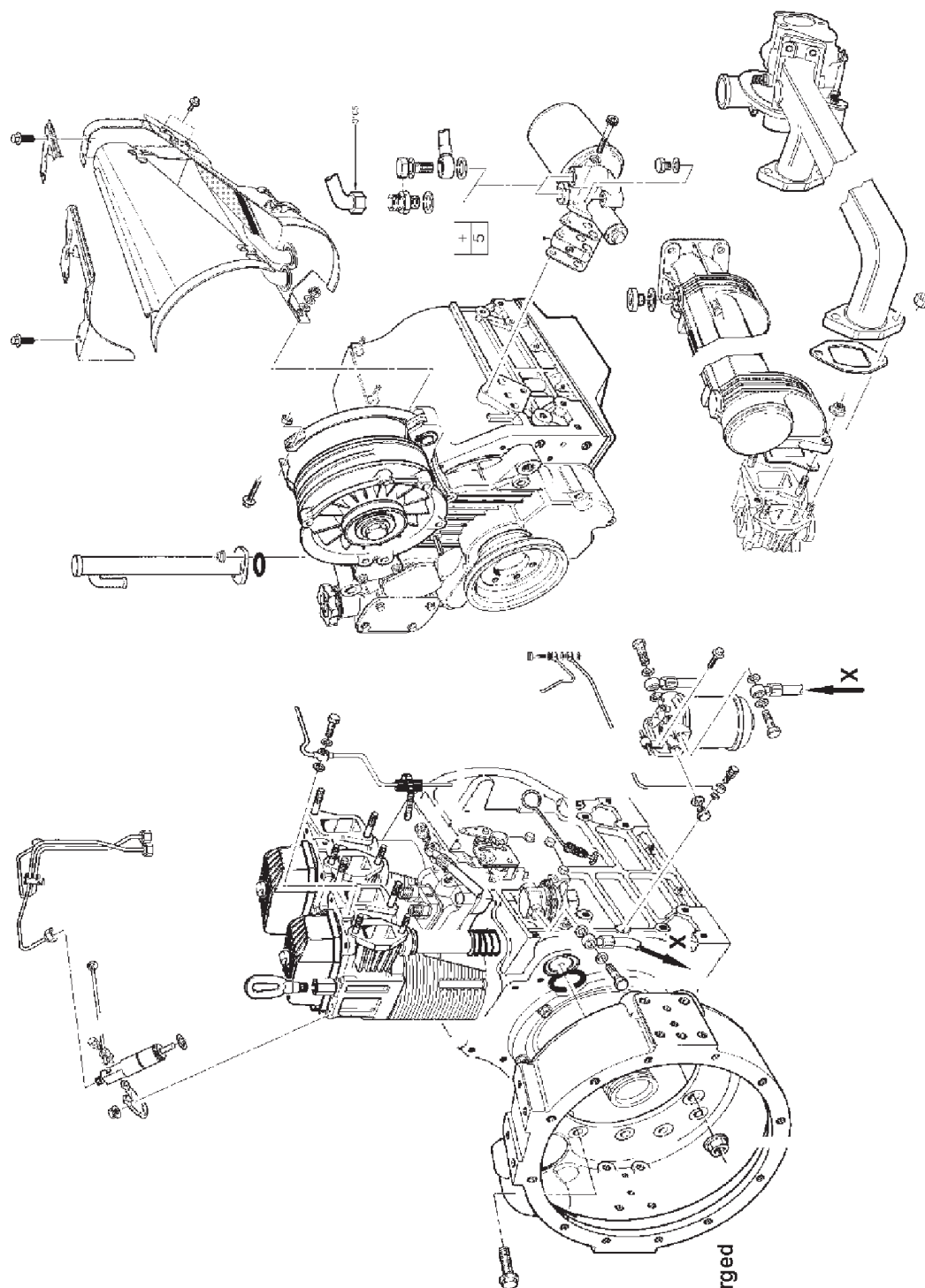
Mot. 2/3/3T

TAB. 2461

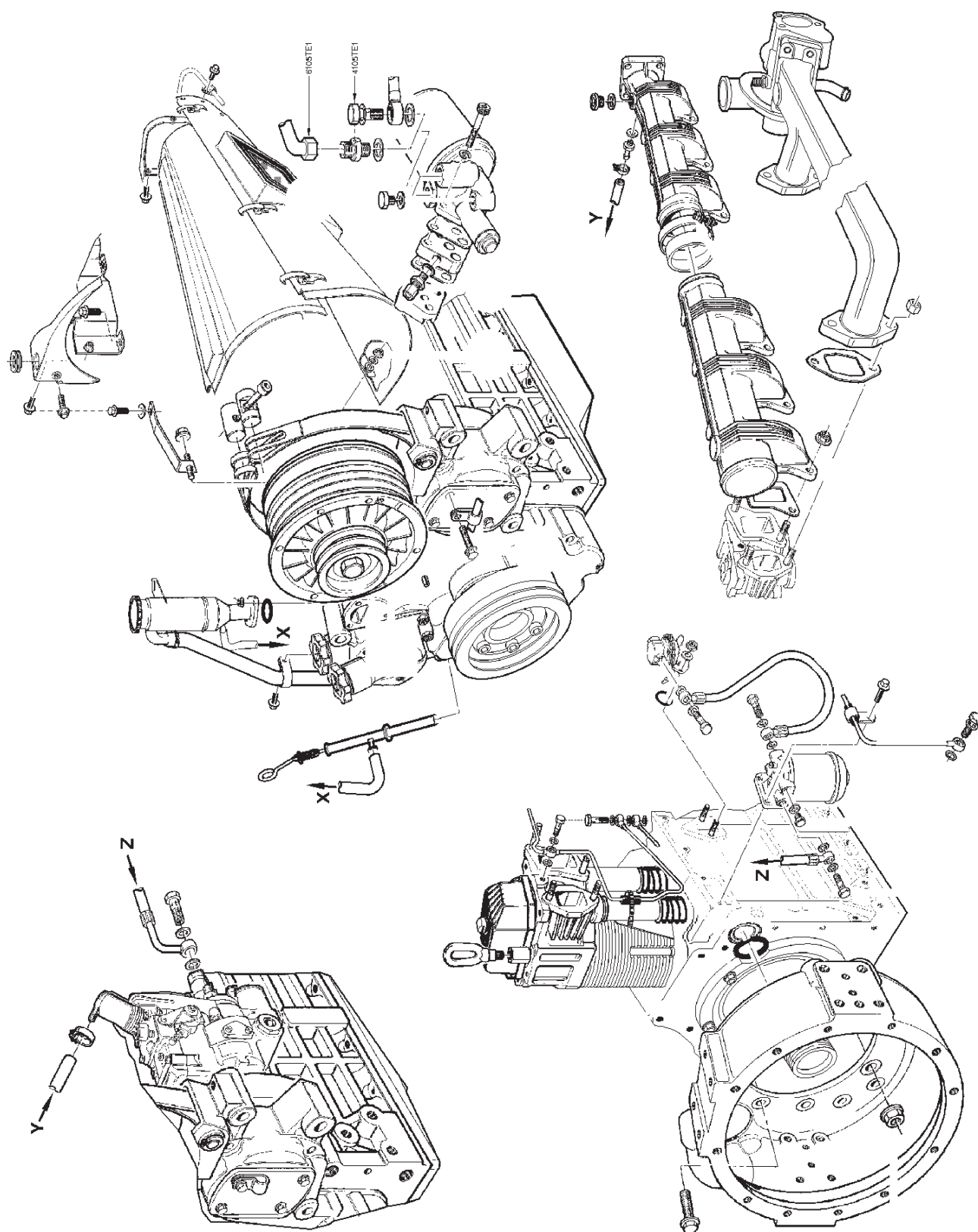


TAB. 2490

SUN. 4/6T

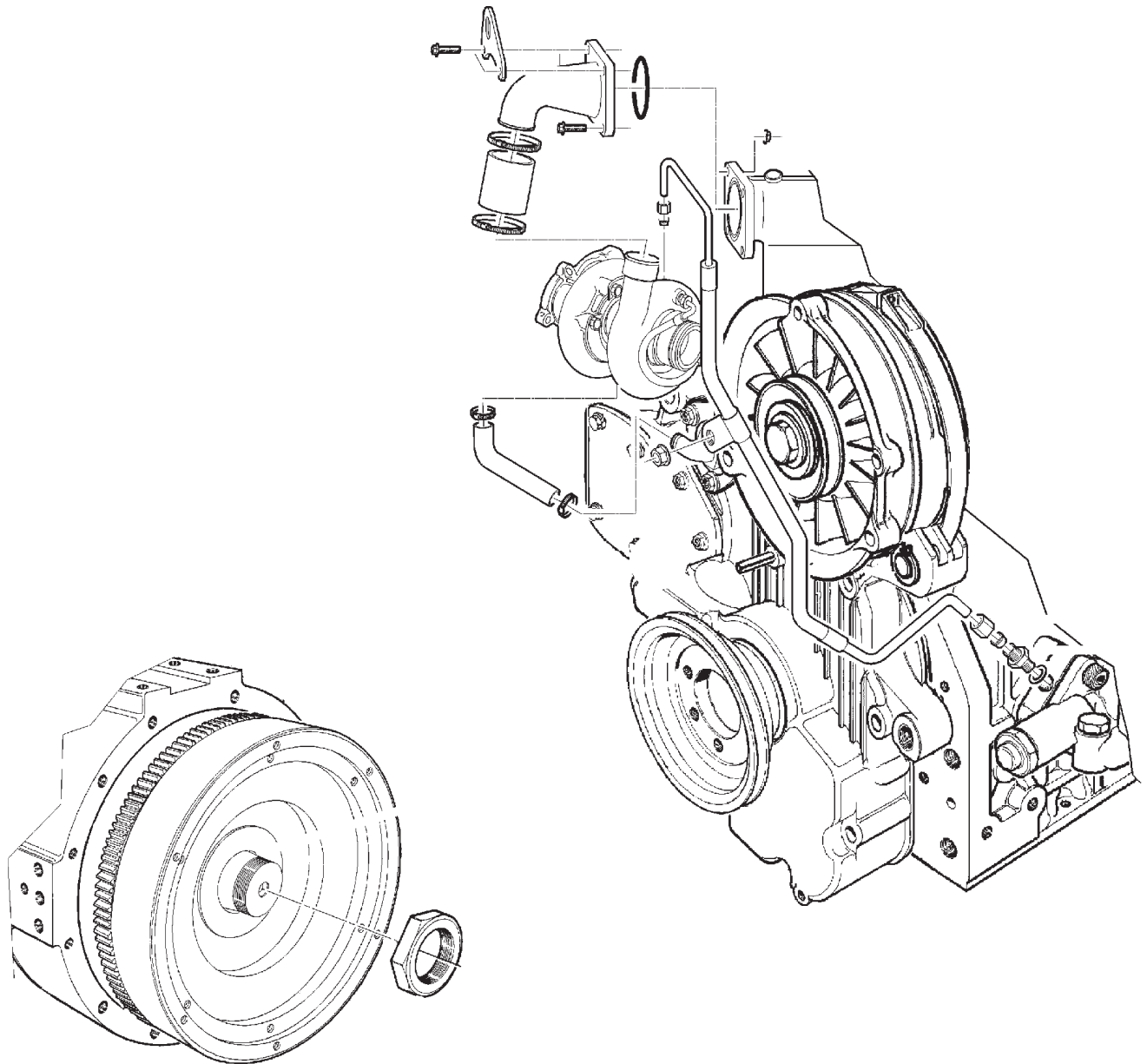


+ 5 Assembly the spacer only
on 3 cylinder engine turbocharged



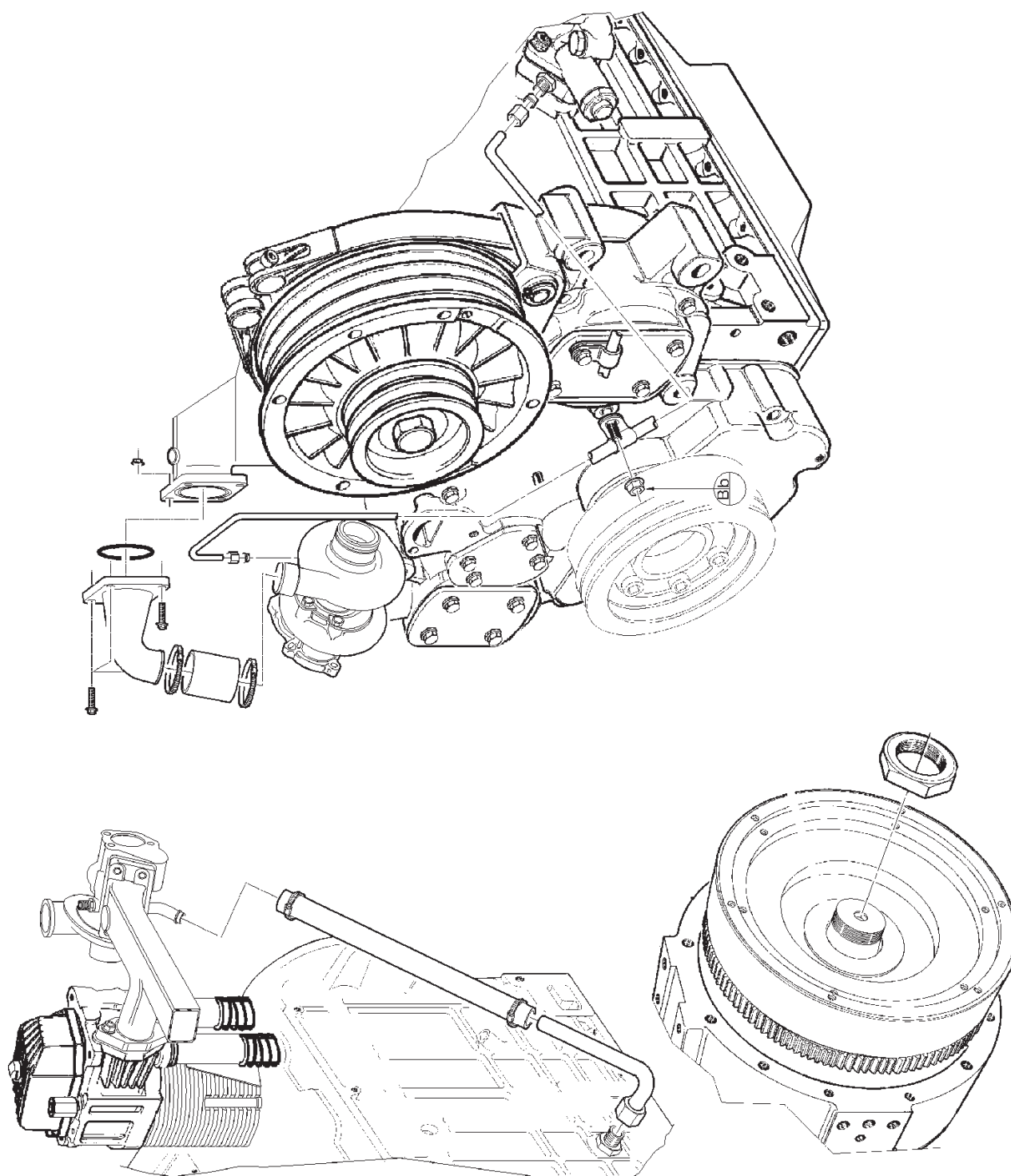
TAB. 2491

Mot. 4/6T



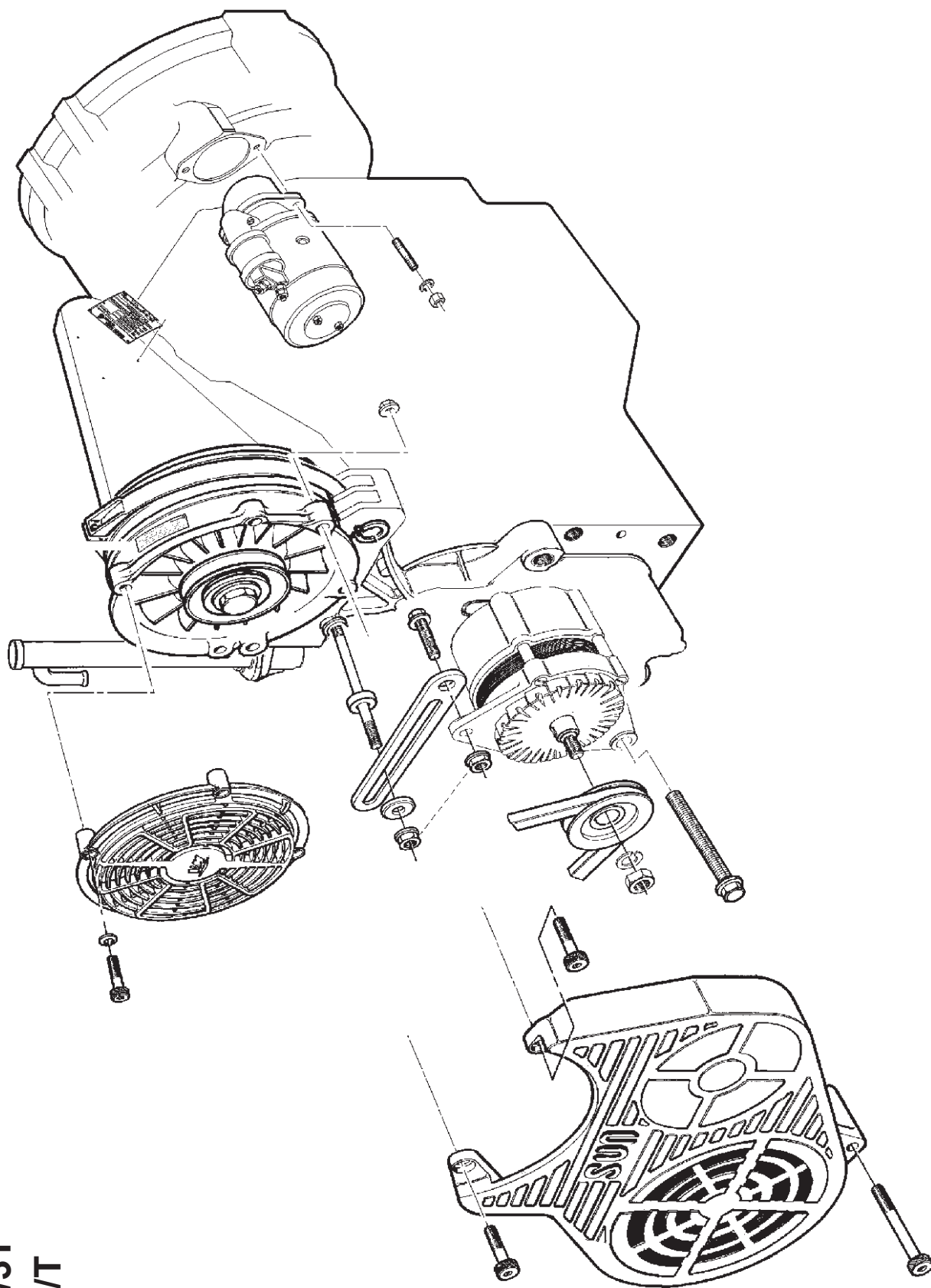
SUN 2/3/3T

TAB. 2463

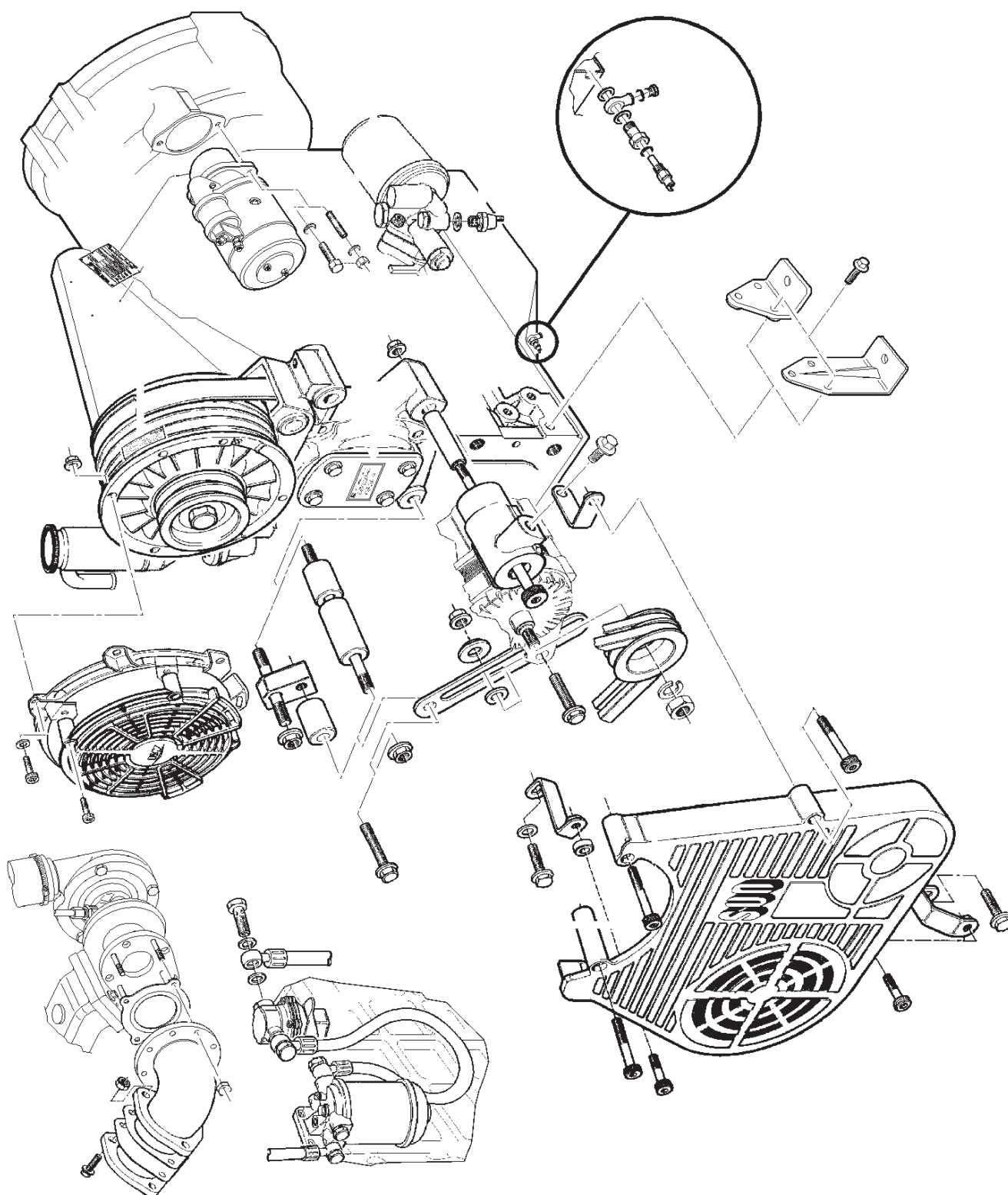


TAB. 2492

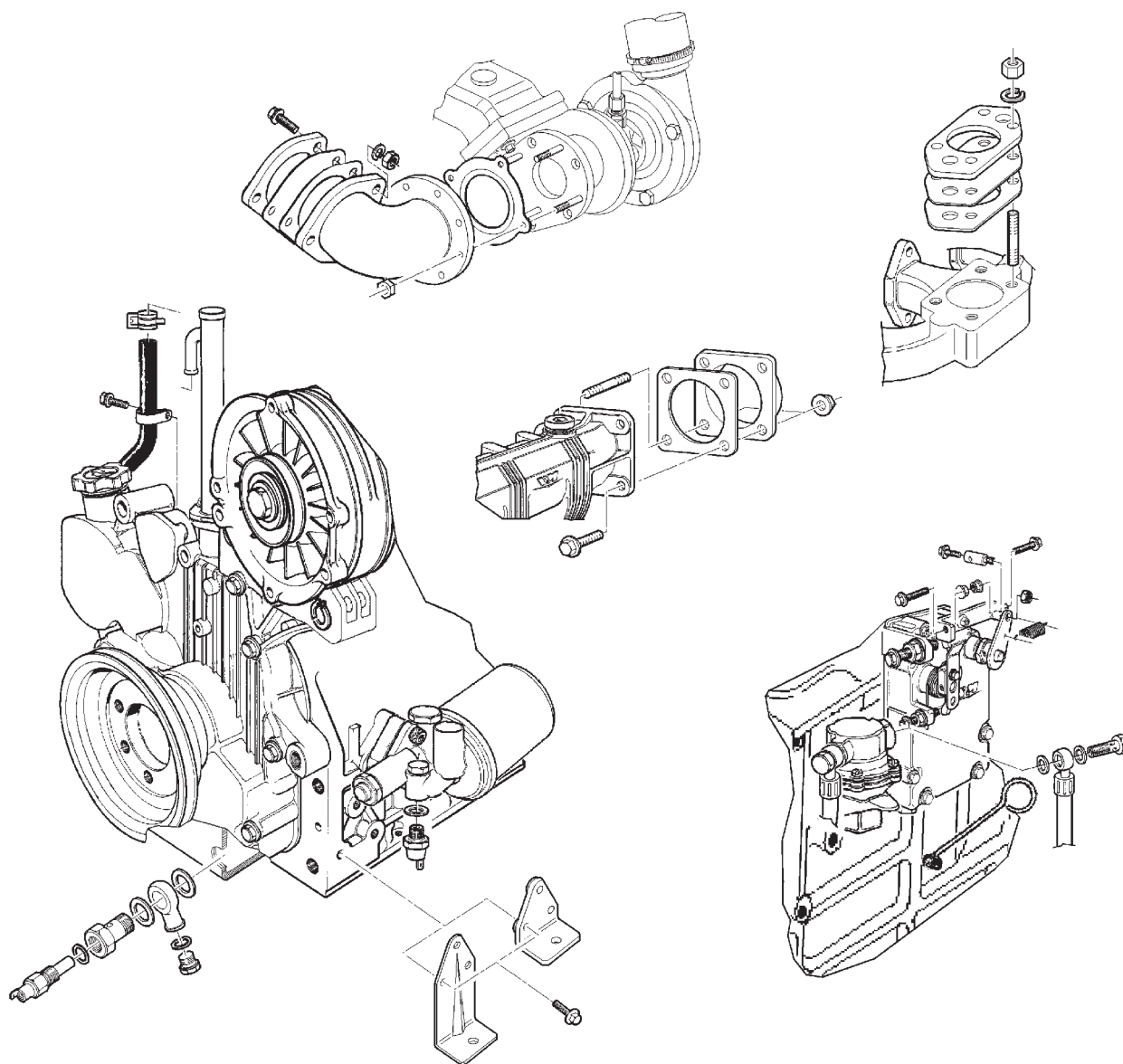
SUN. 4/6T

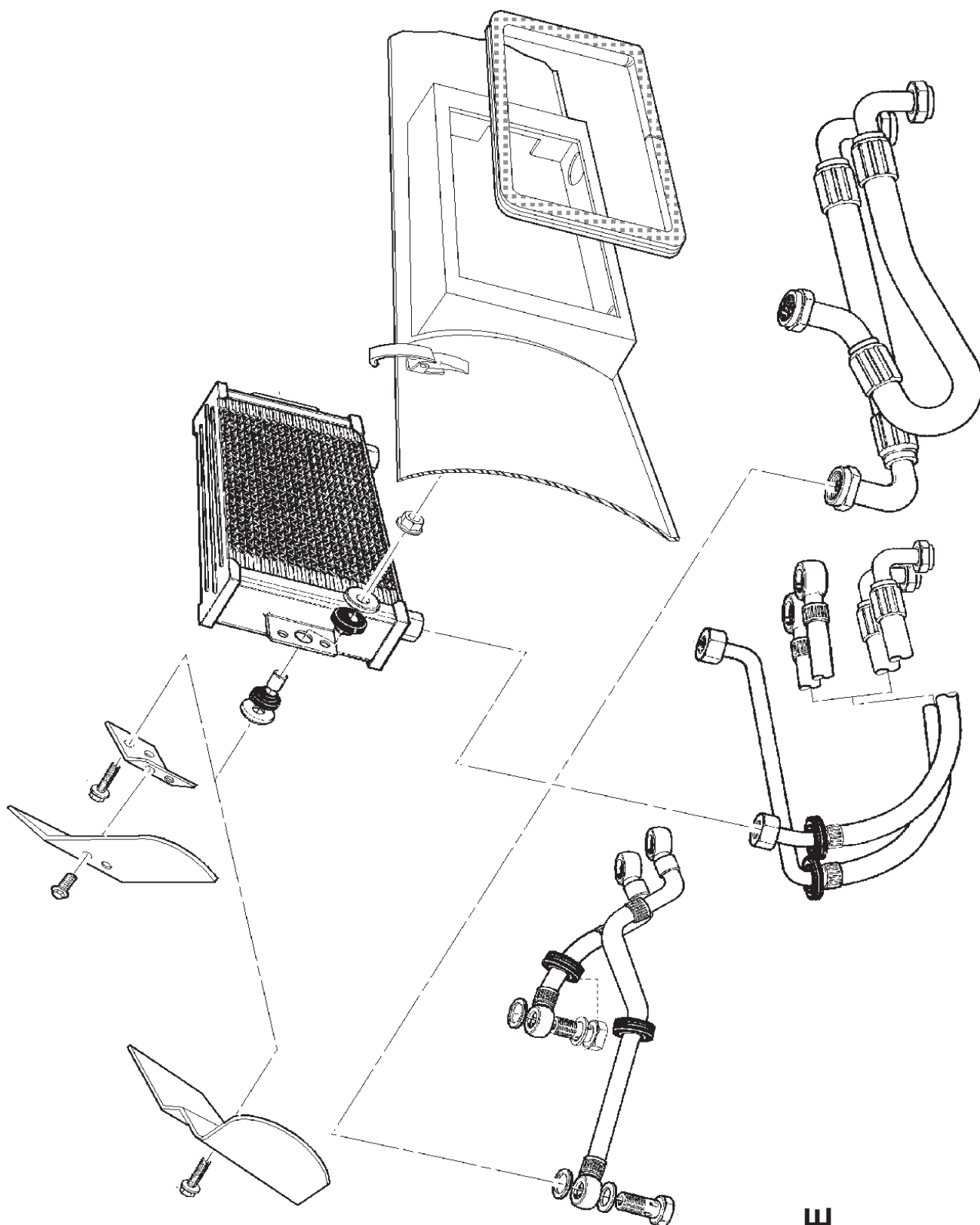


Mot. 2/3/3T
SUN 2/3/T



Mot. 4/6T
SUN 4/6 T
TAB. 2493





Mot. SERIE
Engine
Series
TAB. 2454

7.1 TAPPETS (FIG. 7.1)

Position the crankcase with the cylinder head flange facing downwards.

Lubricate the surface of tappet **A** with engine oil.

Lubricate the tappet location in the crankcase.

Repeat the above steps for each tappet.

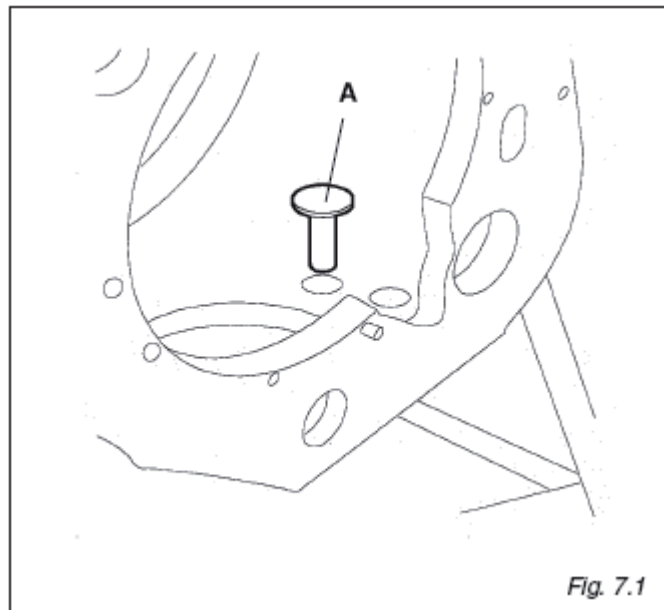


Fig. 7.1

7.2 CAMSHAFT (FIG. 7.2)

Replace bearing **A**.

Smear engine oil on the mating surfaces between bearings and crankcase.

Insert the camshaft taking care not to damage the bearings.

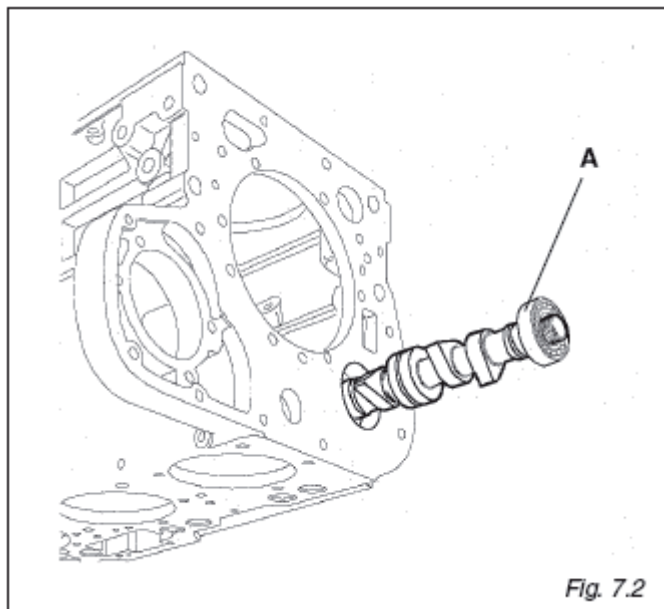


Fig. 7.2

7.3 CRANKSHAFT (FIG. 7.3)

Use engine oil to lubricate the contact surfaces of crankshaft **A** taking care not to damage the counterweights and supports.

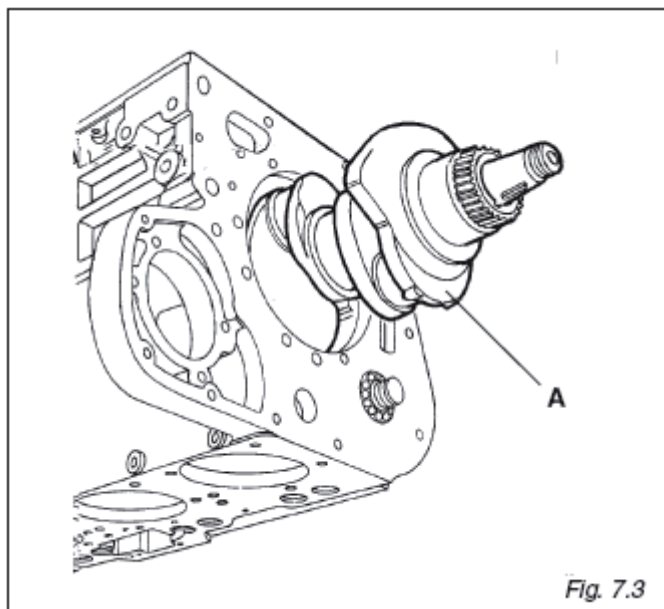


Fig. 7.3



FOR 2-3 CYLINDER ENGINES fit the counterweights, matching the number punched in the counterweight with the number on the crankshaft.
Torque the counterweights to the value shown.

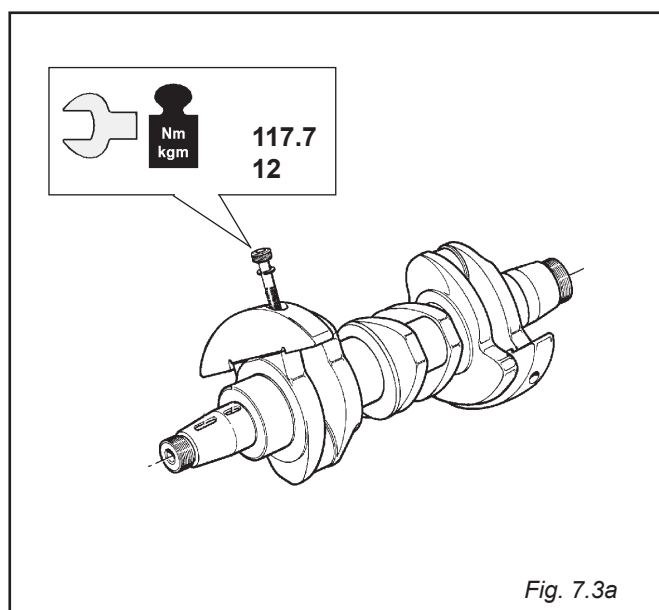


Fig. 7.3a

7.4 CENTRAL MAIN BEARINGS (FIG. 7.4)

Replace the bearing, checking that there is no foreign material on the mating surfaces. Lubricate the contact surfaces between bearing and crankshaft using engine oil.

Make sure that each main bearing half-shell corresponds to its respective half-shell by checking the alphanumerical markings described in the disassembly section of the manual.

Tighten the main bearings by means of the fixing screws **A** as described.

Ensure that the lubrication holes in the crankcase are perfectly aligned with the holes in the bearings.

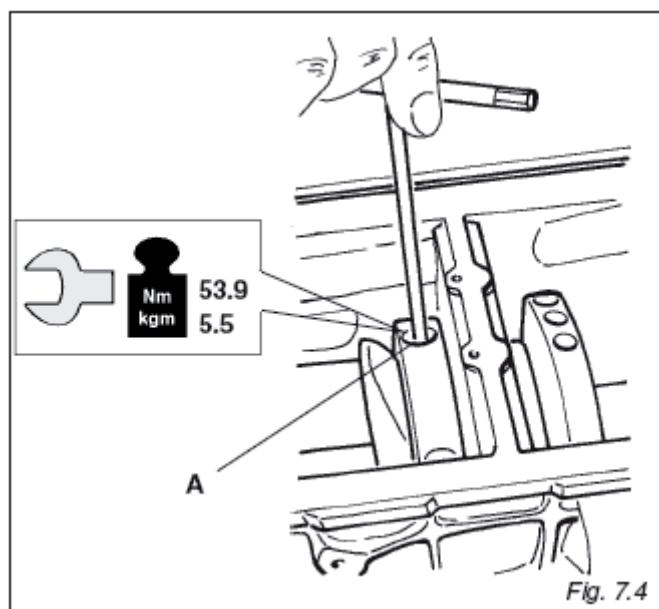


Fig. 7.4

7.5 FRONT MAIN BEARING (CAMSHAFT SIDE INTERMEDIATE GEAR - SUN 4105 - 6105) (FIG. 7.5)

Fit the clearance rings **A** locating the smooth side of the rings against the bearing seat. The grooves **A1** must be pointed toward the crankshaft front end **A2**.

Use a drift and rubber mallet to drive gear **C** onto the crankshaft.

Lubricate the clearance rings and the bushings inside the bearing.

Insert the pin on the crankcase. Align the two notches on the intermediate gear **B** with the notch on crankshaft gear **C**, notches or reference marks carried out during disassembling operation. Drive in the bearing slowly and then tighten the screws **D** located behind the intermediate gear. Tighten screws **E** to the value shown.

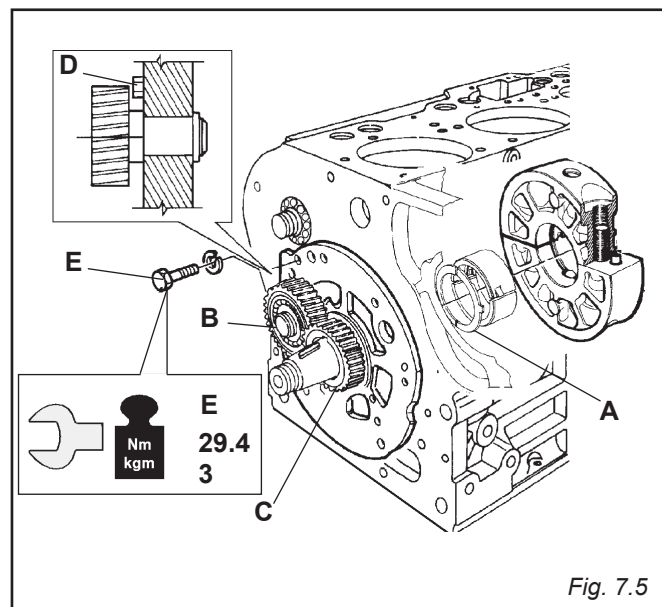
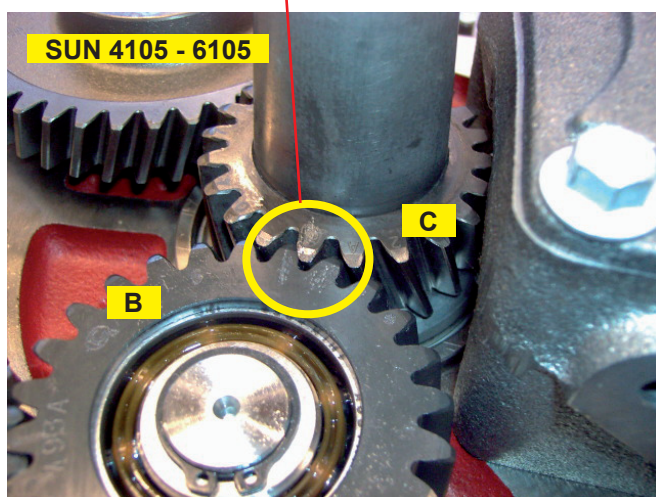
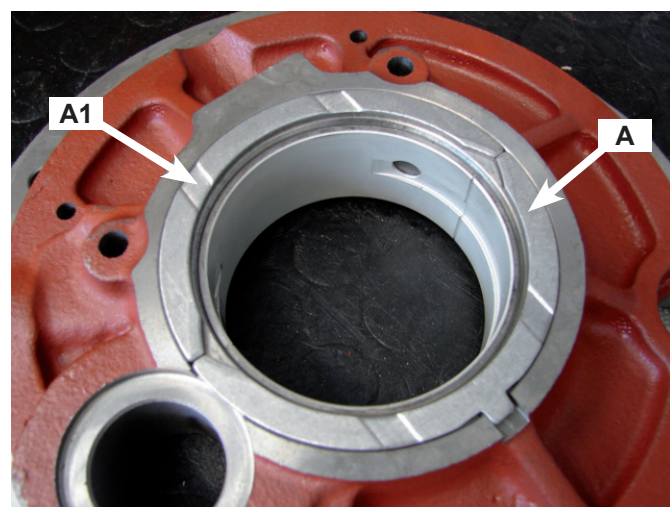
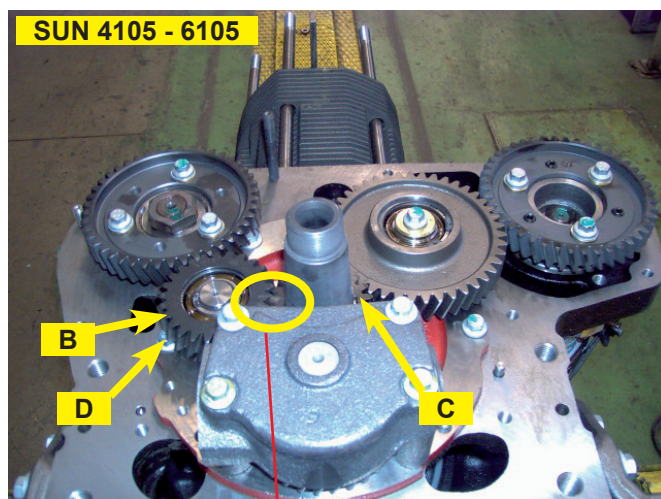


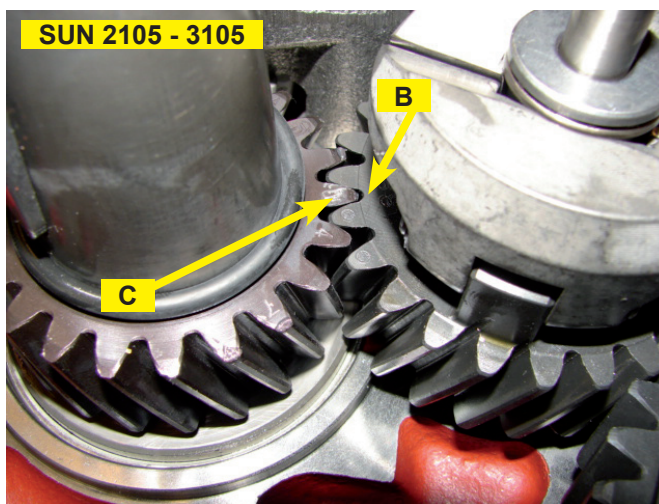
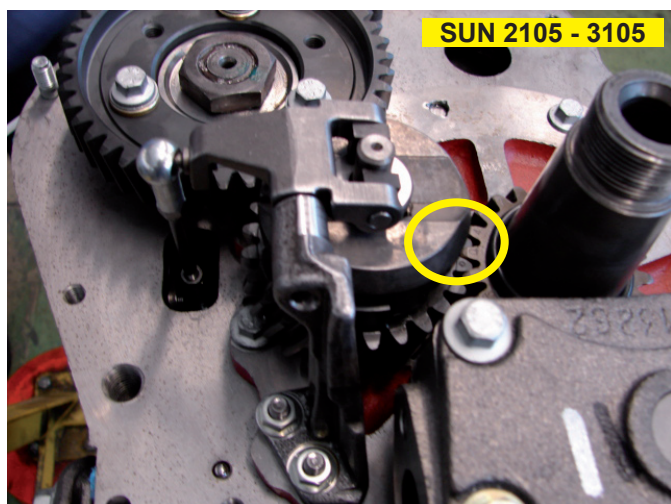
Fig. 7.5



Tacche o Segni di riferimento - Nothches or Reference marks

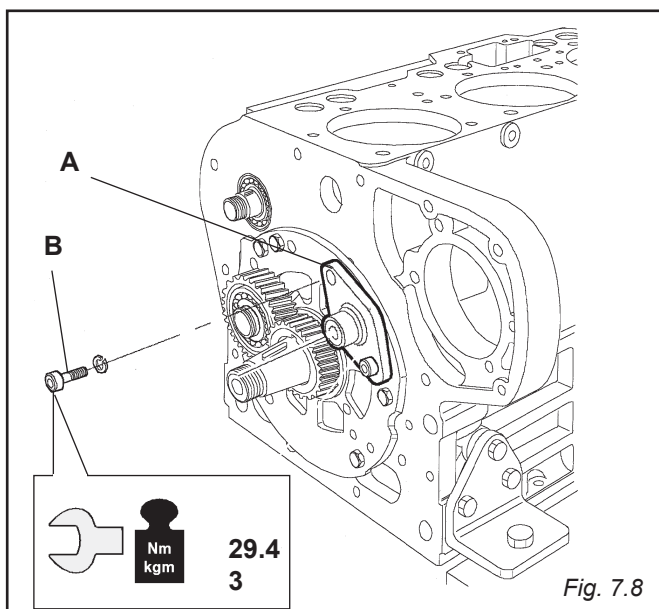
Tacche o Segni di riferimento - Nothches or Reference marks

intermediate gear **B**
crankshaft gear **C**



7.6 INTERMEDIATE GEAR SUPPORT (INJECTION PUMP SIDE) (FIG. 7.8)

Fit support **A**, insert screws **B** and torque to the value specified.

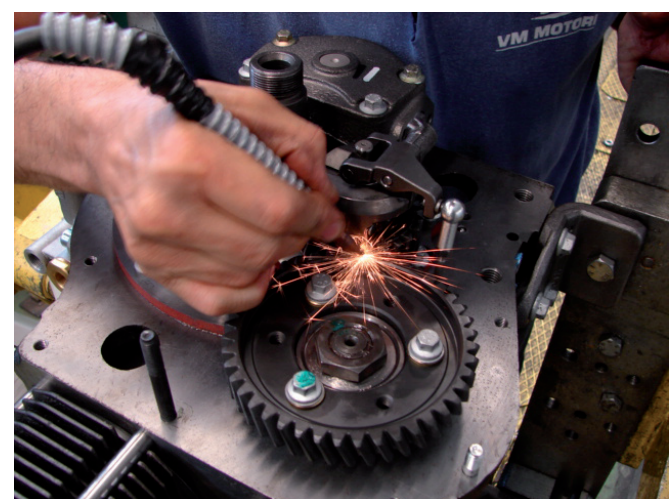
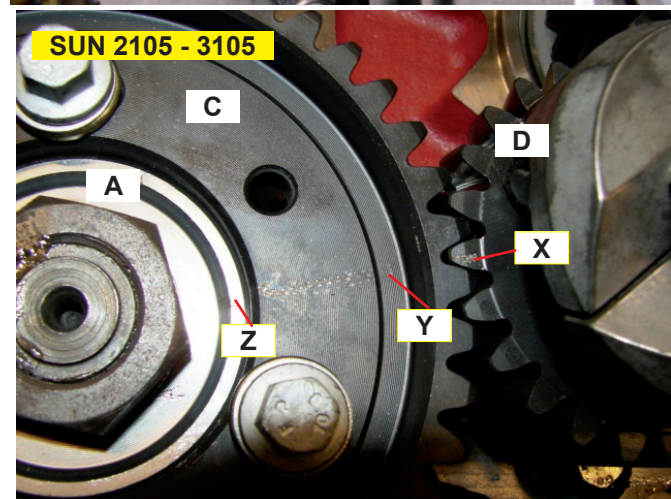
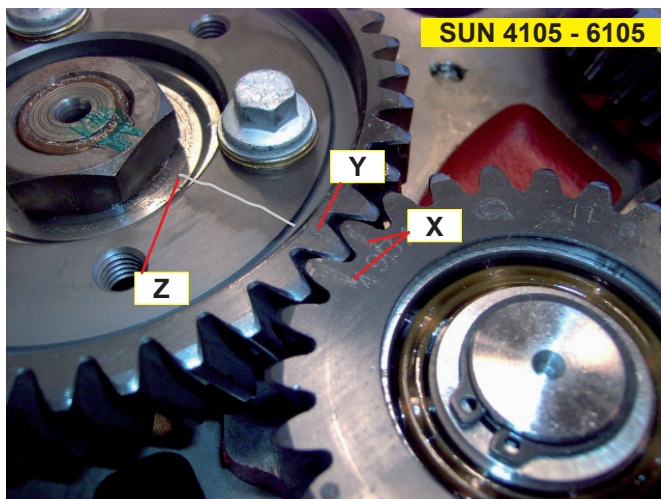
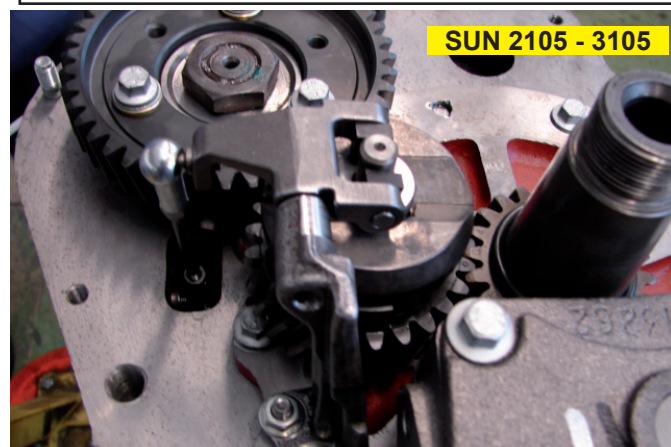
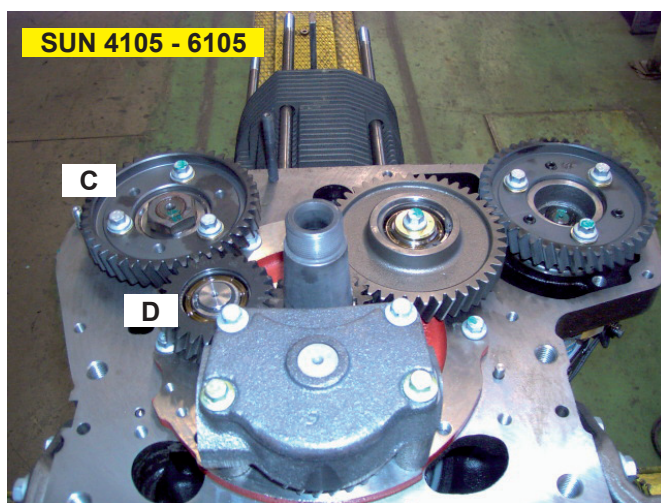
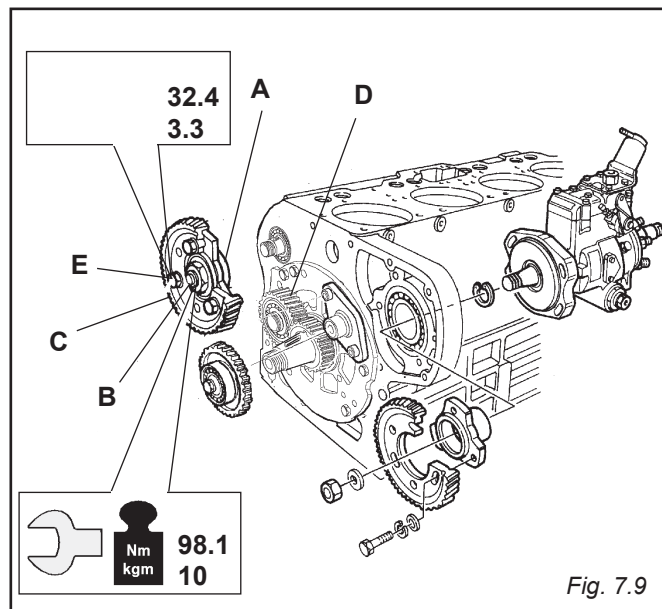


7.7 CAMSHAFT FLANGE AND GEAR (FIG. 7.9)

Check that the camshaft is equipped with the key. Fit flange **A** and secure with nut **B**. Fit gear **C** aligning it with the reference notch or mark **X** on intermediate gear **D**, align also the arrow-notch or reference mark **Y** on gear **C** with the reference mark or notch **Z** on flange **A**.

Immobilize the crankshaft using a wrench and torque screws **E** to the value specified.

Torque nut **B** to the value specified.



7.8 INTERMEDIATE GEAR PLUS INJECTION PUMP SUPPORT AND GEAR (FIG. 7.10)

Fit intermediate gear **A** aligning the notches **X** with the notch **Y** on the crankcase gear **B**.

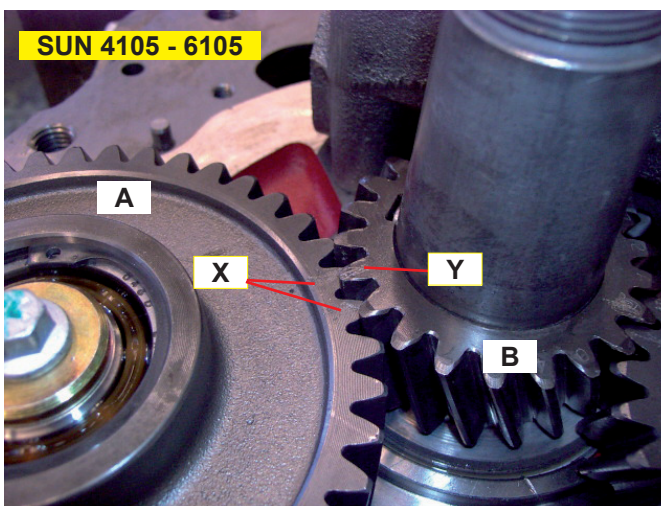
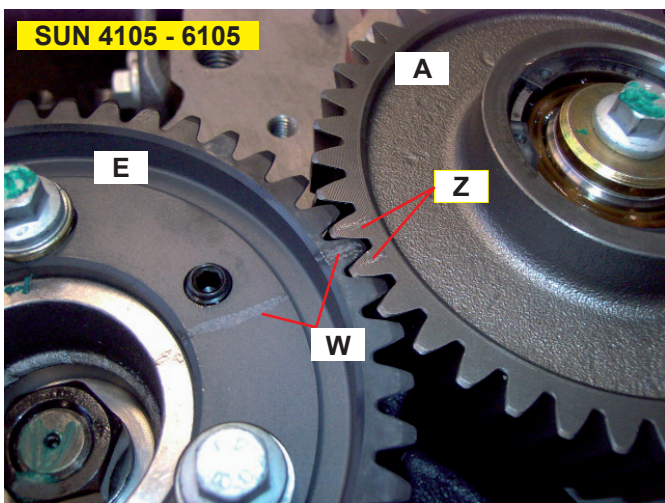
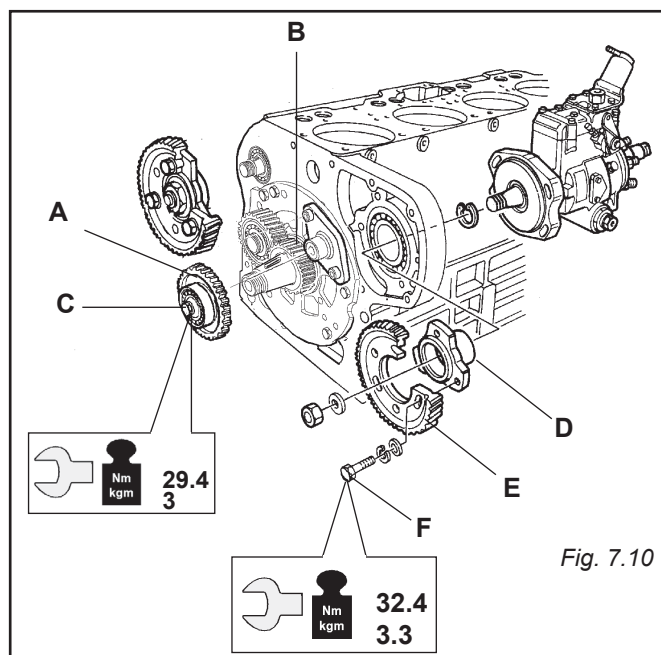
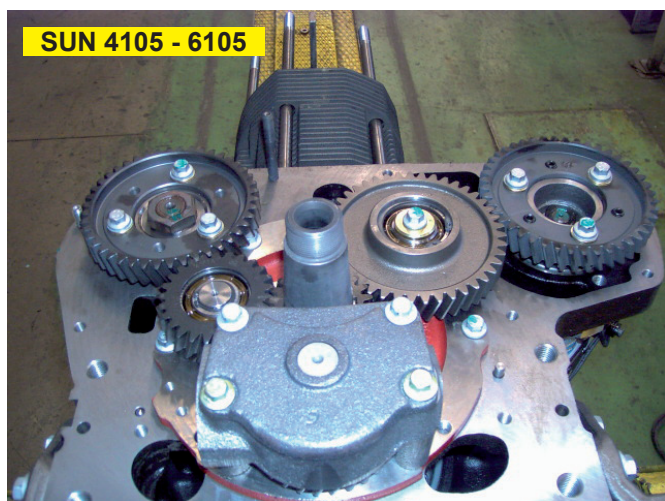
Insert screw **C** and torque it to the value specified.

Fit injection pump gear **E** aligning the notch **W** with the notches **Z** on intermediate gear **A**. Turn flange **D** until the arrow is aligned with the arrow on gear **E**. Insert screws **F** with their washers and torque to the value specified.

N.B.: The injection pump driving gear **E** features slots to enable injection pump timing.



WHEN THE TIMING COMPONENTS ARE ASSEMBLED ENSURE THAT THERE IS SLIGHT BACKLASH BETWEEN THE GEARS.

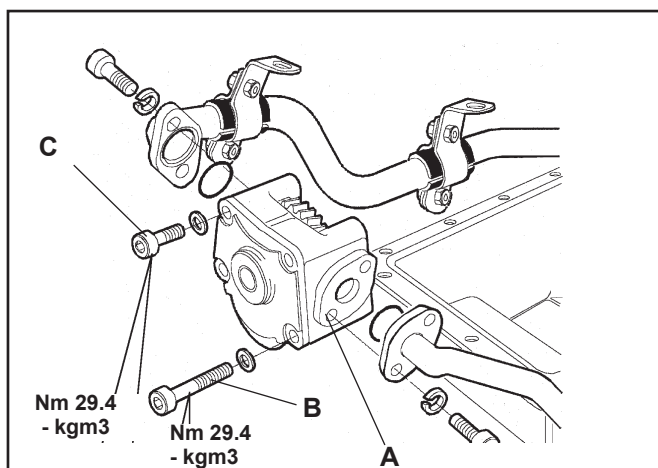


7.9 OIL PUMP (FIG. 7.11)

Remove the oil pump cover.

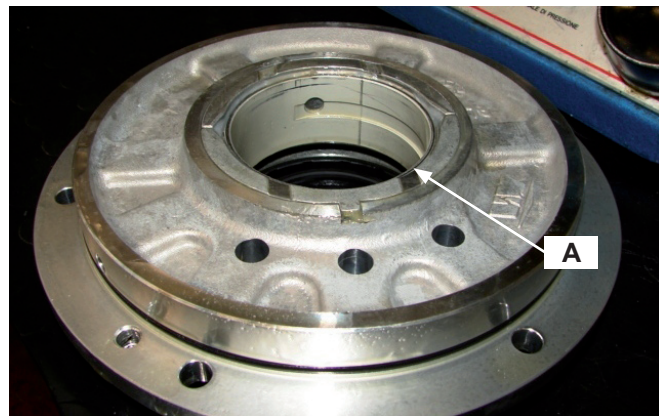
Extract the rotor and check that it is in good condition. Replace the O-ring and re-close the cover, ensuring that the two pins on the cover are correctly located. Fit oil pump **A** to the crankcase, aligning the two locating pins. Pay attention to the correct meshing with the crankshaft gear.

Insert screws **B** and **C** and torque to the value specified.



7.10 REAR MAIN BEARING CARRIER AND CRANKSHAFT AXIAL PLAY (FIG. 7.12 - 7.12a)

Place thrust washers in position on the carrier applying some grease to prevent bearing from falling off during assembly of carrier. Make sure that the thrust washer grooves **A** are towards the crankshaft, as shown in the picture.



Install a dial gauge on the flywheel side of the crankcase so that the feeler gauge touches the crankshaft rear end surface, where the thrust washers contact the crankshaft, as shown in the picture.

Set the dial gauge at "0"



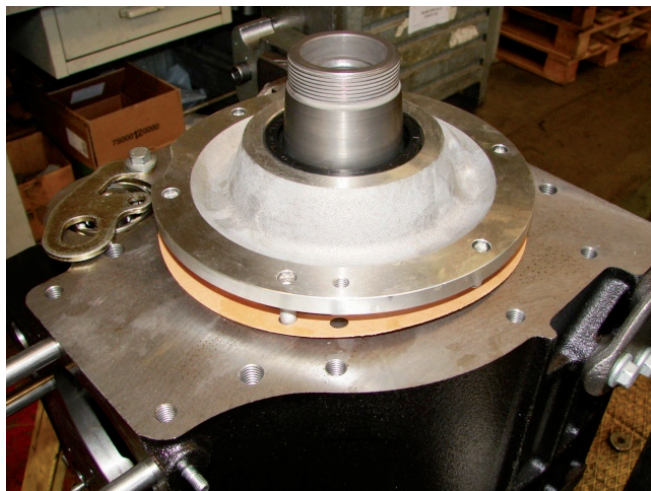
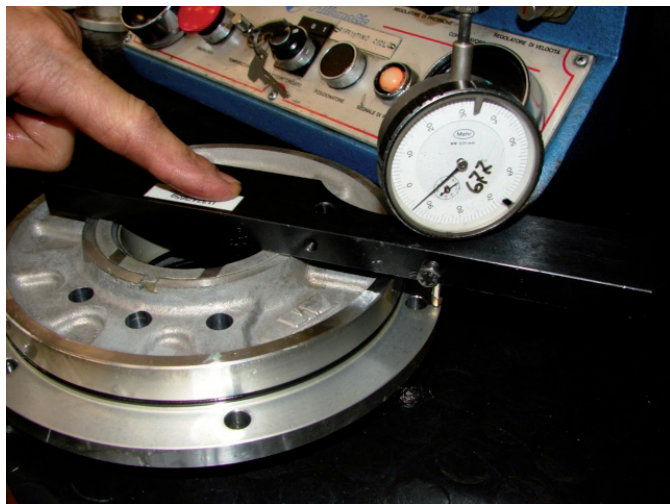
Use the same dial gauge setted at "0" and position it on thrust washers surface.

Position the feeler gauge so that it goes in contact with rear carrier surface, as shown in the picture.

After reading the value, choose the correct gasket.

Gasket Thickness 0.20, 0.30, 0.40 mm

Install the gasket beetwen the crankcase and rear carrier.



At first, mount the carrier **A** without the O-ring, but with the thrust washers and the gasket, by paying attention that the milling **Z** in the radial area coincides with the supporting bearing **B** of the camshaft.

Tighten the carrier and install a dial gauge with terminal board on the engine block front area (fig. 7.12a).

Move the driving shaft axially, by levering with a screwdriver until you obtain the maximum shifting (forwards/backwards) and note down the obtained value.

Disassemble the rear carrier **A** by means of the tool **D** (TAB. 11.1 ref. G), by screwing them up to the stop on the engine block.

At this point, continue to screw them with synchronism up to the complete extraction of the support.

Insert the gasket between carrier and engine block in order to obtain a value of the end float

crankshaft end float	0.180 - 0.320 mm
-----------------------------	-------------------------

and insert it by making the milling on the gasket coincide with the support milling **Z**. Insert the O-ring in the seat on the outer centring diameter of the carrier and lubricate in radial direction.

Mount the carrier by using the tool **D**. Tighten the nuts **C** with the relevant washers according to the indicated value.

Check that the shaft end float is correct.

If it is not possible to obtain a correct end float due to wear or faults of the driving shaft, you can mount some shim rings with different thickness - see (TAB. 8.2.3) - available as spares.

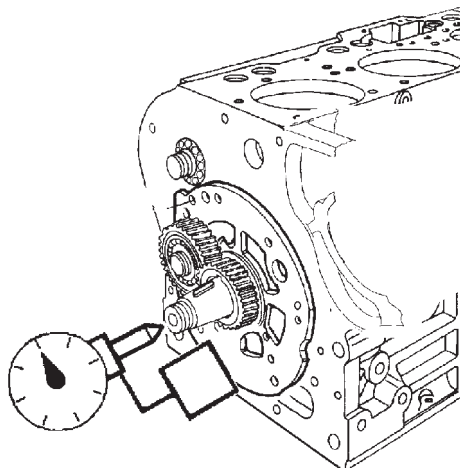
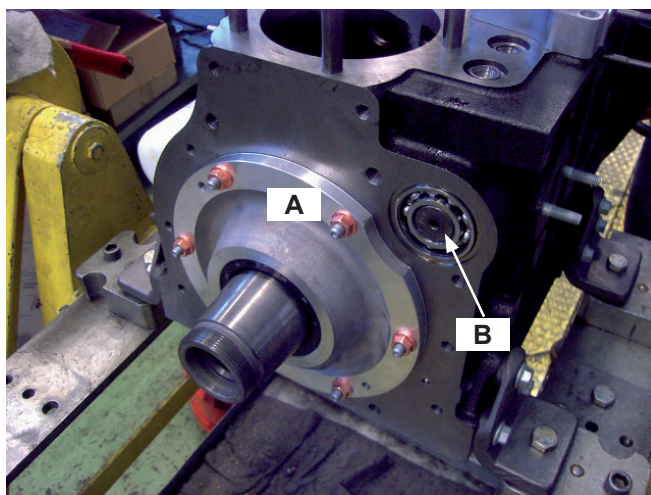
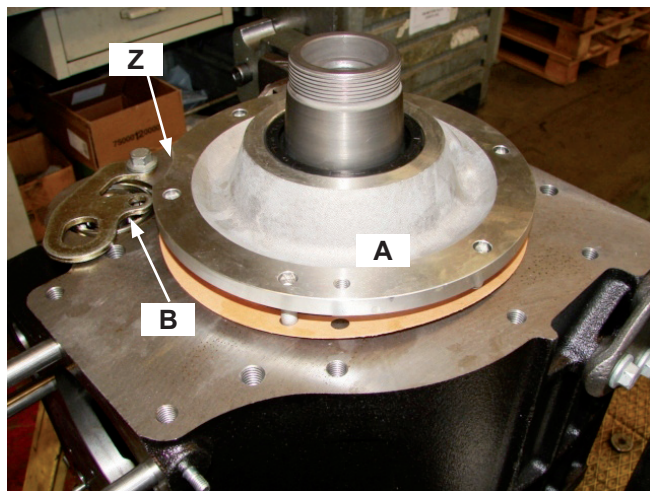


Fig. 7.12a

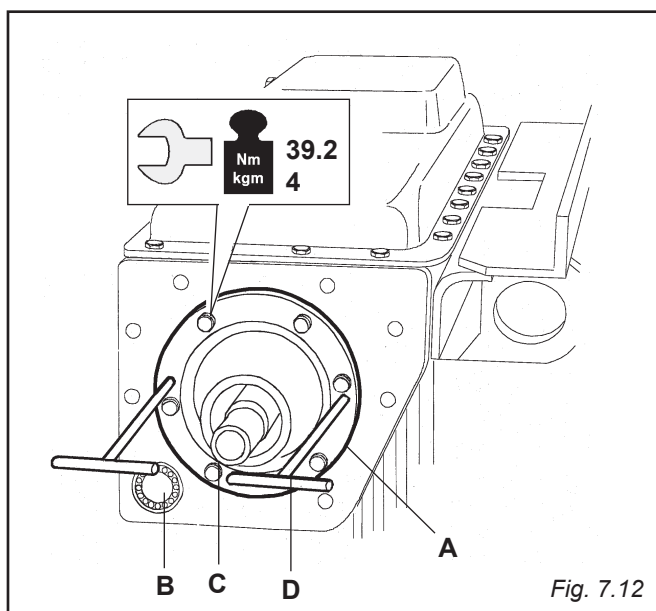


Fig. 7.12

7.11 PISTON TO CONNECTING ROD (FIG. 7.17)

Turn the engine through 180° so that the cylinder head mating surface is facing upwards.

Fit the circlip on the unmarked side **C** of piston **A**.

Fit piston **A** over connecting rod **B** with the arrow stamped on the piston crown facing towards the flywheel side. If the arrow is not present the combustion chamber recess "N" must be pointed toward injection side and the stamped numbers on connecting rod must be aligned in the same direction of combustion chamber recess.

Fit the second circlip on the gudgeon pin and check that the piston is free to rotate on the pin.

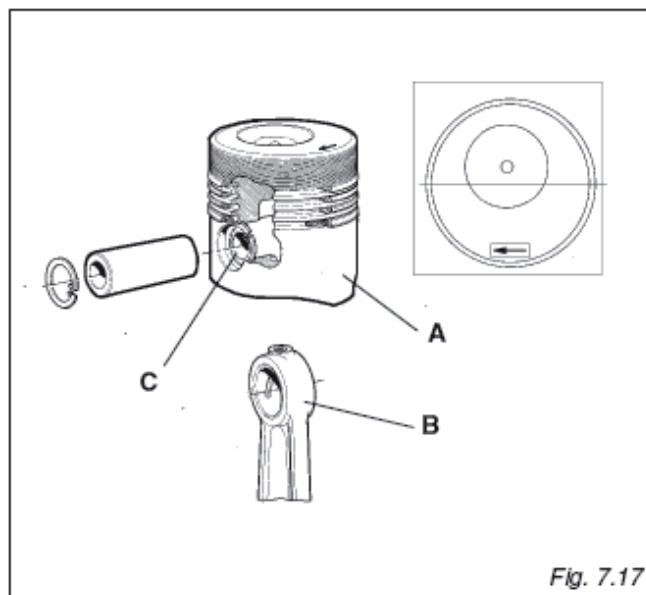


Fig. 7.17

7.12 CONNECTING RODS (FIG. 7.13)



THE CONNECTING RODS ARE DIVIDED INTO WEIGHT CLASSES IDENTIFIED BY MARKINGS. ENSURE THAT ALL THE CONNECTING RODS FITTED HAVE THE SAME MARKING.

Fit bearing **A** into the seat on connecting rod **B** and lubricate with engine oil. Insert fixing screws **D** in connecting rod **B**. Fit the connecting rod to the crankshaft with the stamped number facing the camshaft, injection side.

Fit bearing **A** to the connecting rod cap. Lubricate with engine oil and place it over the previously inserted screws, ensuring the stamped number on con rod cap **X** is aligned with the number on the connecting rod shaft **Y**.

Fit nuts **C** with the machined surface facing the connecting rod cap.

Torque the nuts to the value specified.

Check axial play and ensure that the connecting rod is free to rotate without sticking or undue stiffness.

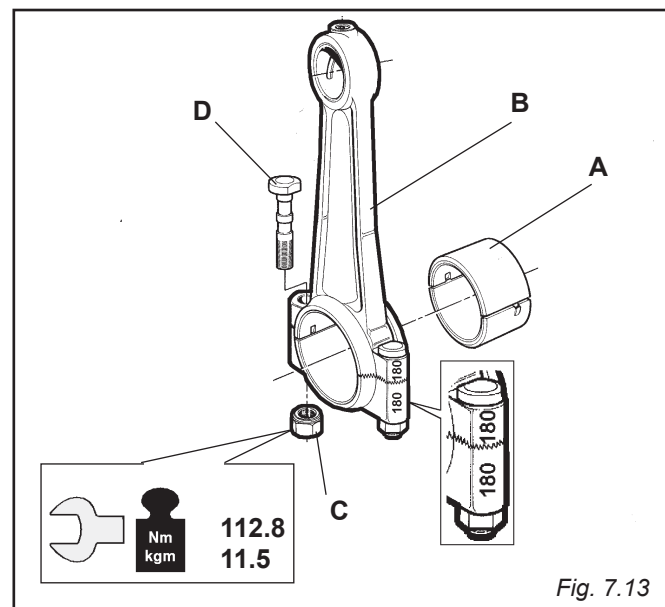
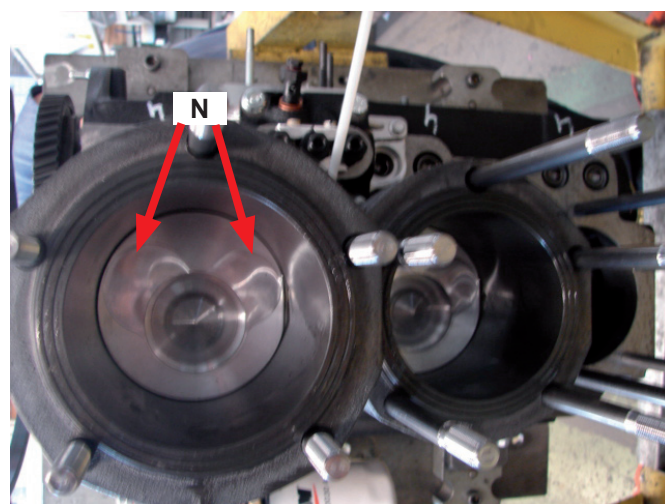
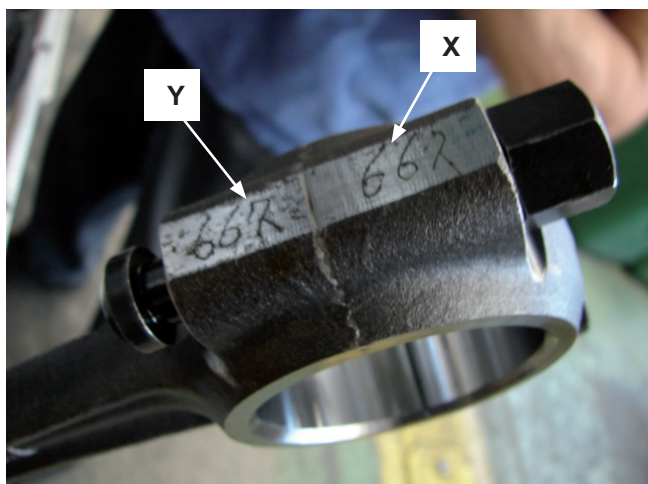


Fig. 7.13



7.13 PISTON RINGS (FIG. 7.18)

Fit the piston rings on the pistons with the gaps offset by a half turn with respect to each other and at $\sim 30^\circ$ from the gudgeon pin bore and with the word TOP facing the piston crown.

The first **1st** piston ring has a trapezoidal section.

The **2nd** piston ring has an internal bevel that must be facing the piston crown.

The **3rd** piston ring has an external step that must be facing the connecting rod.

The **4th** piston ring is the wiper seal



THE ABOVE OPERATIONS MUST BE PERFORMED AFTER MEASURING THE VALUES TO DETERMINE THE PISTON CLEARANCE AS DESCRIBED IN THE FOLLOWING HEADING 7.18.

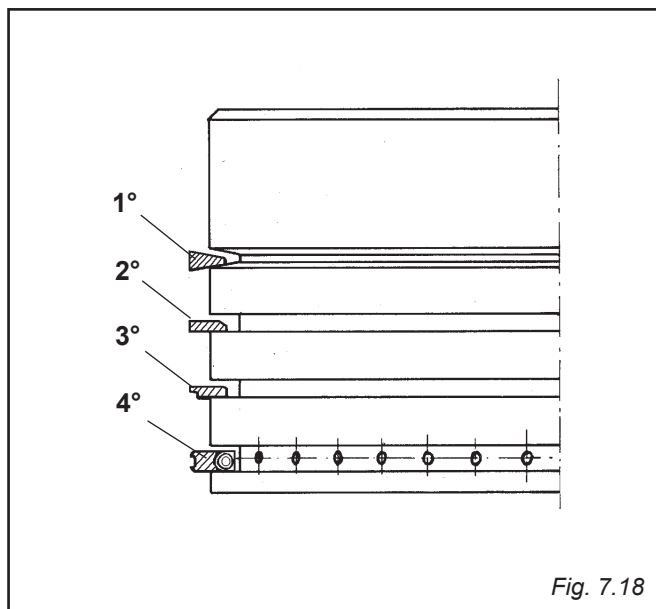
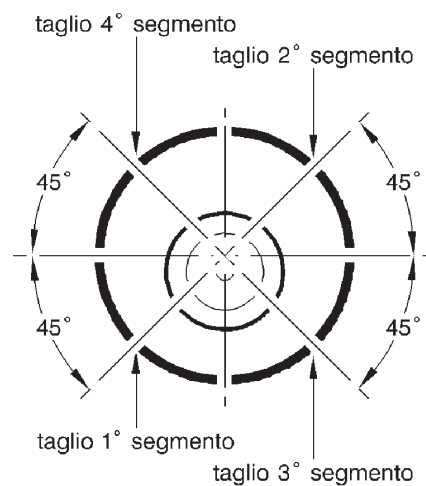
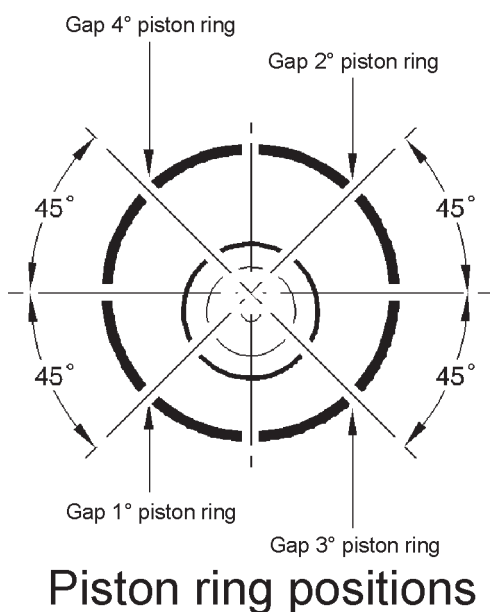


Fig. 7.18



Orientamento segmenti

Fig. 7.18a

7.14 OIL FEED PIPELINE UNIONS AND FIXINGS (FIG. 7.14 - 7.15)

When reassembling the oil pipelines replace all O-rings.

Unscrew the feed pipe unions and fixings leading to the central main bearings. Replace the O-rings on the flange of oil pipe **B** feeding oil to the front, rear and three central bearings.

Fit the oil feed pipe **C** followed by the feed fittings for the front and rear bearings and finally fit the flanges on the stud screws in the bottom of the crankcase.

Fit the seal rings: one under the union on the pipe and one on the calibrated screw **A**. Proceed in the same manner for all the central main bearings.

Tighten the oil feed screw **A** to the value specified. Fit nuts **D** that secure the flange to the crankcase and torque to the value specified.

Fit the oil suction pipe **E** from the sump to pump **F**.

Orient the pipe so that it can be secured to intake filter **L** and fit the filter to the pipe taking care not to damage the O-rings.

Fit the oil drain pipe from overpressure valve **G**, inserting it in the hole connected to the overpressure valve inside the crankcase. Secure the pipe baseplate and the filter baseplate at the same time.

Torque screws **H** to the value specified.

Fix the suction and delivery pipes to oil pump **F** by means of screws **M** and **N**, which must be torqued to the value specified; ensure that the suction pipe is properly inserted in the filter.

Fix support **O** to the crankcase by means of screw **P** and then insert the damper rubber between the pipe and the support; secure the pipe with U clip **Q** and fasten with screws and nuts **R** ensuring that the rubber is positioned correctly.

When fitting the support that holds the oil feed pipe proceed as described above, adding only the clamp of the pipe that supplies oil to the front main bearing.

Secure the clamp with the anti-vibration rubber that restrains the oil feed pipe.

Check that strainer **S** of filter **L** is clean by removing the seal ring **T** and extracting it.

To fit the strainer, perform the above steps in reverse.

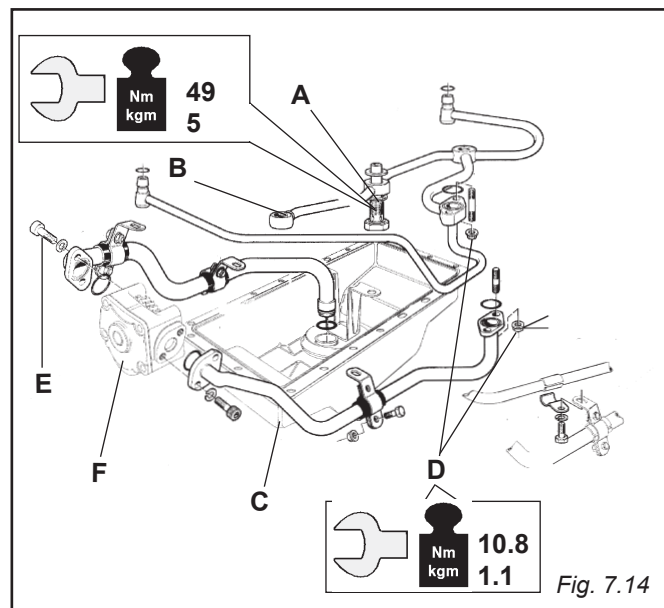


Fig. 7.14

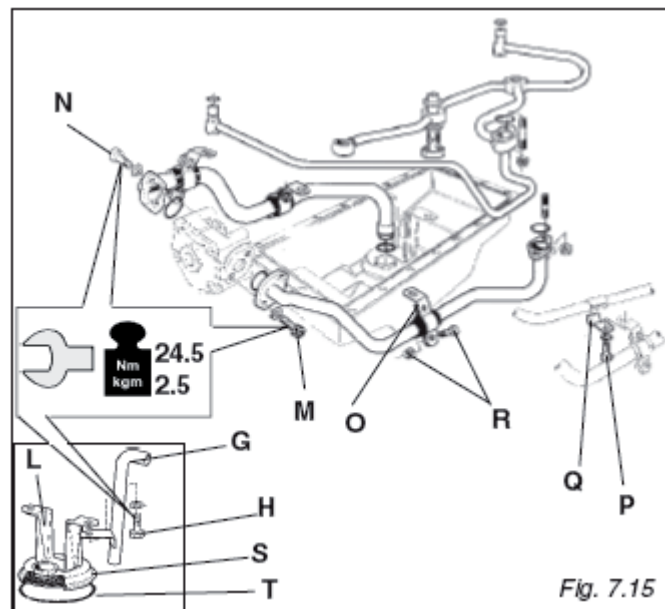


Fig. 7.15

7.15 SUMP (FIG. 7.16)

Clean the crankcase flange to which the sump **A** is to be assembled and smear a uniform coat of silicon, type Dow Corning 7091, around the perimeter of the crankcase. Fit the sump, aligning it with the aid of commercial stud bolts **B** which must be removed after this operation.

Now fit the inserts with screws **C** and torque to the value specified.



THE INSERTS FEATURE AN OFF-CENTER THROUGH-HOLE; MAINTAIN THE WIDEST SIDE TOWARDS THE ENGINE WHEN YOU FIT THEM.

Fit plug **D** with its seal washer and torque. Alternatively, you can fit connector **E** with temperature sensing bulb **F**.

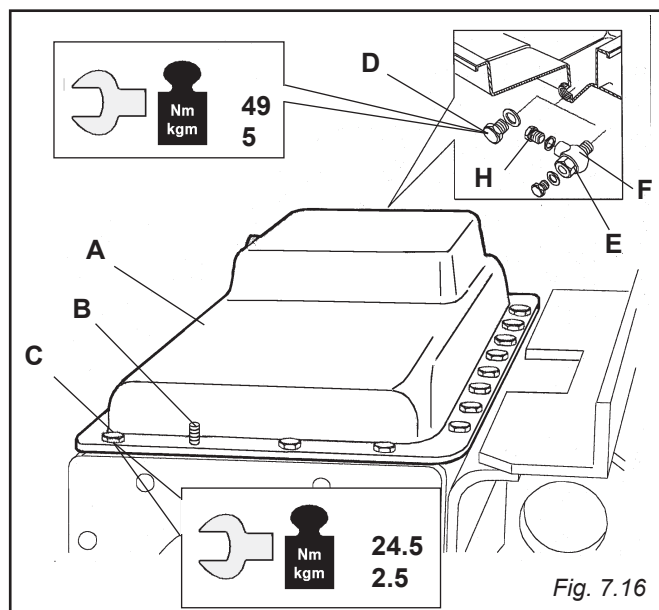


Fig. 7.16

7.16 PISTON CLEARANCE AND CYLINDERS (FIG. 7.19)

Smear oil over the cylinder and piston and fit the cylinder over the piston without a shim between cylinder and crankcase.

Locate the cylinder against the crankcase and use a gauge to measure the distance between the piston at T.D.C. and the edge of the cylinder.

This distance must be 0.00 ± 0.050 mm; in relation to the measurement there are three types of cylinder shim **B** of different thicknesses that are used to create the piston clearance see you (TAB. 8.2.5).

With the 1.0 mm thick metal cylinder head gasket **C**, installed, check that the piston clearance is: $0.95 \div 1.050$ mm.

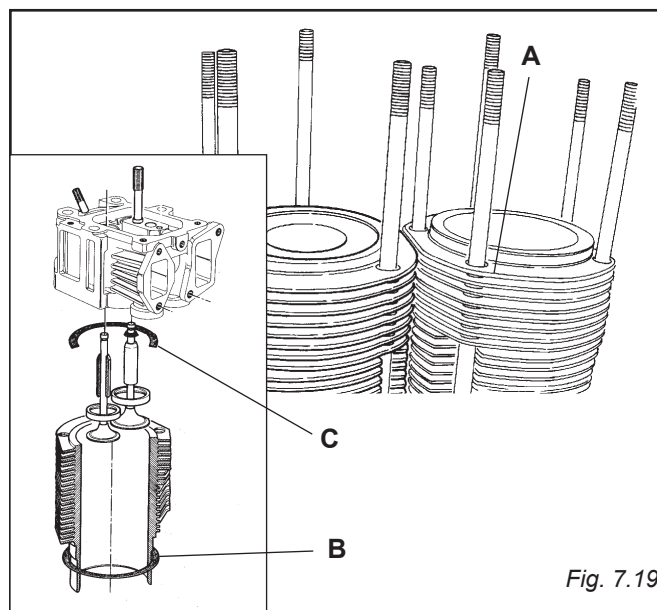


Fig. 7.19

7.17 ASSEMBLY OF INTERNAL INJECTION PUMP AND RELATIVE INJECTION PHASE (SUN 2105-3105 ENGINE) (FIG. 7.34 - 7.35A - 7.35B).

Measure with a depth gauge **B** the height **A** between injection pump mounting face on crankcase and the cam in position of rest (base circle of cam) (Fig. 7.34) .

Write down reading obtained on depth gauge.

Calculate number of shims necessary to reach the correct final height .

Pump shims of various thickness are provided to correctly adjust pump-to-cam height **A**.

See the following table for final height and available shim thicknesses.

Engine Model	pump depth (mm)	Selection of spacers
SUN 2105	83.40 ÷ 83.50	0.100
SUN 2105E1		0.200
SUN 3105		0.250
SUN 3105T		
SUN 3105E1		
SUN 3105TE1		
SUN2105E2	83.70 - 83.80	0.100
SUN 3105E2		0.200
SUN 3105TE2		0.250

INJECTION PUMP TIMING ADVANCE

Fit the pump with the selected shims and torque nuts **Z** (Fig. 7.35B) to the value specified.

With piston no.1 at T.D.C. turn the camshaft until you achieve a position of perfect balance (intake valve opening-exhaust valve closing) and fit the camshaft gear attempting to position the screws in the center of the slots (in the absence of references); pretighten the screws without forcing them.

Connect the fuel inlet union and set the pump in its working position or set the rack rod in a central position. It is preferable to find the start of fuel feed by means of a commercial tool **A** similar to the one shown in (Fig. 7.35B); the tool must be positioned on fuel delivery connection no.1.

If the tool is unavailable use a piston handpump that can deliver pressures in excess of 15 bar (1500 Kpa) (217.5 psi).

Turn the crankshaft through one complete revolution to reach the firing stroke. Use the graduated disc (Table 11.1 Ref. I) .

Bleeding the injection circuit by alternately turning the crankshaft between the delivery start position and T.D.C. until fuel is just delivered from the tool.

Bring the first cylinder to approximately 30 - 35° before T.D.C. in the firing stroke.

Slowly turn the crankshaft in the direction of run. As soon as the fuel starts to rise, or when forced by the applied pump it ceases to be emitted, stop turning the crankshaft: this is the fuel delivery start position.

Check that the graduated disc (Table 11.1 Ref. I) shows the injection advance value indicated in the table on page 6-23.

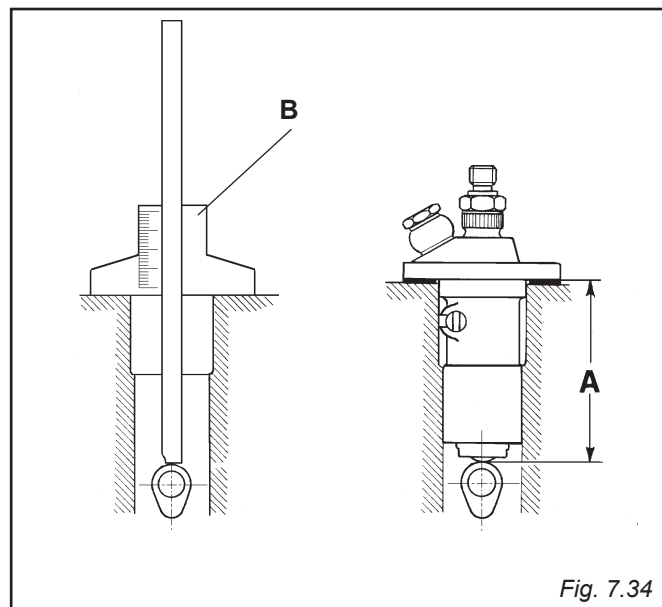


Fig. 7.34

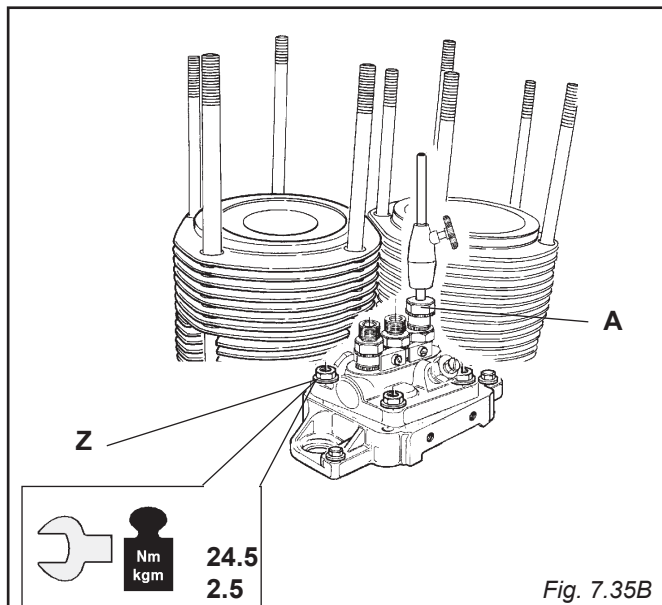
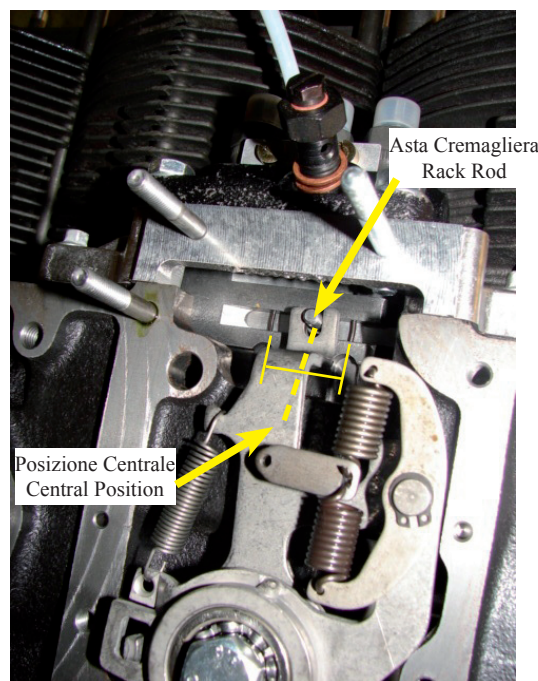


Fig. 7.35B

For cases in which it is not possible to install the graduated disc, the following list shows the injection advance values in mm of linear deviation corresponding to the angular values.

These values can be measured with a gauge on the outer edge of the crankshaft pulley as described below:

Standard pulley diameter: 186 mm

Calculate the circumference and divide it by 360°

Multiply the resulting millimeter value by the phase degrees, e.g.:

$$186 \times 3.14 = 584 \text{ mm}$$

$$584 \div 360^\circ = 1.623 \text{ mm}$$

$$1.623 \times 22^\circ = 35.7 \text{ mm (delivery start reference to be inserted before the T.D.C. reference)}$$



**TO AVOID MODIFICATIONS IN THE
PLUNGER DISPLACEMENT VALUES NEVER DISASSEMBLE THE
DELIVERY UNIONS.**

**IF THE ENGINE IS ADVANCED OR RETARDED, LOOSEN THE CAMSHAFT GEAR FIXING SCREWS AND
TURN THE GEAR SLIGHTLY TO THE RIGHT (ADVANCE) OR TO THE LEFT (RETARD).**

7.18 GOVERNOR (SUN 2105 - 3105 - 3105T ENGINES) (FIG. 7.6 - 7.7)

Assemble the counterweight unit **A** to the front bearing and assemble the front bearing to the crankcase as described in the previous heading 7.5.

Fit the lever support **B** to the front bearing and finger tighten fixing nuts **C**.

Adjust the position of the lever by means of special tool **D** (TABLE 11.1 Ref. M) as follows:

Fit tool **D** to the counterweight unit pin and the lever pin and torque nuts **C** to the value shown, make sure the tool can be removed without sticking.

Fit the thrust spacer **E** (Fig. 7.7), complete bearing **F** and the governor control fork **G** with relative shoes.

Attach the tie rod **H** to the fork **G** and set the rack rod in the maximum flow rate position (governor counterweights completely closed), check that there is no play in the movement of the counterweights.

If play is detected, disengage the tie rod from the fork and adjust its length by tightening or loosening the ball joint.

Check that thrust bearing **F** is free to rotate.

Finally, immobilize the ball joint with nut **I**.

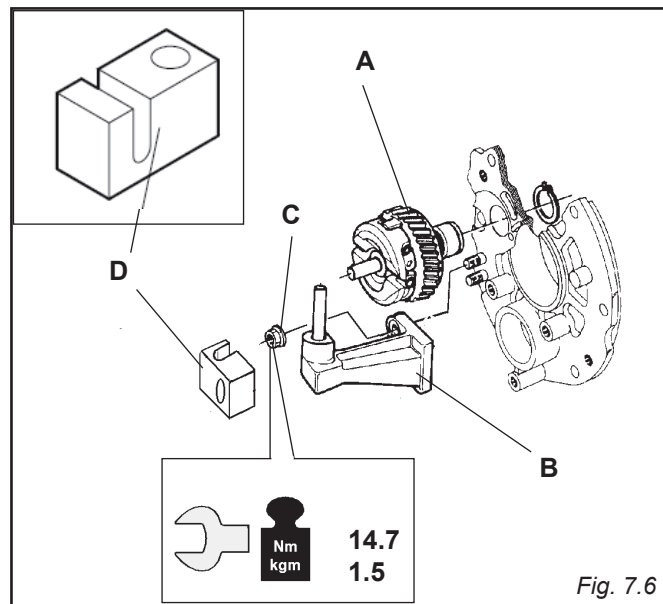


Fig. 7.6

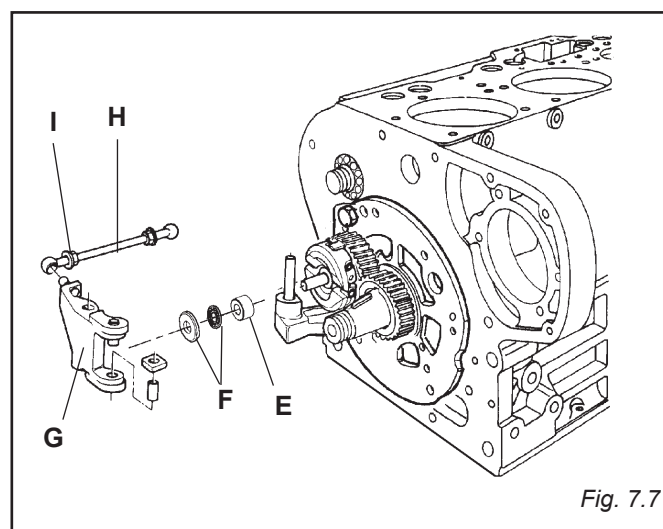


Fig. 7.7

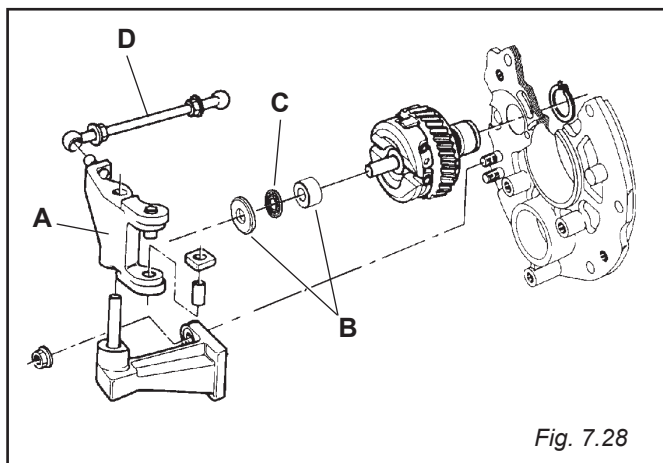


Fig. 7.28

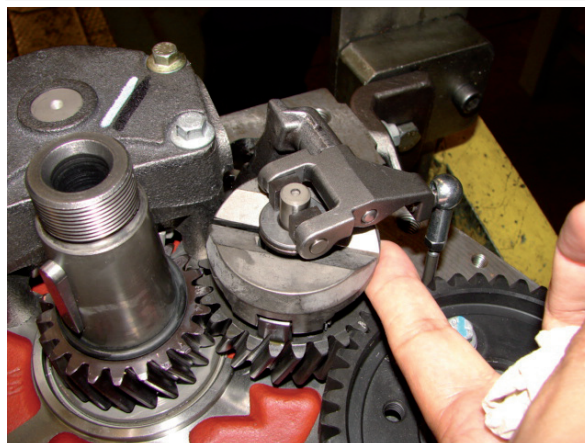
ADJUSTMENT:

With the injection pump in the maximum delivery position and the counterweights closed, bring fork **A** up to spacer **B**.

Using a feeler gauge check that the clearance between bearing **C** and spacer **B** is approx. **0.100 mm**.

If the distance is different, correct by means of the adjuster on the link rod **D**.

The governor is equipped with a supplementary spring, which automatically returns the injection pump rack rod to the boost position when the engine is stopped.



7.19 ASSEMBLY OF ROTARY INJECTION PUMP AND RELATIVE INJECTION PHASE (SUN 4105 - 6105 ENGINES) (FIG. 7.36)

Position the first piston on the top dead centre. Mark the top dead centre referred to a created index on the front pulley (if not present). Rotate the driving shaft in counter-clockwise direction until you reach the spark advance value in degrees or in mm that is specific for the relevant engine.

For the values in degrees see (page 6-24).

At this point you are at the beginning of delivery.

Mount the flange **E** and insert the gasket **A** on the pump.

Insert the pump **B** in the housing, by making the spline coincide with the slot on the flange **E**.

Insert the nut fixing flange to the injection pump and tighten it thus generating a slight torque.

Mount the pump fixing nuts without tightening them.

Mount the gear **F**, by paying attention to position the tightening screws **G** centrally if compared to the length of the slots on the gear without tightening them.

Open the small window **C** on the pump and rotate the pump in clockwise direction to delay it or in counter-clockwise direction to advance it, until the two inner marks are perfectly aligned.

Tighten the screws **G** according to the indicated value.

At this point, lock the pump flange and remount the cover on the small window.

Tighten the nut **H** according to the indicated value.

Mount the accelerator lever **I**, if applicable, and tighten the nuts **D** according to the indicated value.

By means of the setting dial (**TAB. 11.1 ref. I**), check the pump timing by keeping the marks inside the pump window **C** aligned and read the index value on the setting dial - see Table on page 6-24.

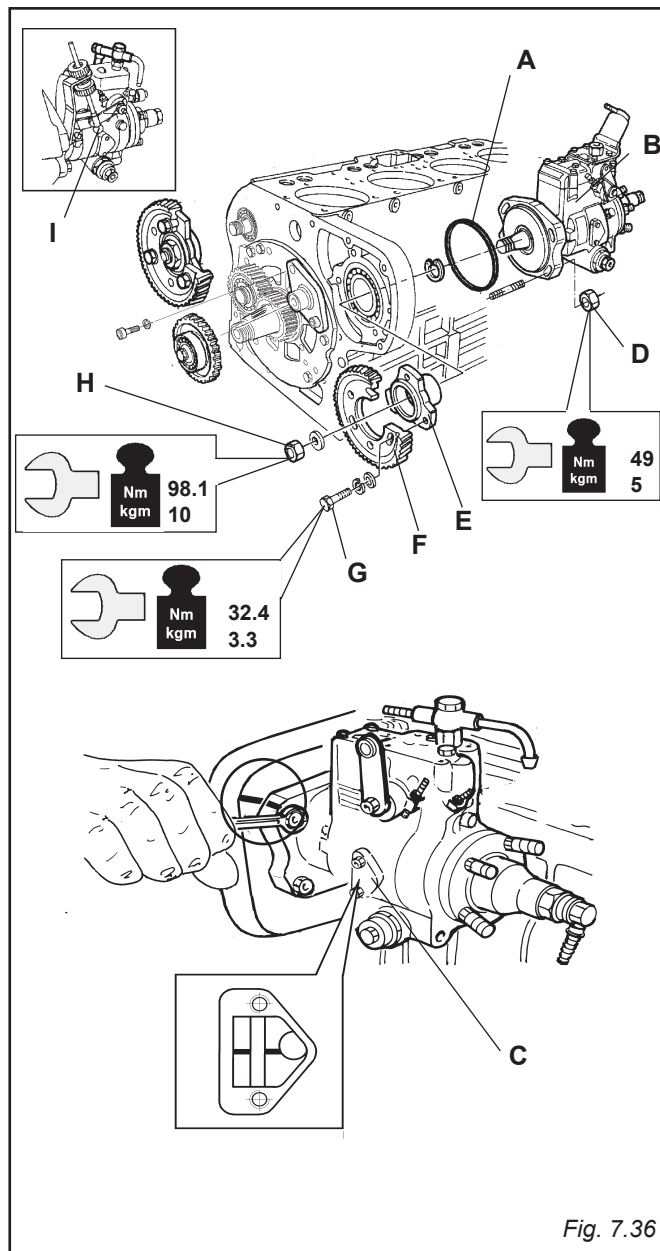


Fig. 7.36



NOTE THAT THE INJECTION PHASE IS REFERRED TO THE FIRST CYLINDER, TIMING SIDE, IN THE FIRING PHASE.

7.21 PREASSEMBLY OF CYLINDER HEADS (FIG. 7.20)

Place the metal 1.0 mm shim **E** between cylinder and cylinder head **D**.

Assemble the cylinder head to the cylinder.

Finger-tighten screws **A** and **B** and the distance collars **C**.

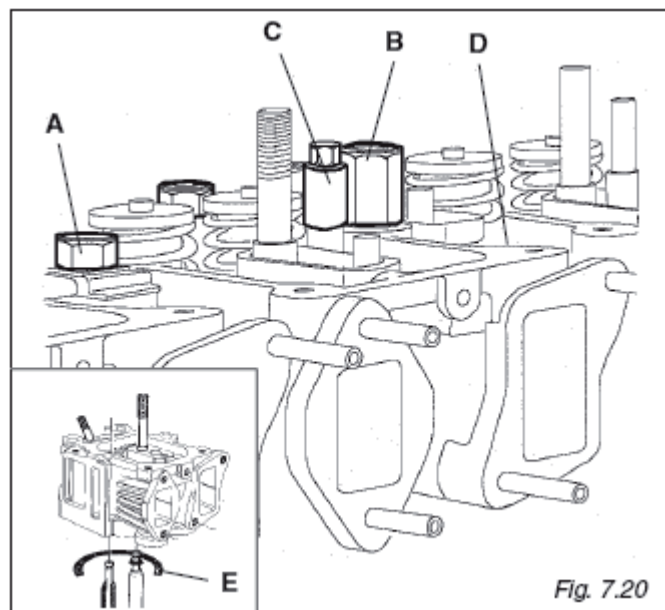


Fig. 7.20

7.22 COOLING JACKET (FIG. 7.21 - 7.22)

Fit jacket **A**.

Tighten screw **B**.

Fit cover **C** and tighten screw **D**.

Fit cover **E** (Fig. 7.22) and tighten screws **F** fastening the cover to the cylinder heads.

Fit cooling air deflector plates **G** between the cylinders and secure with screw **H**.

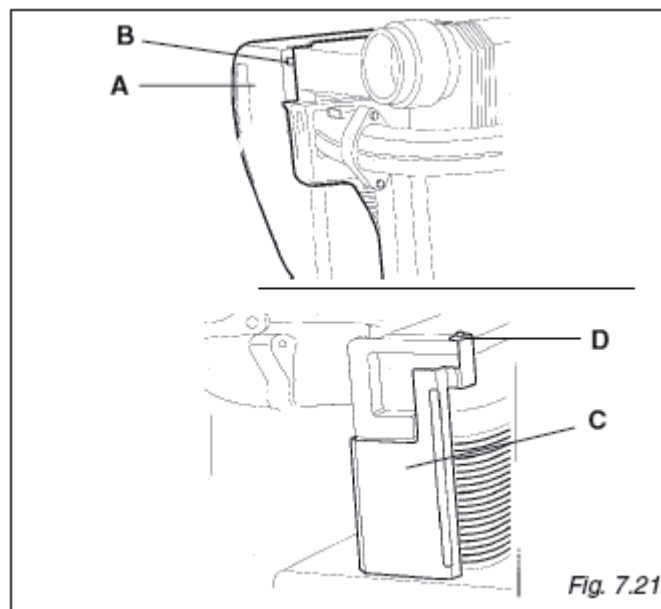


Fig. 7.21

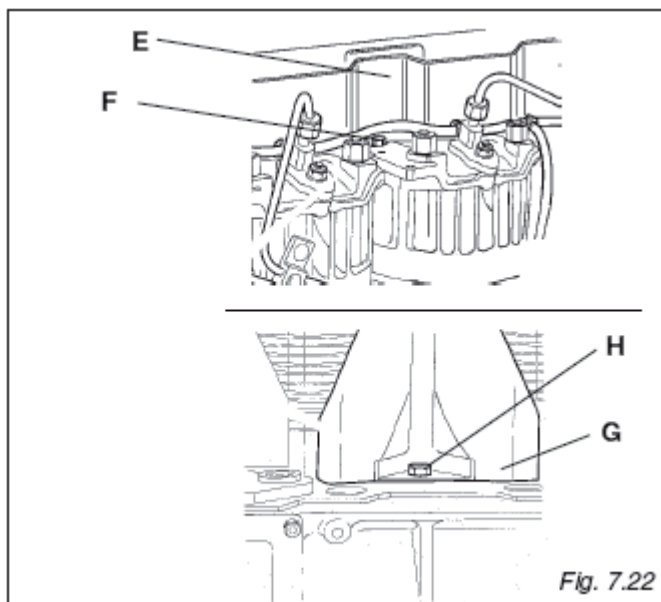


Fig. 7.22

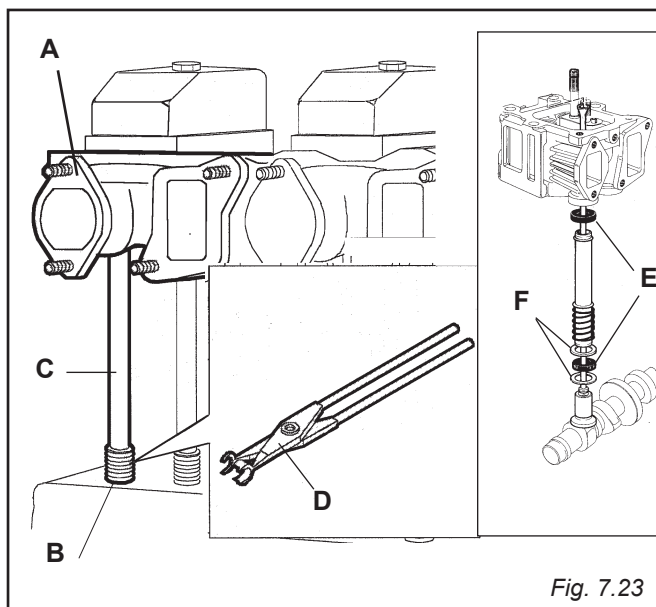
7.23 PUSHROD PROTECTION TUBES (FIG. 7.23)

Fit lubricated gasket **E** onto its seat on cylinder head **A** with the smaller diameter facing upwards.

Fit seal washer **F** and lubricated gasket and lubricated seal **E** into seat **B** on the crankcase with the smaller diameter facing upwards; now fit the last washer **F**.

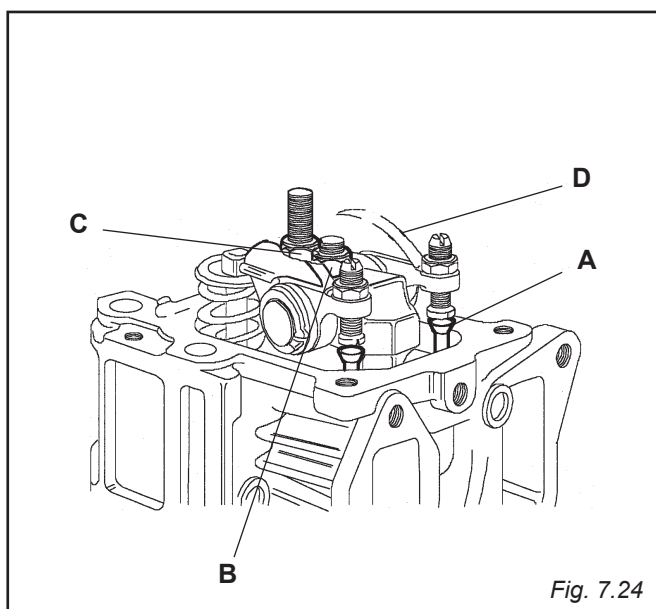
Use tool **D** (TABLE 11. Ref. H) to compress the spring and fit tube **C** oriented as shown in Fig. 7.23.

Proceed as described above to install all the pushrod protection tubes.



7.24 PUSHRODS (FIG. 7.24)

Fit the pushrods **A** with the spherical end facing downwards (towards the camshaft). Remember to fit the **O-RINGS** on the stud bolts in the rocker arm supports.



7.25 ROCKER ARMS (FIG. 7.24)

Fit rocker arms **D** in their seats ensuring that the locating pins are correctly engaged.

Finger tighten rear nut **B** and front nut **C**.

7.26 CAMSHAFT AND ROCKER ARM LUBRICATION PIPELINE (FIG. 7.25)

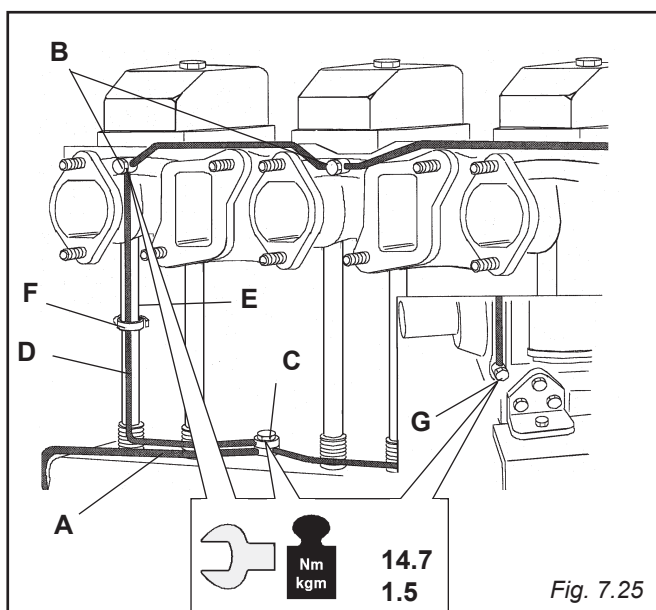
Fit camshaft lubrication pipe **A** in the proximity of the relative locations. Fit the copper gaskets, one over the union and one under the union, and finally fit the unions.

Torque connector **G** to the value specified.

Proceed in the same manner to install rocker arm lubrication pipe **D**.

In the area in which the two pipes are interconnected, stack the two unions, three washers and finally connector **C** and torque to the value specified.

Tighten all connectors **B** to the value specified. Fasten the rocker arm lubrication pipe **D** to the pushrod protection tube **E** by means of plastic clamp **F**.



7.27 CYLINDER HEAD TORQUING (FIG. 7.26)

After fitting the rocker arms and respective pushrods, fit the intake manifold and tighten the nuts.

Now loosen the nuts by half a turn to avoid the creation of stress on the manifold while the heads are being torqued.

For correct tightening procedure see below scheme.

After the tightening procedure remove the intake manifold.

Schemi motori e dadi e manicotti utilizzati

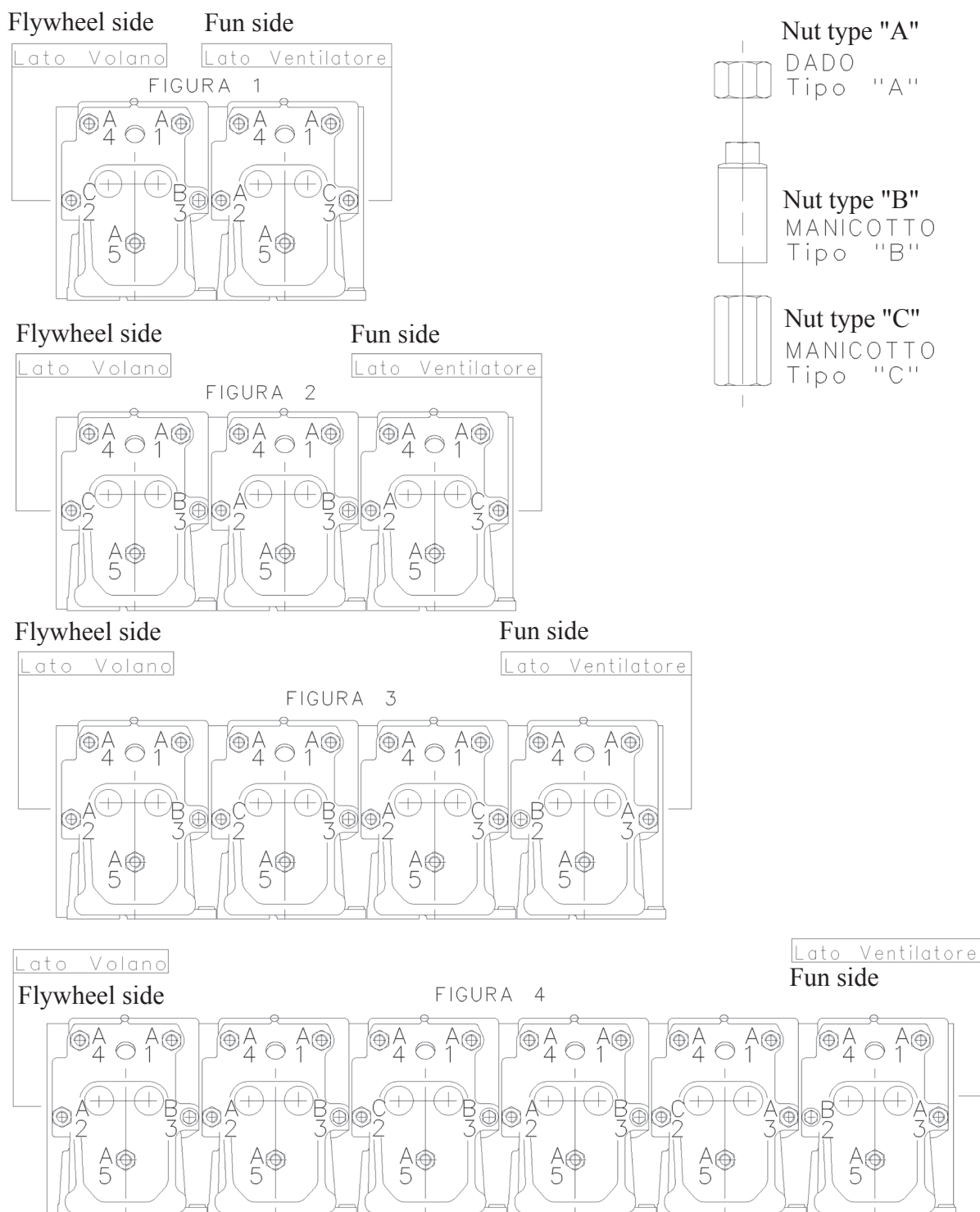


Fig. 7.26

1st OPERATION:

Lubricate nuts and sleeves (open and blind) with engine oil only in case of a reset after the operation. In case of first assembly, do not lubricate them.

2nd OPERATION:

Position all the nuts (type A) and the sleeves (type B and C) manually by approaching the heads according to the number of cylinders and the diagram.

3rd OPERATION:

By starting from the handwheel side head and continuing with the following ones, with a torque wrench tighten a nut per time according to the sequence 1, 2, 3, 4, 5 (see diagram) with a torque wrench setting of 50 Nm (5.1 kgm) in clockwise direction.

4th OPERATION:

Without loosening, repeat the third operation in the same way, by tightening with a torque wrench setting of 88.3 Nm (9.1 kgm) until completion.

5th OPERATION:

At the end of the tightening, we recommend to carry out a paint punching on the relevant screw, in order to confirm that the tightening has been carried out.

This operation helps to avoid to omit some tightening.



DUE TO THE DIFFICULTY OF THE OPERATION, YOU MUST CONSIDER THAT THE TOLERANCE ON THE FINAL CLOSING VALUE MUST NOT DIFFER OF $\pm 5\%$, BECAUSE THIS IS CONSIDERING A CLASS "A" TIGHTENING.

7.28 INTAKE MANIFOLD (FIG. 7.27)

Fit the exhaust manifold gaskets.

Fit manifold **A** over the stud screws and finger-tighten nuts **B** then torque to the value specified.

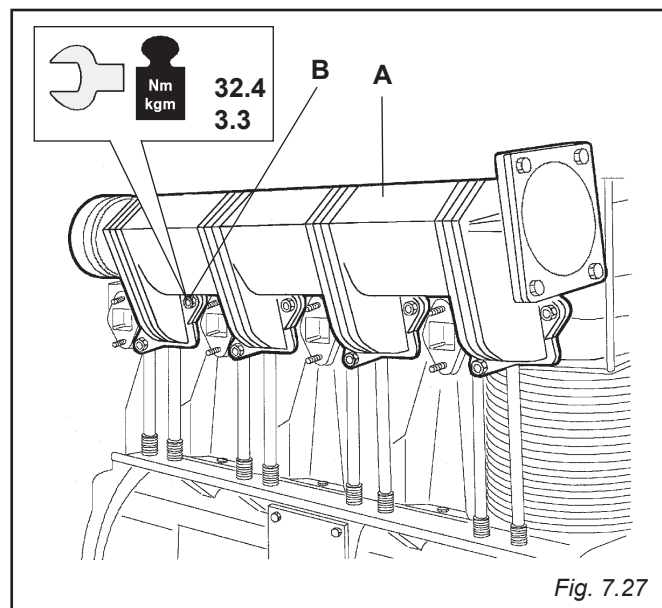


Fig. 7.27

7.29 EXHAUST MANIFOLD (FIG. 7.28)

Fit manifold **A** and then finger-tighten nuts **B**; now torque the nuts to the value specified.

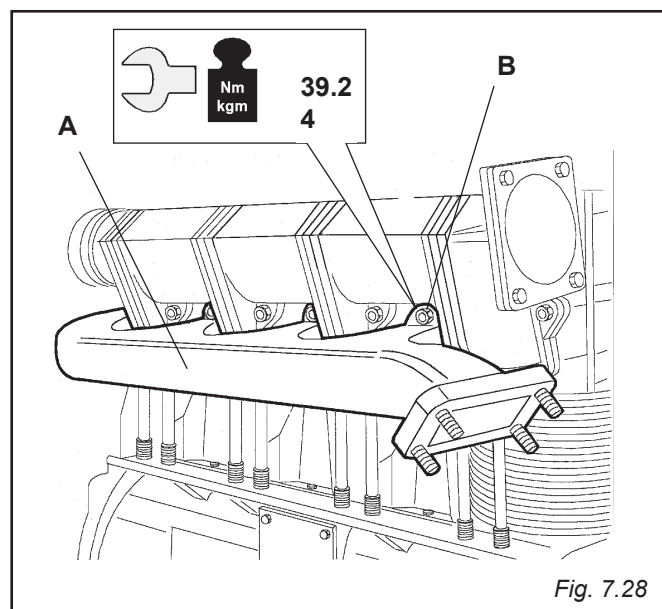


Fig. 7.28

7.30 VALVE ADJUSTMENT (FIG. 7.29)

Adjust the intake and exhaust valves to **0.30 mm** (with engine cold).

Bring the pistons to T.D.C. in the firing phase.

Insert the **0.30 mm** feeler gauge, loosen nut **B** and tighten grub screw **C** to locate the rocker arm **D** against the feeler gauge.

It is recommended not to change the feeler gauge adjustment during measurements between intake and exhaust valves or you may encounter differences during the timing check.

Note: Adjust the valves according to the firing sequence:

2 cylinder engine: 1-2

3 cylinder engine: 1-3-2

4 cylinder engine: 1-3-4-2

6 cylinder engine: 1-5-3-6-2-4



THE CRANKSHAFT ROTATES IN A CLOCKWISE DIRECTION WHEN OBSERVING THE ENGINE FROM THE TIMING GEAR SIDE.

CONVENTIONALLY, CYLINDER NUMBER 1 IS CONSIDERED TO BE THE FIRST CYLINDER ON THE TIMING SIDE.

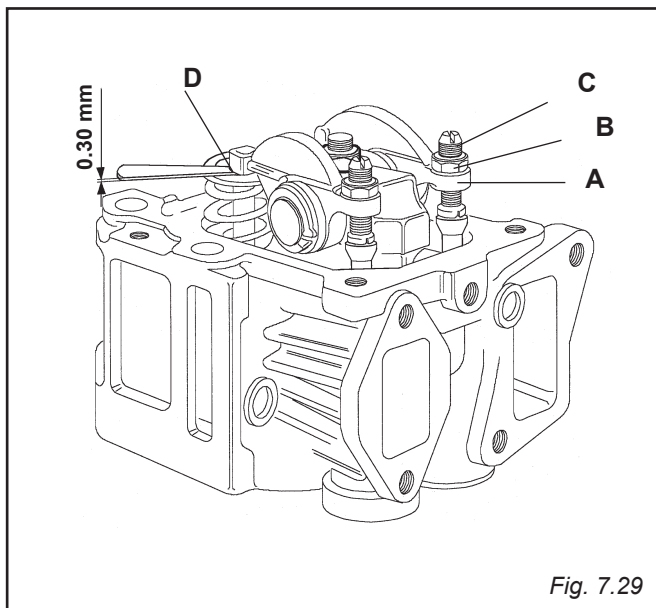
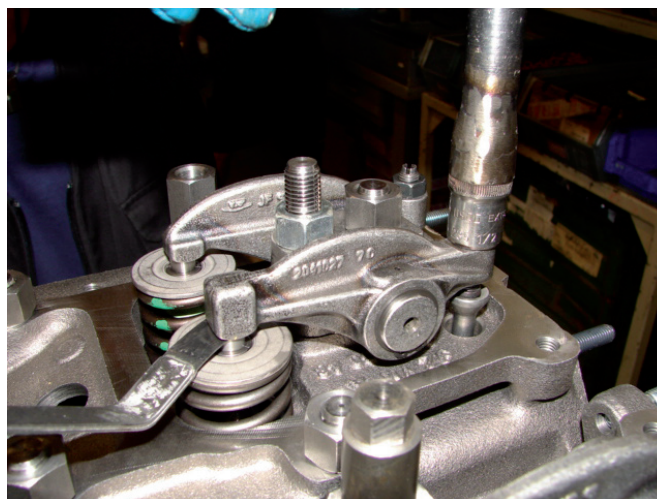


Fig. 7.29



7.31 TOP DEAD CENTER (FIG. 7.30)

Fit the graduated disc (**Table 11.1 Ref. I**).

To use the graduated disc correctly proceeds as follows:

- Temporarily fit the front pulley on the crankshaft.
- Fix the graduated disc and position an index in the proximity of the numbered angular gasket.

Fit commercial tool **B** to create the axial pack at the top of the spring.

Fit a dial gauge **C** at the top of the tool and turn the crankshaft with the appropriate tool, checking the points at which the dial gauge readings change direction.

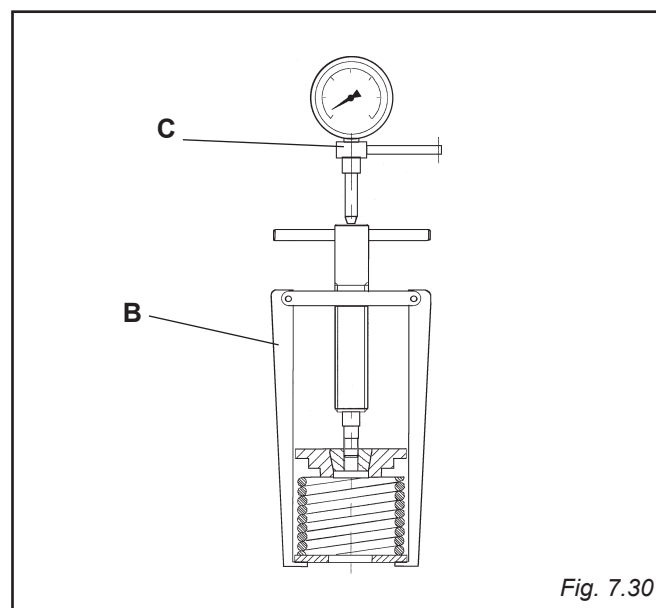


Fig. 7.30

7.30 CAMSHAFT TIMING CHECK (FIG. 7.31 - 7.32)

With adjusted valves at 0.30 mm, verify the start of opening of the intake valve and the exhaust valve closes.

The values should be taken using the graduated disk (Tab 11.1 ref I).

Preliminary phase:

Mount the graduated disk on the crankshaft, put the first piston (timing system side) on the T.D.C. (compression stroke) and put the index to the zero point on the graduated disk.

Put a gauge on the upper cap of the intake valve as shown in fig. 7.32 (in the illustration, the gauge is placed on the exhaust valve)

Intake stroke valve opening start check:

Turn the crankshaft one turn clockwise; the opening of the exhaust valve will be noted first. The intake valve start opening the as soon as gauge starts moving.

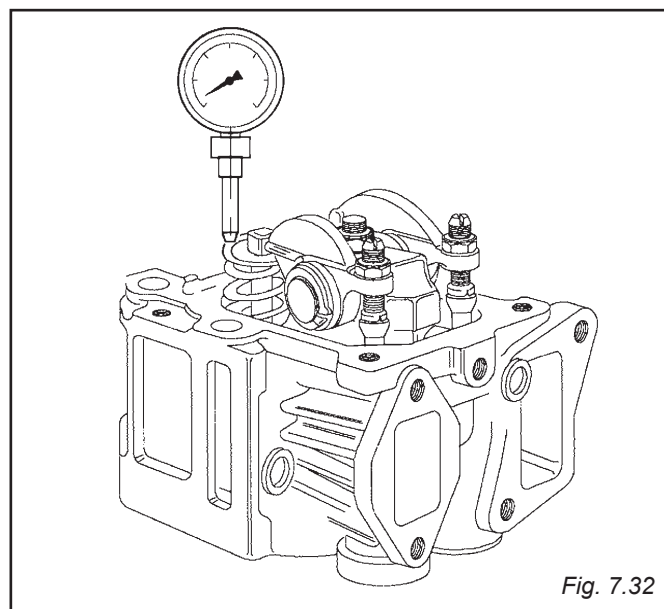
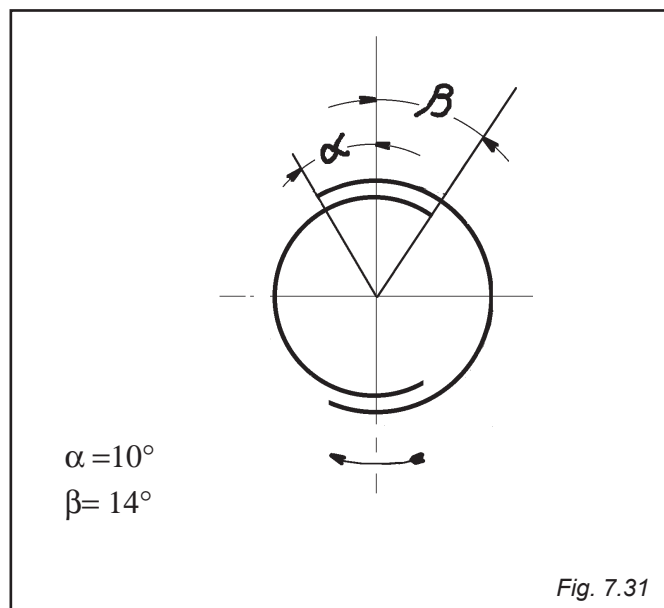
At this point, check the value of the movement α on the graduated disk: this should be = 10°

Exhaust stroke valve closing end check:

Move the gauge onto the exhaust valve and continue to turn the crankshaft in the same clockwise direction.

As soon as it stop, the reading shown on the graduated disk must be equal to a β of 14° .

If the above values are not found, advance or retard the timing gear on the camshaft to obtain the correct reading.



7.33 VALVES (FIG. 7.33)

Disassembly

Use a commercial tool (valve lifter) **A** to compress spring **B**.

Extract half-cones **D**.

Extract the spring and washer.

Extract the valve.

Repeat the above steps for each valve.

Re-assembly

Lubricate the valve stem **C** and insert it into its seat.

Fit lower spacer **F**.

Use tool **A** to compress spring **B** and upper washer **E** and fit the parts onto valve stem **C**.

Fit the two half-cones **D**.

Loosen the tool until the upper washer locates against the half-cones.

Repeat the following steps for all the valves.

Smear grease on the gasket seat on the head so that gasket will remain in position during insertion of the head on the top of the cylinder.

Tighten the heads using a wrench on the nuts; ensure the nuts are fitted with the machined surface facing the shoulder on the cylinder head surface.

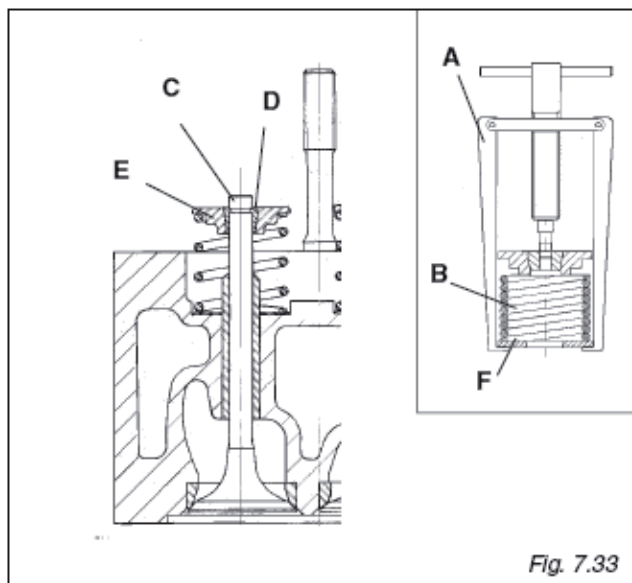


Fig. 7.33

7.34 ROCKER COVER (FIG. 7.37)

Place the gasket on the top of the cylinder heads and then fit cover **A**.

Fit nut **B** with its **O-ring** on the tie rod and tighten it.

Repeat this procedure for all the rocker covers and then torque to the value specified (**A** = cover with decompression lever) and (**B** = std rocker-arm cover).

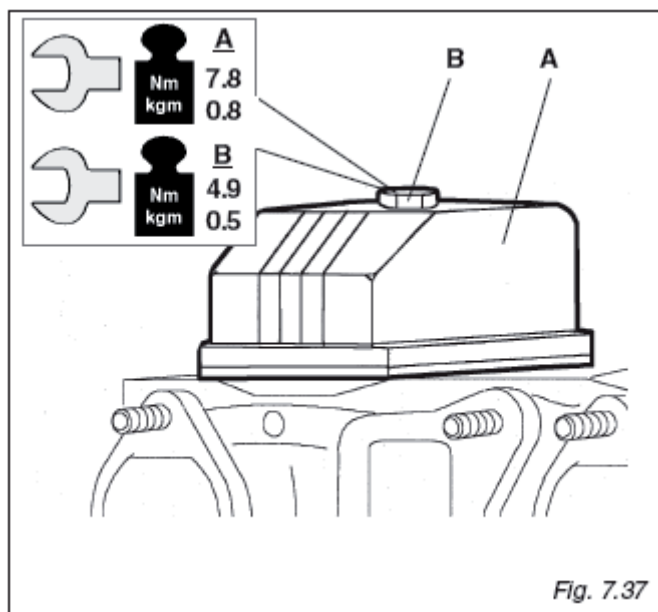


Fig. 7.37

7.35 INJECTORS (FIG. 7.38)



**BEFORE FITTING INJECTORS "C"
REMEMBER TO INSERT INTERNAL
SEAL "D" .**

Fit clamp **A** to injector **B**.

Torque nut **C** to the value shown.

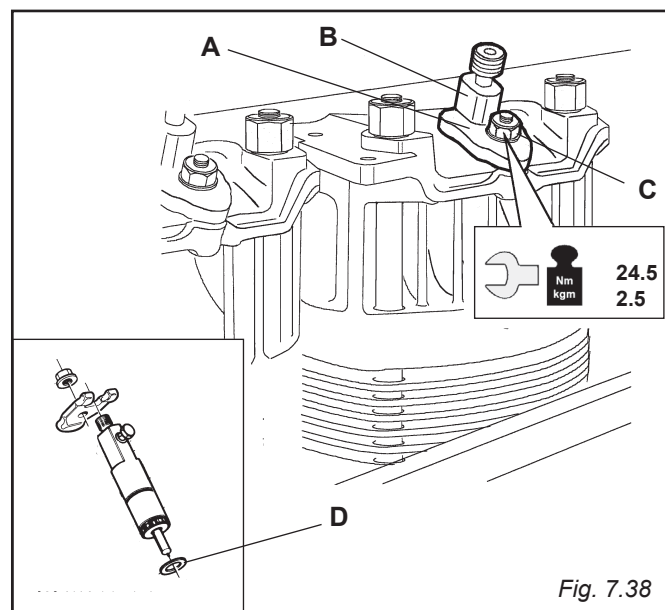


Fig. 7.38

7.36 FUEL RETURN AND DELIVERY PIPES (INJECTORS) (FIG. 7.39 - 7.40)

Fit screws **A** on connectors **B** of pipe **C**.

Fit the two washers and insert the pipe at the rear of the injector; tighten using a commercial wrench.

To fix fuel return pipe **C** to the injection pump fit union **D** to the injection pump placing a washer between the two; torque screw **E** to the value specified.

Connect pipe **C** to union **D** on the pump.

Assemble the fuel feed pipes from the pump to the injectors inserting nuts **F** (Fig. 7.40) located at the end of pipes **G** and tightening them onto injectors **H**.

Repeat the same procedure also for nuts **I** located in the area of the injection pump.

Use a commercial wrench to torque nuts **F** and **I** to the value specified.

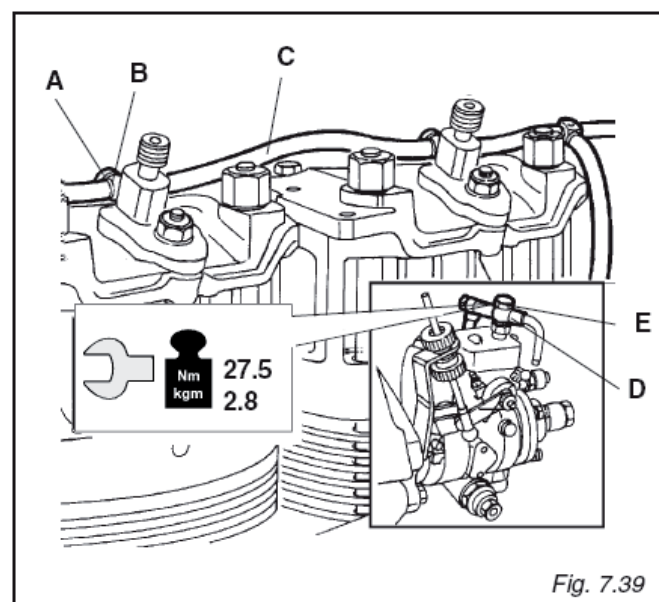


Fig. 7.39

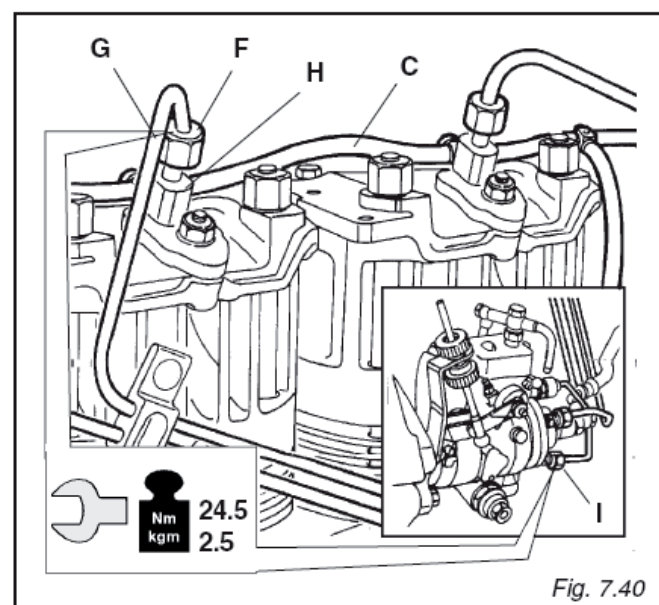


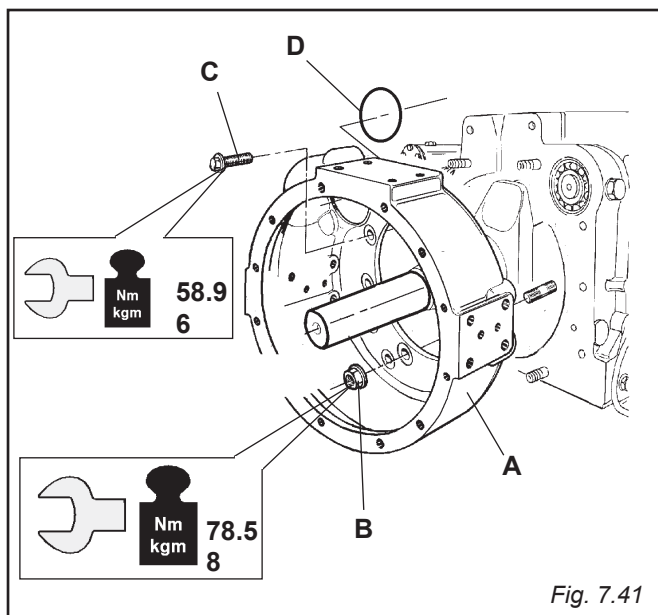
Fig. 7.40

7.37 FLYWHEEL HOUSING (FIG. 7.41)

Fit flywheel **A** on the tie rods in the crankcase, fit the nuts with washers **B** and finger-tighten.

Fit flywheel housing screws **C** and **B** torque to the value specified.

Take care not to damage seal **D**.



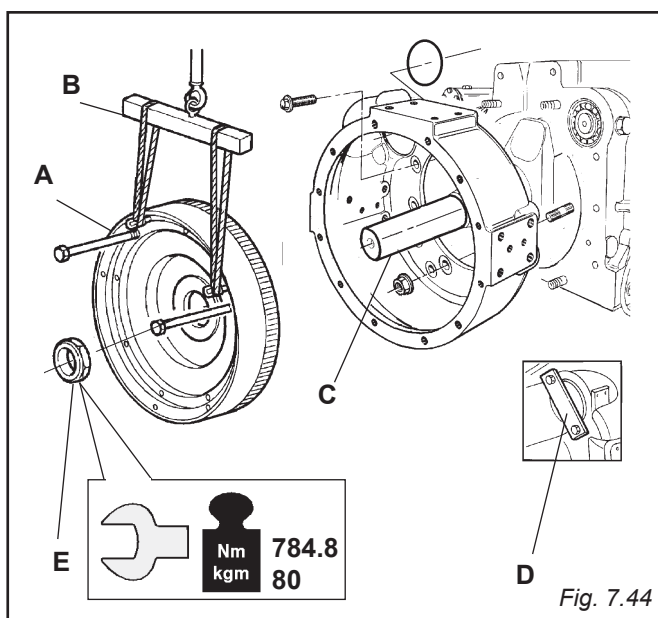
7.38 FLYWHEEL (FIG. 7.44)

Lift flywheel **A** by means of a gantry hoist **B** (commercial tool) and fit it over the crankshaft.

This can be done with the use of a commercial sleeve **C**.

Disassemble the hoist **B**. Secure tool **D** (TABLE 11.1 Ref. L) to fasten the flywheel by means of the nuts located at 120° intervals.

Tighten central nut **E** to secure the flywheel and torque to the value specified.



7.39 FRONT COVER (FIG. 7.47)

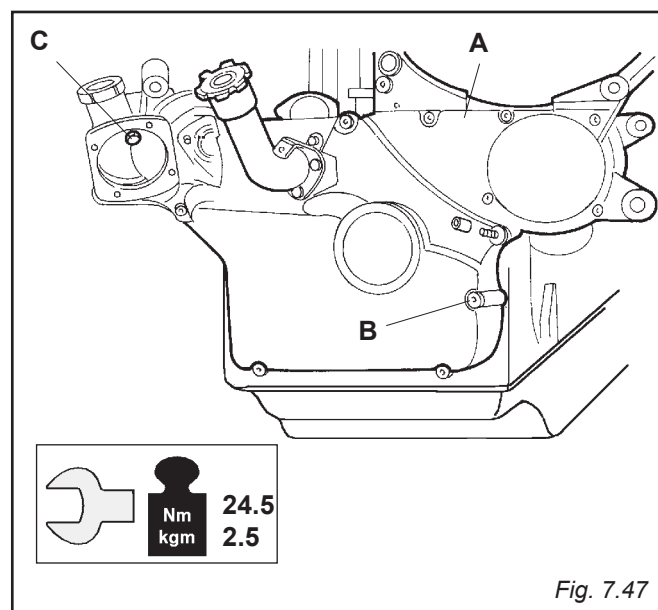
Fit the **O-ring** on the crankshaft.

Position the key in the keyway on the crankshaft, tapping lightly with a mallet until it is pushed fully home in its location.

Fit the gasket between the cover and crankcase ensuring it is positioned correctly.

Replace cover **A** on the crankcase referring to the locating pins previously installed.

Insert all the fixing screws **B** and **C** using the long screws at the bottom and the short screws at the top. Torque the screws to the value specified.



7.40 COVERS ON THE TIMING COVER (FIG. 7.47a)

Fit injection pump cover **A**, identifiable by means of a sticker affixed to the front and torque screws **B**.
Install the relevant gasket and then torque screws **B**.

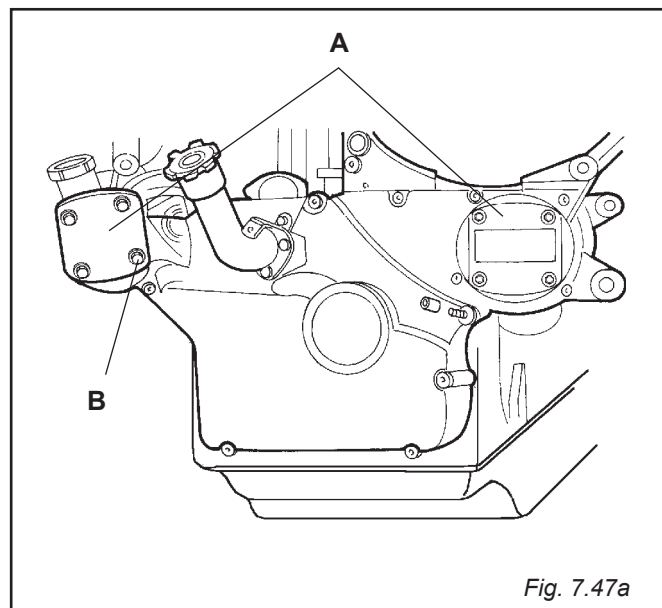


Fig. 7.47a

7.41 FRONT PULLEY HUB 4 AND 6 CYLINDERS (FIG. 7.48)

Make sure that in the working zone **C** of the seal ring there are no steps due to wear, and then fit hub **A** onto the crankshaft.

Fit nut **B** in the central area and torque to the value specified.

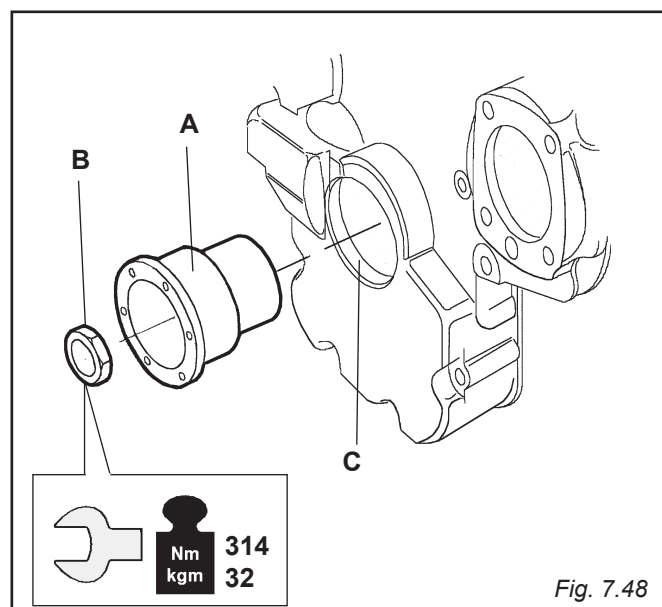


Fig. 7.48

7.42 OIL FILLER PIPE (FIG. 7.49)

Fit the **O-ring** in its seat.

Fit pipe **A** fit washers and nuts **B** and torque them.

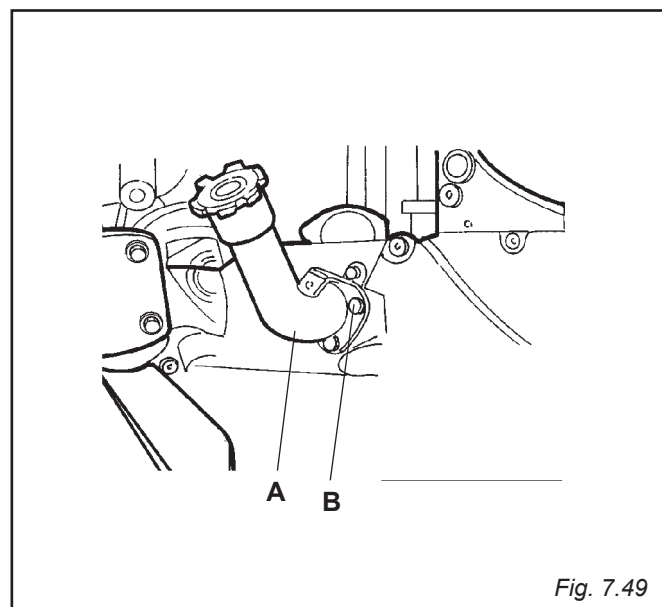


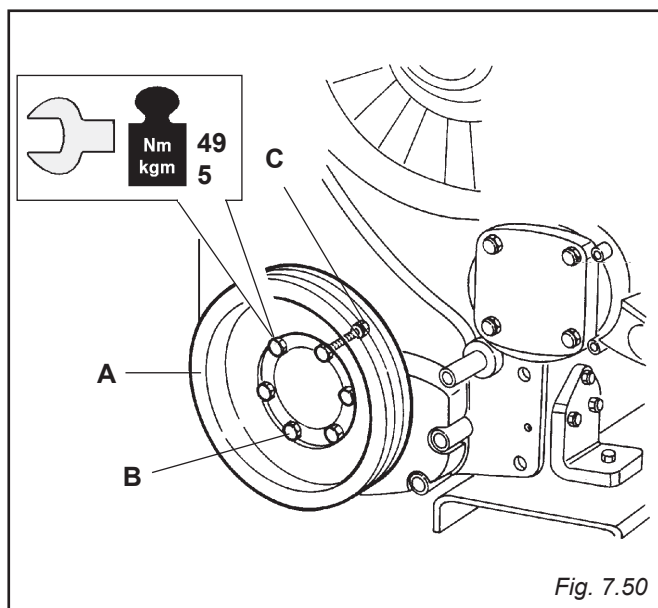
Fig. 7.49

7.43 FRONT PULLEY 4 AND 6 CYLINDERS (FIG. 7.50)

Fit pulley **A** ensuring that the marking on the pulley is vertically aligned with the engine axis on the top.

Fit screws **B** and, at the rear of the pulley, nuts **C**.

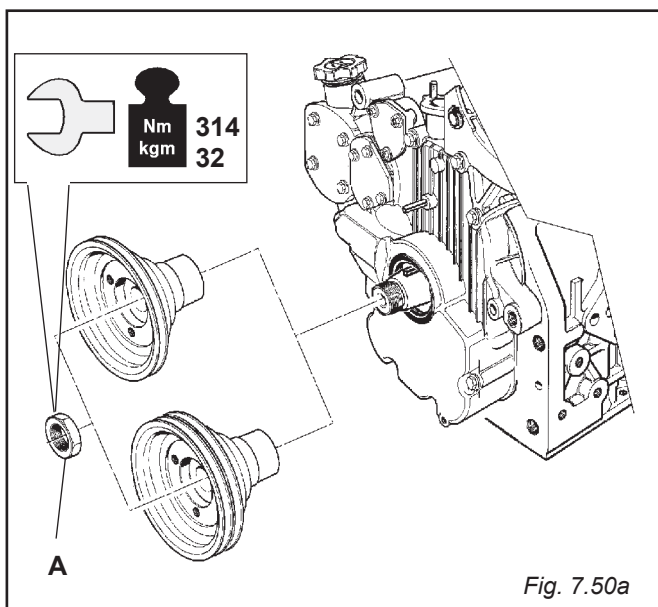
Torque the front screws to the value specified, holding the rear screws **C** by means of a commercial wrench.



7.44 FRONT PULLEY 2 AND 3 CYLINDERS (FIG. 7.50a)

Fit pulley ensuring that the marking on the pulley is vertically aligned with the engine axis on the top.

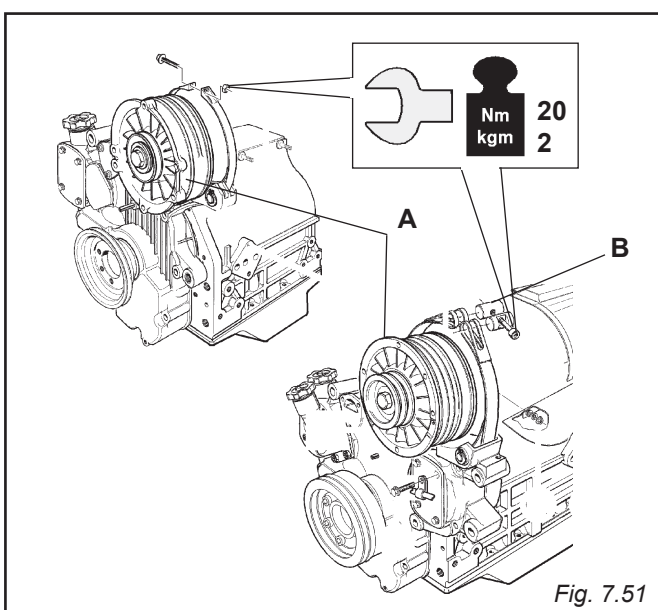
Fit screws **A** and torque it to the value specified.



7.45 COOLING JACKET FAN (FIG. 7.51)

Fit fan **A** paying attention to the two tabs located at the bottom that serve to block radial movement of the fan.

Insert locking pins **B** of the clamps, fit the screw and tighten it to the value specified.



7.46 AIR COOLING JACKET (FIG. 7.51)

Fit the front oil cooler support air cooling jacket:
Fit the slots of jacket **A** and relative washers over the threaded studs.
Fit nuts **B** and the screw **C** and torque it.
ONLY for 4 and 6 cylinders - insert clip **G** in the fan rear area, as well as nut **H** and screw **I** and tighten them.

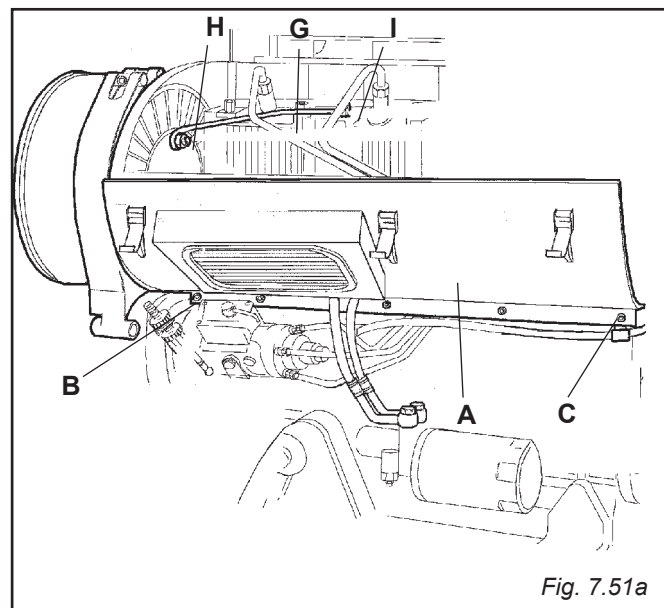


Fig. 7.51a

7.47 OIL COOLER (FIG. 7.52)

Insert pipes **A** routing them through the bottom of the front cooling jacket **B**.
Fit oil cooler **C**.
Fit the union inside the banjo unions of the oil inlet and outlet pipes and tighten them to the base of the oil cooler.



USE A COMMERCIAL WRENCH TO HOLD THE UNION ON THE OIL COOLER DURING THIS OPERATION TO PREVENT DAMAGE.

Fit the anti-vibration mount on the oil cooler support and deflector **F** that forces air over the oil cooler; use screws **D** to fasten the oil cooler to the supports on the rear of the cooling jacket.



FIT THE TWO RUBBER GROMMETS "E" IN THE COOLING JACKET TO PROTECT THE OIL PIPES.

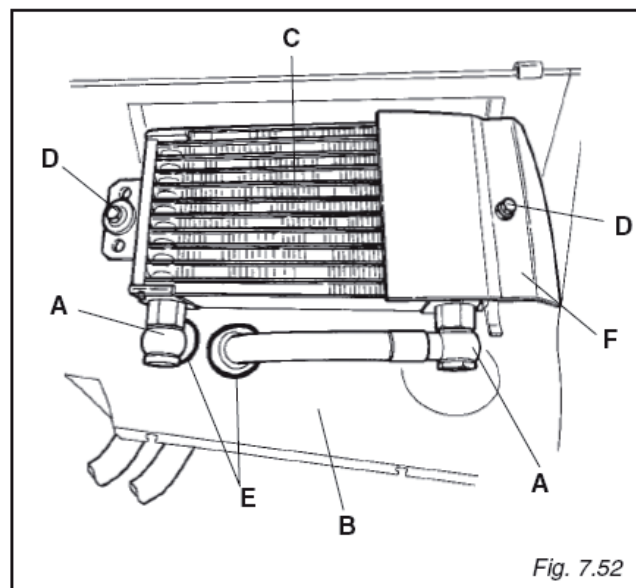


Fig. 7.52

7.48 OIL FILTER AND THERMOSTATIC VALVE (FIG. 7.53)

Turbocharged version.

Assemble spacer **A** with gaskets **B**.
Insert fixing screws **C** and torque to the value specified.
Insert oil pressure valve **F** into its location without forcing it.
Insert thermostatic valve **G** and torque to the value specified.

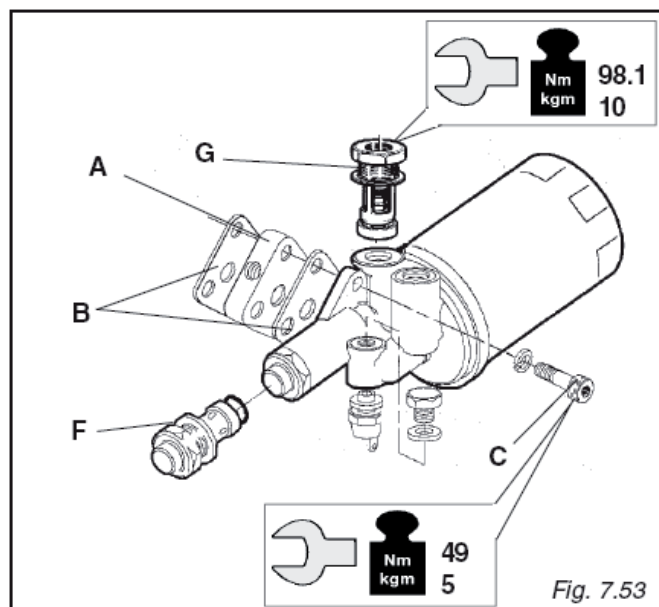
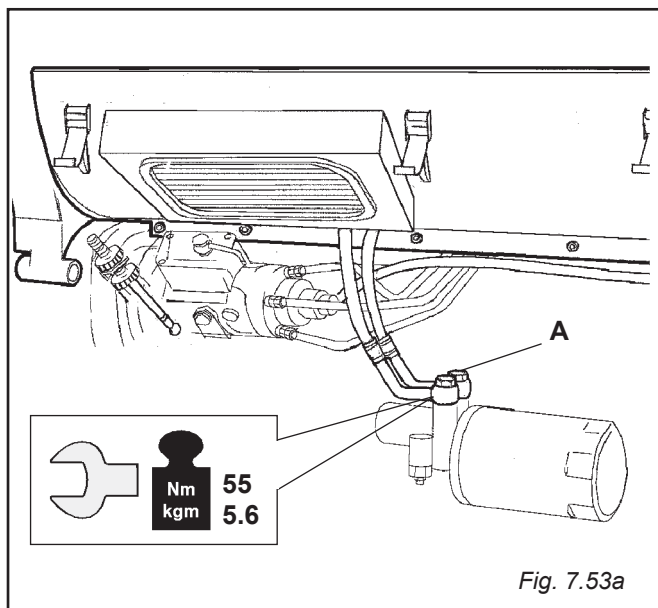


Fig. 7.53

7.49 OIL PIPE (FIG. 7.53a)

Fit connectors located at the top of the filter and torque screws **A** to the value specified.

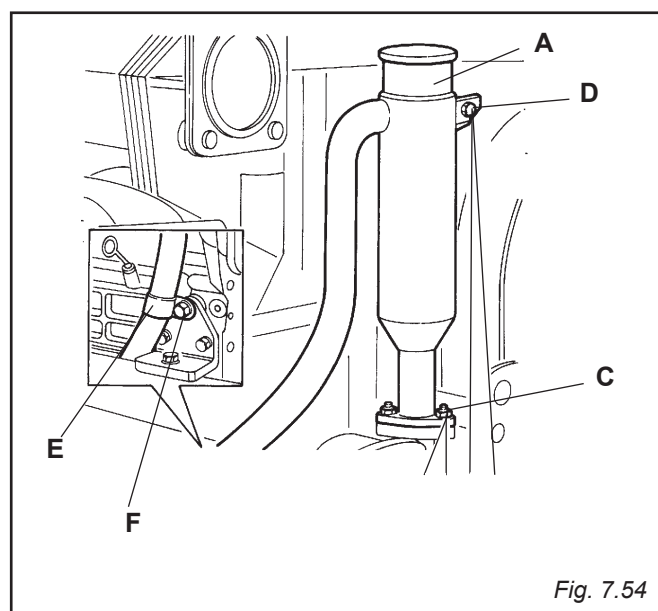


7.50 OIL BREATHER PIPE (FIG. 7.54)

Fit the **O-RING** on the flange of pipe **A**.
 Insert the pipe into the flange on the front cover and fasten it with nuts **C** and screw **D**.
 Fasten with clamp **E** and screw **F**.



IT IS GOOD PRACTICE TO TIGHTEN FIRST NUTS "C" AND THEN SCREW "D". ALSO, ENSURE THAT THE BREATHER PIPE IS UNOBSTRUCTED.

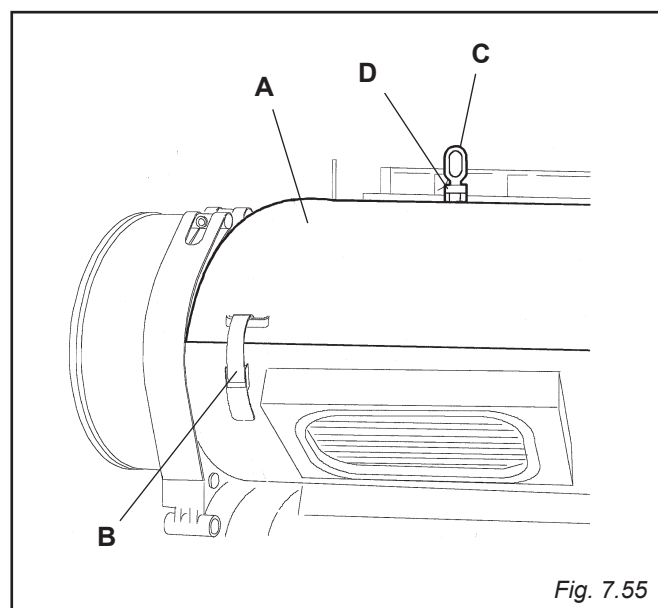


7.51 AIR JACKET COVER (FIG. 7.55)

Fit cover **A** and fasten by means of clips **B**.

7.52 EYEBOLT (FIG. 7.55)

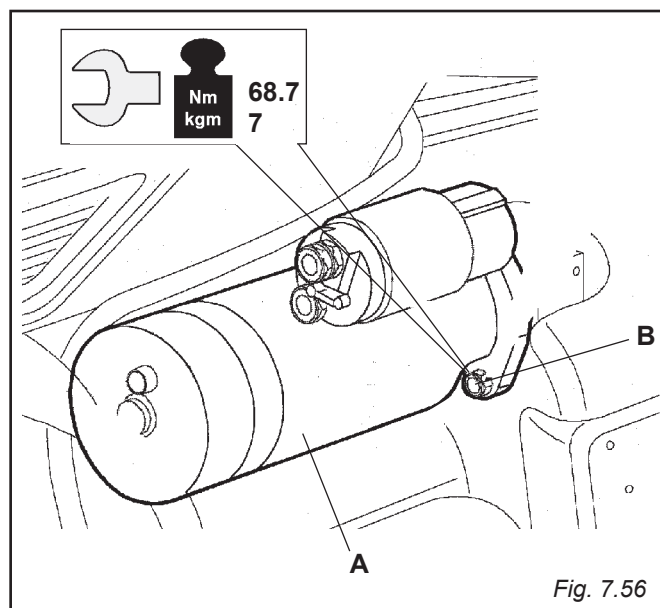
Fit eyebolts **C** mounted to stud screws **D** and tighten.



7.53 STARTER MOTOR (FIG. 7.56)

N.B.: Disassemble flywheel holder tool **C** (TABLE 11.1 Ref. L).

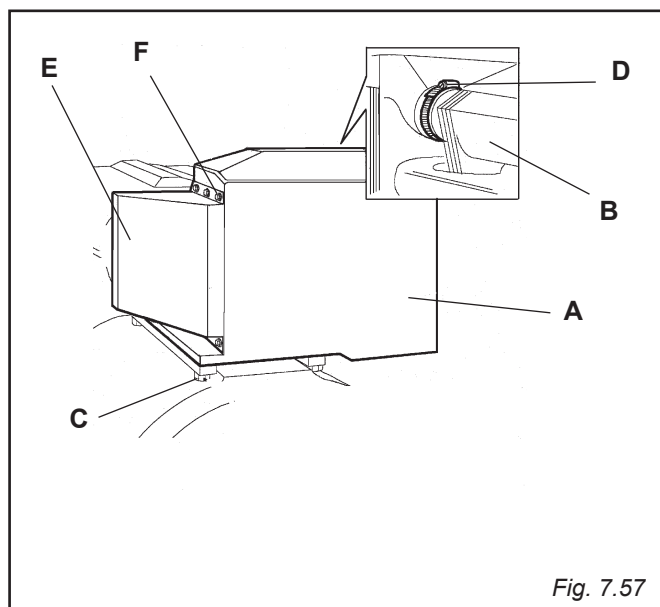
Fit starter motor **A** to the stud screws in the crankcase; fit nuts **B** and torque to the value specified.



7.54 INTERCOOLER (FIG. 7.57)

Fit intercooler **A** paying attention to the connection with the intake manifold **B**, and secure to the support base, torquing nuts **C**.

Now fix clamp **D** connecting to manifold **B**.



7.55 INTERCOOLER SHROUD (FIG. 7.57)

Fit the gaskets to shroud **E**. Now mount the shroud and secure it with screws **F**, pressing towards the shroud so that the gaskets seal correctly.

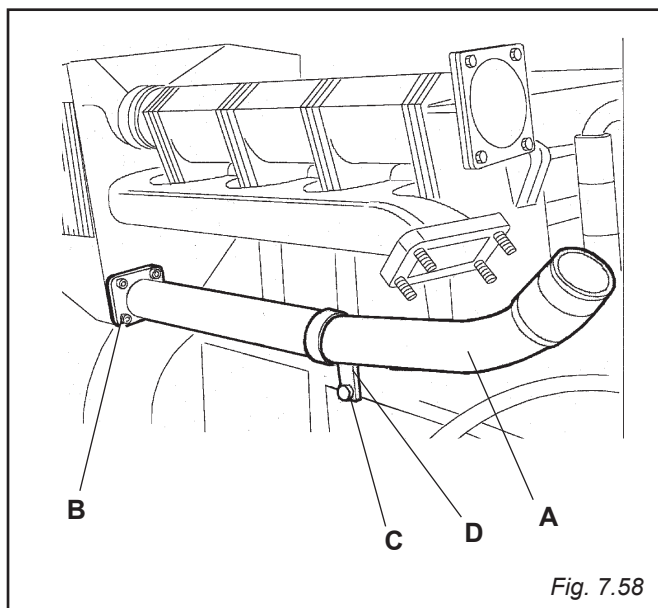
7.56 TURBOCHARGER (FIG. 7.58 - 7.59)

Fit pipe **A** and secure by means of nuts **B**; torque screw **C**, responsible for fixing clamp **D**.

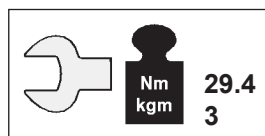
Arrange clamps **E** (Fig. 7.59) on the hose and gasket **F** on exhaust manifold **G**.

Fit turbocharger **H** on manifold **G** and torque nuts **I** to the value specified.

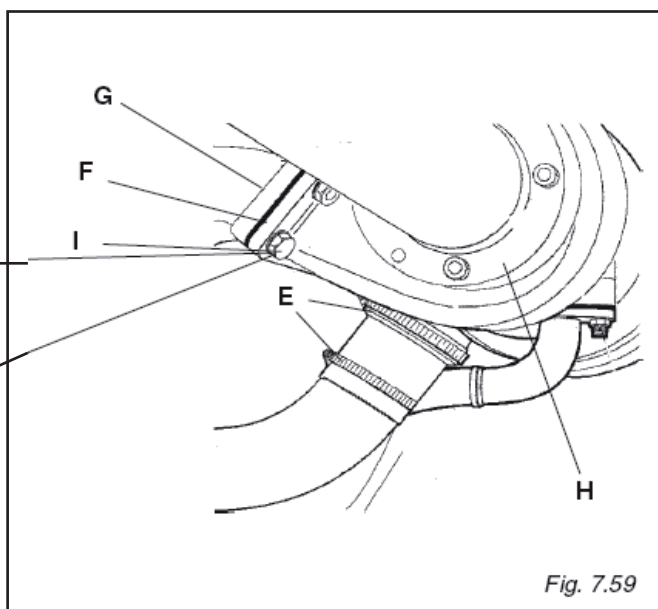
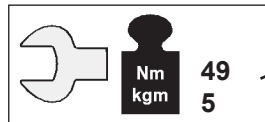
Position clamps **E** and torque them.



4 cilindri
4 cylinders



6 cilindri
6 cylinders



7.57 TURBOCHARGER OIL INLET AND OUTLET PIPES (FIG. 7.60 - 7.61 - 7.62)

Interpose the gasket between flange **A** and oil outlet pipe **B** in the seat on the turbocharger.

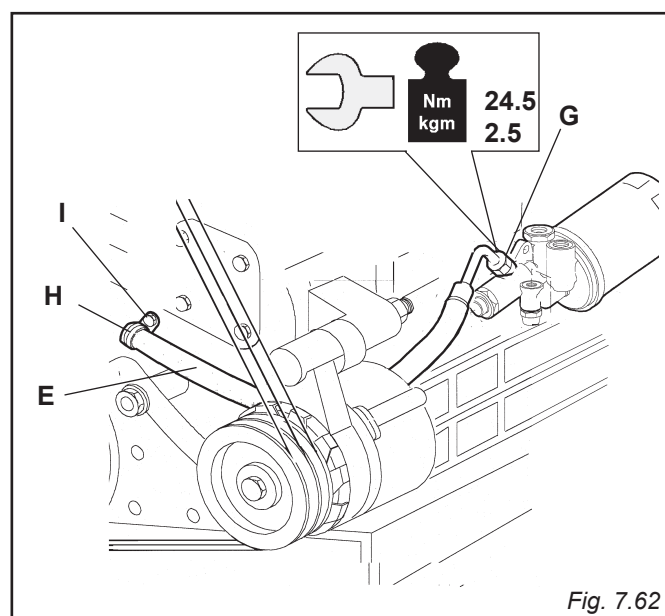
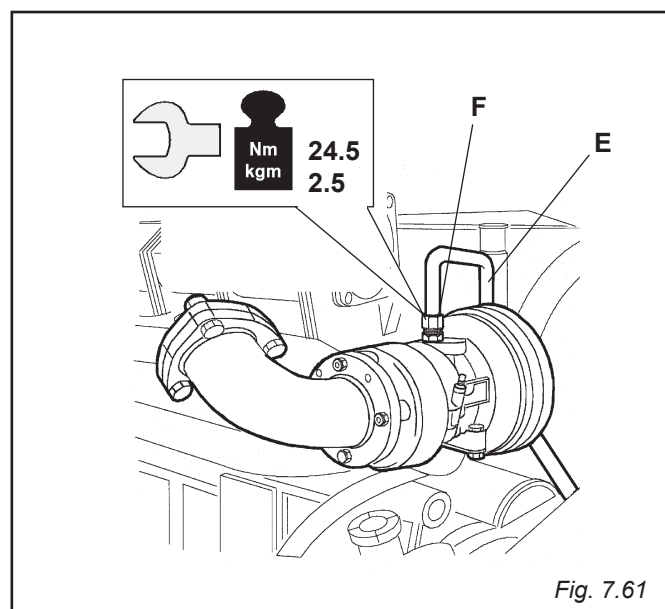
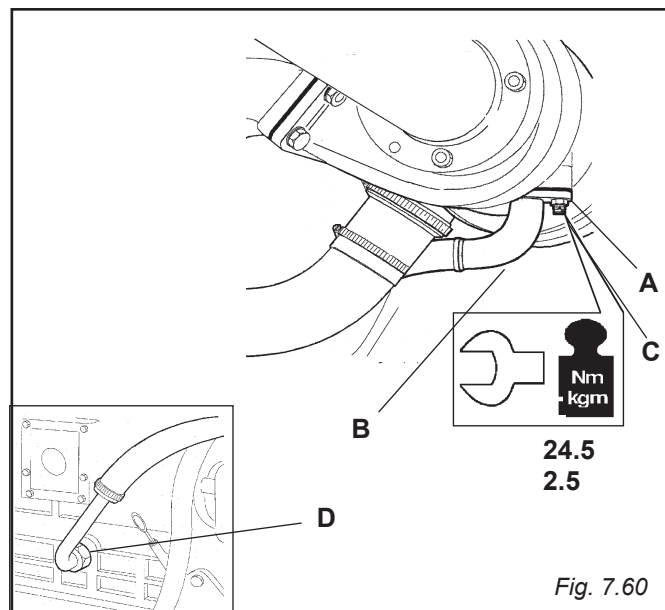
Torque nuts **C** to the value specified.

There is a threaded union at the bottom of the turbocharger; fasten with nut **D** located at the end of the outlet pipe.

Torque oil outlet pipe **E** to union **F** (Fig. 7.61) to the value specified, located at the top of the turbocharger.

Fix the other end of the oil outlet pipe to the oil filter support by means of union **G** (Fig. 7.62) and torque to the value specified.

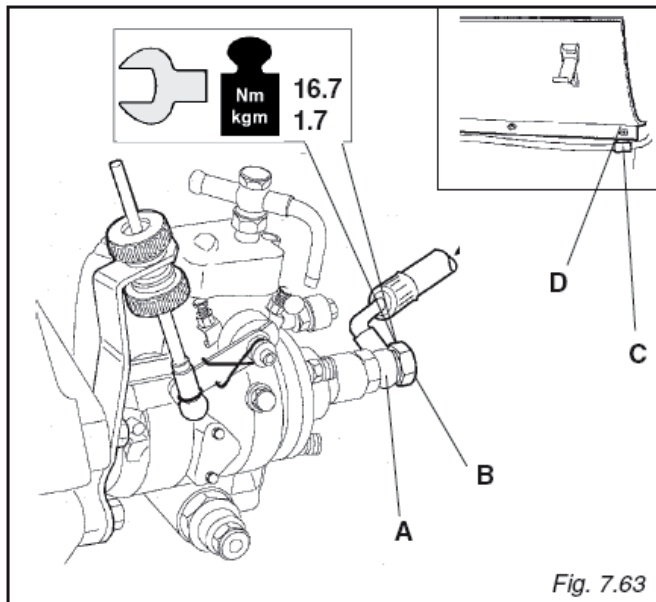
Fix the pipe on the timing side by means of clamp **H** and torque nut **I**.



7.58 INJECTION PUMP FILTER PIPE (FIG. 7.63)

Fit union **A** of the fuel filter pipe at the rear of the pump and tighten screw **B**.

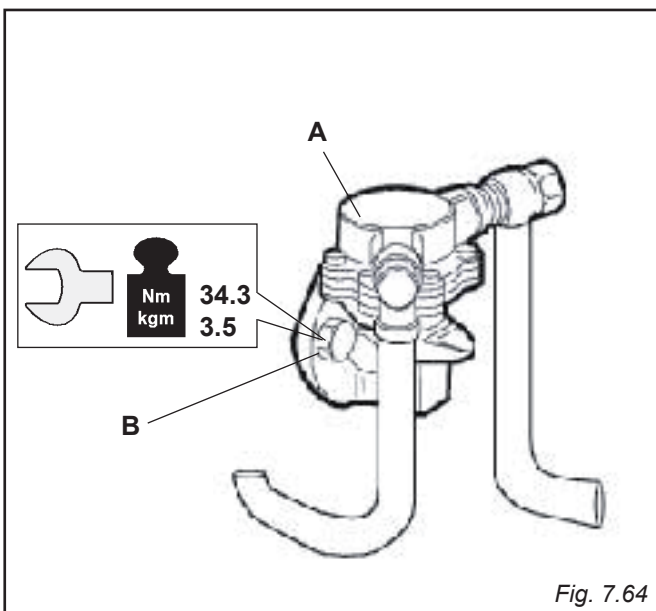
Secure clamp **C** located next to the shroud by torquing screw **D**.



7.59 FUEL PUMP (FIG. 7.64)

Fit the **O-ring** in its seat and fit pump **A** over the relative stud bolts.

Secure the pump by torquing nuts **B** to the value specified.



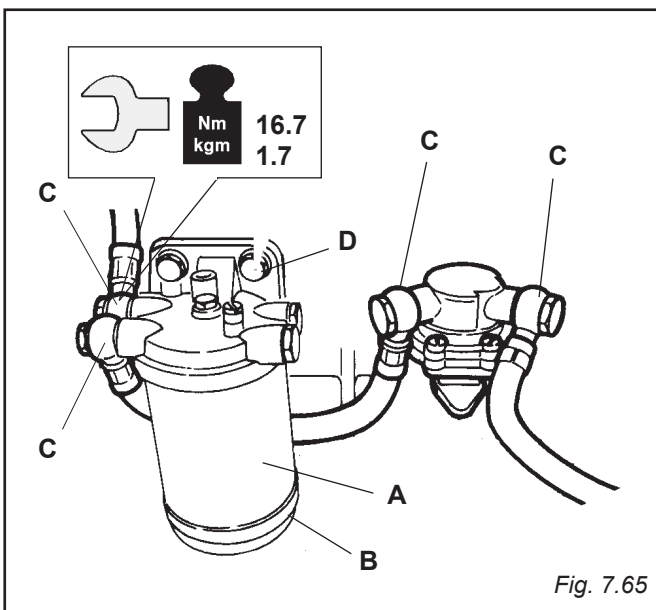
7.60 FUEL FILTER (Fig. 7.65)

Fit the two gaskets in the filter support: one in the internal collar and one in the external perimeter area.

Insert filter cartridge **A** and then fit the gasket on the fuel filter base **B** and insert it into the cartridge.

Insert screw **C** with relative seal on the filter support and torque to the value specified, until filter and support are correctly assembled.

Fit the filter in its location by means of screws **D**, which must be torqued.



7.61 ALTERNATOR (FIG. 7.66)

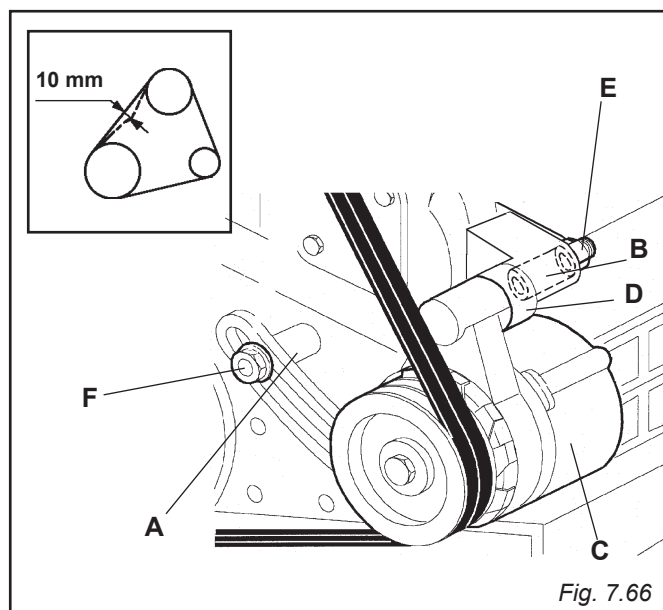
Fit the spacers **A** on the tie rods in the crankcase and fit bushings **B**.

Fit pivot assembly **D** to alternator **C** and mount it in its seat, fastening it with nut **E**.

Insert the belts in their seats and lever the alternator using a screwdriver to tension the belts correctly; now tighten nuts **F** and **E**.

Apply a load of $7.0 \div 8.0$ kg and check that belt deflection is **10 mm**.

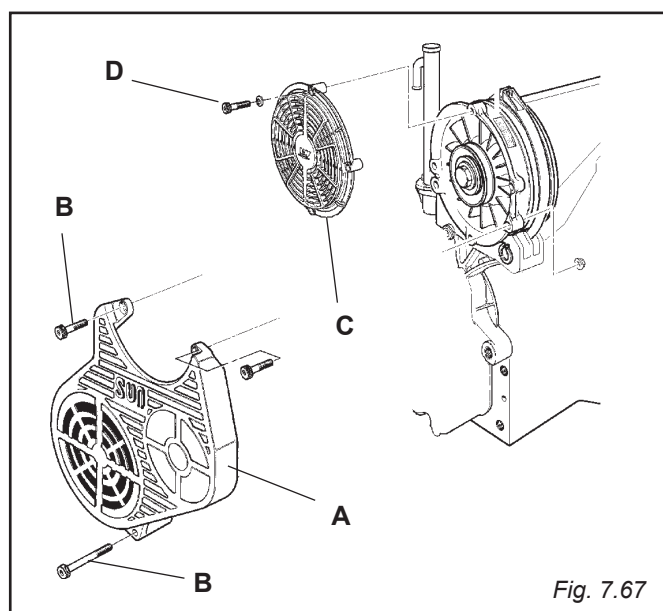
Now tighten screw **F** that secures the slide to the alternator and torque nut **E**.



7.62 BELT GUARD AND FAN GUARD (FIG. 7.67)

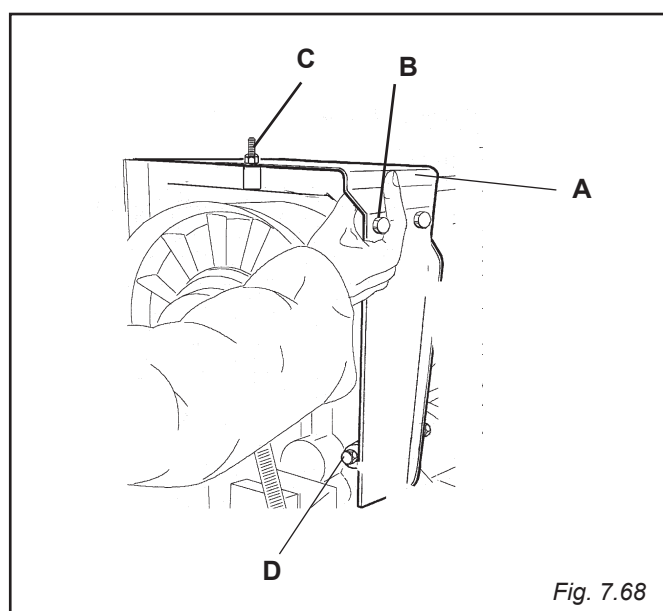
Fit belt guard **A** and torque screws **B**.

Fit fan guard **C** and torque screws **D**.



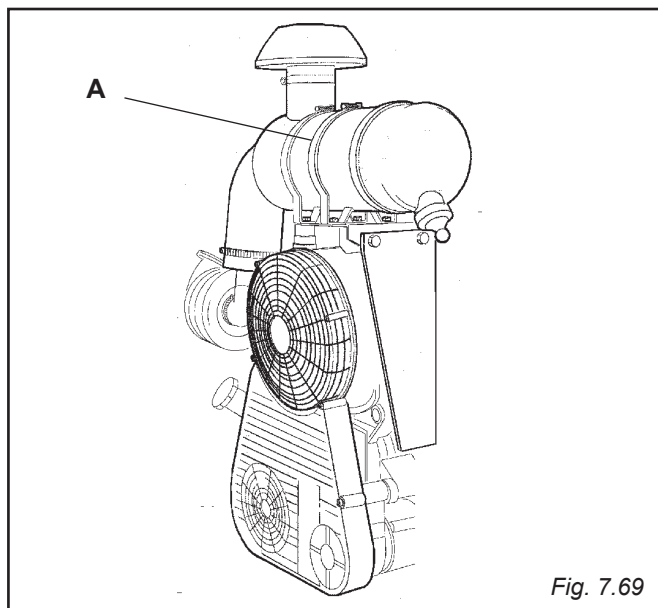
7.63 FILTER SUPPORT (FIG. 7.68)

Fit support **A** and torque the screws **B-C-D**.



7.64 AIR FILTER (FIG. 7.69)

Assemble filter with the support clamps **A**.
Arrange the filter in its correct position and fix the screws.

*Fig. 7.69*

8.1 TIGHTENING TORQUES

REF.	DESIGNATION	THREAD	TIGHTENING TORQUE		LUBRIFICATION
			Nm	kgm	
01	Banjo	M6x1	7.8	0.8	NO
02	"	M8x1	14.7	1.5	NO
03	"	M10x1	25,5	2.6	NO
04	"	M12x1.5	27.5	2.8	NO
05	"	M14x1.5	39.2	4	NO
06	Nut	M6x1	10.8	1.1	NO
07	"	M8x1.25	24.5	2.5	NO
08	"	M10x1.5	47.1	4.8	NO
09	"	M12x1.75	83.4	8.5	NO
10	"	M16x1.5	53.9	5.5	NO
11	Pressure sensor	M10x1 Con.	17.7	1.8	NO
12	Connection	M14x1.5	39.2	4	NO
13	"	M16x1.5	58.8	6	NO
14	"	M18x1.5	63.7	6,5	NO
15	"	M22x1.5	68.6	7	NO
16	Plug	M14x1.5	37.3	3.8	NO
17	"	M20x1.5	68.6	7	NO
18	"	M22x1.5	78.5	8	NO
19	Screw	M6x1	10.8	1.1	NO
20	"	M8x1.25	24.5	2.5	NO
21	"	M10x1.25	47.1	4.8	NO
22	"	M12x1.75	83.4	8.5	NO

8.2 REFERENCE DIMENSIONS

8.2.1 Crankshaft

REF.	DESIGNATION	DIMENSIONS
A	Front main journal diameter	68.160 ÷ 68.180 mm
B	Central journal diameter	68.160 ÷ 68.180 mm
C	Rear journal diameter	68.160 ÷ 68.180 mm
D	Crank journal diameter	57.060 ÷ 57.079 mm
	1 st Oversize for A-B-C-D	0.250 mm
	2nd Oversize for A-B-C-D	0.500 mm
	Roughness max	0.3 µm

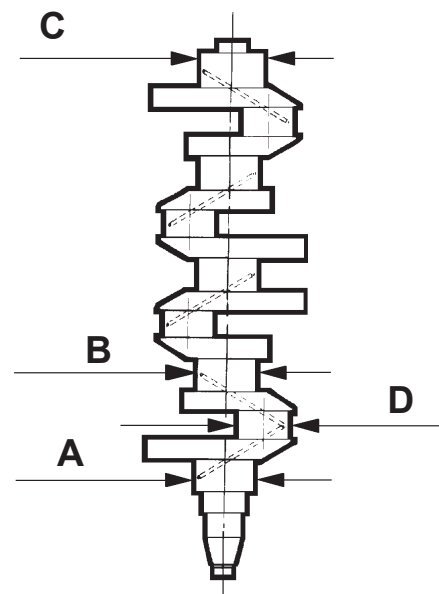


Fig. 8.2.1a

REF.	DESIGNATION	DIMENSIONS
A	Radius	R=2.5 0/+ 0.3 mm

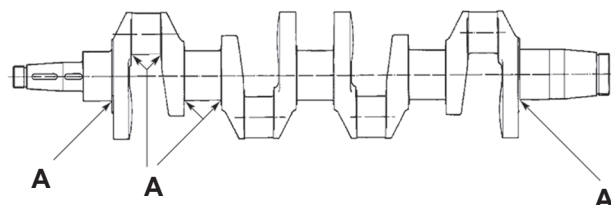


Fig. 8.2.1b

8.2.2 Camshaft

REF.	DESCRIPTION	DIMENSIONS
A	Cam dimensions Intake	33.900 - 34.100 mm
A1	Cam dimensions Exhaust	33.900 - 34.100 mm
A2	Cam dimensions Injection	31.970 - 32.000 mm
B	Stroke cam Intake	7.5 mm
B1	Stroke cam Exhaust	8.0 mm
B2	Stroke cam Injection	7.96 - 7.98 mm
C	Front-rear bearing journal diameter	25.000 - 25.013 mm
D	Seat inside diameter (crankcase)	51.920 ÷ 51.940 mm
C-D-C	Roughness max	0.8 µm

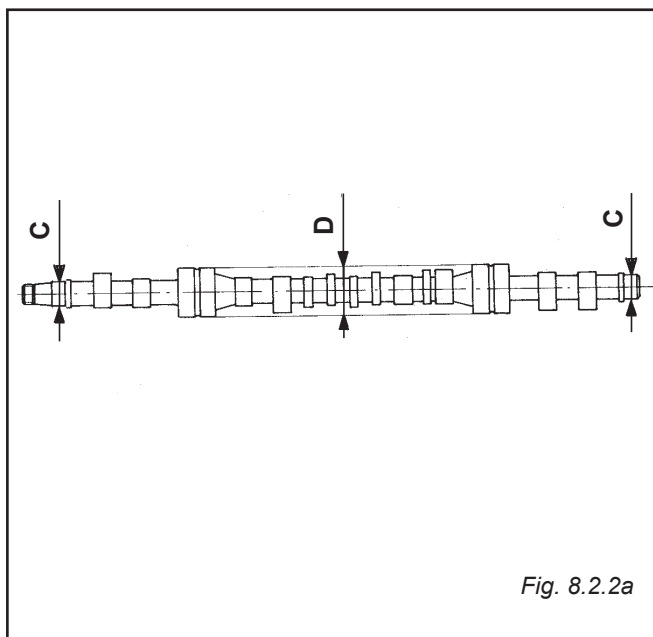


Fig. 8.2.2a

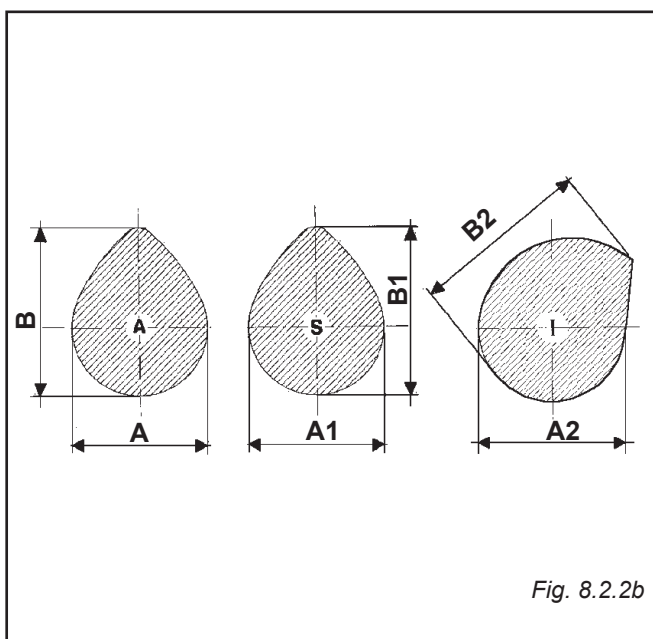


Fig. 8.2.2b

8.2.3 Clearance rings

REF.	DESCRIPTION	DIMENSIONS
	Thickness std.	0.00 mm
	Thickness 1st oversize	0.10 mm
	Thickness 2nd oversize	0.20 mm

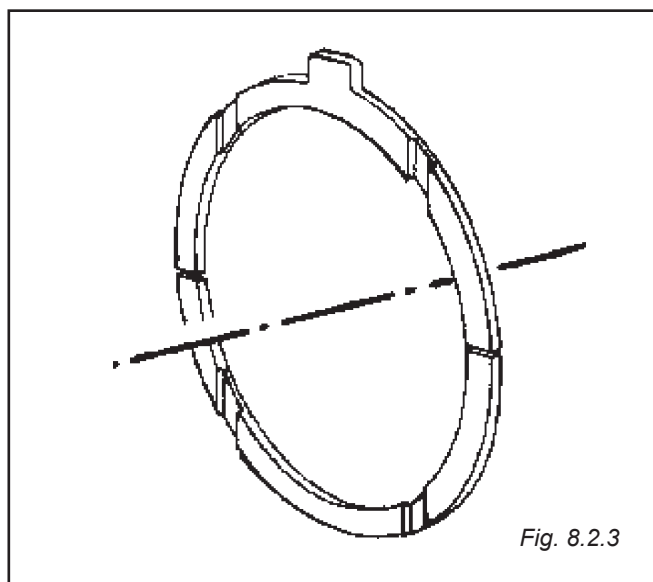


Fig. 8.2.3

8.2.4 Cylinder

REF.	DESCRIPTION	DIMENSIONS
Inside diameter (mm):		
A	Class A Nominal	105.000 ÷ 105.015
	Class A Oversized	105.600 ÷ 105.615
B	Class B Nominal	105.016 ÷ 105.030
	Class B Oversized	105.616 ÷ 105.630

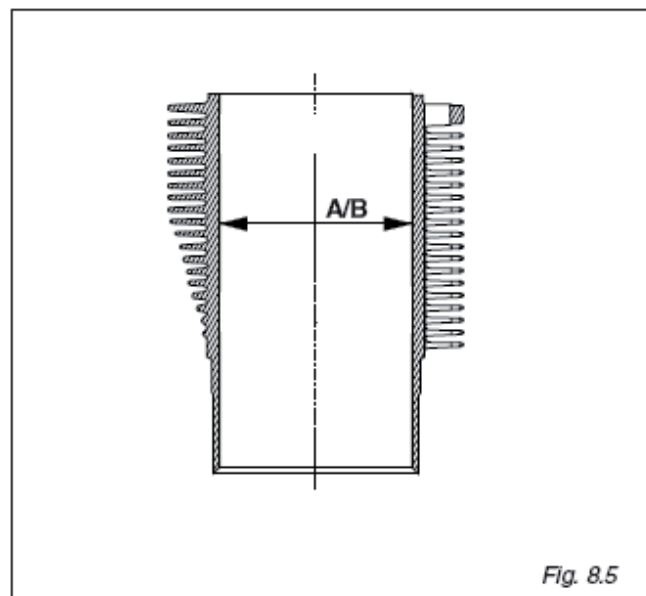


Fig. 8.5

8.2.5 Cylinder head gaskets

REF.	DIMENSIONS
Thickness	
A	0.100 ± 0.015 mm
B	0.200 ± 0.015 mm
C	0.300 ± 0.015 mm

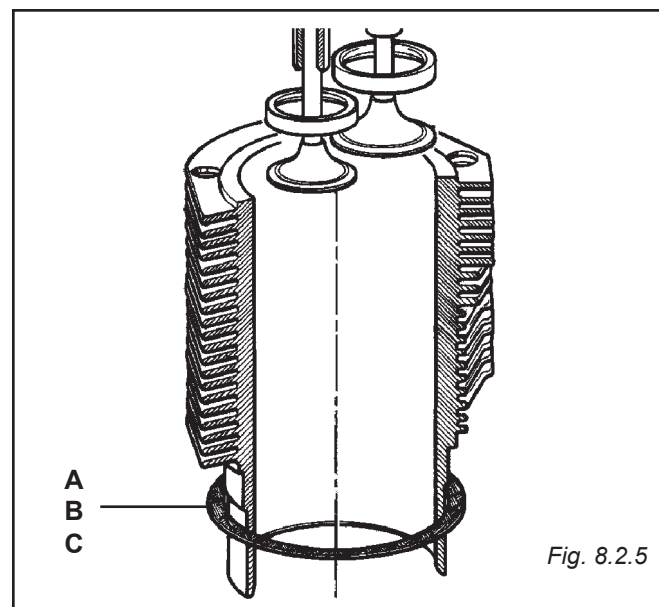


Fig. 8.2.5

8.2.6 Piston clearance

REF.	1 mm cylinder head gasket
	0.950 - 1.050 mm

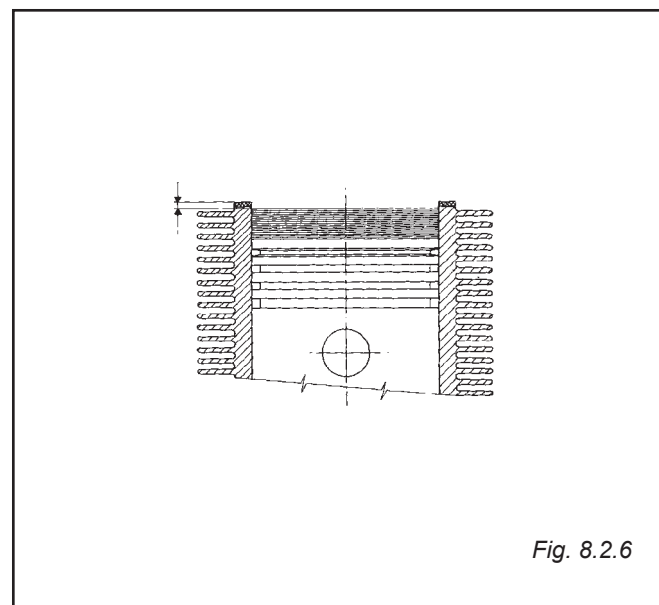
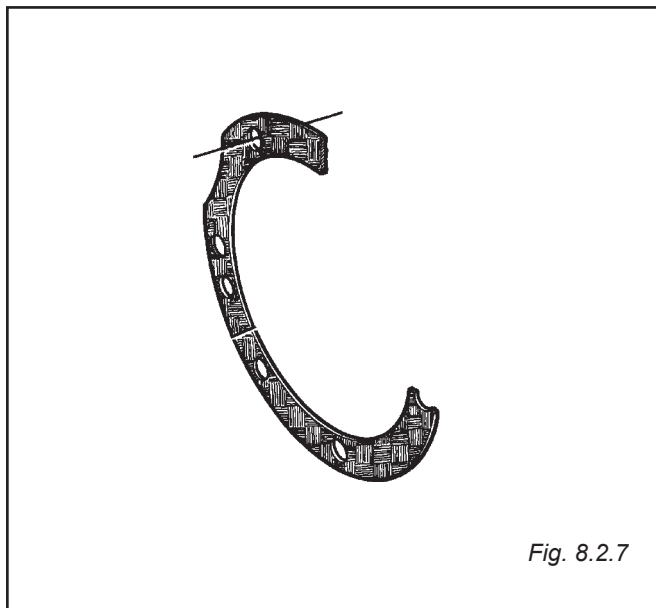


Fig. 8.2.6

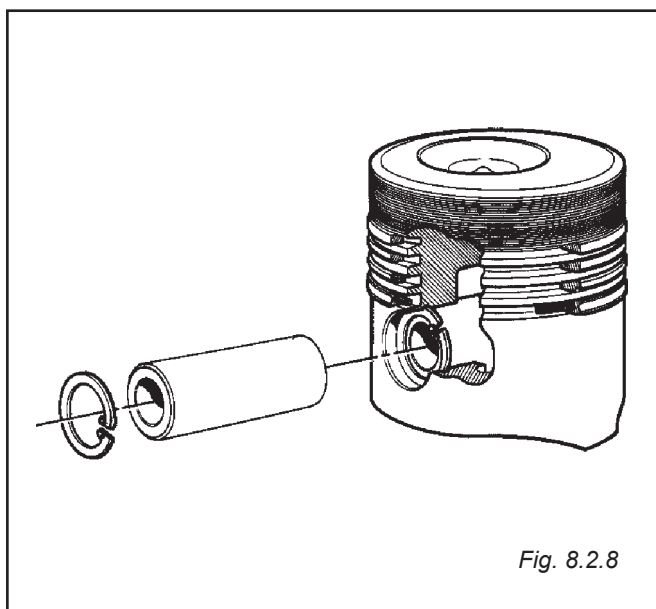
8.2.7 Rear bearing gaskets

REF.	DESCRIPTION	DIMENSIONS
1st thickness		0.20 mm
2nd thickness		0.30 mm
3rd thickness		0.40 mm



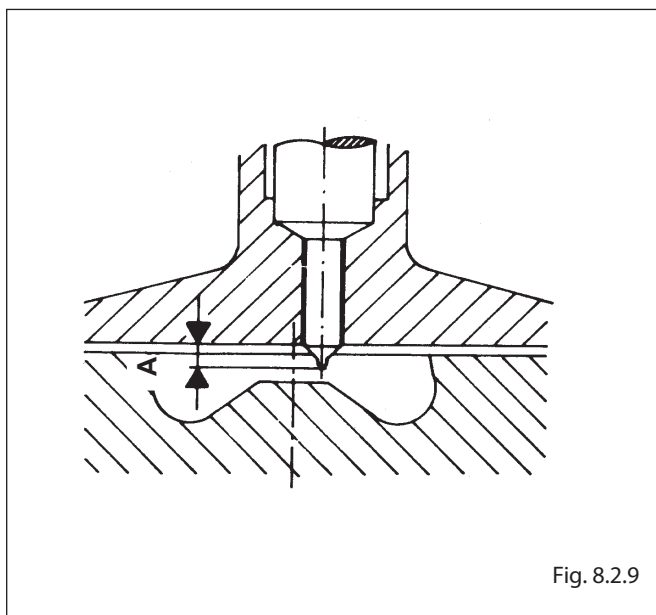
8.2.8 Gudgeon pin

REF.	DESCRIPTION	DIMENSIONS
Type	FREE	
A	Gudgeon pin diameter	1) 35.005 ÷ 35.0075 mm 2) 35.0075 ÷ 35.010 mm
B	Bore diameter	1) 35.020 ÷ 35.035 mm
C	Bushing play	min. 0.010 mm max. 0.025 mm



8.2.9 Injectors

REF.	DESCRIPTION	DIMENSIONS
A	injector protrusion	4.3 - 4.5 mm



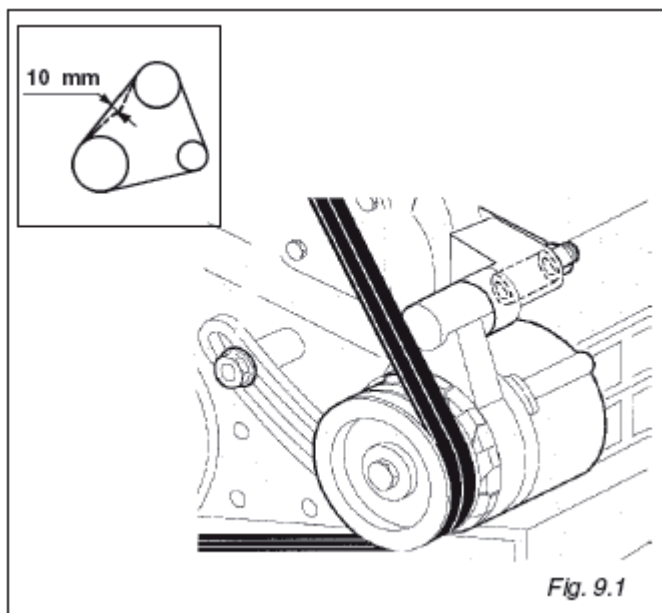
series **SUN-E-E1-E2****RUNNING TESTS AND ADJUSTMENTS****9****9.0 ADJUSTMENTS / engine running - testing**

The following chapter "Tests and adjustments with engine running" is identical for all **SUN-SUNE-E1** series engines.

9.1 TESTS BEFORE STARTING THE ENGINE*(fig. 9.1)*

After you have finished assembling the engine, proceed as follows:

- Secure the engine to a base; to the driven machine or to a dynamometer brake.
- Check the oil level in the sump.
- If the engine is equipped with an oil-bath air filter, check also the level of oil in the filter.
- Connect the starter motor and the injection pump solenoid valve (Bosch or Stanadyne pump) to the battery.
- Ensure that when a load of **7 ÷ 8 kg** is applied, alternator drive belt deflection is **10 mm**.

**Fig. 9.1**

9.2 BLEEDING THE FUEL CIRCUIT (FIG. 9.2 - 9.3)

Before bleeding the fuel circuit, make sure the fuel pump can supply the maximum flow rate of fuel by operating it by means of external lever **A**: the initial free movement will be followed by the effective working stroke of the lever.

If the working stroke is short, turn the crankshaft through about one half revolution to completely free the pump from the control lobe on the camshaft.

Bleed the fuel filter by operating lever **A** until you get a continuous flow of fuel from the previously loosened bleed screw **B**.

Tighten bleed screw **B** and continue to operate fuel pump lever **A** loosening screw **C** on the injection pump; keep pumping until all the air is expelled.

Retighten the screws.

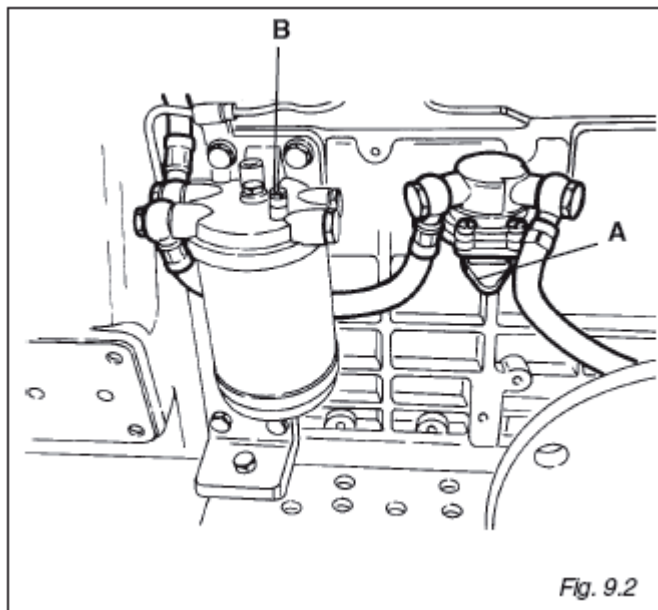


Fig. 9.2

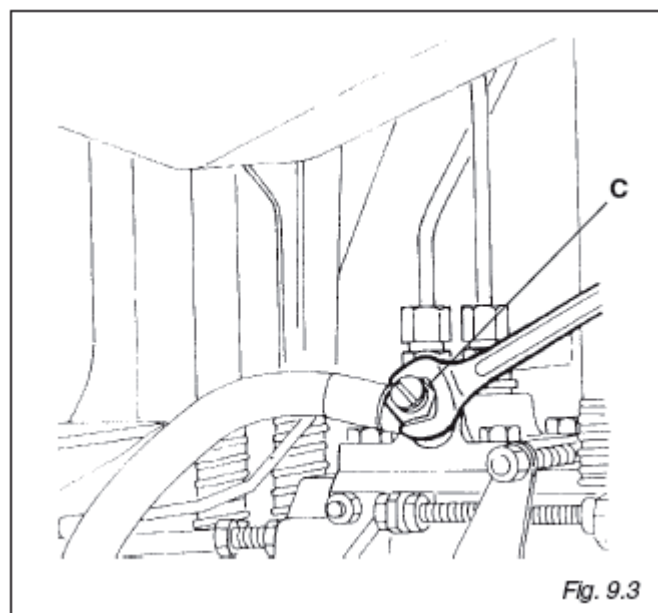


Fig. 9.3

9.3 STANADYNE CIRCUIT (ROTARY PUMP) (FIG. 9.4)

- Bleed the fuel filter by operating lever **A** until you get a continuous flow of fuel from the previously loosened bleed screw **B**. The injection pump is self-bleeding.
- Completely loosen the pipes leading to the injectors.
- Turn over the engine by means of the starter motor until fuel is emitted from the injector unions with no trace of residual air.
- Tighten the injector unions and start the engine.

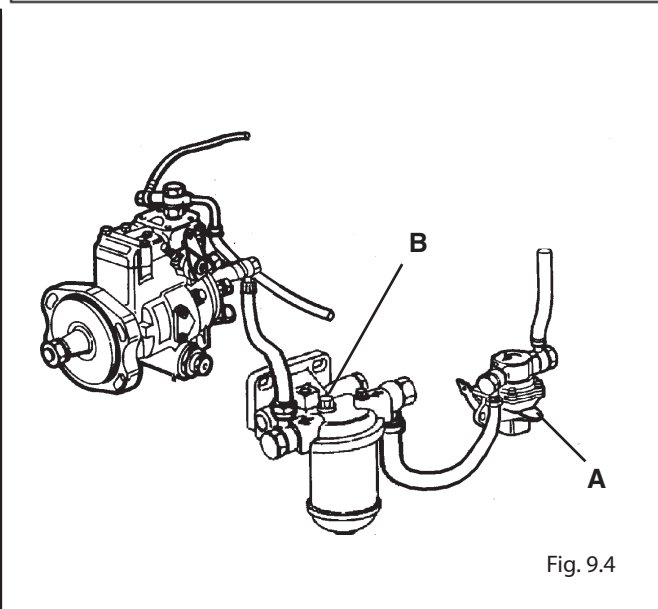


Fig. 9.4



PROTECTIVE EYEWEAR IS ESSENTIAL BECAUSE OF THE RISK OF EMISSION OF JETS OF FUEL AT HIGH PRESSURE.



WEAR PROTECTIVE GLOVES DIESEL FUEL CAN HARM THE SKIN.

9.4 NO-LOAD RUNNING TEST

All adjustments must be made with the engine hot and with the assistance of a tachometer.

- Connect a 10 kPa (0.1 bar) pressure gauge with a union to the oil filter support and check the oil pressure with the engine running.
- Run the engine at low speed for a few minutes to warm it up.
- Check for oil leaks, abnormal vibration and noise.
- Check the electrical system.

9.5 RUNNING IN

During the running in period (about 50 hours) do not run the engine at more than 70% full power.



THE LONGER THE INITIAL RUNNING IN PERIOD USING APPROPRIATE LOADS, THE LONGER VARIOUS PARTS OF THE ENGINE WILL LAST AND THE LOWER THE RELATIVE MAINTENANCE AND RUNNING COSTS.



NOTE: PROPER RUNNING IN IS NOT POSSIBLE IF THE ENGINE RUNS FOR PROLONGED PERIODS AT LOW LOADS (LESS THAN 50%) OR AT LOW SPEEDS.

In this case, improper bedding in of the piston rings can result in excess oil consumption or oil emission from the exhaust.

9.6 CHECKS AND ADJUSTMENTS

Check the vacuum of the air suction to the intake manifold : new filter **1.5 - 2 kPa (0.015 - 0.02 bar)**, dirty filter (max.) **5 kPa (0.05 bar)**.

9.7 EXHAUST GAS BACK-PRESSURE (fig. 9.5)

Apply a liquid column manometer to the exhaust pipe - downline of the turbocharger in turbocharged engines. The optimum compression value at max speed is:

naturally aspirated engines **8 - 9 kPa (0.08 - 0.09 bar)**

turbocharged engines **7 - 8 kPa (0.07 - 0.08 bar)**

For values greater than **10 kPa (0.1 bar)** check the exhaust pipe or silencer.

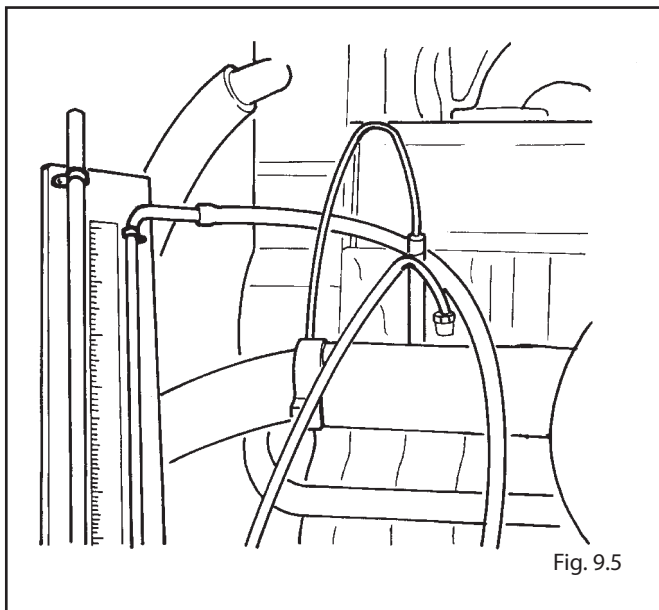


Fig. 9.5

9.8 FUEL FLOW RATE ADJUSTMENT

Adjustment of fuel flow rate is normally carried out on the test bench. It is therefore recommended, in consideration of the difficulty of performing the adjustment directly on the installed engine, to make sure that the problem you are attempting to remedy is due to insufficient or excess fuel.

9.9 FUEL PUMP PRESSURE (FIG. 9.8)

Apply a pressure gauge upline from the fuel inlet to the Stanadyne injection pump and check the fuel supply pressure, which must be no lower than **20 kPa (0.2 bar)** and no higher than **30 kPa (0.3 bar)**.

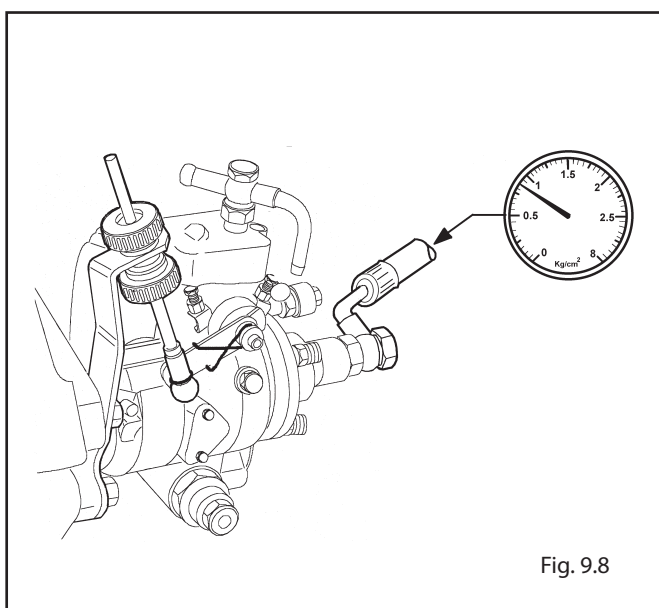


Fig. 9.8

9.10 COMPRESSION TEST (FIG. 9.10)

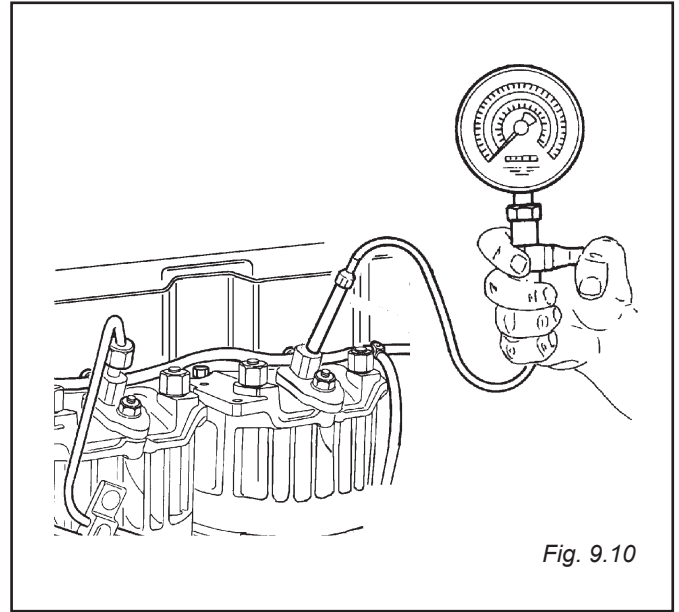
Check the pressure developed in each cylinder. Insufficient compression will cause power loss, increased fuel and oil consumption, exhaust fumes, difficult starting and partial seizure.

Test procedure

- To take away all the injectors.
- Clean the injector seat and install the compression tester.
- Zeroset the dial and crank the engine with the starter motor .
- Repeat the operation with the other pistons.
- Check the battery conditions.

During the test the battery must be in the optimal condition, because in different case there are several possibility to do a wrong test.

- If low readings are obtained or if the difference among different cylinders exceeds **500 kPa** (5 bar)(72.5 psi), check piston rings, valves, cylinder liners and pistons.

*Fig. 9.10*

**9.11 TROUBLE SHOOTING****ENGINE SUN 2105-3105**

PROBLEM	POSSIBLE CAUSES
FAILURE TO START	A1 - A2 - A3 - A4 - A5 - A6 C1 - C2 - C3 - D4 - E1 - E3 - E6
STARTS THEN STOPS	A1 - A2 - A3 - A4 - A5 - E4 - D1
POOR ACCELERATION	A1 - A2 - A3 - A4 - D1 - D2 - D4
UNEVEN RUNNING SPEED	A4 - E4
OIL CONSUMPTION	B2 - E1 - E6 - E7
BLACK SMOKE	A6 - A8 - D1 - D2 - D4 - E1 - E2 - E7
WHITE SMOKE	A8 - B2 - E1 - E6 - E7
ENGINE OVER-HEATING	A8 - B5 - B8 - B9 - D2 - D4 - D7 - E5
LOW OIL PRESSURE	B1 - B3 - B4 - B5 - B7 - B8 - B9 - E6
NOISY ENGINE	A6 - A8 - D4 - E5 - E6 - E8
OIL PRESSURE TOO HIGH	B3 - B7
LOW POWER	A5 - A6 - A8 - D1 - E2

ENGINE SUNe 4105-6105

PROBLEM	POSSIBLE CAUSES
FAILURE TO START	A1 - A2 - A3 - A4 - A5 - A6 - C1 C2 - C3 - C4 - E1 - E3 - E6
STARTS THEN STOPS	A1 - A2 - A3 - A4 - A5 - D1
POOR ACCELERATION	A1 - A2 - A3 - A4 - D1 - D2
UNEVEN RUNNING SPEED	A4
OIL CONSUMPTION	B2 - E1 - E6 - E7
BLACK SMOKE	A6 - A8 - B2 - D1 - D2 - D4 - E1 - E2 - E7
WHITE SMOKE	A8 - B2 - E1 - E6 - E7
ENGINE OVER-HEATING	A8 - B5 - B8 - B9 - D2 - D4 - D7 - E5
LOW OIL PRESSURE	B1 - B3 - B4 - B5 - B7 - B8 - B9 - E6
NOISY ENGINE	A6 - A8 - D4 - E5 - E6 - E8
OIL PRESSURE TOO HIGH	B3 - B7
LOW POWER	A5 - A6 - A8 - D1 - E2



TROUBLE SHOOTING		POSSIBLE CAUSES
FUEL SYSTEM	FAULTY OR CLOGGED FUEL PUMP	A1
	OBSTRUCTED FUEL LINES	A2
	FUEL FILTER CLOGGED	A3
	FAULTY INJECTION PUMP	A4
	AIR IN FUEL SYSTEM	A5
	INJECTORS NOT SET CORRECTLY OR SEIZED	A6
	HARDENED CONTROL ROD RACK	A7
	INJECTION PUMP NOT SET CORRECTLY	A8
	BLOCKED STOP SOLENOID VALVE	A9
	EXCESS FUEL DEVICE SEIZED	A10
	INJECTION PUMP VALVE BLOKED	A11
	FAULTY OIL PUMP	B1
LUBRICATION	OIL LEVEL TOO HIGH	B2
	OIL PRESSURE RELIEF VALVE STICKING	B3
	OIL VISCOSITY TOO HIGH	B4
	OIL LEVEL TOO LOW	B5
	FAULTY PRESSURE GAUGE OR SWITCH	B7
	OIL SUCTION LINES CLOGGED OR UNIONS LOOSE	B8
	OIL COOLER CLOGGED	B9
	HIGH OIL CONSUMPTION	B10
	BATTERY DISCHARGED	C1
	LOOSE CABLE CONNECTION	C2
ELECT.SYSTEM	FAULTY STARTING SWITCH	C3
	FAULTY STARTER MOTOR	C4
	PICK-UP BROKEN OR NOT CONNECTED	C5
	FUSE BROKEN	C6
	POTENTIOMETER DON'T GO TO END STROKE	C7
	CLOGGED AIR CLEANER	D1
	ENGINE OVERLOADED	D2
	TIMING NOT SET CORRECTLY	D4
MAINTENANCE	IDLE SPEED NOT SET CORRECTLY	D5
	RADIATOR/INTERCOOLER STOPPED	D6
	CLOGGED COOLING CIRCUIT FINS	D7
	SEA WATER PUMP FAULTY	D8
	SEA WATER FILTER OBSTRUCTED	D9
	BELT LOOSE	D10



TROUBLE SHOOTING		POSSIBLE CAUSES
REPAIRS	WORN OR STUCK RINGS	E1
	POOR VALVE SEALING	E2
	STUCK VALVES	E3
	GOVERNOR SPRING BROKEN OR WRONG SPRING	E4
	FAN FAILURE	E5
	WORN CON. RODS/OR MAIN BEARINGS	E6
	WORN CYLINDERS	E7
	WRONG VALVE CLEARANCE	E8

APPLICATIONS

10

10.1 COOLING

The minimum air flow required for engine cooling is 60 m³/HPh.

In installations in enclosed places with engines driving generators, take into consideration also the air required for thermal combustion and for cooling of the alternator.

The table shows minimum dimensions of ducts and

openings (Fig. 10.11) required in such installations to assure the correct flow of air for engine cooling and combustion.

With ducts longer than 2 m multiply the cross section by 1.5 - 3.5 times. If the openings dimensions and duct sections must be restricted, install fans (Fig. 10.12) selecting the flow rates in relation to the required temperature rise.

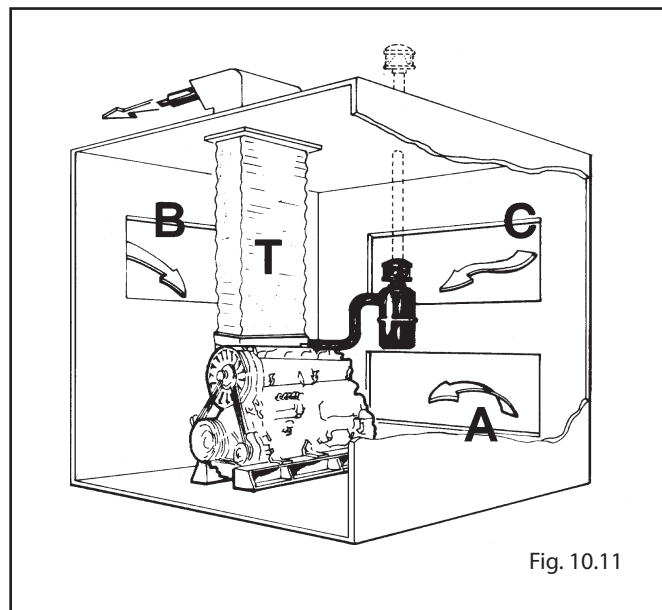


Fig. 10.11

ENGINE		A	B	C	T
SUN 2105/E1	cm ²	2100	900	2100	1050
SUN 3105/E1	cm ²	2100	900	2100	1100
SUN 4105E/E1	cm ²	2800	900	2800	1450
SUN 4105 TE/TE1	cm ²	4000	1850	4000	2150
SUN 6105E/E1	cm ²	4000	1850	4000	1850
SUN 6105 TE/TE1	cm ²	5200	2300	5200	2650

ENGINE ASPIRATION

Check the aspiration vacuum downstream from the filter and before the intake manifolds. The maximum permissible vacuum is indicated below:

EXHAUST BACK-PRESSURE.

Check that the exhaust back-pressure values are no greater than kPa 6.8 (0.068 bar).

MAX. VACUUM PERMITTED WITH AIR FILTER NEW

oil bath air filter	2.5 kPa (0.025 bar)
dry air filter	2.0 kPa (0.020 bar)
dry air filter obstructed	6.0 kPa (0.060 bar)

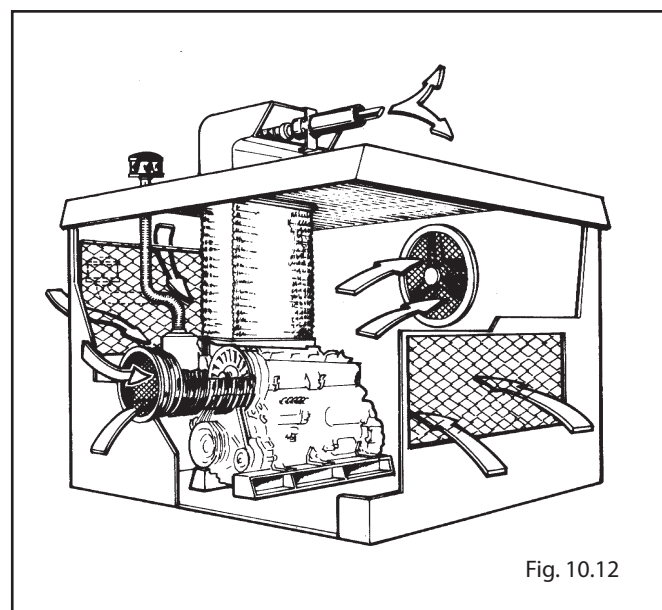


Fig. 10.12

10.2 EXHAUST OUTLET ELBOW

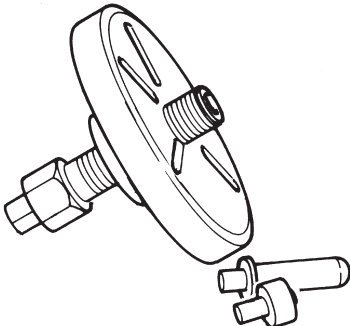
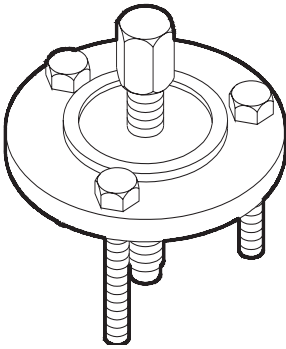
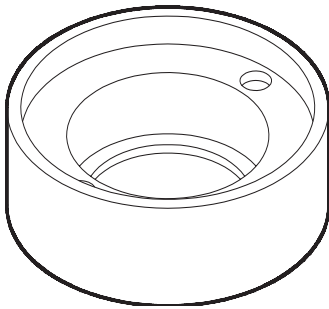
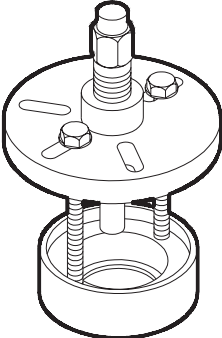
The turbo version engine is supplied with an exhaust elbow that is installed downstream of the turbocharger.

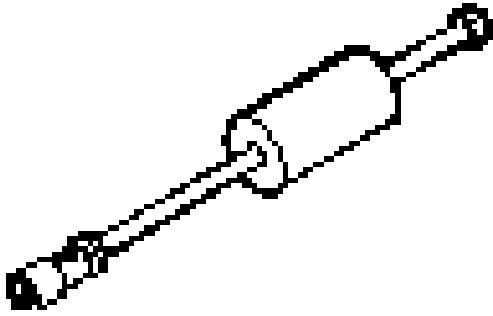
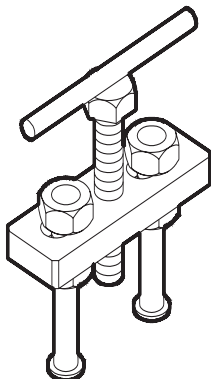
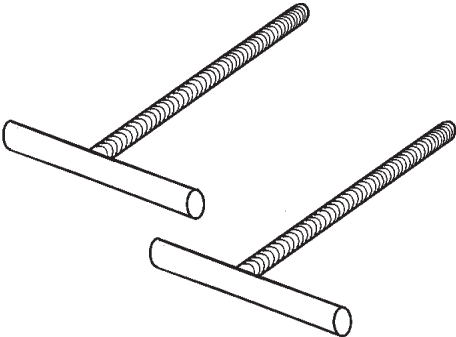
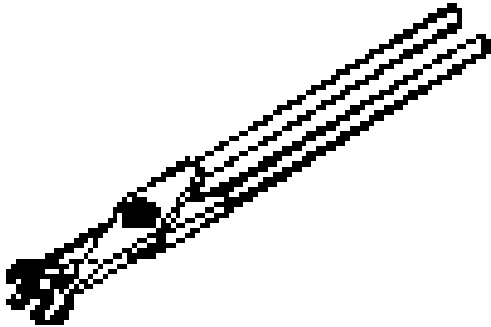
However, great care must be taken to support the exhaust system in the best possible manner. When, depending on the position of the turbocharger, a dedicated turbocharger support bracket is not installed, the first part of the exhaust down-pipe must have a suitable support bracket. The bracket being fixed to possibly either dedicated bosses on the engine block, or flywheel housing.

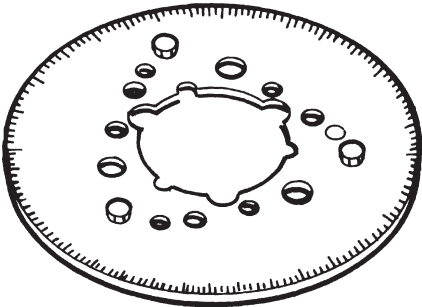
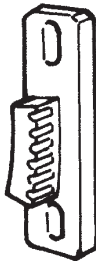
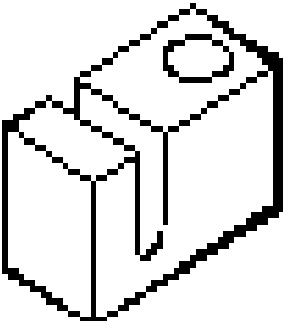
Even if the turbocharger does have a support bracket, supporting the first part of the exhaust down-pipe, is always strongly recommended. The adoption of a flexible part (metallic braided joint), as close as possible to the engine, in the exhaust system, is also strongly recommended. **VM recommends to connect the turbocharger and muffler through a flexible joint and that the exhaust system must be supported in adequate manner using either the engine block bosses or flywheel housing.**

Any application must be fully evaluated, with the appropriate machine reliability tests, prior to the application being signed-off.

11.1 ATTREZZI SPECIALI

CODE	DESIGNATION	TOOL
68400001B	Pulley remover	
A		
68400002A	Camshaft gear puller	
B		
68400003B	Crankshaft gear puller	
C		
68400029A	Crankshaft gear puller complete with pulley extractor (This tool includes tools A+C)	
D		

CODE	DESIGNATION	TOOL
68400004A	Injector extracting tool	
E		
68400007A	Oil pump rotor puller	
F		
68400008A	Rear supports extractor	
G		
68430001A	Push rod covers pliers	
H		

CODE	DESIGNATION	TOOL
68450003A	Timing disc	
I		
68480003A	Flywheel ring gear clamp	
L		
68480005A	Governor for location shaft (only SUN engines type)	
M		
68400034F	Injector extracting tool adactor (M12)	
N		

KEY TO DEFINITIONS

R/R = removal and re-installation

U.d.P. = unit of power

INTERPRETING THE CODE OF THE OPERATION

Cod. **3Z - EAA / 4**

The first code group identifies the operation performed (ex: **3Z** = replacement)

The second group separated by a dash, identifies the component (ex: **EAA** = camshaft)

The number after the slash, identifies the quality of components involved in the operation, this number can be omitted if there are no other similar components on the engine.

1°) exsample: **3Z - EAA**

replacement camshaft

This type of code is used when there are no other similar components or multiple components on the engine.

2°) exsample: **10Z - OAA / 1** or **10Z - OAA / 6**

test function on 6 injectors

test function on 1 injector

this type of code is used when there are other similar components or multiple components on the engine.



OPERATION CODE	ENGINE - REMOVE AND REINSTALL	N. CYL.	U.d.P.	IND.	MAR.
14Z-AAA	Remove and Reinstall engine: of the application.			4.0	



OPERATION CODE	ENGINE OVERHAUL	N. CYL.	U.d.P.	IND.	MAR.
7Z-AAA	Total engine overhaul: – External cleaning of engine, disassembly and cleaning of all engine components, checking of dimensions and wear of crankshaft and inspection of all parts. – Replacement of all cylinders. – Replacement or removal, as necessary, of camshaft and relative bearings. – Check and, if necessary, replacement of timing gears. – Inspection and replacement, if necessary, of oil pump and turbocharger. – Grinding of valves and valve seats, reaming of valve guides and replacement if necessary. – Replacement of valves and valve seats if necessary. Inspection of valve springs, washers, half-cones and replacement if necessary. Grinding of valves. Reassembly. – Valve adjustment.	2		18.0	
		3		21.0	
		4		25.0	
		6		32.5	
8Z-AAA	Partial engine overhaul: – Steam cleaning and complete disassembly. Cleaning of all parts, check of dimensions and wear of crankshaft: – Polishing (roughing) of cylinders. – Replacement or removal, where necessary, of camshaft and bearings – Bench test. – Valve adjustment.	2		8.0	
		3		9.0	
		4		10.0	
		6		12.0	
2I-AAA	Service to reduce oil consumption: – Removal of cylinder heads. – Disassembly of pistons and cylinders. – Cylinder internal roughing (if smooth). – Cylinder cleaning and inspection, replacement if necessary. – Cleaning of pistons and inspection for wear with replacement if necessary and replacement of all piston rings. – Reassembly with new gaskets.	2		7.0	
		3		8.0	
		4		10.2	
		6		15.5	
8Z-DAA	Overhaul of upper engine parts: (cylinder heads and gaskets) – Removal of heads and relative gaskets. – Removal of all traces of deposits and gasket residues. – Injector inspection. – Check of heads and valve adjustment. – Installation of new gaskets. – Engine test. – Valve adjustment.	2		6.5	
		3		7.5	
		4		8.5	
		6		10.5	
8Z-KDA	1 (one) additional hour on all engine series with turbocharger relative to the following operation codes:	3	1.0	-	-
		4	1.0	-	-
		6	1.0	-	-

OPERATION CODE	ENGINE OVERHAUL	N. CYL.	U.d.P.	IND.	MAR.
3Z-ABA	Replacement: (crankcase) – Steam cleaning of engine (high pressure washer). Disassembly and inspection of all parts. – Reassembly of engine with new crankcase using same pistons or new pistons, new piston rings, new set of bearings and clearance rings, gaskets and oil seals. Tightening to specified torques. – Engine testing and check for leaks. – Valve adjustment.	2		12.5	
		3		13.5	
		4		15.0	
		6		16.5	
3Z-DAA	Replacement of cylinder heads and/or cylinder head gaskets: – R/R replacement or overhaul of rocker arms. – R/R intake manifold. – R/R exhaust manifold. – R/R rocker arm lubrication pipeline. – Installation of new gaskets.	2		3.0	
		3		3.7	
		4		4.5	
		6		6.0	
11Z-DGA	Valve adjustment.	2		1.0	
		3		1.0	
		4		1.0	
		6		1.2	
10Z-DGA	Valve check – Cleaning and disassembly of rocker units. – Inspection of parts, overhaul or replacement as necessary. – Reassembly.	2		0.5	
		3		0.9	
		4		1.1	
		6		1.5	
3Z-DGG 3Z-DGF	Replacement of valve guides including forced removal: including : R/R of cylinder head.	2		6.0	
		3		6.5	
		4		7.5	
		6		9.0	



OPERATION CODE	BASIC ENGINE	N. CYL.	U.d.P.	IND.	MAR.
3Z-BAA	Removal and replacement of crankshaft:	2		10.0	
	– Replacement of rear oil seals.	3		12.0	
	– R/R flywheel housing.	4		13.0	
	– R/R sump.	6		15.0	
	– R/R cylinder heads.				
	– R/R connecting rod-piston units.				
	– R/R main bearings.				
	– R/R timing cover.				
	– R/R anti-vibration pulley.				
	– R/R clearance rings.				
3Z-MCE	Replacement of front oil seal ring:	2		0.5	
		3		0.5	
		4		0.5	
		6		0.7	
3Z-BIG	Removal and replacement of rear oil seal ring:	2		0.7	
		3		0.7	
		4		0.7	
		6		0.7	
3Z-BOA 3Z-BHA 3Z-BIA	Replacement of main bearings: (replacement of all crankshaft bearings including front and rear) – R/R Sump and oil pipe in sump (suction rose).	2		10.0	
		3		12.0	
		4		13.0	
		6		15.0	

OPERATION CODE	BASIC ENGINE	N. CYL.	U.d.P.	IND.	MAR.
3Z-BIA01	Replacement of rear main bearing: — R/R Flywheel housing.	2		2.0	
		3		2.0	
		4		2.0	
		6		2.0	
3Z-BOA	Replacement of front main bearing: — R/R timing cover and gasket.	2		1.7	
		3		1.7	
		4		1.7	
		6		1.7	
3Z-QBB	Connecting rod bushing replacement: — R/R connecting rod.	2		6.0	
		3		6.6	
		4		7.7	
		6		10.2	
3Z-IBC	Oil cooler replacement .	2		0.5	
		3		0.5	
		4		0.5	
		6		0.5	
3Z-QAA	Removal and replacement of front crankshaft bearing: — R/R Sump and oil pipe in sump (suction tube).	2		6.0	
		3		6.0	
		4		6.0	
		6		6.0	



OPERATION CODE	BASIC ENGINE	N. CYL.	U.d.P.	IND.	MAR.
3Z-QAD	Replacement of crankshaft rear main bearing: — R/R Flywheel housing.	2		2.0	
		3		2.0	
		4		2.0	
		6		2.0	
3Z-BLA	Replacement of pulley and anti-vibration unit:	2		0.3	
		3		0.3	
		4		0.3	
		6		0.3	
3Z-JAF	Replacement of fan belt:	2		0.2	
		3		0.2	
		4		0.2	
		6		0.2	
3Z.BFA	Replacement of flywheel complete with ring gear:	2		0.3	
		3		0.3	
		4		0.3	
		6		0.3	
3Z-BFE	Replacement of flywheel ring gear:	2		0.5	
		3		0.5	
		4		0.5	
		6		0.5	

OPERATION CODE	BASIC ENGINE	N. CYL.	U.d.P.	IND.	MAR.
3Z-MAA	Replacement of flywheel housing: — R/R flywheel.	2		0.5	
		3		0.5	
		4		0.5	
		6		0.5	
3Z-BAF 3Z-BAG 3Z-EAC 3Z-BGL 3Z-PAC	Replacement of timing gear: — Removal of front cover. (excluding camshaft on 4 - 6 cylinder engines).	2		3.0	
		3		3.0	
		4		3.0	
		6		3.0	
3Z-MCA	Replacement of front cover and gasket: — Removal of front anti-vibration pulley.	2		1.0	
		3		1.0	
		4		1.0	
		6		1.0	
3Z-MCE	Replacement of front oil seal:	2		1.0	
		3		1.0	
		4		1.0	
		6		1.0	
3Z-PAC	Replacement of injection pump gear: — R/R front cover.	2		1.5	
		3		1.5	
		4		1.5	
		6		1.5	
3Z-BAF	Replacement of crankshaft gear: — R/R front cover.	2		2.0	
		3		2.0	
		4		2.0	
		6		2.0	



OPERATION CODE	BASIC ENGINE	N. CYL.	U.d.P.	IND.	MAR.
3Z-CAA/1	Replacement of piston: — R/R heads and gaskets.	2		3.0	
		3		3.0	
		4		3.0	
		6		3.0	
3Z-CAA/2	Replacement of all pistons: — R/R heads and gaskets.	2		6.0	
3Z-CAA/3		3		6.4	
3Z-CAA/4		4		7.5	
3Z-CAA/6		6		10.0	
3Z-CAD	Replacement of rings on all pistons: — R/R pistons.	2		5.0	
		3		6.0	
		4		7.0	
		6		9.0	
3Z-AIA/2 3Z-AIA/3 3Z-AIA/4 3Z-AIA/6	Replacement of all cylinders and check of piston clearance.	2		5.0	
		3		6.0	
		4		8.0	
		6		10.0	
3Z-AIA/1	Replacement of 1 (one) cylinder:	2		4.0	
		3		4.0	
		4		4.0	
		6		4.0	
3Z-DAA	Replacement of all cylinder heads:	2		3.0	
		3		5.0	
		4		6.0	
		6		7.0	
3Z-CBA/1	Replacement of connecting rod (one): — R/R sump.	2		5.0	
		3		5.4	
		4		6.5	
		6		9.0	
3Z-CBA/2 3Z-CBA/3 3Z-CBA/4 3Z-CBA/6	Replacement of connecting rods (all): — R/R sump.	2		6.0	
		3		6.4	
		4		7.5	
		6		10.0	

OPERATION CODE	BASIC ENGINE	N. CYL.	U.d.P.	IND.	MAR.
3Z-EAA	Replacement of camshaft: – R/R valve stems. – R/R timing gear. – R/R front cover and gasket. – R/R rocker arm ass. – R/R sump. – Valve adjustment.	2		5.0	
		3		5.5	
		4		6.5	
		6		8.5	
3Z-EAC	Replacement of camshaft gear: – R/R front cover and gasket.	2		1.6	
		3		1.6	
		4		1.6	
		6		1.6	
3Z-EAF	Replacement of camshaft rear O-ring: – R/R flywheel housing.	2		0.7	
		3		0.7	
		4		0.7	
		6		0.7	
3Z-DFA/2 3Z-DFA/3 3Z-DFA/4 3Z-DFA/6	Replacement of rocker arm asm.: (all) – Valve adjustment.	2		1.0	
		3		1.3	
		4		1.5	
		6		1.8	
3Z-DFA/1	Replacement of rocker arm ass. (one): – Valve adjustment.	2		0.5	
		3		0.5	
		4		0.5	
		6		0.5	
3Z-ECA	Replacement of all pushrods: – R/R rocker arm asm.	2		1.0	
		3		1.4	
		4		1.6	
		6		1.9	
3Z-EBB	Total tappet replacement: – R/R camshaft.	2		5.3	
		3		5.6	
		4		6.6	
		6		8.7	
3Z-DGH/1 3Z-DGI/1	Replacement of valve spring asm. (one) – R/R valve cover (rocker arms) and gaskets.	2		0.8	
		3		0.8	
		4		0.8	
		6		0.8	



OPERATION CODE	BASIC ENGINE	N. CYL.	U.d.P.	IND.	MAR.
3Z-DGH/2/3/4/6 3Z-DGI/2/3/4/6	Replacement of valve spring asm. (all)	2 3 4 6		1.2 1.7 2.0 2.5	
3Z-MHA	Replacement of rocker cover and gasket:	2 3 4 6		0.3 0.3 0.3 0.3	
3Z-KAA	Replacement intake manifold:	2 3 4 6		0.2 0.3 0.4 0.6	
3Z-KDA	Replacement turbocharger:	3 4 6		1.0 1.0 1.0	
3Z-MBA	Replacement oil sump:	2 3 4 6		0.4 0.4 0.4 0.5	
3Z-KBA	Replacement exhaust manifold:	2 3 4 6		0.2 0.2 0.3 0.5	
3Z-NBA	Replacement spring governor:	2 3 4		1.0 1.0 1.0	

OPERATION CODE	FUEL CIRCUIT	N. CYL.	U.d.P.	IND.	MAR.
3Z-OAA/1	Replacement of injector: (one)	2 3 4 6		0.2 0.2 0.2 0.2	
3Z-OAA/2	Replacement of all injectors	2		0.6	
3Z-OAA/3		3		0.7	
3Z-OAA/4		4		0.8	
3Z-OAA/6		6		1.0	
3Z-OAB/1	Replacement of atomizer: (one)	2 3 4 6		0.3 0.3 0.3 0.3	
3Z-OAB/2	Replacement of atomizers: (all)	2		1.0	
3Z-OAB/3	— Test.	3		1.3	
3Z-OAB/4		4		3.0	
3Z-OAB/6		6		2.0	
3Z-NAA	Replacement of governor unit:	2 3		1.0 1.0	
3Z-PAA	Replacement of injection pump: — Pump timing check. — R/R fuel pipelines.	2 3 4 6		2.0 2.0 2.0 2.0	
3Z-OFA	Replacement of fuel pump:	2 3 4 6		0.2 0.2 0.2 0.2	
10Z-PAA	Injection pump inspection and timing adjustment:	2 3 4 6		1.0 1.0 1.0 1.0	
12Z-OEL	Fuel circuit bleed:	2 3 4 6		0.1 0.1 0.1 0.1	



OPERATION CODE	FUEL CIRCUIT	N. CYL.	U.d.P.	IND.	MAR.
3Z-SGD	Replacement of stop solenoid (shutoff solenoid):	2		0.5	
		3		0.5	
		4		0.5	
		6		0.5	
3Z-OEC	Replacement of fuel filter:	2		0.2	
		3		0.2	
		4		0.2	
		6		0.2	
3Z-OCA	Replacement of fuel pipelines: (each)	2		0.2	
		3		0.2	
		4		0.2	
		6		0.2	
3Z-OCA	Replacement of fuel pipelines (all)	2		0.5	
		3		0.5	
		4		0.5	
		6		0.5	

OPERATION CODE	LUBRICATION CIRCUIT	N. CYL.	U.d.P.	IND.	MAR.
3Z-GAA	Replacement of oil pump:	2		2.0	
		3		2.0	
		4		2.0	
		6		2.0	
3Z-GGA	Replacement of overpressure valve:	2		0.2	
		3		0.2	
		4		0.2	
		6		0.2	
3Z-GAQ	Replacement of rocker arm lubrication pipeline:	2		0.3	
		3		0.4	
		4		0.5	
		6		0.6	
3Z-GID	Replacement of breather pipe:	2		0.2	
		3		0.2	
		4		0.2	
		6		0.2	
3Z-GBA	Oil filter change:	2		0.2	
		3		0.2	
		4		0.2	
		6		0.2	
3Z-GAO	Replacement of suction tube:	2		0.6	
		3		0.6	
		4		0.6	
		6		0.7	
3Z-SNA	Replacement of oil thermostat:	2		0.3	
		3		0.3	
		4		0.3	
		6		0.3	



OPERATION CODE	COOLING CIRCUIT	N. CYL.	U.d.P.	IND.	MAR.
3Z-IAA	Replacement of fan:	2		0.5	
		3		0.5	
		4		0.5	
		6		0.5	
3Z-IBC	Replacement of oil cooler:	2		1.0	
		3		1.0	
		4		1.0	
		6		1.0	
3Z-IBI	Replacement of oil cooler hoses:	2		0.7	
		3		0.7	
		4		0.7	
		6		0.7	

OPERATION CODE	ELECTRICAL EQUIPMENT	N. CYL.	U.d.P.	IND.	MAR.
3Z-SEA	Replacement of alternator:	2		0.3	
		3		0.3	
		4		0.4	
		6		0.5	
3Z-SEF	Replacement of voltage regulator:	2		0.2	
		3		0.2	
		4		0.2	
		6		0.2	
3Z-SGA	Replacement of starter motor:	2		0.3	
		3		0.3	
		4		0.3	
		6		0.3	
3Z-SGD	Replacement of starter motor electromagnets:	2		1.5	
		3		1.5	
		4		1.5	
		6		1.5	
3Z-SAA	Replacement of wiring harnesses:	2		0.1	
		3		0.1	
		4		0.1	
		6		0.1	



OPERATION CODE	ADJUSTMENTS	N. CYL.	U.d.P.	IND.	MAR.
11Z-DGA/1	Valve clearance adjustment (single valves): – R/R rocker cover.	2		0.2	
		3		0.2	
		4		0.2	
		6		0.2	
11Z-DGA/2	Valve clearance adjustment (all valves): – R/R rocker cover.	2		0.7	
11Z-DGA/3		3		0.8	
11Z-DGA/4		4		0.9	
11Z-DGA/6		6		1.1	
11Z-NCQ	Adjustment of governor with engine running:	2		0.2	
		3		0.2	
		4		0.2	
		6		0.2	
10Z-DGA	Valve clearance check: – R/R rocker cover.	2		0.7	
		3		0.8	
		4		0.9	
		6		1.0	