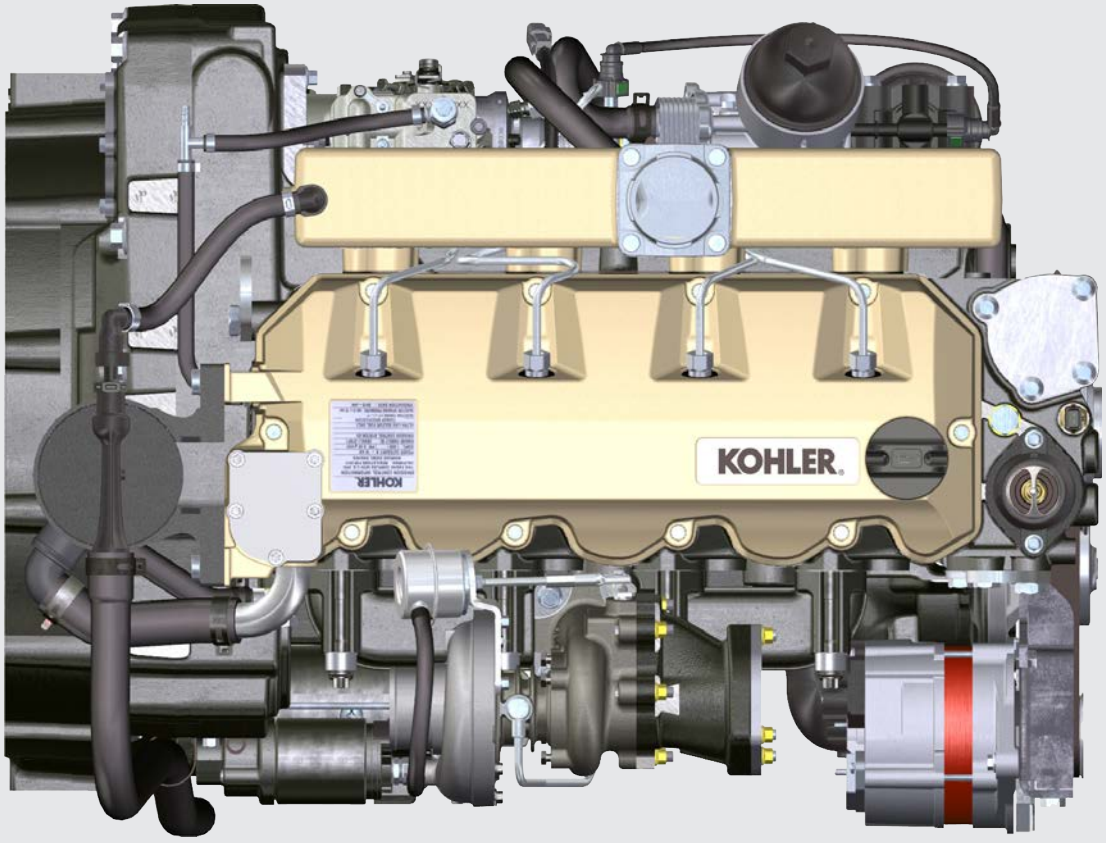
KDI 3404 TM

WORKSHOP MANUAL

KOHLER® Diesel KDI



KOHLER® Engines

TP-6983 04/16

REGISTRATION OF MODIFICATIONS TO THE DOCUMENT

Any modifications to this document must be registered by the drafting body, by completing the following table.

Drafting body	Code document	Model N°	Edition	Revision	Date issue	Date Review	Written by	Endorsed
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TRANSLATED FROM THE ORIGINAL MANUAL IN ITALIAN LANGUAGE.

Data reported in this issue can be modified at any time by KOHLER.

Important

- Connect to http://iservice.lombardini.it > **KDI KOHLER DIESEL** section > "**TECHNICAL DOCUMENTATION**" > select "**KDI 3404 TM**" and download the latest version of this manual onto your device.

NOTE: *you can select the desired language before downloading the manual, as shown in the figure below.*

1.1 Useful information

- This manual contains the instructions needed to carry out proper use and maintenance of the engine, therefore it must always be available, for future reference when required.
- Information, description and pictures in this manual reflect the state of the art at the time of the marketing of engine (**Par. 1.4 e Par. 1.5**).
- However, the development of engines is continuous. Therefore, the information in this manual is subject to change without notice.
- **KOHLER** reserves the right to make, at any time, changes on the engines for technical or commercial reasons.
- These changes do not require **KOHLER** to intervene on the production marketed up to that time and nor to consider this manual as inappropriate.
- The paragraphs, tables and figures are numbered by chapter and followed by the progressive paragraph, table and/or figure number.

E.g.: **Par. 1.3** - chapter **1** paragraph **3**.
Tab. 2.4 - chapter **2** table **4**.
Fig. 4.5 - chapter **4** figure **5**.

NOTE: The paragraphs may contain sub-paragraphs.

- All technical terms, specific components and symbols (**Tab. 15.1**) that are in the manual are listed and described inside the glossary, which can be consulted in (**Chap. 15**).
- The references of the objects described in the text and in the figure are indicated by letters and numbers, which are always and only related to the paragraph you are reading unless there are specific references to other figures or paragraphs.
- Reference to values are indicated by letters or numbers (**in red and underlined**).
- Other important references are highlighted in **red**.
- The mark (⮑) after the title of a paragraph, indicates that the procedure is not required in order to disassemble the engine, however the procedures are featured in order to illustrate the disassembly of components.
- Any additional section that **KOHLER** will deem necessary to supply at a later stage must be kept with the manual and considered as an integral part of it.
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1.1.1 Useful Information -accident prevention - environmental impact

- Before proceeding repair - handling the motor, read the entire **Chap. 3**, which contains important information about the procedures to be followed for safety and environment.

1.2 Manufacturer and engine identification

The engine identification name plate is situated in the lower part of the crankcase; it is visible from the intake or exhaust side.

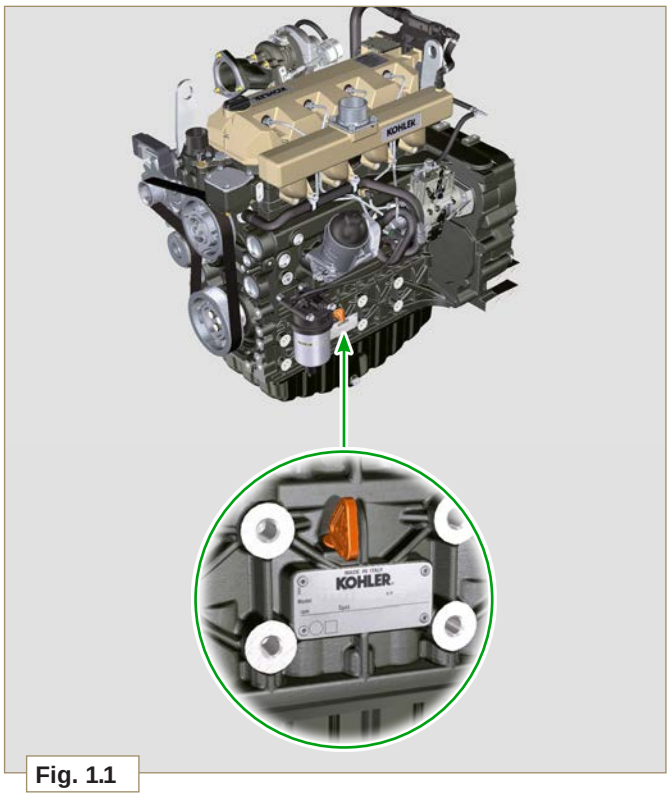


Fig. 1.1

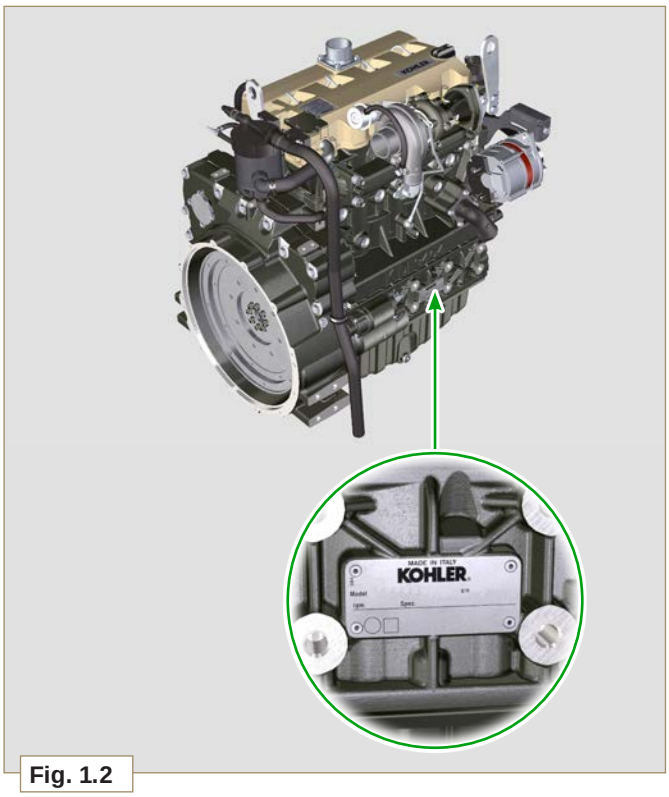


Fig. 1.2

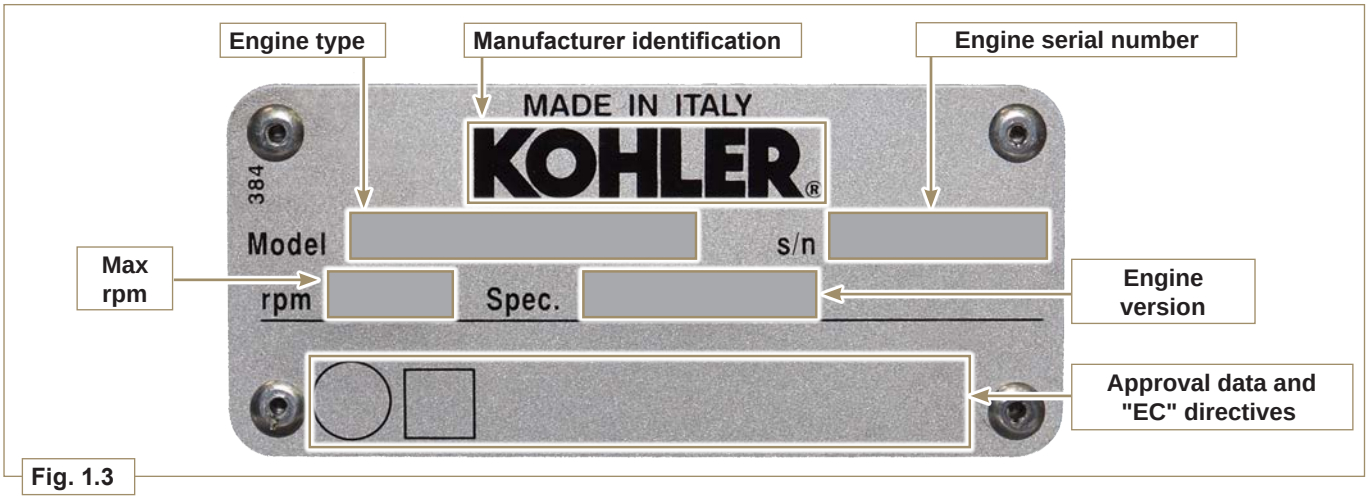


Fig. 1.3

1.3 Name plate for EPA regulations

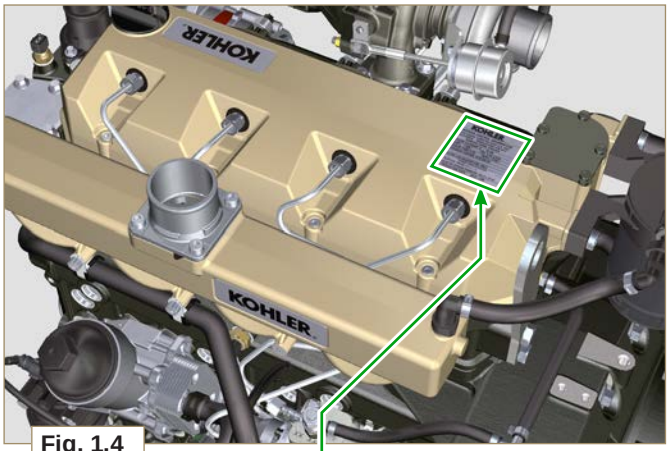
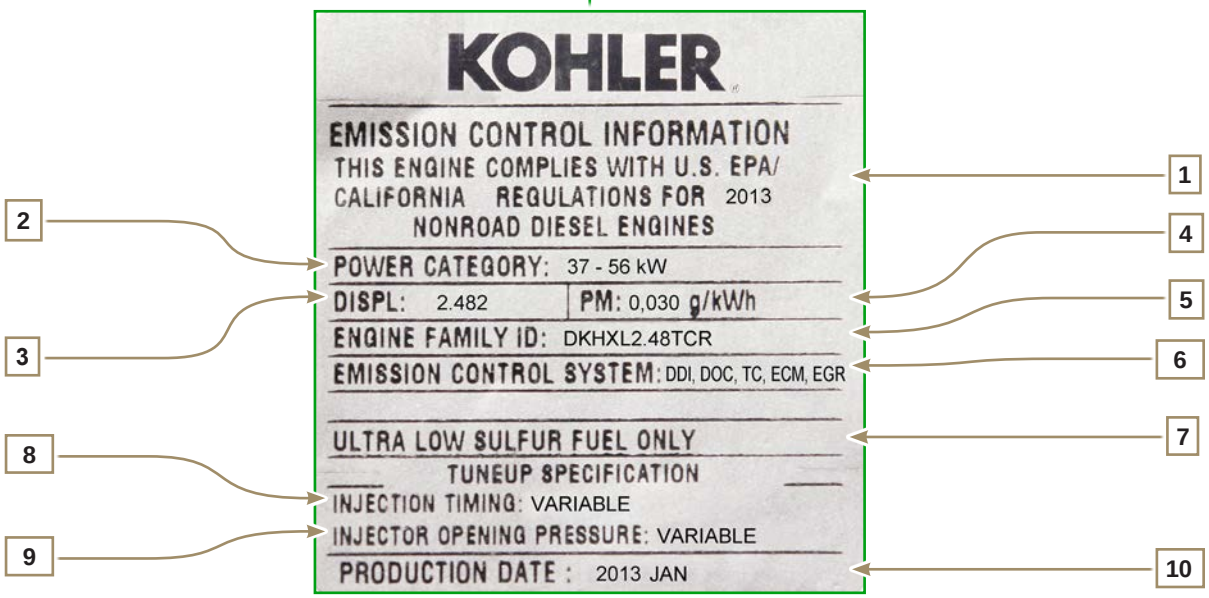


Fig. 1.4



Tab. 1.1

POS.	DESCRIPTION
1	Model year in compliance with the rules
2	Power category (kW)
3	Engine displacement (Lt.)
4	Particulate emission limit (g/kWh)
5	Engine family ID
6	Emission Control System = ECS
7	Fuel with low sulphur content
8	Injection timing
9	Electronic injector opening pressure (bar)
10	Production date (example: 2013.JAN)

1.4 Identification of the main internal components of the engine and operating reference (BASE CONFIGURATION)

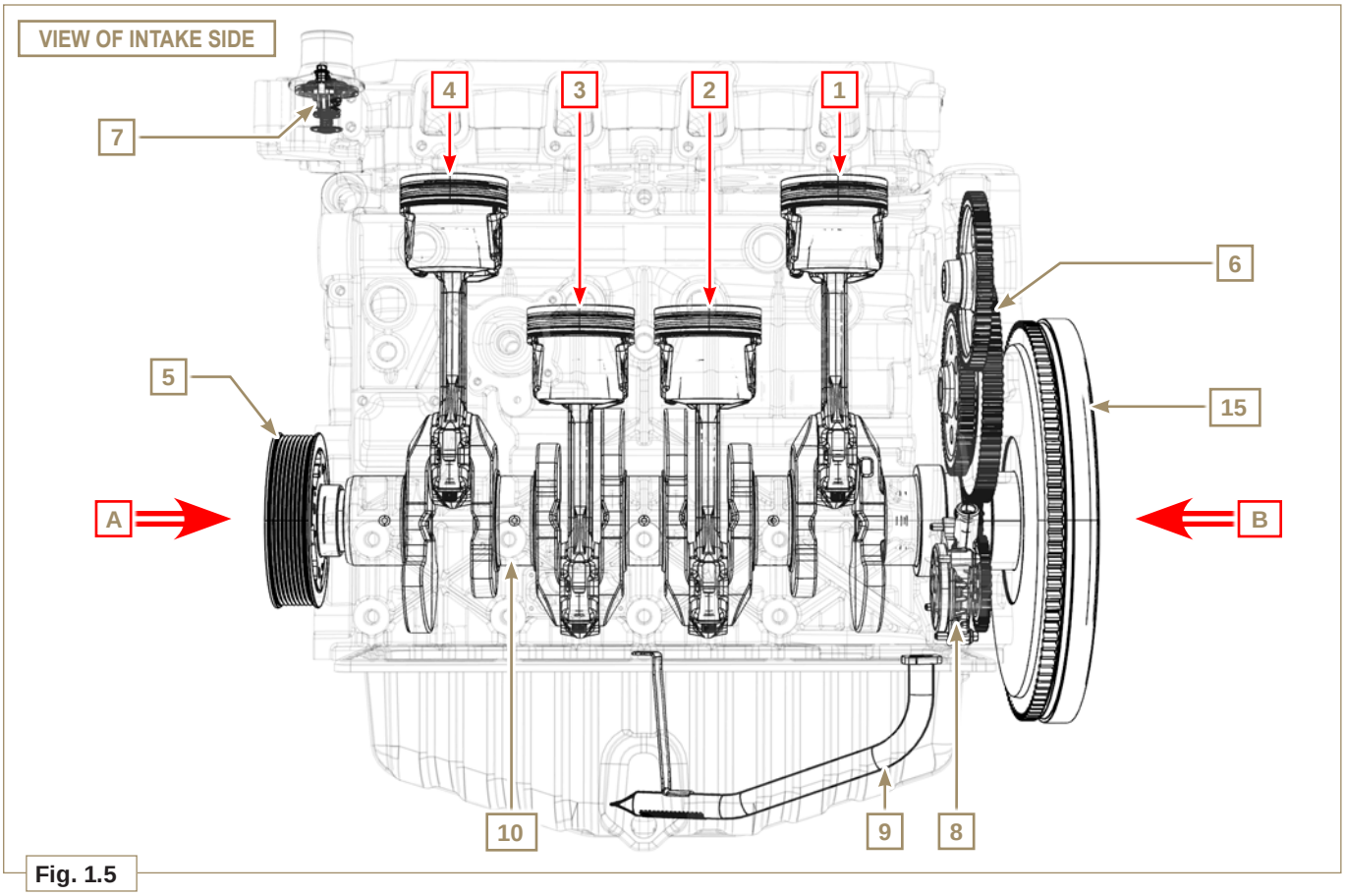


Fig. 1.5

The following chapters contain operating references in order to clearly understand the engine. This paragraph illustrates these references that may be recognised by means of some main internal components.

Should you need to execute complex operations, always consult this paragraph.

NOTE: it is advisable to keep this page visible during disassembly and assembly operations.

Tab. 1.2

REF.	DESCRIPTION
A ⇒	View of crankshaft pulley (2nd PTO)
B ⇒	View of flywheel side (1st PTO)
C ⇒	View of exhaust side
D ⇒	View of intake side
1	Cylinder/Piston N. 1
2	Cylinder/Piston N. 2
3	Cylinder/Piston N. 3
4	Cylinder/Piston N. 4

POS.	DESCRIPTION
5	Crankshaft pulley (2nd PTO)
6	Gear timing system
7	Thermostatic valve
8	Oil pump
9	Oil suction hose
10	Crankshaft
11	Exhaust manifold
12	Intake manifold
13	Camshaft
14	Flywheel (1st PTO)

VIEW OF FLYWHEEL SIDE

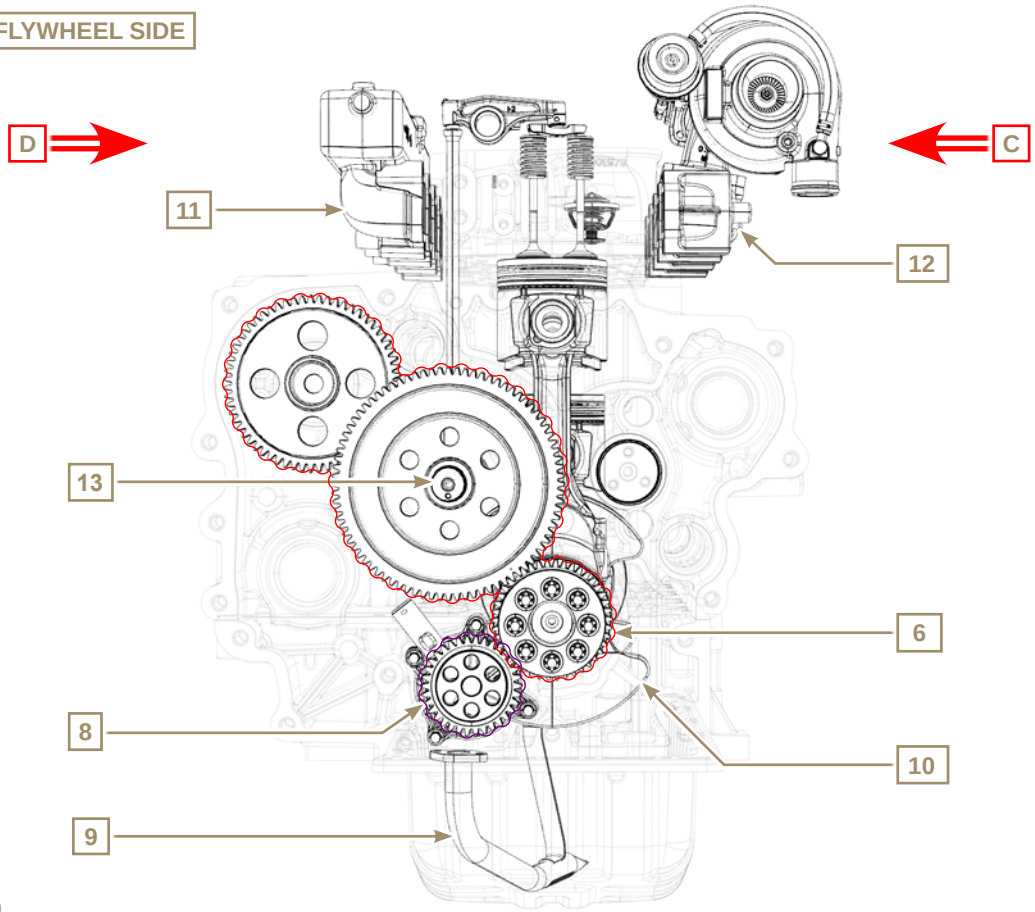


Fig. 1.6

1.5 Identification of the external components of the engine (BASE CONFIGURATION)

VIEW OF PULLEY SIDE - INTAKE

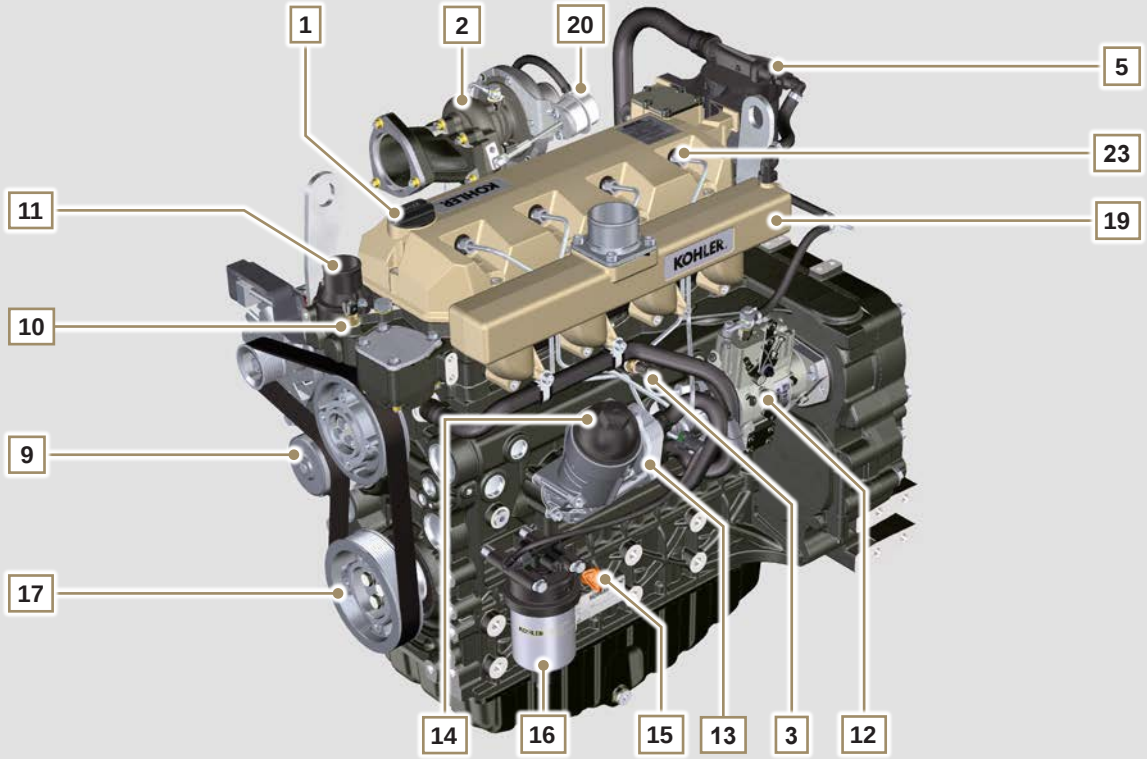


Fig. 1.7

VIEW OF FLYWHEEL SIDE - EXHAUST

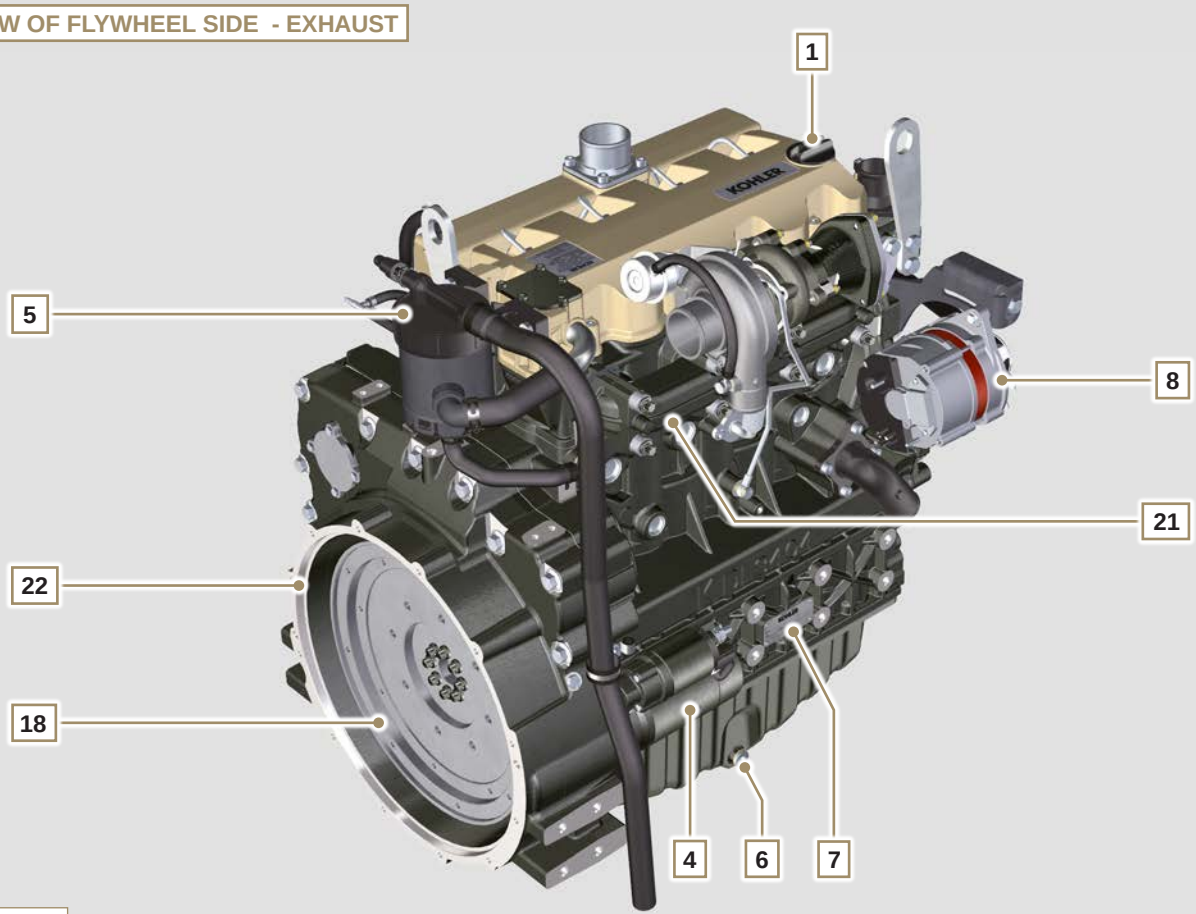


Fig. 1.8

This paragraph illustrates all external components that are present in the base configuration of the engine.

For components present on engines that differ from those represented in these illustrations, refer to **Chap. 11**.

NOTE: The illustrated components may differ from those illustrated; the illustration is only as an example.

Tab. 1.3

POS.	DESCRIPTION
1	Oil filler cap
2	Turbocharger
3	Oil pressure switch
4	Starter motor
5	Oil steam separator
6	Oil drain plug
7	Engine identification name plate
8	Alternator
9	Coolant pump
10	Coolant temperature sensor
11	Thermostatic valve
12	Fuel injection pump

POS.	DESCRIPTION
13	Oil Cooler
14	Lub. oil filter
15	Oil dipstick
16	Fuel filter
17	Crankshaft pulley (2nd PTO)
18	Flywheel (1st PTO)
19	Intake manifold
20	Waste Gate valve control actuator
21	Exhaust manifold
22	Flange bell
23	Injectors

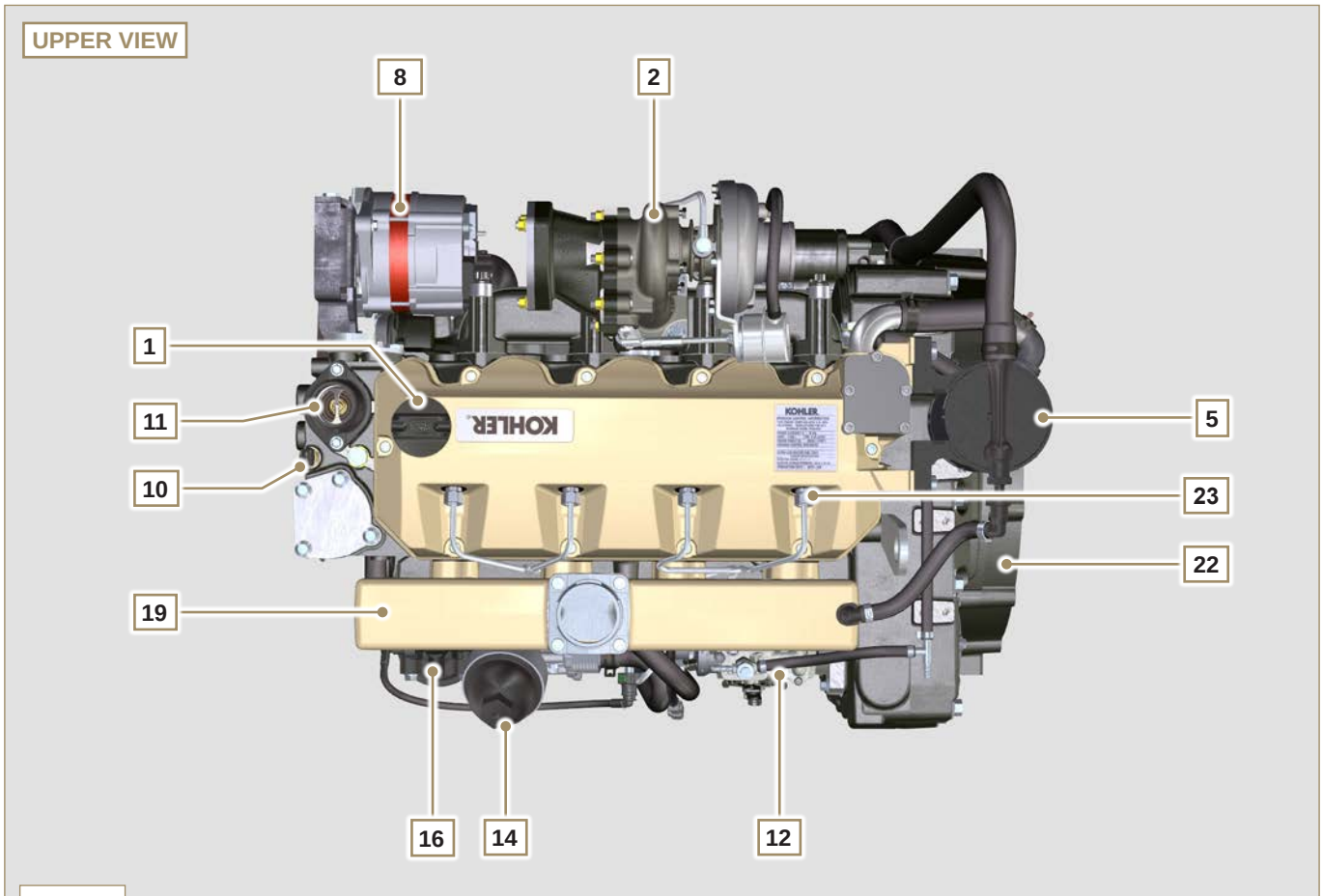


Fig. 1.9

2.1 Engine specifications

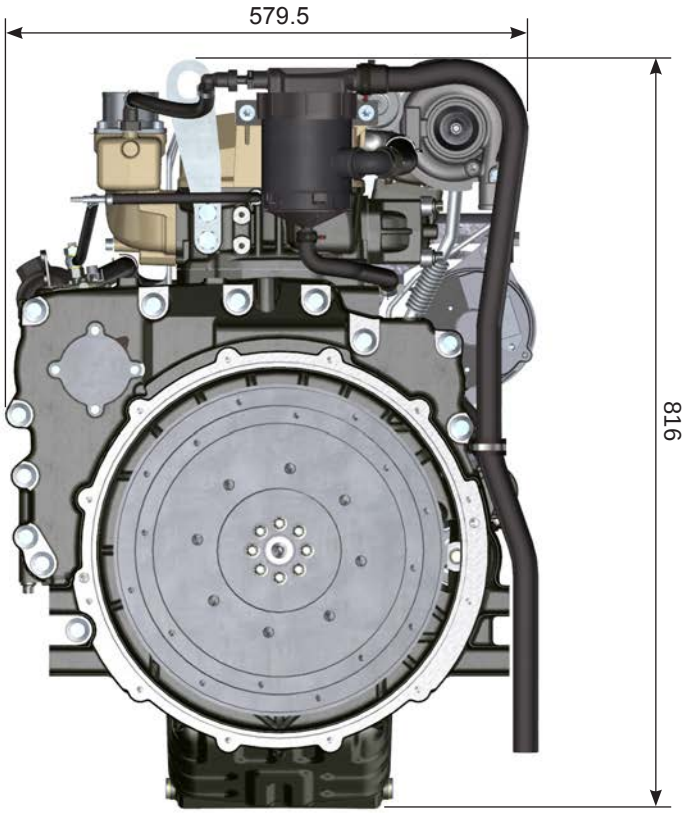
Tab. 2.1

MANUFACTURER SPECIFICATIONS AND OPERATION		
GENERAL INFORMATION	**UNIT OF MEASURE**	**KDI 3404 TM**
Operating cycle		diesel - 4-stroke
Cylinders	No.	4
Bore x stroke	mm	96x116
Displacement	cm^3	3359
Compression ratio		17:1
Intake		Supercharged with Turbocharger
Cooling		Liquid
Crankshaft rotation (view from flywheel side)		Counterclockwise
Combustion sequence		1-3-4-2
Timing System		
Valves per cylinder		4
Timing System		Rods and rocker arms - Camshaft in the crankcase
Tappets		Hydraulic
Injection		Direct
Engine dry weight	Kg	394
MAX inclination 30' continuous operation	α	40°
MAX inclination 1' continuous operation	α	45°
POWER AND TORQUE		
GENERAL INFORMATION	**UNIT OF MEASURE**	**KDI 3404 TM**
MAX. operating speed	Rpm	2400
MAX. operating power (ISO TR 14396 - SAE J1995 - CE 97/68)	kW	100
Maximum torque (at 1500 rpm)	Nm	500
CONSUMPTIONS		
GENERAL INFORMATION	**UNIT OF MEASURE**	**KDI 3404 TM**
Specific fuel consumption (best point)	g/kWh	205
Oil consumption	%Fuel	< 0.1
FUEL SUPPLY SYSTEM		
GENERAL INFORMATION	**UNIT OF MEASURE**	**KDI 3404 TM**
Type of fuel		Diesel UNI-EN590 - ASTM D975
High-pressure fuel injection pump		STANADYNE - DB
Fuel supply		Low pressure electric pump
Fuel filter		
Filtering surface	cm^2	2300
Degree of filtration	µm	5
Maximum pressure at injection pump inlet	bar	0.2
LUBRICATION CIRCUIT		

GENERAL INFORMATION	UNIT OF MEASURE	KDI 3404 TM
Lubrication		
Recommended oil		see **Par. 2.4**
Circuit forced		Lobe pump
Oil sump capacity (**MAX**)	Lt.	15,6
Oil pressure switch		
Intervention pressure (**MIN**)	bar	0.6±0.1
Oil filter		
Maximum operating pressure	bar	7.0
Degree of filtration	µm	17 ±2
Filtering surface	cm^2	1744
COOLING CIRCUIT		
GENERAL INFORMATION	**UNIT OF MEASURE**	**KDI 3404 TM**
Coolant	%	see **Par. 2.6**
Coolant pump	Lt./min	155
Thermostatic valve		
Opening temperature	°C	+83
Stroke at 95°C	mm	7.50
Liquid recirculation	Lt./h	9
ELECTRICAL SYSTEM - ELECTRIC FAN		
GENERAL INFORMATION	**UNIT OF MEASURE**	**KDI 3404 TM**
Circuit rated voltage	V	12
External alternator (rated current)	A	90
Starter motor power	kW	2
System electrical consumption, excluding: heater, electric pump, electric fan, starter motor	W	
Coolant temperature indicator light		
Indicator light operating temperature	°C	+100 / +110

2.2 Engine dimensions (mm)

NOTE: Dimensions vary according to engine configuration.



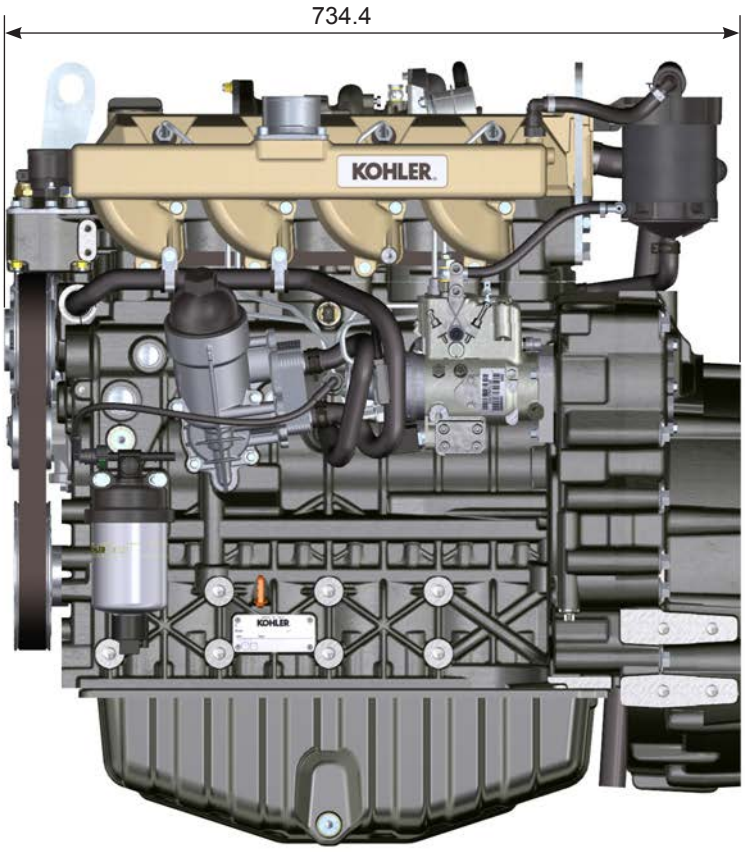


Fig. 2.1

2.3 Performance

	with **AFTER COOLER**				without **AFTER COOLER**
	70HZ @1800 RPM	**60HZ @1800 RPM**	**50HZ @1800 RPM**	**63HZ @1500 RPM**	**63HZ @1500 RPM**
POWER					
Stand-by power (kW/HP)	70 / 95.2	60 / 81.6	50 / 68	63 / 85.7	63 / 85.7
Prime power (kW/HP)	63 / 85.7	54 / 73.4	45 / 61.2	56.7 / 77.1	56.7 / 77.1
FUEL CONSUMPTION (g/kWh)					
Fuel consumption 100% load	229.0	241.6	240.8	223,2	219
Fuel consumption 75% load	242.8	260.8	255.4	232.5	228
Fuel consumption 50% load	242.4	265.1	272	248.5	238
Fuel consumption 25% load	274.2	298.4	325.1	263.1	261
Fuel consumption 10% load	425.3	452.1	510.8	366.6	380

2.4 Oil

Important

- The engine may be damaged if operated with improper oil level.
- Do not exceed the MAX level because a sudden increase in engine rpm could be caused by its combustion.
- Use only the recommended oil to ensure adequate protection, efficiency and service life of the engine.
- The use of lubricants other than recommended may shorten the engine life.
- Viscosity must be appropriate to the ambient temperature to which the engine is to be exposed **Par. 2.4.1)**.

Danger

- Prolonged skin contact with the exhausted engine oil can cause cancer of the skin.
- If contact with oil cannot be avoided, thoroughly wash your hands with soap and water as soon as possible.
- For the exhausted oil disposal, refer to the **Par. 3.6.**

2.4.1 SAE oil classification

- In the SAE classification, oils are identified according to viscosity without considering any other qualitative characteristic.
- The code is made up of two numbers. The first number refers to the viscosity when cold, for use during winter ("**W**"= winter), while the second number is for viscosity at high temperatures.

Tab. 2.2

RECOMMENDED OIL			
VISCOSITY	SAE	5W-30 (≥ -25°C) 0W-30 (< -25°C)	LOW S.A.P.S.
WITH SPECIFICATIONS	API	CJ-4	
	ACEA	E6 - E7 - E9	

N. B.: **Low S.A.P.S. technology** (fuel with low Sulphate, Phosphorous, Sulphur content) keeps catalyst in working conditions. The presence of sulfate, phosphorus and sulfur ashes causes with time the catalyst clogging and its consequent inefficiency.

Tab. 2.3

CLASSIFICATION	DESCRIPTION ACEA SPECIFICATION
E6	Long drain LOW S.A.P.S.
E7	High power over long distances (Euro 4 - 5 engines)
E9	Long drain MID S.A.P.S.

2.4.2 International lubricant specifications

- They define performances, procedures and laboratory tests that lubricants must pass successfully to be considered suitable and in compliance with the type of lubrication required.
- Check the code on the oil container to understand and compare the characteristics of the lubricant to be chosen.
- A specification with a greater number or letter is preferable to one with a lower number or letter.
- For the purchase of oil refer to **Tab. 2.2**.

Tab. 2.4

A.P.I	(American Petroleum Institute).
MIL	U.S.A. military engine oil specification.
ACEA	European Automobile Manufacturers Association.

2.5 Fuel

Important

- Use the same type of diesel fuel as used in cars (EN 590 for E.U. - ASTM D975 regulation - S 15 for U.S). Use of other types of fuel could damage the engine. Do not use dirty diesel fuel or mixtures of diesel fuel and water since this would cause serious engine faults.
- **Any failures resulting from the use of fuels other than recommended will not be warranted.**

Warning

- Clean fuel prevents the fuel injectors from clogging. Immediately clean up any spillage during refuelling.
- Never store diesel fuel in galvanized containers (i.e. coated with zinc). Diesel fuel and the galvanized coating react chemically to each other, producing flaking that quickly clogs filters or causes fuel pump and/or injector failure.

2.5.1 Fuel for low temperatures

- For the operation of the engine at temperatures lower than 0 ° C suitable for use fuels normally distributed by the oil companies and in any case corresponding to the specifications of **Tab. 2.5**.
- These fuels reduce the formation of paraffin in diesel at low temperatures.
- When paraffin forms in the diesel, the fuel filter becomes blocked interrupting the flow of fuel.

2.5.2 Biodiesel fuel

- Fuels containing less than 10% methyl ester or B10, are suitable for use in this engine provided that they meet the specifications listed in the **Tab. 2.5**.
- **DO NOT USE** vegetable oil as a biofuel for this engine.

Tab. 2.5

FUEL COMPATIBILITY								
	Compatible		Warranty coverage		Engine waste		Certification emission	
	yes	no	yes	no	yes	no	yes	no
EN 590, DIN 51628 - Military NATO fuel F-54 (S=10 ppm)							(2)	
Bio Fuels (EN14214)	(4)		(4)			(4)	(4)	
ARCTIC (EN 590/ASTM D 975)	(1)							
No 1 Diesel (US) - ASTM D 975 - Grade 1-D S 15 (S=15 ppm)							(3)	
No 1 Diesel (US) - ASTM D 975 - Grade 1-D S 500 (S=500 ppm)								
No 2 Diesel (US) - ASTM D 975 - Grade 2-D S 15							(3)	
No 2 Diesel (US) - ASTM D 975 - Grade 2-D S 1500								
High sulfur fuel < 5000 ppm (<0.5%)								
High sulfur fuel > 5000 ppm (>0.5%)								
High sulfur fuel > 10000 ppm (>1%)								
Civil Jet Fuels Jet A/A1						(1)		
Civil Jet Fuels Jet B								

(1) Without adding oil.

(2) Stage 3A.

(3) EPA TIER III.

(4) Max. 10% in fuel.

2.5.3 Emission-Related Installation Instructions

Failing to follow the instructions in the applications guidebook when installing a certified engine in a piece of nonroad equipment violates federal law (40 CFR 1068.105(b)), subject to fines or other penalties as described in the Clean Air Act.
OEM must apply a separate label with the following statement: “ULTRA LOW SULFUR FUEL ONLY” near the fuel inlet.
Ensure you are installing an engine appropriately certified for your application. Constant speed engines may only be installed on constant speed equipment for constant speed operation.
If you install the engine in a way that makes the engine's emission control information label hard to read during normal engine maintenance, you must place a duplicate label on the equipment, as described in 40 CFR 1068.105.

2.6 Coolant

Tab. 2.6

TECHNICAL SPECIFICATIONS
50% ETYLENGLYCOL e 50% DECALCIFIED WATER
50% PROPYLENGLYCOL e 50% DECALCIFIED WATER

2.7 Battery features

Battery not supplied by Kohler

Tab. 2.7

RECOMMENDED BATTERIES	
AMBIENT TEMPERATURE	BATTERY TYPE
≥ - 15°C	100 Ah - 800 CCA/SAE
< -15°C	120 Ah - 1000 CCA/SAE

2.8 Periodic maintenance

The intervals of preventive maintenance in **Tab. 2.8** and **Tab. 2.9** refer to the engine operating under normal operating conditions with fuel and oil meeting the recommended specifications.

Tab. 2.8

CLEANING AND CHECKING						
OPERATION DESCRIPTION	PERIODICITY (HOURS)					
	10	250	500	1000	1500	5000
Engine oil level	■					
Coolant level / Radiator check (2)	■					
Water presence in fuel filter	■					
Dry-type air filter (2)	■					
Alternator belt tension (8)		■				
Radiator heat-exchange surface (2)		■				
Rubber hoses			■			
Fuel hose			■			
Starter Motor						■
Alternator						■

Tab. 2.9

REPLACEMENT							
OPERATION DESCRIPTION		PERIODICITY (HOURS)					
		10	250	500	1000	1500	5000
Engine oil (1) (9)				■			
Oil filter cartridge (1) (9)				■			
Fuel filter cartridge (1)				■			
Coolant (4) (interior radiator cleaning)					■		
Intake manifold sleeve (air filter - intake manifold) (7)							■
Coolant hoses (7)							■
Fuel hose (7)							■
Alternator belt	Poly-V belt heavy environmental condition					■	
	Poly-V belt not heavy environmental condition						■
Dry air cleaner external cartridge (2)		After 6 checks with cleaning					

(1) - In case of low use: 12 months.
(2) - The period of time that must elapse before checking the filter element depends on the environment in which the engine operates.
The air filter must be cleaned and replaced more frequently under very dusty conditions.
(3) - In case of low use: 36 months.
(4) - In case of low use: 24 months.
(7) - The replacement interval is only an indication, it strongly depends from environmental condition and hose status detected during regular visual inspection.
(8) - **The first check** must be done after 10 hours.
(9) - **250hrs** for **Stage IIIA** or **Tier 3** engine with **CE** homologation (**Par. 1.2**) or **EPA** label (**Par. 1.3**).

Important

- In the event one does not reach the times scheduled for maintenance, one must in any case replace the components described in **Tab. 2.10**.

Tab. 2.10

DESCRIPTION	PERIOD MAX
Engine oil	12 months
Oil filter cartridge	12 months
Fuel filter cartridge	12 months
Dry air filter cartridge	12 months
Coolant	24 months
Fan/alternator belt	36 months

(*) Once removed, the fan/alternator belt must be replaced, even if it has not completed the hours required or the **MAX** period.

2.9 Fuel system

2.9.1 Supply system (Fig. 2.3)

Important

- The high pressure supply injection system is highly susceptible to damage if the fuel is contaminated.
- It is crucial that all components of the injection circuit are thoroughly cleaned before the components are removed.
- Thoroughly wash and clean the engine before maintenance.
- Contamination in the fuel supply injection system may cause a reduction in effectiveness / operation of engine fault indication.
- If the engine is cleaned with high pressure washer, then the nozzle must be kept at a minimum distance of 200mm from the surface, and not directed at electrical components and connectors.

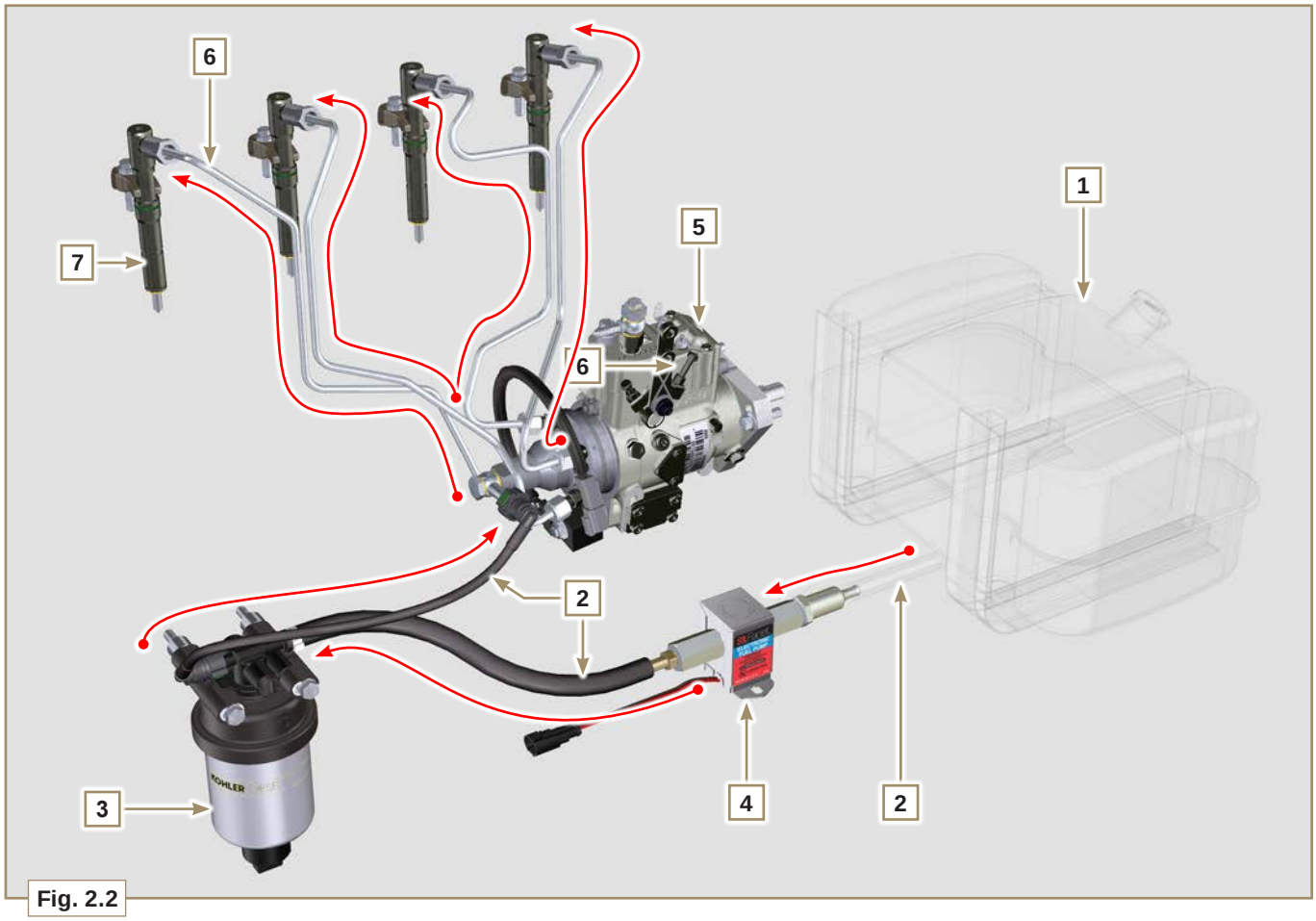


Fig. 2.2

Tab. 2.11

POS.	DESCRIPTION
1	Fuel tank
2	Fuel supply hose from the tank to the injection pump
3	Fuel filter
4	Electrical fuel feed pump
5	Injection pump
6	Injector high-pressure hose from the injection pump to the injectors
7	Injectors

The fuel supply system is under low pressure from the tank **1** to the injection pump **5**.

NOTE: The representation of fuel tank is purely indicative. Component not necessarily supplied by **KOHLER.**

2.9.2 Fuel return circuit

The fuel return circuit is under low pressure.

Tab. 2.12

POS.	DESCRIPTION
1	Injectors
2	Injectors fuel return pipe
3	Injection pump
4	Fuel tank
5	Fuel return pipe to the tank

NOTE: The representation of fuel tank is purely indicative.
Component not necessarily supplied by **KOHLER.**

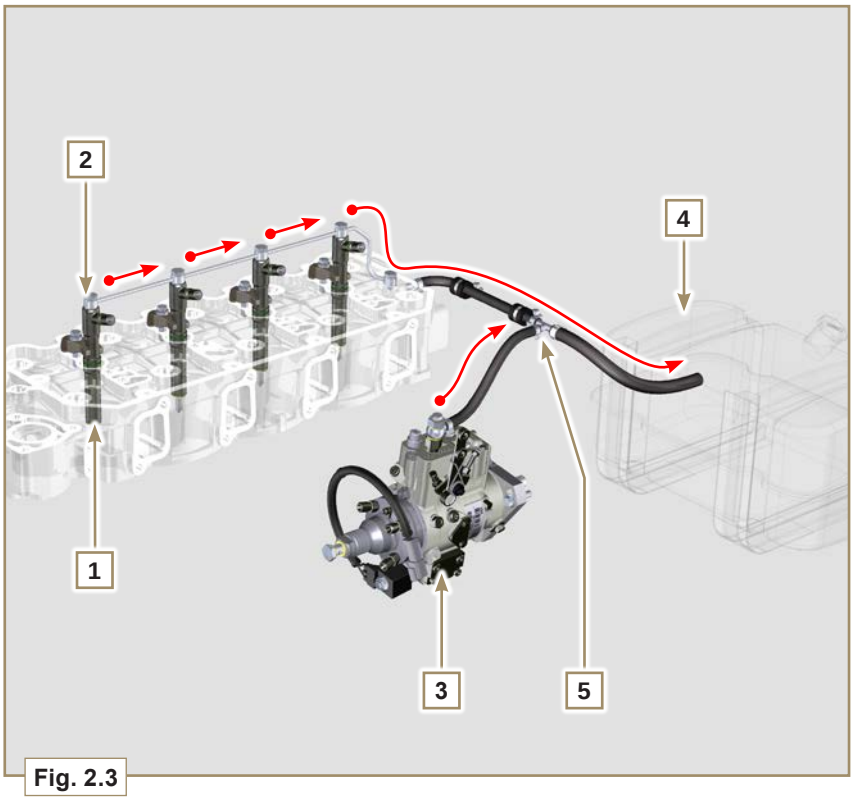


Fig. 2.3

2.9.3 Injection pump

Pressure into the injection pump must be positive in all operating conditions.
The injection pump is operated by means of the pump control gear (**Tab. 2.40 - Pos. 7**) and sends high-pressure fuel to the injectors.

NOTE: In the event of leakage from the high pressure circuit do not intervene with the engine running, but turn it off and wait 5 - 10 minutes before checking the leak.

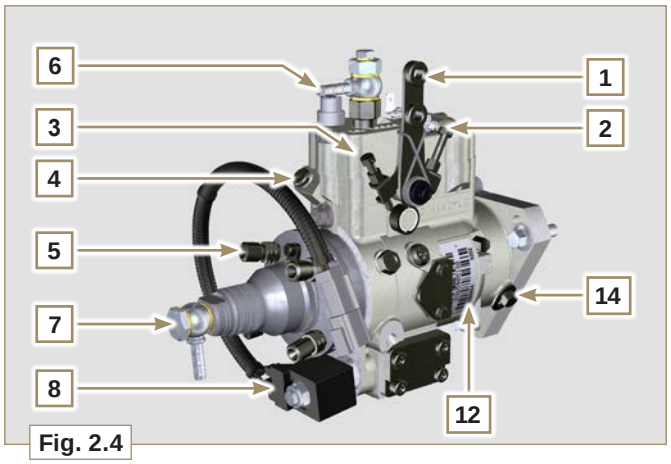


Fig. 2.4

Tab. 2.13

POS.	COMPONENTS DESCRIPTION
1	Accelerator lever
2	Max adjustment
3	Min Adjustment
4	Torque adjustment
5	High pressure delivery to injectors
6	Return to fuel tank
7	Inlet suction fuel
8	Cold Start Advance
9	Gasket
10	Shaft
11	Advance settings (locked)
12	Pump identification label
13	Air bleeding screw
14	Pump control shaft blocking device

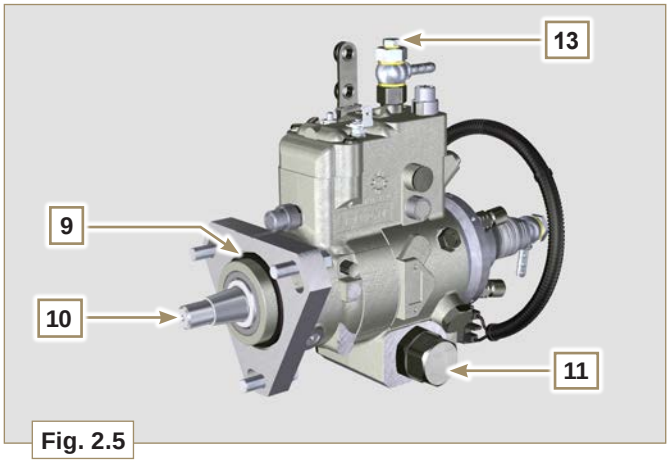


Fig. 2.5

2.9.4 Injector

It is a device used to introduce fuel, in the form of one or more jets that are adequately pulverised and suitably oriented directly into the combustion chamber. They consist of a metallic body that internally provides a mobile element that acts on the needle: this, rising against the action of a calibrated spring, allows the release of fuel under high pressure.

Important

- The injectors are calibrated individually.
- Fuel contamination causes serious damage to the injection system.

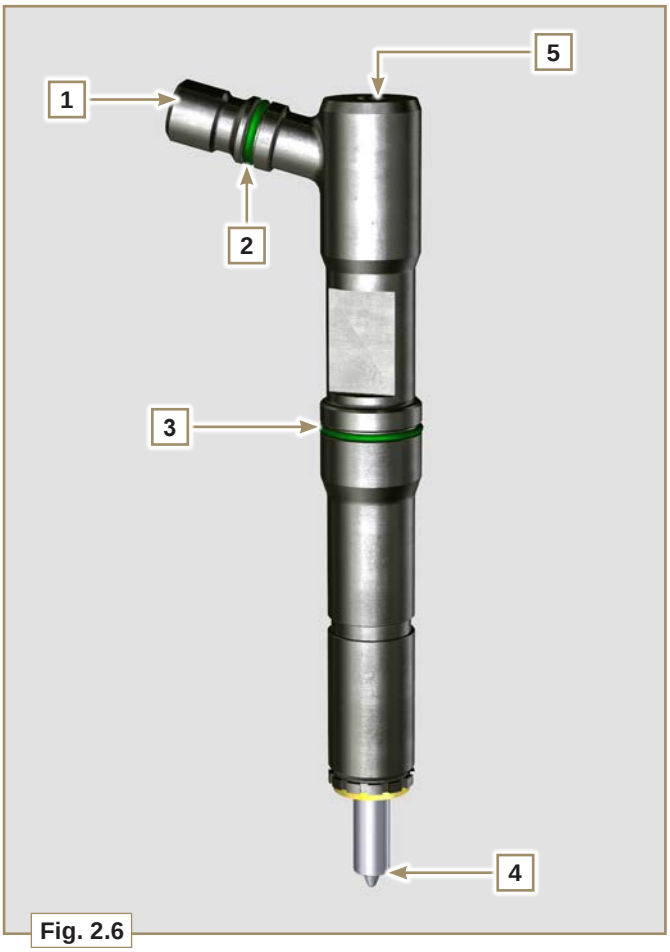


Fig. 2.6

Tab. 2.14

POS.	COMPONENTS DESCRIPTION
1	Inlet fuel
2	Gasket
3	Gasket
4	Nozzle
5	Hole for fuel return to fuel tank

2.9.5 Fuel filter

The fuel filter is situated on the crankcase of the engine or it may be assembled on the frame of the vehicle.

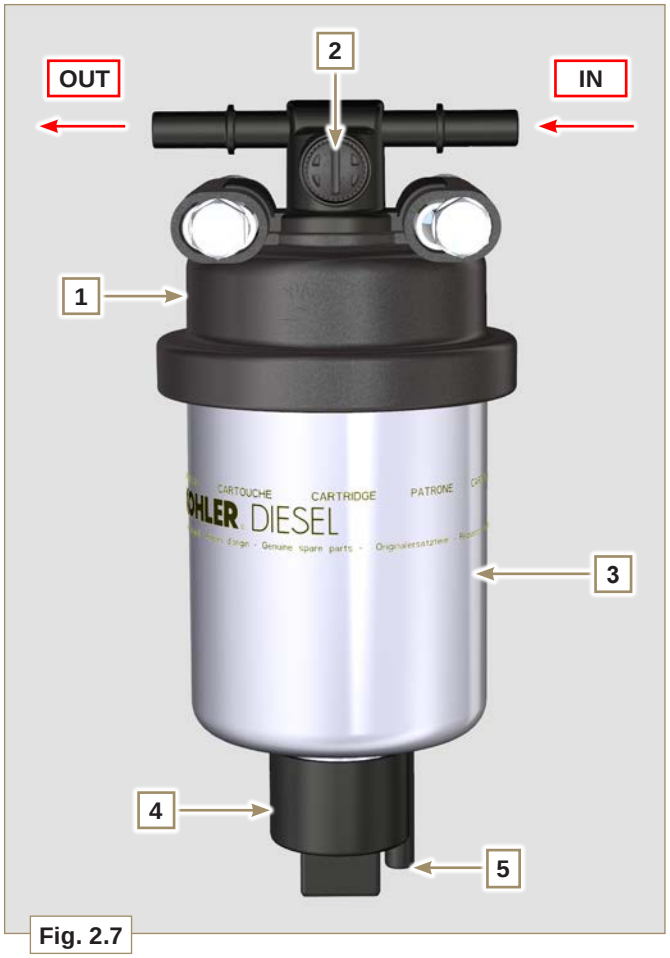


Fig. 2.7

Tab. 2.15

POS.	COMPONENTS DESCRIPTION
1	Fuel filter support cartridge
2	Air bleeding screw
3	Cartridge
4	Water draining device
5	Hole water drainage

Tab. 2.16 ***Cartridge characteristics.***

DESCRIPTION	VALUE
Filtering surface	2,300 cm^2
Degree of filtration	5 µm
Max operating pressure	2.0 Bar

2.9.6 Electric fuel pump (optional)

When the electric fuel pump is installed in a diesel engine, one must:

1 - Remove any filters installed on the inlet of the electric injection pump;
2 - Insert a pre-filter between the tank and the electric pump;
3 - The electric pump may be assembled on application at a maximum height of 500 mm from the position of the fuel tank.
4 - Insert a shut-off valve to prevent dry operation due to the emptying of the intake manifold;
5 - The supply pressure given from the electric pump must not exceed the pressure of 0.2 bar to the input of injection pump.

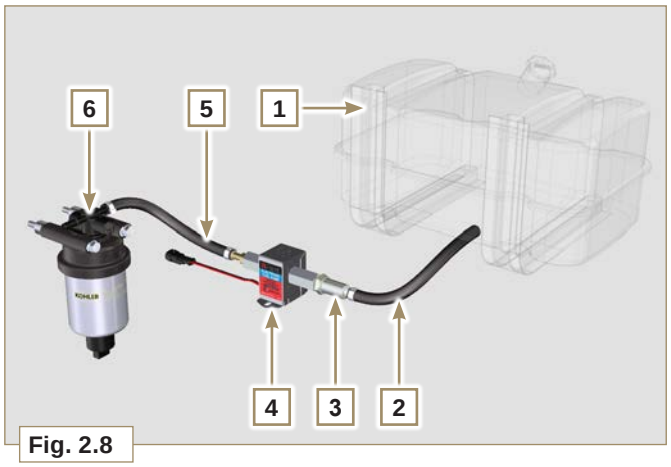


Fig. 2.8

Tab. 2.17

POS.	DESCRIZIONE
1	Fuel tank
2	Arrival pipe from the tank
3	Prefilter
4	Electric pump
5	Flow pipe to the fuel filter
6	Fuel filter

2.9.7 Guards for fuel injection circuit components

High-pressure injection circuit components are particularly sensitive to impurities.
To prevent impurities, even microscopic ones, from accessing the fuel input or output unions, you are required to close these accesses by means of specific caps as soon as the various tubes are disassembled and disconnected.
Disassembly of any component of the injection circuit must not occur in dusty environments.
Cap guards must remain closed in their housing (**ST_40**) until the moment they are to be used.

Pay special attention when using the caps and avoid any contamination of dust or dirt of any kind.

Even after using the caps illustrated in this paragraph, all components of the injection circuit must be placed with care in environments that are free of any type of impurity.

Fig. 2.10, and **2.11** illustrate the caps that must be used on components of the injection circuit.

Cap guards must be accurately washed after use and placed back in their housing **ST_40**.

Important

- It is highly recommended to have this page visible during disassembly operations of the components of the fuel injection circuit.

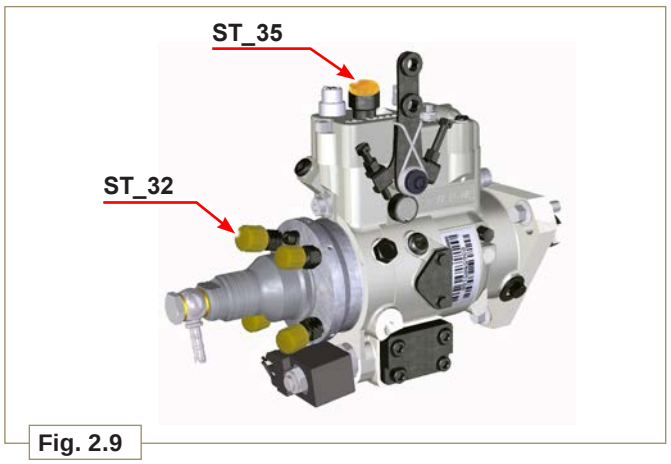


Fig. 2.9

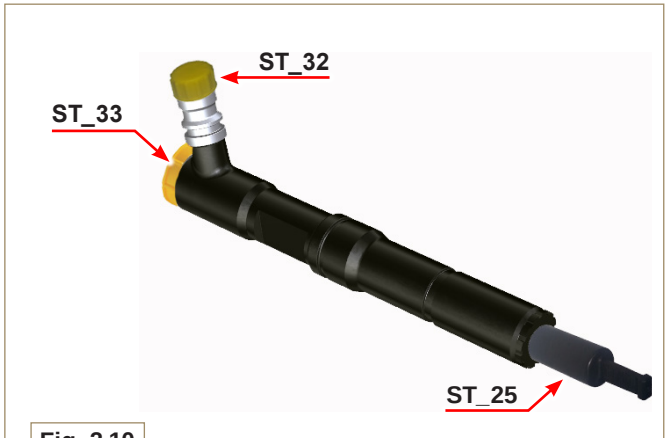


Fig. 2.10

2.10 Lubrication circuit

2.10.1 Lubrication circuit diagram

The oil pump is driven by the crankshaft on the timing system side.
On the parts of the systems shown in green on In the parts in green, the oil is in intake, in the parts in red, the oil is under pressure and in those in yellow the oil is returning towards the oil sump 2 (not under pressure).

Tab. 2.18

COLOUR	DESCRIPTION
	Oil in intake
	Oil under pressure
	Oil returning to the oil sump

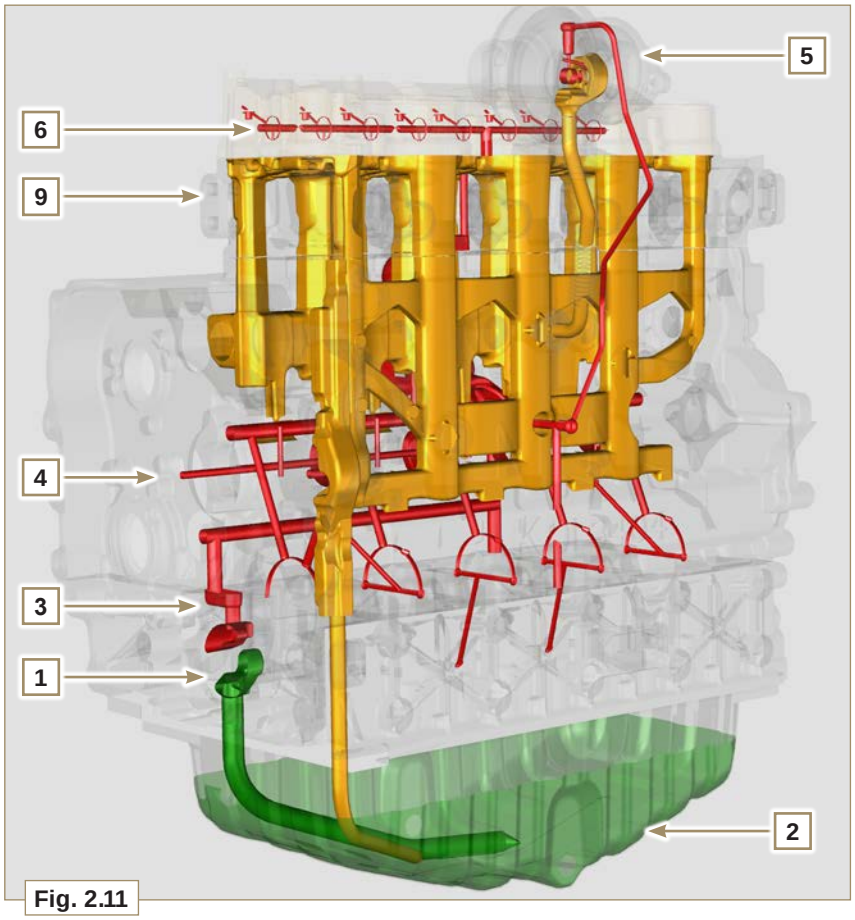


Fig. 2.11

Tab. 2.19

POS.	DESCRIPTION
1	Oil pump rotors
2	Oil sump
3	Crankshaft
4	Camshaft
5	Turbocharger
6	Rocker arm pin
7	Hydraulic tappets
8	Rocker arm cover
9	Cylinder head
10	Upper crankcase
11	Lower crankcase
12	Oil filter
13	Oil Cooler

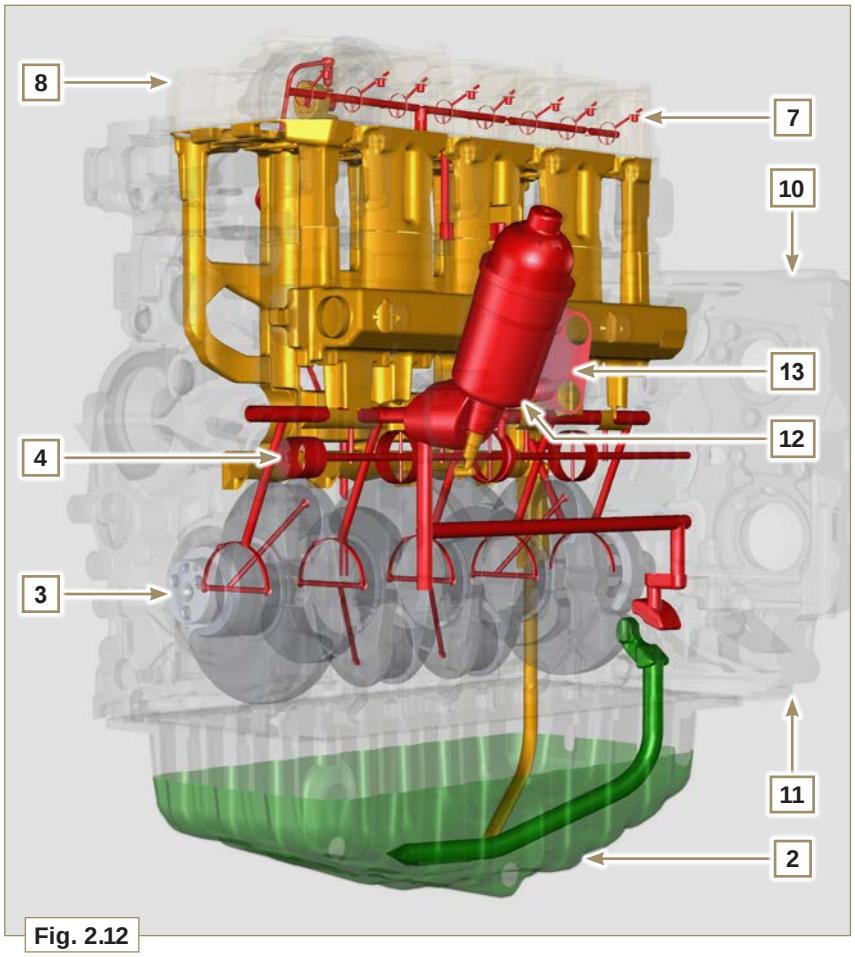


Fig. 2.12

2.10.2 Oil pump

The oil pump rotors are trochoidal (with lobes) and are activated from the crankshaft by means of the key.
The pump body is situated inside the distribution guard.
It is imperative to assemble the rotors with reference **A** visible by the operator.

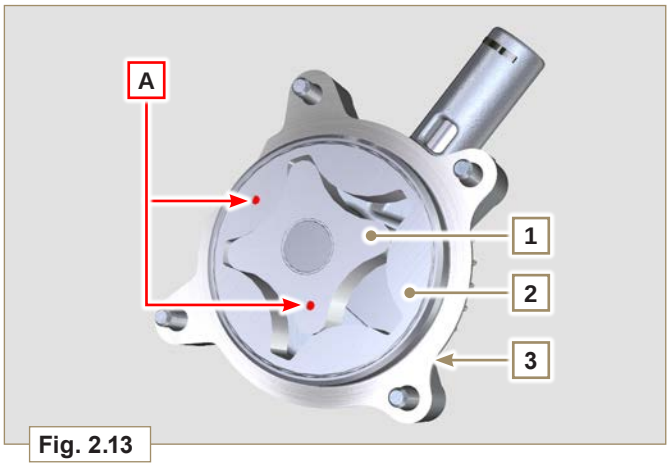


Fig. 2.13

Tab. 2.20

POS.	DESCRIPTION
1	Internal rotor
2	External rotor
3	Oil pump crankcase
4	Oil pump control gear
5	Crankshaft gear

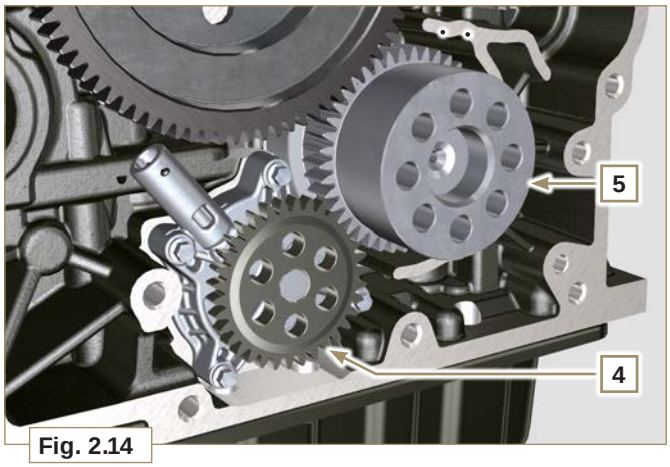


Fig. 2.14

2.10.3 Oil filter and Oil Cooler

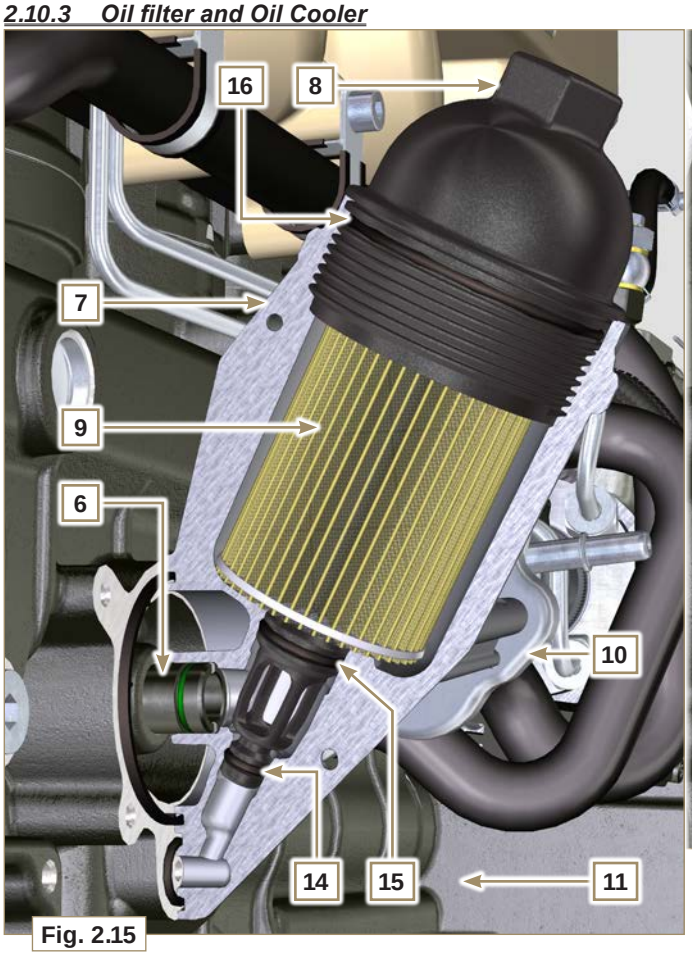
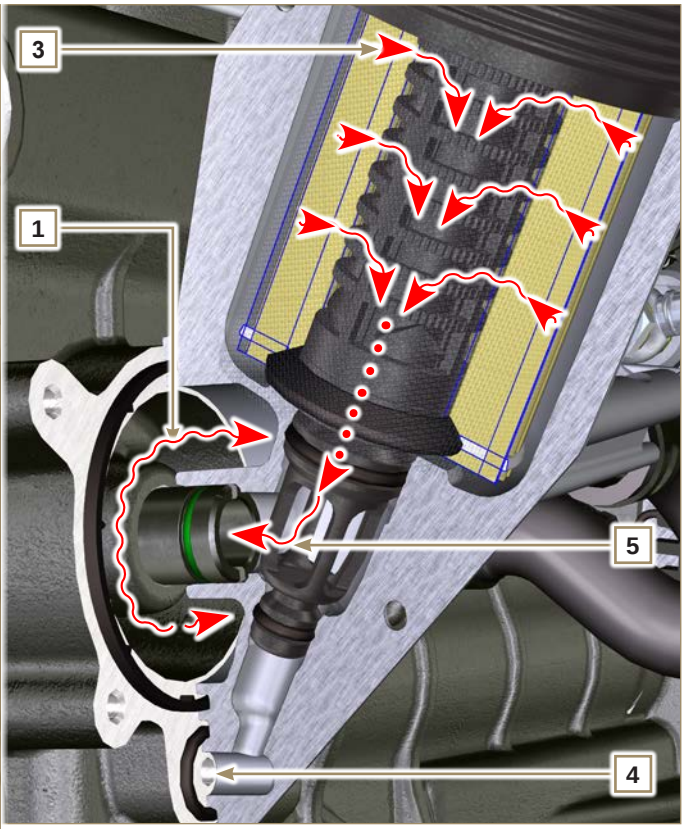


Fig. 2.15



NOTE: **unscrewing the cartridge holder cover makes the oil in support 7 flow towards the oil sump by means of the drain duct 4.**

Tab. 2.21

POS.	DESCRIPTION
1	Oil arriving from the pump
2	Oil cooling
3	Oil filtering
4	Oil drain duct (oil sump return)
5	Oil returning into the circuit
6	Outgoing fitting from filter
7	Oil filter support
8	Cartridge holder cover
9	Oil filter cartridge
10	Oil Cooler
11	Crankcase
12	Oil flowing to the cartridge
13	Coolant
14	Oil drain duct closure gasket
15	Oil filtering chamber closure gasket
16	Cartridge holder cover gasket

Tab. 2.22 ***Cartridge characteristics.***

DESCRIPTION	VALUE
Filtering surface	2,300 cm^2
Degree of filtration	2 µm
Max operating pressure	4.0 Bar
Max flow rate	190 litres/hour

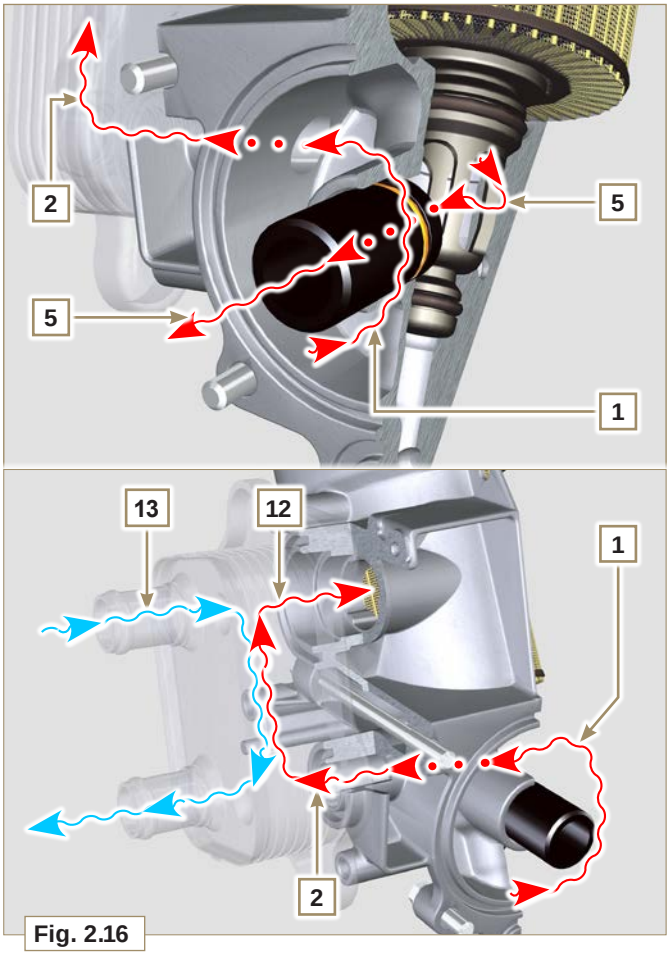


Fig. 2.16

2.11 Coolant circuit

2.11.1 Coolant circuit diagram

Tab. 2.23

POS.	DESCRIPTION
1	Coolant pump
2	Coolant intake
3	Coolant, cylinder
4	Coolant, cylinder head
6	Coolant to radiator
7	Coolant into radiator
9	Coolant in the Oil Cooler
10	Coolant input into the Oil Cooler
11	Coolant output from the Oil Cooler
12	Vent line from radiator (to **15**)
14	Return from compensation tank
15	Compensation tank
16	Thermostatic valve
17	Coolant drain cap from crankcase

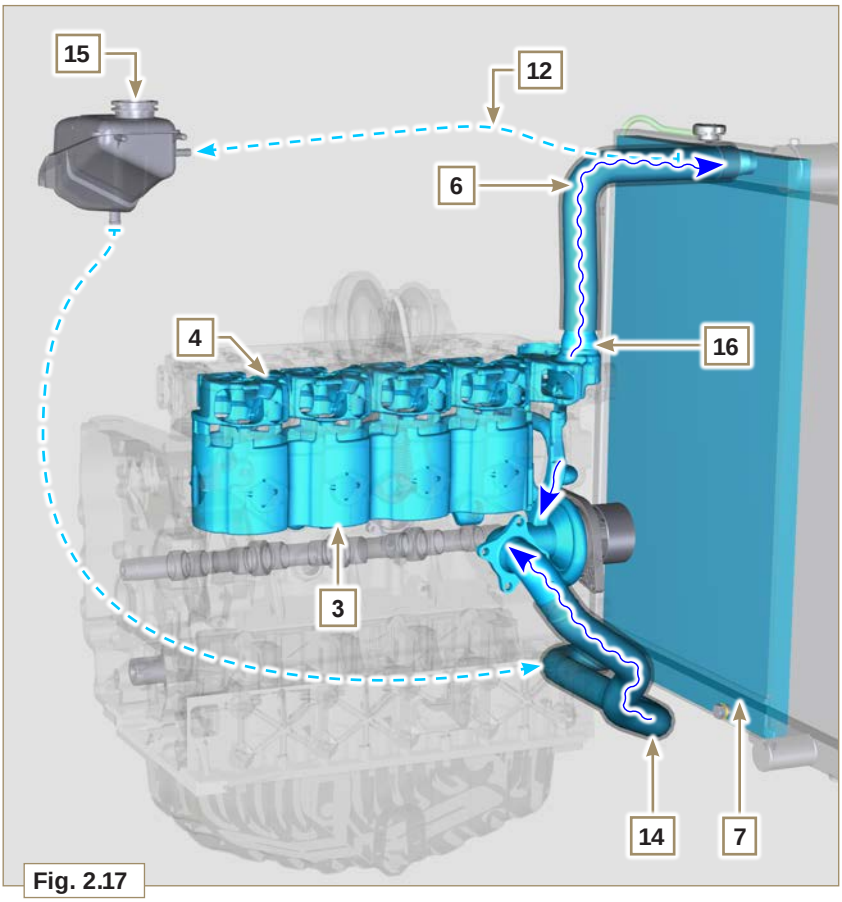


Fig. 2.17

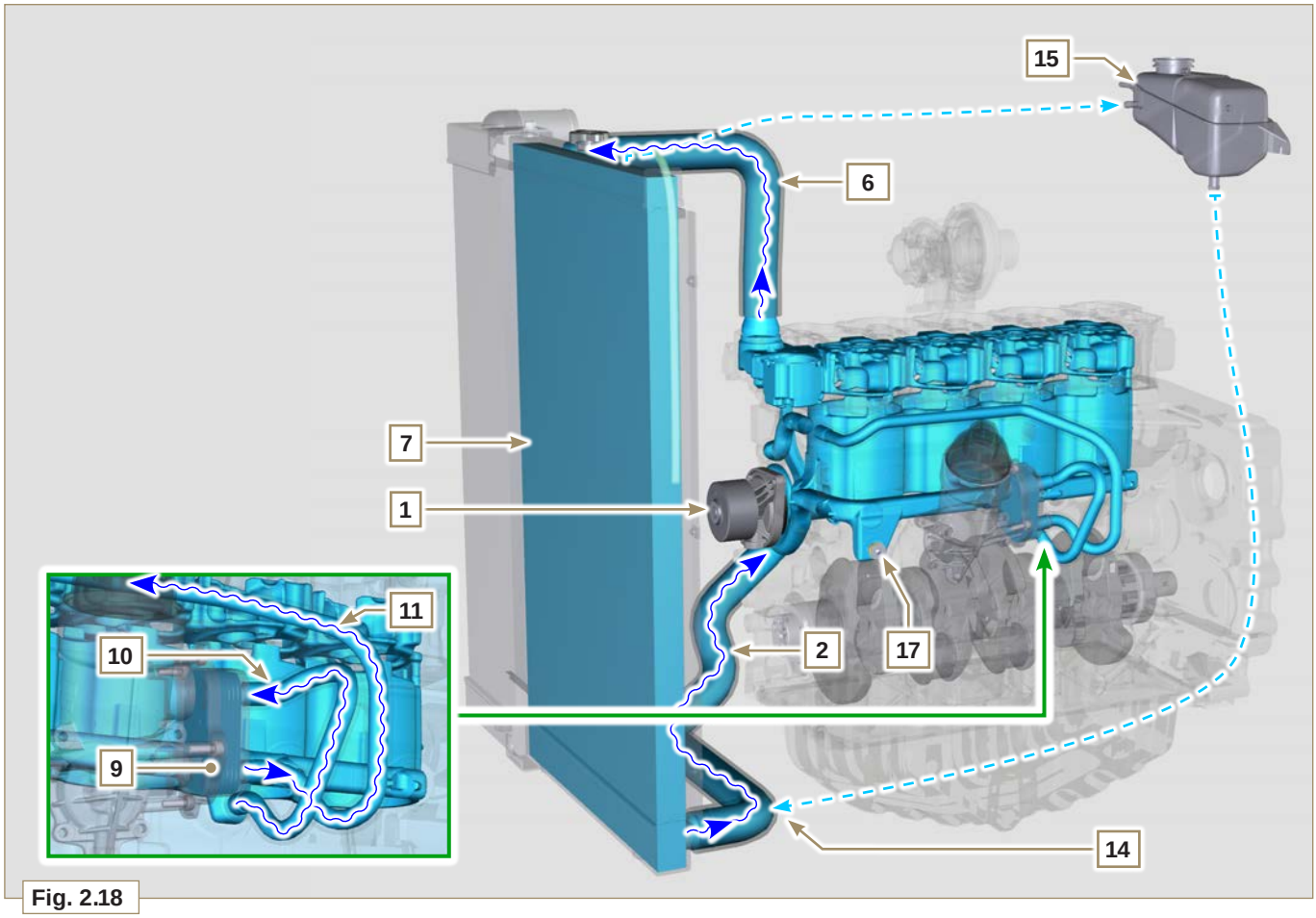


Fig. 2.18

2.11.2 Coolant pump

Tab. 2.24

POS.	DESCRIPTION
1	Coolant pump control pulley
2	Coolant intake fitting

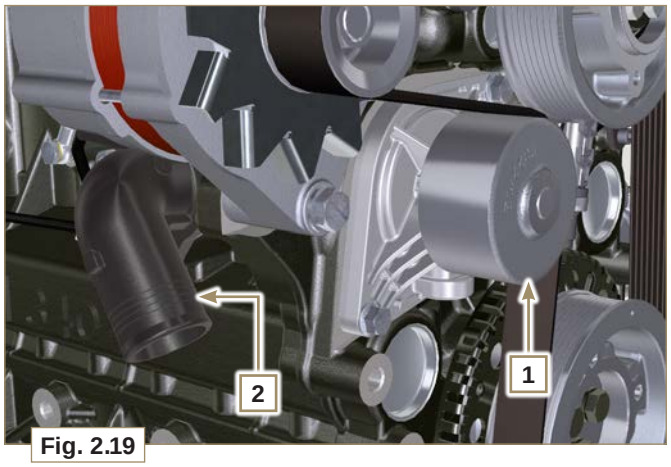


Fig. 2.19

2.11.3 Thermostatic valve

Tab. 2.25

POS.	DESCRIZIONE
1	Cylinder head
2	Coolant outlet cover
3	Thermostatic valve
4	Gaskets
5	Air bleeding hole

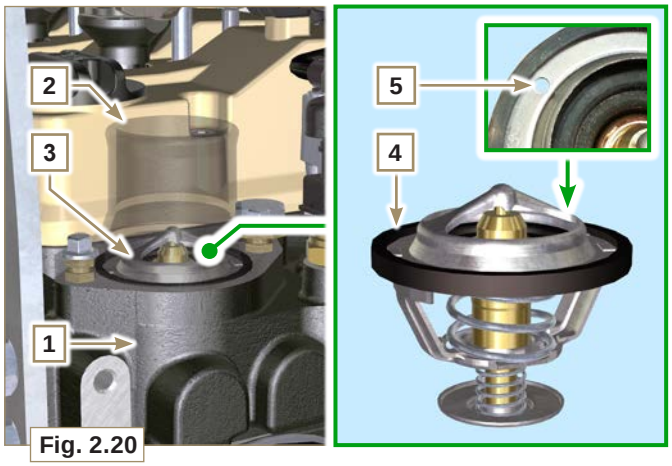


Fig. 2.20

Opening temperature +89° ± 3°C.

2.11.4 Radiator (optional)

Tab. 2.26

POS.	DESCRIPTION
1	Radiator
2	Coolant refill cap
3	Vent tube or excess coolant return
4	Coolant flow manifold
5	Coolant intake manifold
6	Fan
7	Protective grid
8	Air hose (from Intercooler to manifold - **Fig. 2.22**)
9	Intercooler air delivery hose (**Fig. 2.22**)
10	Compressed air delivery hose to the intake manifold **(Fig. 2.21)**

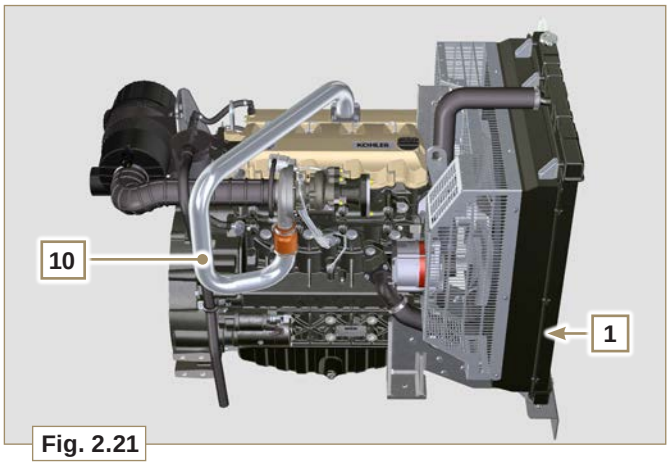
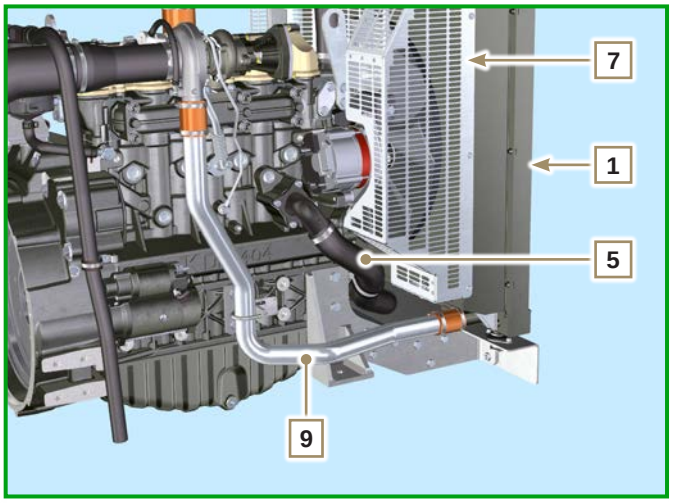


Fig. 2.21

NOTE: Nella **Fig. 2.21** illustrates the radiator without Intercooler (the differences in POS. 10). **Fig. 2.22** illustrates the radiator with Intercooler (the differences in POS. 8 - 9).

Component not necessarily supplied by **KOHLER**.



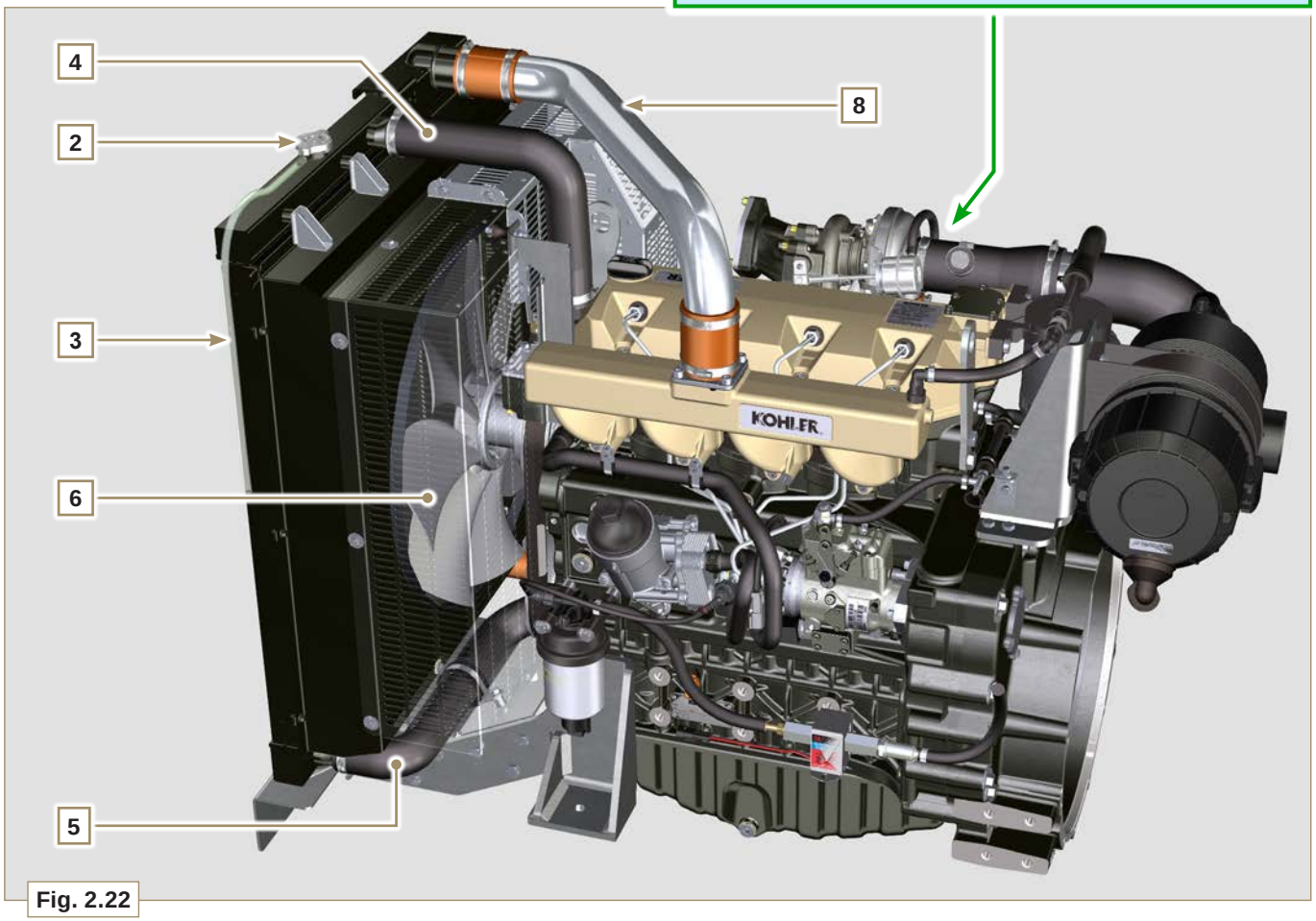


Fig. 2.22

2.12 Intake and exhaust circuit

2.12.1 Intake and exhaust circuit diagram with Intercooler

Air in intake Gas in exhaust

Tab. 2.27

POS.	DESCRIPTION
1	Air in intake from air filter
2	Air in compression
3	Air in intercooler flow
4	Air cooling
5	Air in intake manifold flow
6	Cylinder head air intake
7	Air in cylinder intake
8	Gas in cylinder outlet
9	Cylinder head gas outlet
10	Exhaust gas from the turbocharger
A	Diagram, intake and exhaust circuit without Intercooler
B	Exhaust manifold
C	Crankcase
D	Radiator/intercooler

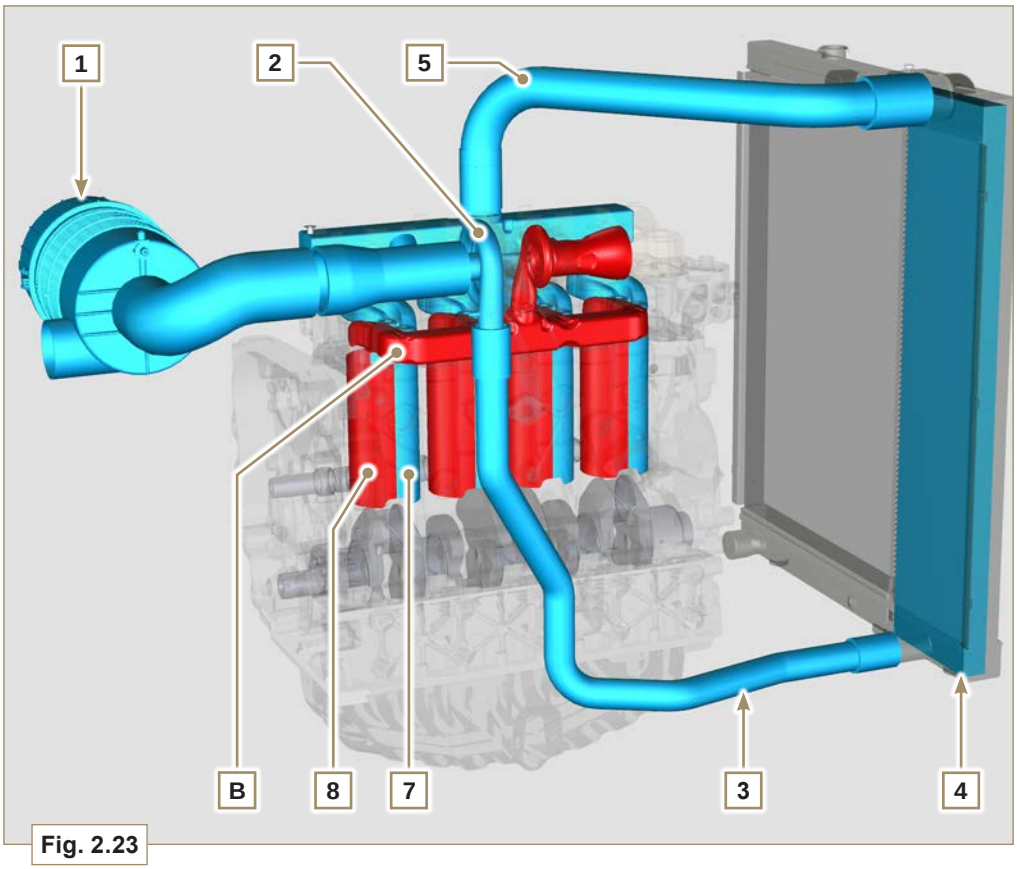


Fig. 2.23

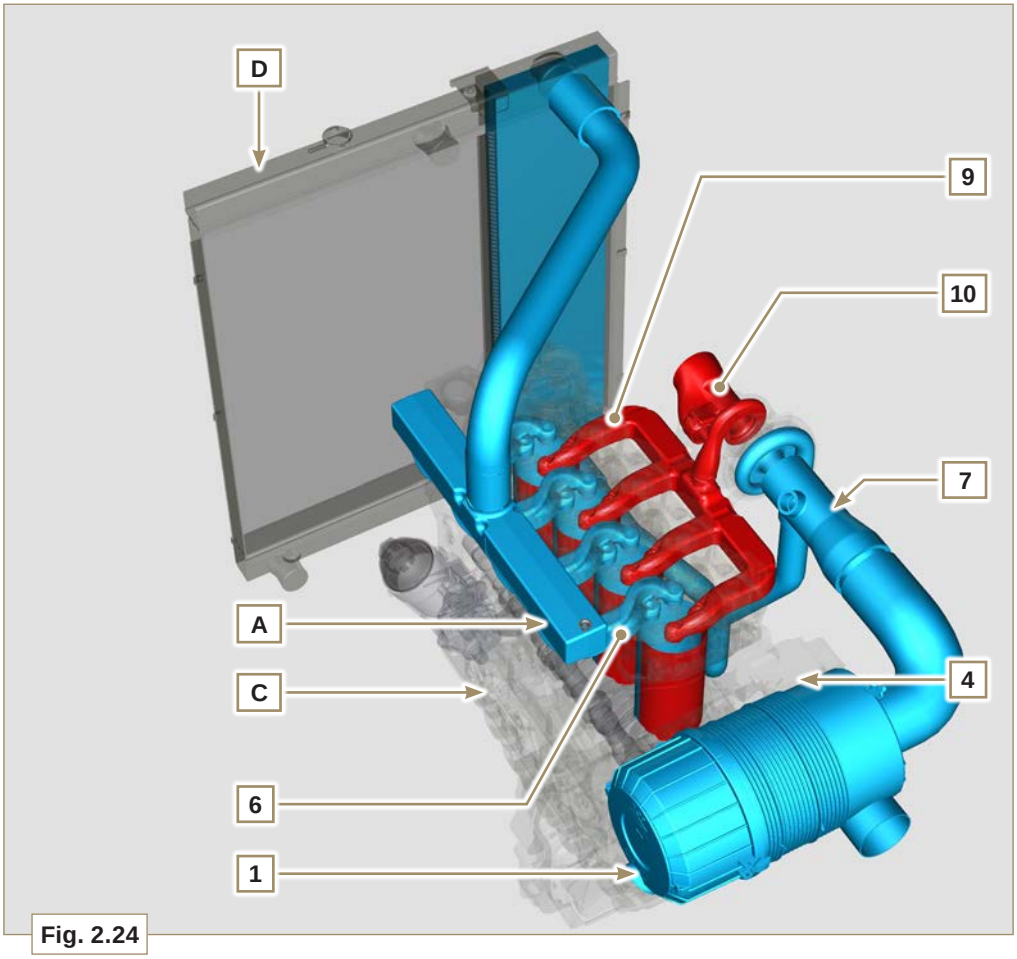


Fig. 2.24

Important

- The air temperature inside the intake manifold must never exceed that of the environment by 10°C.

Clean air is sucked by means of an intake manifold and via ducts in the cylinder head, enters the cylinders. Compressed air inside the cylinders and mixed with the fuel transforms into Gas after combustion. Gas is expelled from the cylinders and sent to the exhaust manifold, which expels the gas towards the exhaust muffler.

2.12.2 Diagram, intake and exhaust circuit without Intercooler

Air in intake Gas in exhaust

Tab. 2.28

POS.	DESCRIPTION
1	Air in intake from air filter
2	Air in compression
3	Air in intake manifold flow
4	Air in head intake
5	Air in cylinder intake
6	Gas in cylinder outlet
7	Gas in head outlet
8	Exhaust gas from the turbocharger
A	Intake manifold
B	Exhaust manifold
C	Crankcase

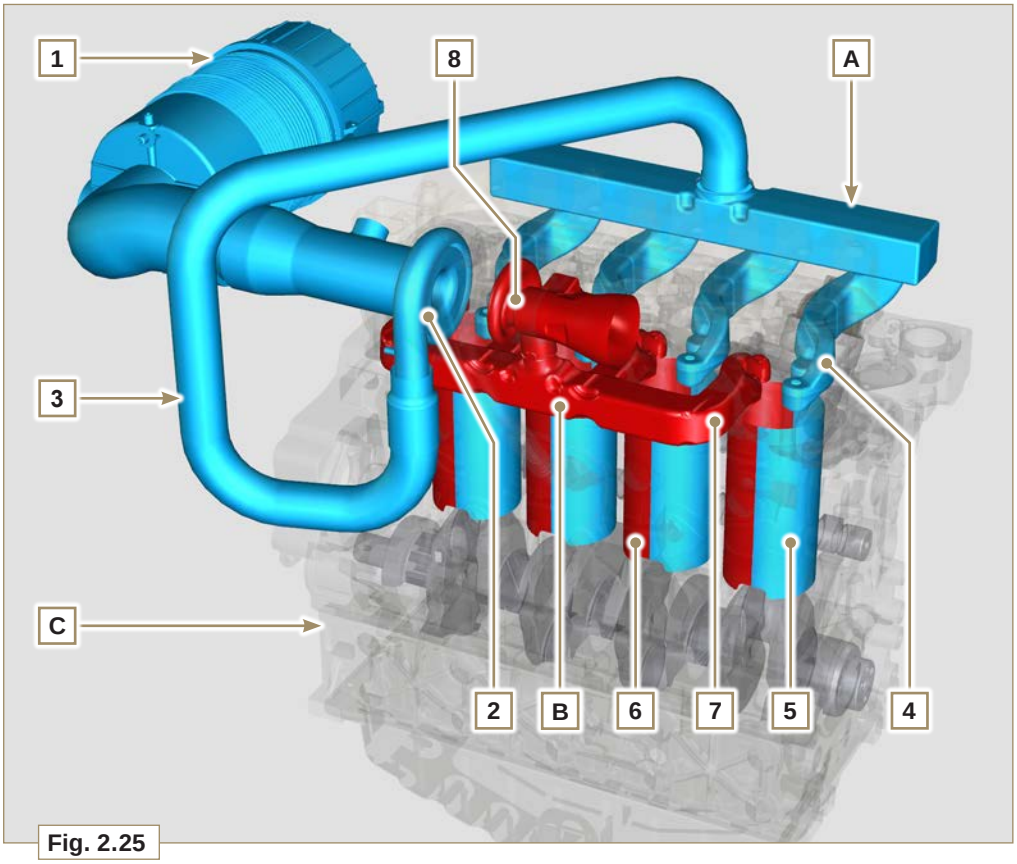


Fig. 2.25

2.12.3 Turbocharger

The turbocharger is controlled by means of exhaust gas that activates the turbine.

Important

- **See Par. 2.19**.

Tab. 2.29

POS.	DESCRIPTION
1	Air intake hose
2	Air compression volute
3	Turbo charger central body
4	Turbine housing with Waste Gate valve
5	Gas exhaust flange
6	Waste Gate control valve hose
7	Waste Gate valve control actuator
8	Waste Gate control valve linkage
9	Air compressed flow pipe to intercooler
10	Oil drain pipe
11	Turbo charger lubrication pipe

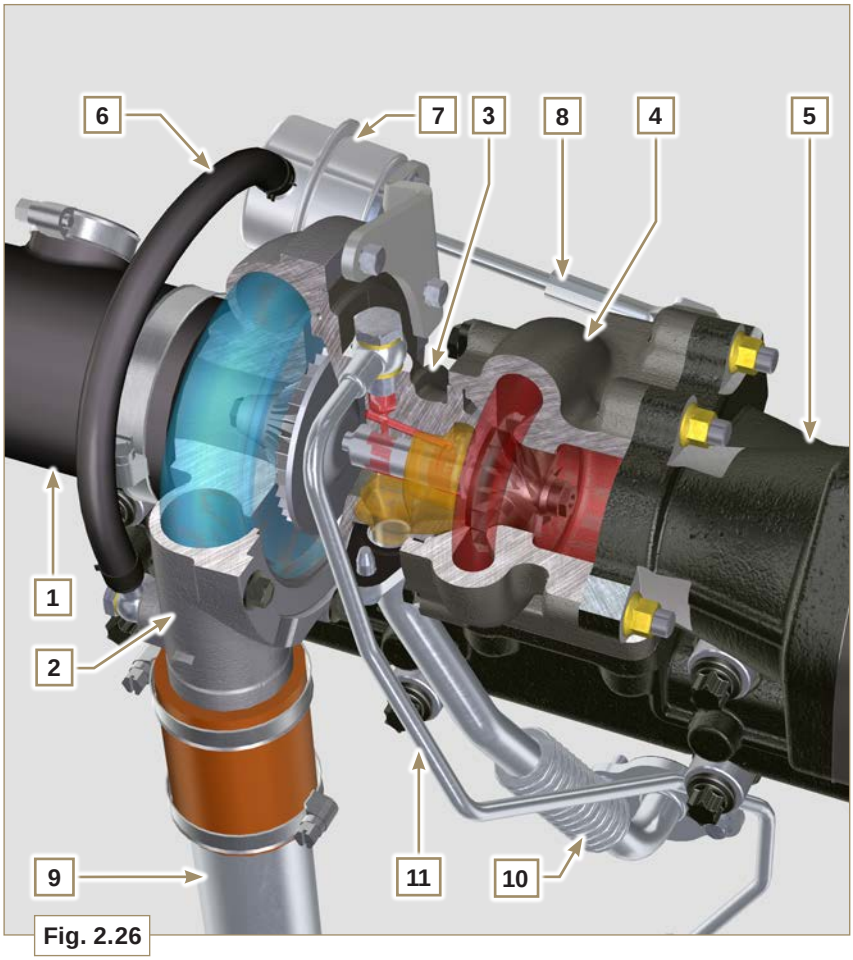


Fig. 2.26

2.12.4 Air filter (optional)

NOTE: Component not necessarily supplied by **KOHLER**.

Important

- The air filter is a dry-type one, with a replaceable paper filter cartridge **H** (refer to **Tab. 2.8** and **Tab. 2.9** for procedure frequency on components).
- The filter intake must be positioned in a cool area.
- Should a hose be used, the length must not exceed 400 mm and is to be as straight as possible.

Tab. 2.30

POS.	DESCRIPTION
H	Air filter cartridge
M	Filter cover
N	Filter support
Q	Dust exhaust valve
R	Filter cover hook

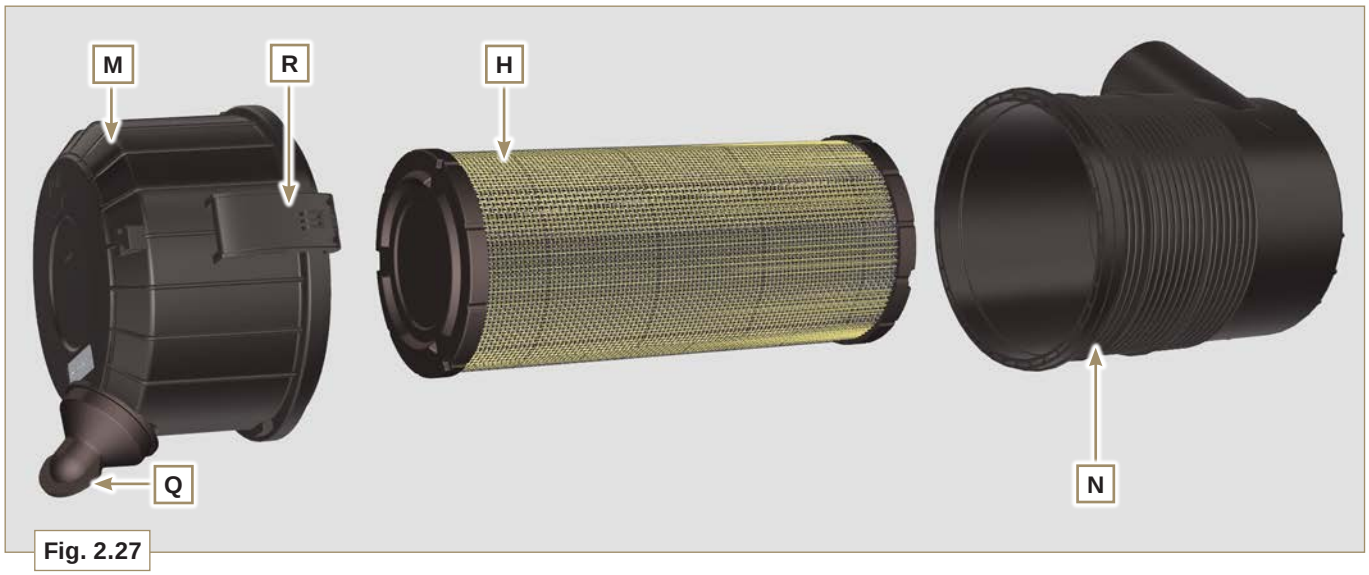


Fig. 2.27

2.12.5 Internal EGR

The internal EGR is only on Stage IIIA or Tier 3 engines provided with "CE" approval (Par. 1.2) or "EPA" name plate (Par. 1.3).
It is a system that enables breakdown of pollutants through recirculation of combusted gas by reintegrating it in the cylinder during the intake stage.
This process occurs through the use of cam **J** on the profile of exhaust cam **K** of camshaft **F**.
Cam **J** slightly opens the exhaust valves during opening of the intake valves.

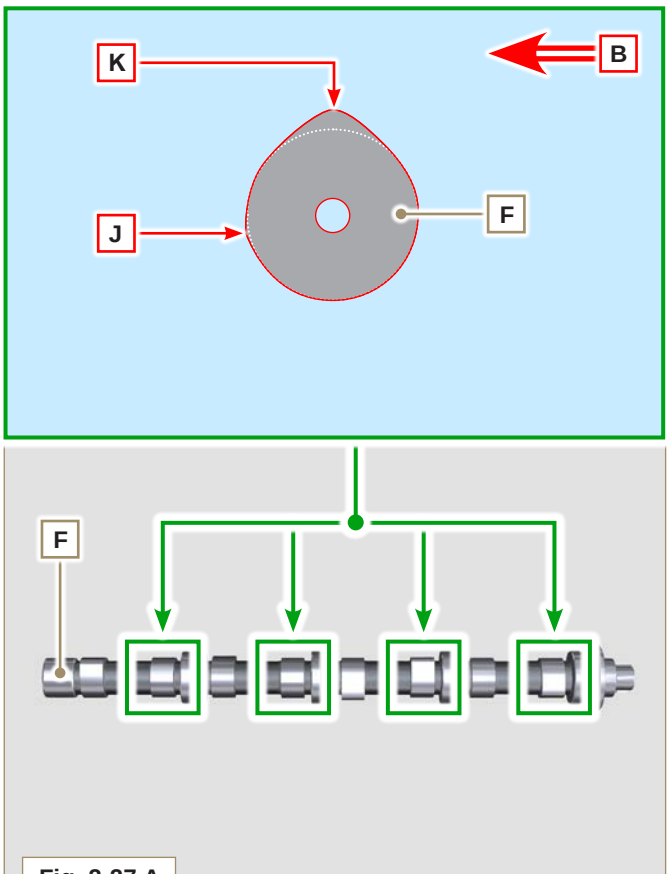


Fig. 2.27 A

2.13 Electric system

2.13.1 Engine electrical wiring (opzional)

NOTE: Component not necessarily supplied by **KOHLER.**

Electrical wiring is supplied upon request, it interfaces with the panel by means of 19-way Deutsch connectors (female on engine panel - male on accessories panel).

The connectors are described in **Tab. 2.31**.

Tab. 2.31

REF.	DESCRIPTION
1	Engine panel connector interface (**Fig. 2.27**)
2	Accessories panel connector interface (**Fig. 2.28**)
3	Electrical fuel pump connector
4	Cold Start Advance connector (on injection pump - **Fig. 2.46**)
5	Fuse connector
6	Electro-Stop connector (on injection pump)
7	"L" alternator connector (Iskra)
8	"W" alternator connectors (Iskra)
9	Coolant temperature sensor connector
10	Oil pressure switch connector
11	Starter motor connector "+ 50"
12	Starter motor connector "+ 30"
13	Air cleaner clogging sensor connector
14	Earth connector

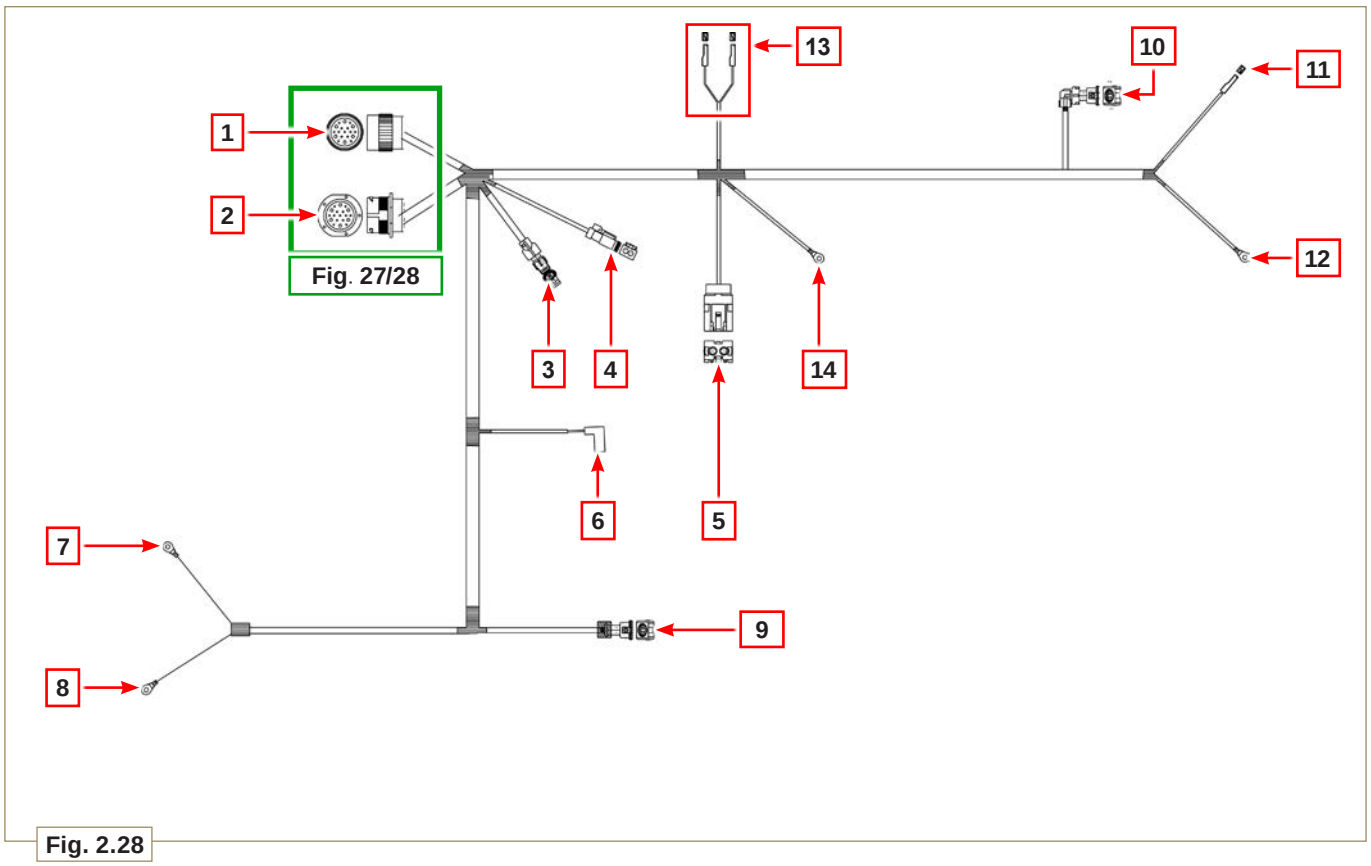


Fig. 2.28

2.13.1.1 Connector panel on the engine/machine

The connector is a female 19-way Deutsch type. There is a list of all PIN connections in **Tab. 2.32**.

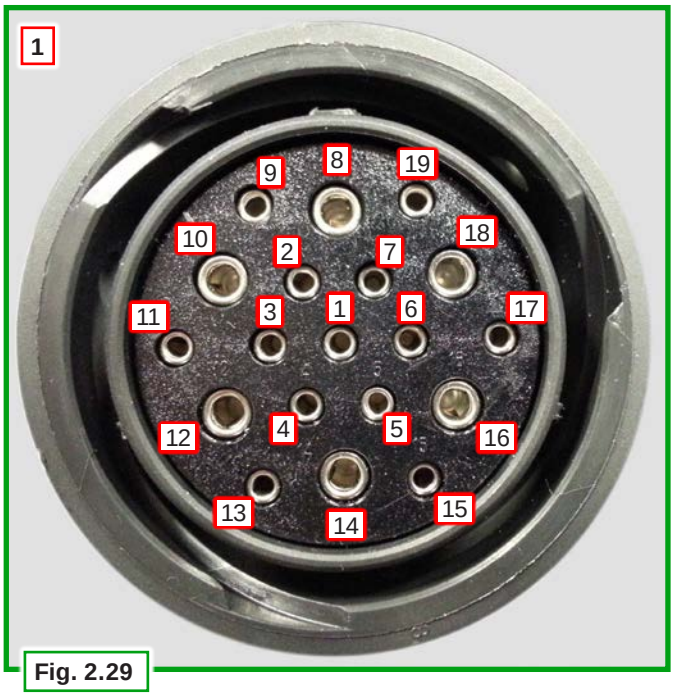


Fig. 2.29

Tab. 2.32

PIN.	INLET SIGNALS TO THE PANEL
1	Oil pressure switch
2	Alternator indicator light
3	Coolant temperature warning light
4	Air cleaner clogging warning light
7	Outlet indicator general alarm
9	Electro-Stop
13	Alternator (W)
14	Starter motor (+ 30)
15	Inlet indicator general alarm
PIN.	**OUTLET SIGNALS FROM THE PANEL**
5	Earth
6	IG excitation alternator (+15 wrench)
8	Starter motor (+ 50)
10	Grid heater (Relay)
11	Electric pump
18	Injection pump (Cold Start Advance - **Fig. 2.46**)

2.13.1.2 Accessories panel connector

The connector is a male 19-way Deutsch type. There is a list of all PIN connections in **Tab. 2.33**.

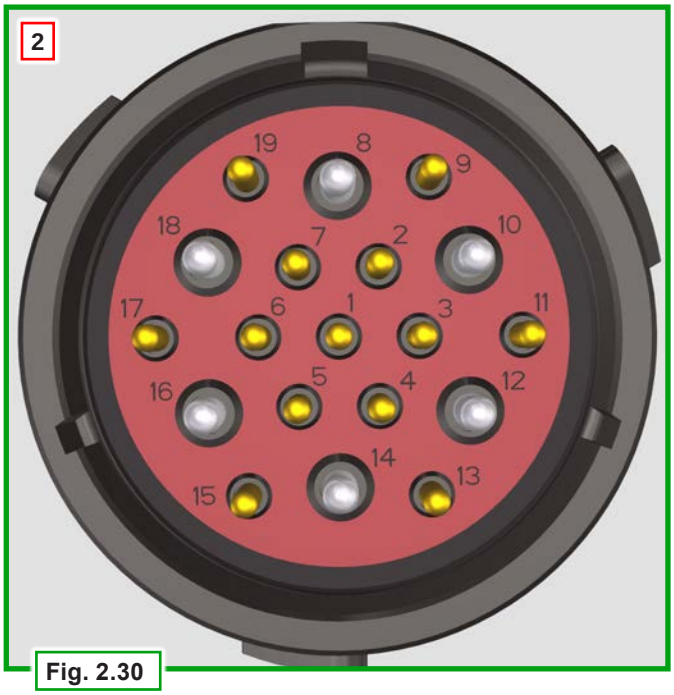


Fig. 2.30

Tab. 2.33

PIN.	INLET SIGNALS TO THE PANEL
2	Fuel filter (water detection sensor)
4	Radiator (coolant level sensor)
7	Outlet indicator general alarm
9	External Stop
15	Inlet indicator general alarm
19	Fuel tank (fuel level sensor)
PIN.	**OUTLET SIGNALS FROM THE PANEL**
5	Earth
6	Relay with 5A fuse (+ 15 wrench)
10	Grid heater (Relay)
13	Alternator (W)
17	Coolant temperature warning light

2.13.1.3 Wiring disconnection

Some sensor connectors and electronic control devices are sealed.
This tipe of connectors must be disconnected by means of pressure on tabs **A** or unblock the retainers **B**, as illustrated from **Fig. 2.29** to **Fig. 2.33**.

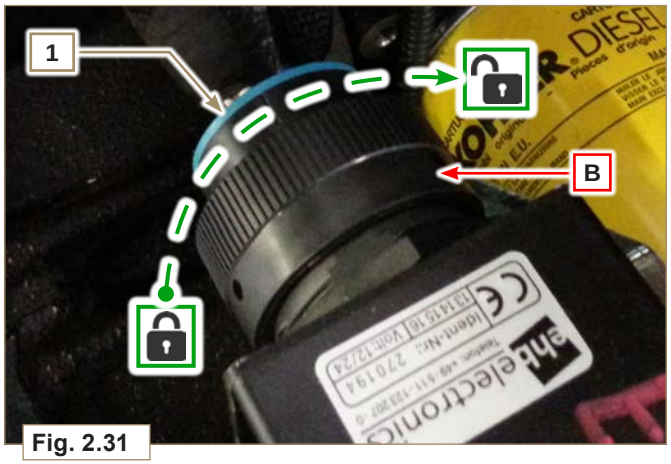


Fig. 2.31

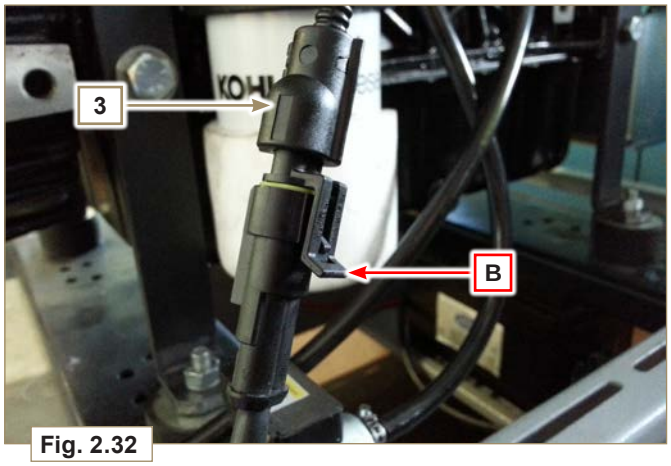


Fig. 2.32

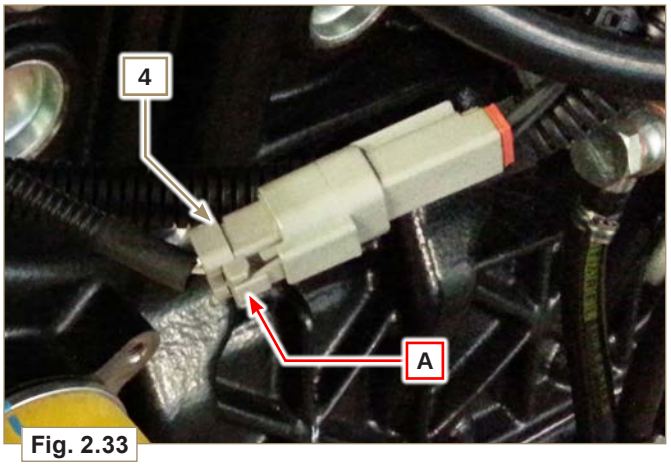


Fig. 2.33

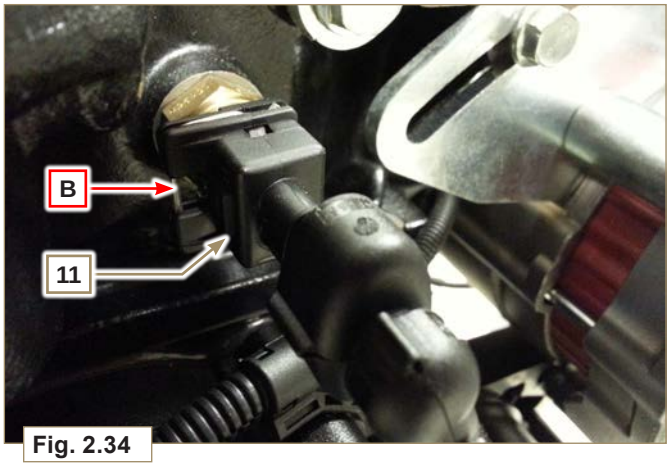


Fig. 2.34

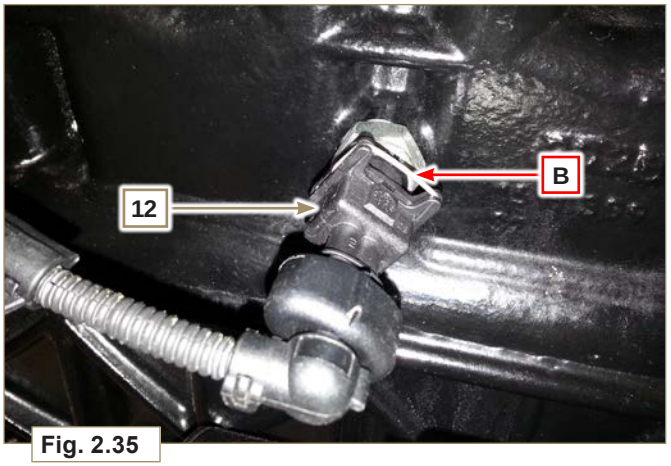


Fig. 2.35

2.14 Sensors and switches

2.14.1 Fuel filter water detection sensor (optional)

The water presence sensor in the fuel filter serves to indicate the presence of water in the fuel.
The sensor closes the electrical circuit and the warning lamp in the panel board switches on the dashboard of the car on which the motor is mounted.
Water, if present in the fuel, because of its greater specific weight separates and settles in the lower part of the filter where there is a drain plug.
Gently loosen the water drain plug without removing it and spill out the water if present. Re-tighten the water drain plug **H** as soon as the fuel spills.

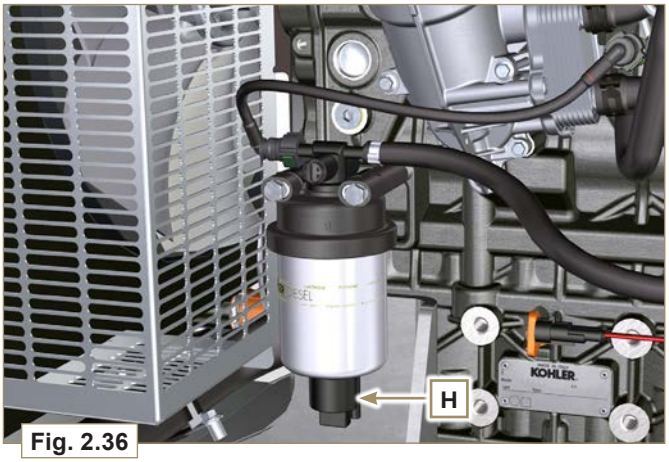


Fig. 2.36

2.14.2 Oil pressure switch

Oil pressure switch **N** is situated on the crankcase near to the injection pump.

It is a **N/C** switch, calibrated at 0.8 bar ± 0.1 bar.
The switch closes the electrical circuit and the warning lamp in the panel board switches on the dashboard of the application on which the motor is mounted.

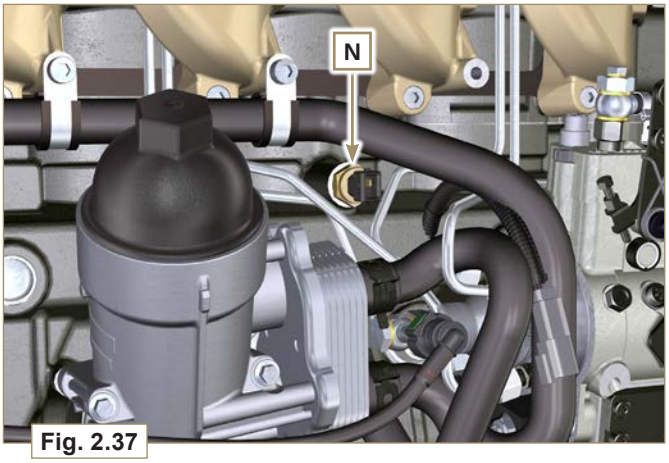


Fig. 2.37

2.14.3 Coolant temperature sensor

The coolant temperature sensor **P** of the cooling circuit is situated on the engine head.

Sensor **P1** or **P2** (**Fig. 2.39**) can be assembled on the engine:

P1 Characteristics indicated in **Tab. 2.34** (blue connector). Thermal contact N/O with closing temperature at +110 °C ±3°C, re-opening +88 °C / +100 °C.

P2 Characteristics indicated in **Tab. 2.35** (white connector). Thermal contact N/O with closing temperature at +110 °C ±3°C, re-opening +88 °C / +100 °C.

NOTE: R indicates the pin where it is possible to measure electrical resistance.

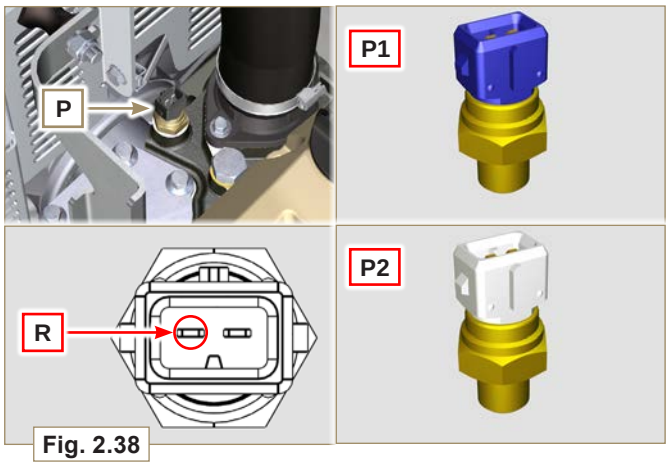


Fig. 2.38

Tab. 2.34

SENSOR P1 CHARACTERISTICS		
°C	R min Ω	R max Ω
-35	53.983	73.806
-30	39.229	52.941
-15	18.006	20.825
0	7.095	8.929
30	1.717	2.039
60	0.520	0.589
90	0.188	0.204
120	0.076	0.084

Tab. 2.35

SENSOR P2 CHARACTERISTICS		
°C	R min Ω	R max Ω
-36	11.835	15.724
-30	8.258	10.834
-16	3.721	4.753
0	1.611	2.003
30	414,1	493
60	132	151,7
90	50,27	56,11
120	21,6	24,29

2.14.4 Air cleaner clogging switch

NOTE: Component not necessarily supplied by **KOHLER.**

The switch is assembled on the air cleaner. When the filter is clogged, it sends a signal to the panel.

Features:

- Operating temperature: -30 °C / +100°C
- Contact usually open.
- Contact closed by vacuum: -50 mbar.

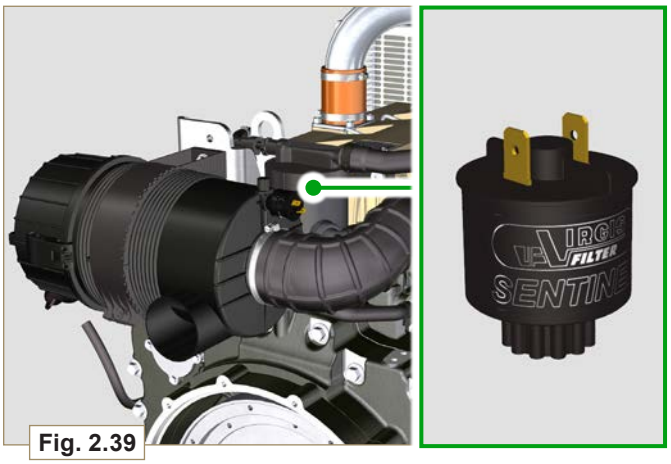


Fig. 2.39

2.15 Electrical components

2.15.1 Alternator (A)

Externally controlled by the crankshaft by means of a belt.

Characteristics:

- Ampere: 90 A
- Volt: 12 V

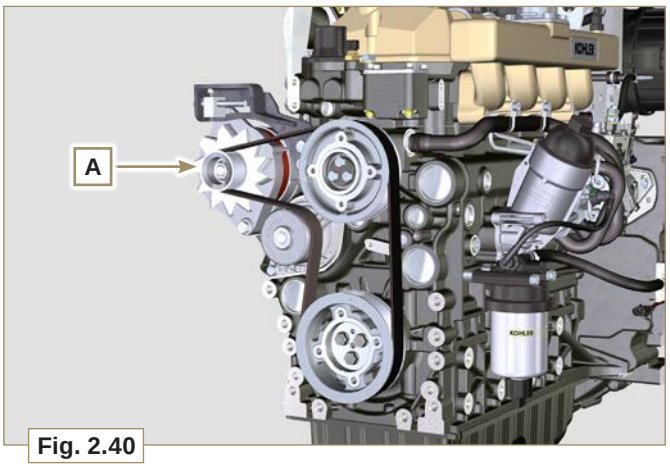


Fig. 2.40

2.15.2 Starter motor (C)

Characteristics:

• Type Bosch	12 V
• Power	3,2 kW
• Direction of rotation	anticlockwise (seen from timing system side)

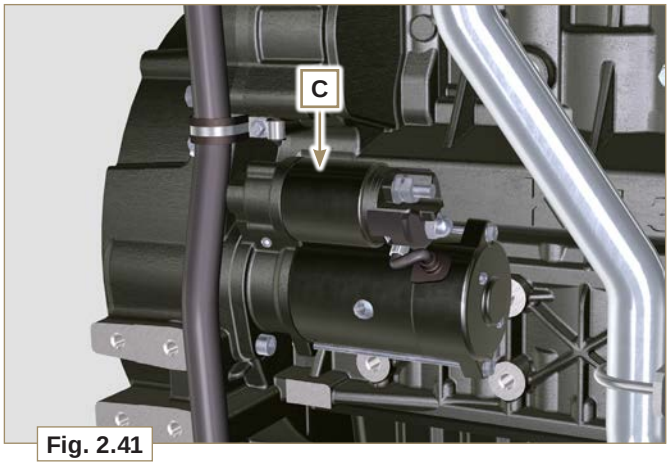


Fig. 2.41

2.15.3 Cold starting device (Heater)

The cold starting device consists of a resistance, managed by the pre-heater timer **H**, which is activated when the ambient temperature is ≤-16° C.
The intake air is heated through the resistance and facilitates starting the engine.

Characteristics cold starting device:

• Type Hidria AET	12 V
• Power	550 W

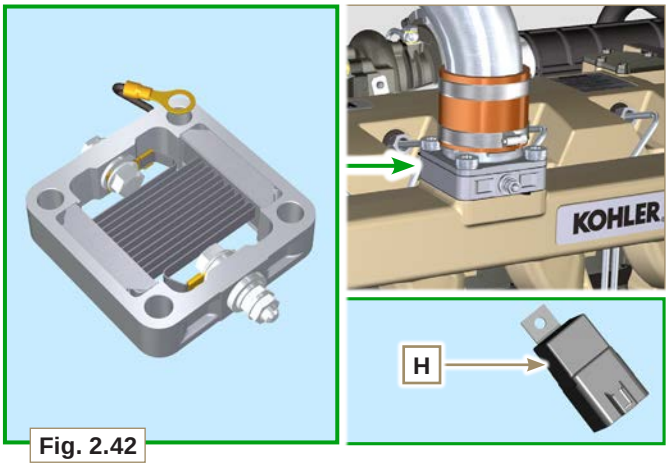


Fig. 2.42

2.15.4 Electric fuel pump (optional)

NOTE: Component not necessarily supplied by **KOHLER.**

The electric pump **A** is located before the fuel filter.

Characteristics:

- Delivery: 60.56 L/h @ 0.41 bar
- Volt: 12 V

Tab. 2.36

POS.	DESCRIPTION
1	Electrical connection
2	Prefilter pump
IN	Ingoing fitting (**IN**) from tank
OUT	Outgoing fitting (**OUT**) to fuel filter

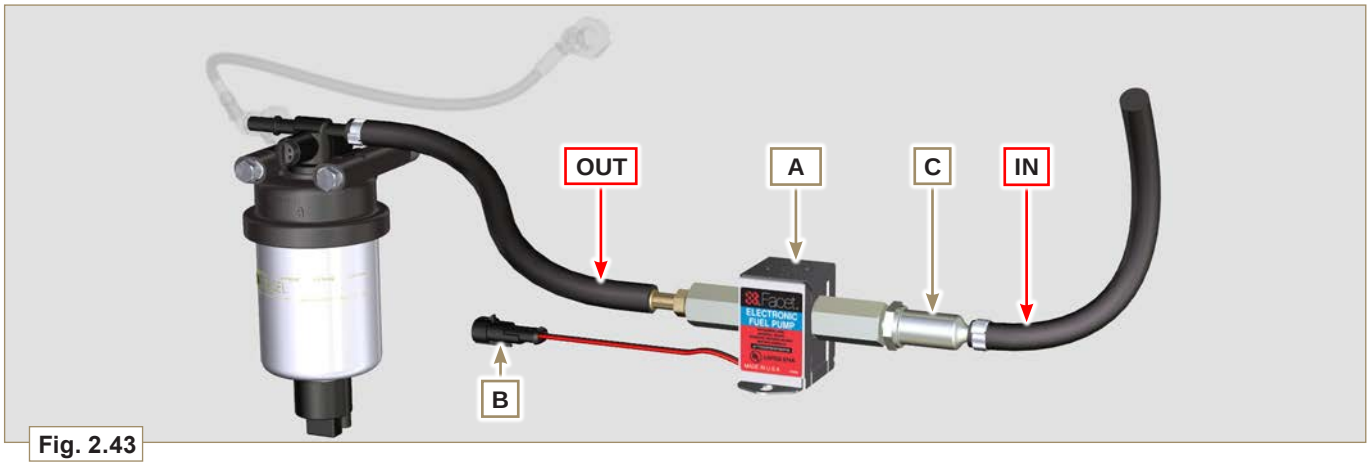


Fig. 2.43

2.15.5 Cold Start Advance

The Cold Start Advance **E** device is part of injection pump **D**; it provides for advance injection modification to enable advance of the engine at low temperatures.

2.15.6 Electro-Stop

The electro-stop **F** device is part of injection pump **D**; it turns off the engine by blocking the flow of fuel into pump **D**.

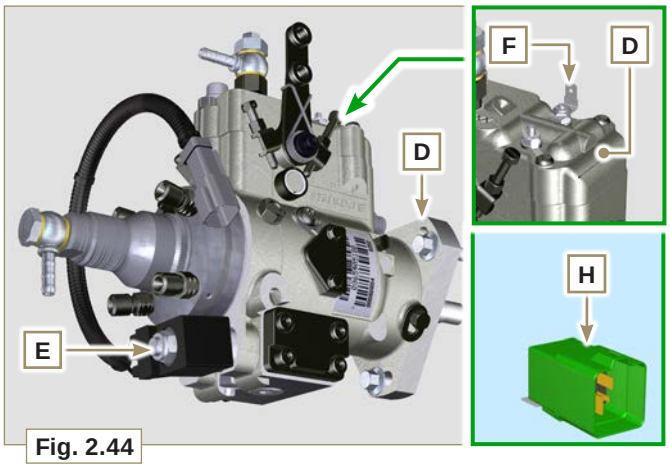


Fig. 2.44

2.15.8 Start-up relay

The **H** device assists cold engine ignition controlling the "cold starting device" (Heater) and the "Cold Start Advance" (CSA). **Tab. 2.37** indicates the activation times based on the ambient temperature.

Tab. 2.37

°C	HEATER	CSA
≤ 20 ÷ -15	0"	120"
-16	16"	
-21	21"	
-26	26"	
≤ -32	32"	


Fig. 2.45

Tab. 2.38

POS.	CONNECTED TO:
1	Heater
2	50 - ignition
3	15 - ignition
4	CSA
5	30 - battery
6	...
7	Earth
8	Control panel indicator

2.15.7 Fuse

Device **G** is assembled on cylinder head **P** (flywheel side); it protects the electrical circuit in the event of an overload or short circuit.

NOTE: Component not necessarily supplied by **KOHLER**.

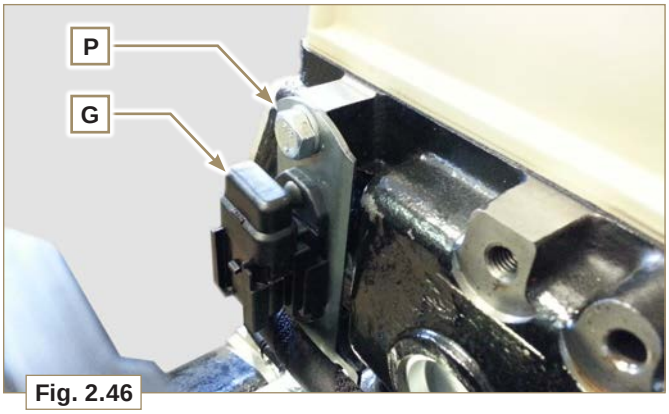


Fig. 2.46

2.15.9 Control panel (optional)

Panel **L** can be assembled on the engine or machine.
In **Tab. 2.39**, are described the main functions are illustrated.

Tab. 2.39

POS.	DESCRIPTION
M	Hour-meter indicator
S	Control switch to start the engine
W1	Panel ignition indicator
W2	Warning Light - battery not charging
W3	Warning Light - engine oil not pressurised
W4	Warning Light - high coolant temperature
W5	Warning Light - alarm general indicator

NOTE: Component not necessarily supplied by **KOHLER**.

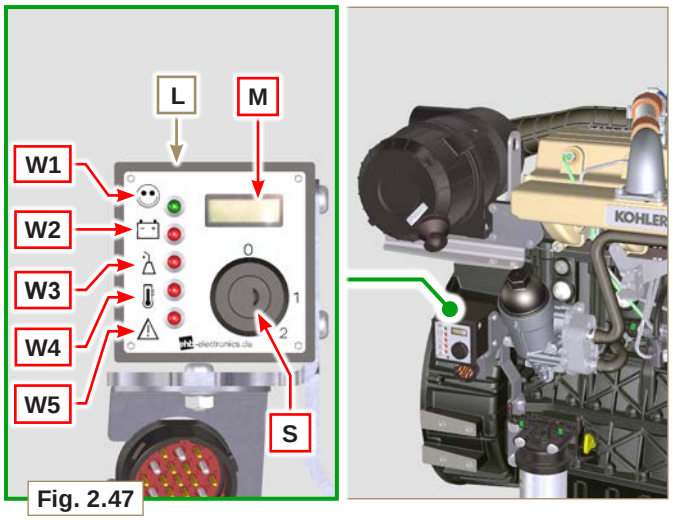


Fig. 2.47

2.16 Timing system and tappets

The distribution system is equipped with hydraulic tappets that automatically recover the operation of the rocker rods assembly. No registration is therefore required.

2.16.1 Components identification

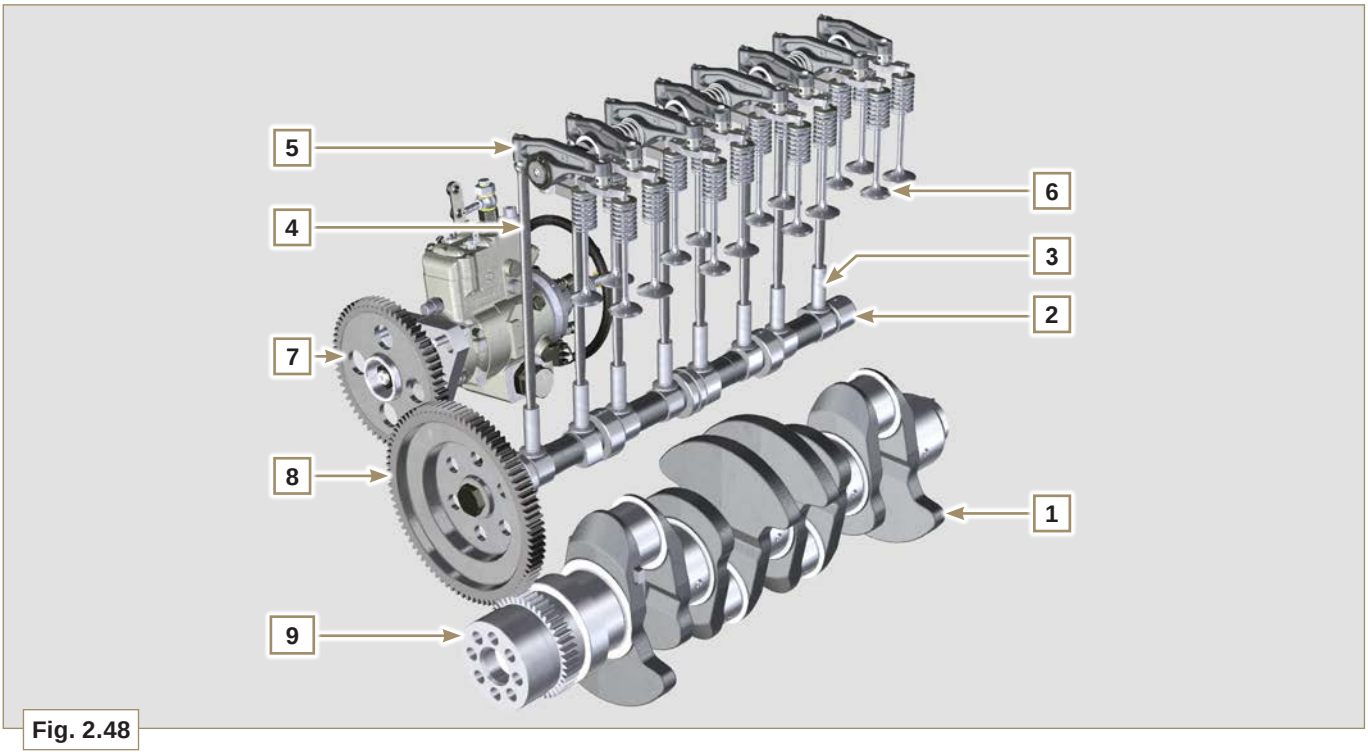


Fig. 2.48

Tab. 2.40

POS.	DESCRIPTION
1	Crankshaft
2	Camshaft
3	Camshaft tappets
4	Rocker arm control rod
5	Rocker arms
6	Valves
7	Fuel injection gear pump control
8	Camshaft control gear
9	Crankshaft gear
10	Valve control bridge
11	Articulation control valves
12	Hydraulic tappets

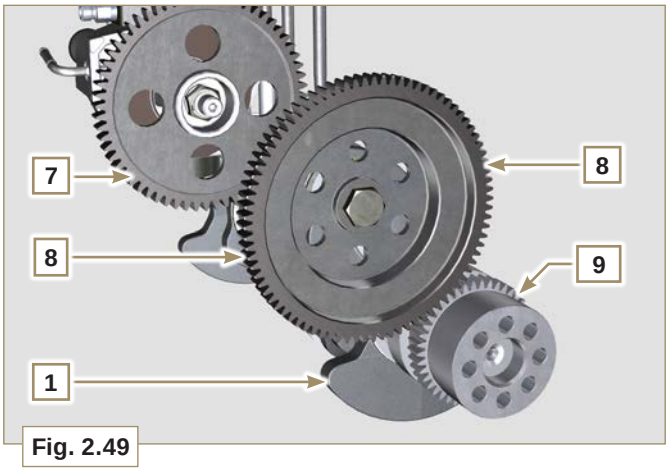


Fig. 2.49

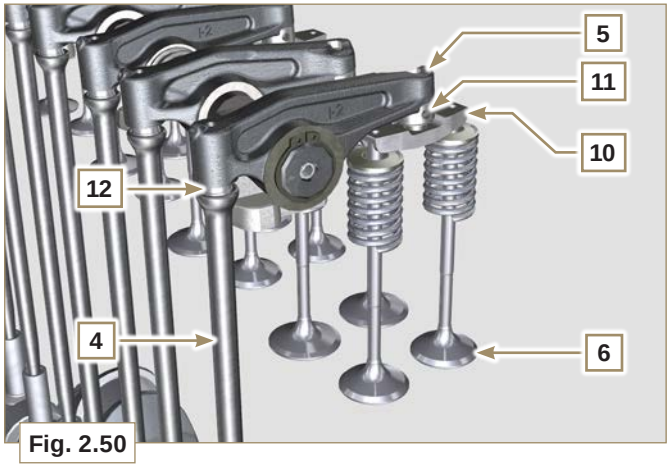


Fig. 2.50

2.16.2 Timing system phasing angles

Important

- For information purposes, **Tab. 2.41** reports the timing system diagram phasing angle values.
- It should be noted that the said values may be verified by rotating the crankshaft (**Pos. 1 of Fig. 2.50**), by means of handling the rocker arm control rod (**Pos. 4 of Fig. 2.49**).

NOTE: Detecting the value by means of handling the rocker arm/valves may not be correct due to the hydraulic tappets, which may compress and create clearances that alters the actual value.

Tab. 2.41

INTAKE	EXHAUST
opens 12° before TDC	opens 22° before BDC
closes 36° after BDC	closes 8° after TDC

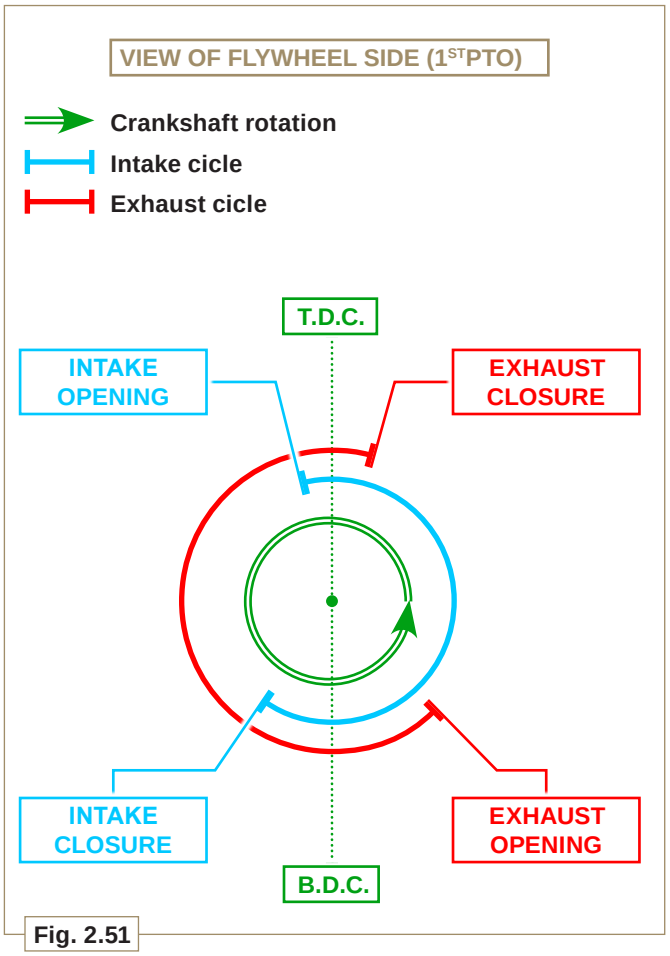


Fig. 2.51

2.16.3 Rocker arm pin

Tab. 2.42

POS.	DESCRIPTION
1	Rocker arm pin
2	Rocker arm distancing spring
3	Rocker arm pin support
4	Exhaust rocker arm
5	Intake rocker arm

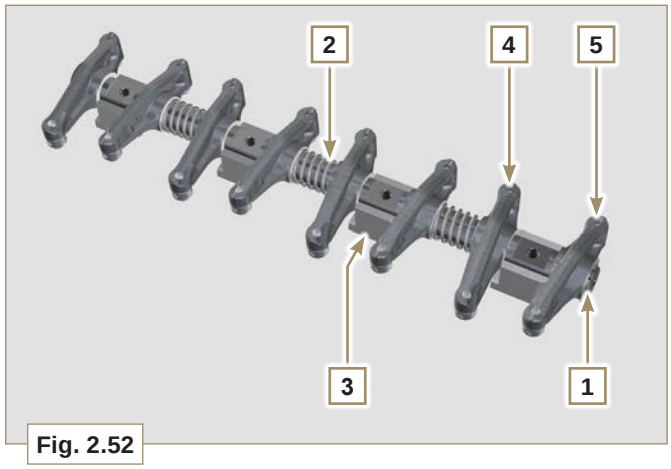


Fig. 2.52

2.16.4 Rocker arms

Tab. 2.43

POS.	DESCRIPTION
1	Rocker arm body
2	Hydraulic tappet oil refill line
3	Valve tappet lubrication line
4	Valve tappet
5	Hydraulic tappet
6	Oil flow line

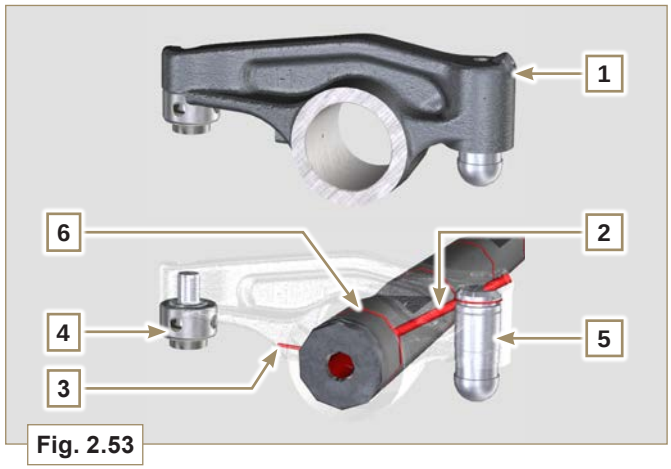


Fig. 2.53

2.16.5 Hydraulic tappets

Tab. 2.44

POS.	DESCRIPTION
A	Low pressure chamber
B	Hight pressure chamber
1	Hydraulic tappets oil refill pipe
2	Retaining ring
3	Piston
4	Unidirectional valve
5	Tappet body
6	Spring

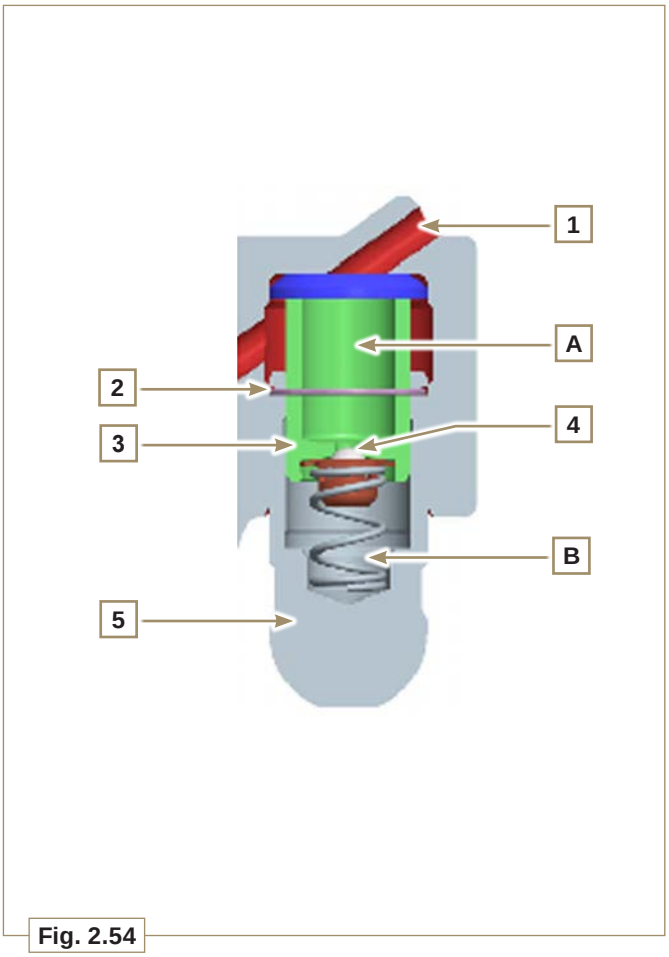


Fig. 2.54

2.16.5.1 Hydraulic tappet operation

The operating principle of the hydraulic tappet is based on the incompressibility of the liquids and on controlled leakage.
The oil under pressure enters the tappet chamber **A**, providing a constant supply of oil in the low-pressure chamber.
Through the non-return valve, **4** the oil can only access the high-pressure chamber **B** and exit via the clearance between the piston **3** and the tappet body **5** (controlled leakage).
The chamber **B** is filled when the rocker arm is on the base radius of the cam and the spring **6** keeps the piston **3** against the valve stem, thus eliminating any system play. Thanks to the spring extension, the tappet "extends", creating a small depression in the chamber **B**, making the non-return valve **4** open, and allowing the oil in the chamber **A** to pass to chamber **B**, restoring the proper amount of oil required to eliminate any play in the valves.

2.16.5.2 Difficult operating conditions:

For proper operation of the hydraulic tappets is essential that the low pressure chamber of the piston 3 is always full of oil.
In some conditions this may not occur (due to the fact that oil leaks, when the engine is switched off, can also partially drain the tappets): this situation will result in play that will occur with a typical noise similar to ticking, not to be confused with the normal ticking of the injectors.

1 - When the engine is cold, the tappet filling time could be very long if the oil used is not suitable for the specific environmental conditions (**Tab. 2.2**).

2 - If the engine is very hot: at idle speed, oil pressure may be low, and small air bubbles could form in the circuit. Because of this, this compressing the tappet slightly and producing valve play which is responsible for the ticking sound. On account of this, the tappet compresses slightly giving rise to a valve clearance, thus generating a slight ticking sound, which however disappears rapidly (**MAX** 10 seconds) once normal operating conditions have been restored.

Anyway the duration of ticking Anyway the duration of ticking sound must be **MAX** 30 seconds**.** If not, the problem is surely due to the poor quality of the oil, wear or impurities that, transported by the oil, can infiltrate between the ball valve and its seat inside the piston, compromising the operation of the tappet itself; In these cases, the only solution is to replace the oil or hydraulic tappets.

The prolonged persistence of the ticking sound or abnormal noise must be investigating in order to prevent any malfunctions; if necessary, replace the hydraulic tappets and engine oil.

2.17 Components handling

2.17.1 Injection pump

- Only handle by means of the points marked by **Y**.
- It is forbidden to handle using the points marked by **N**.

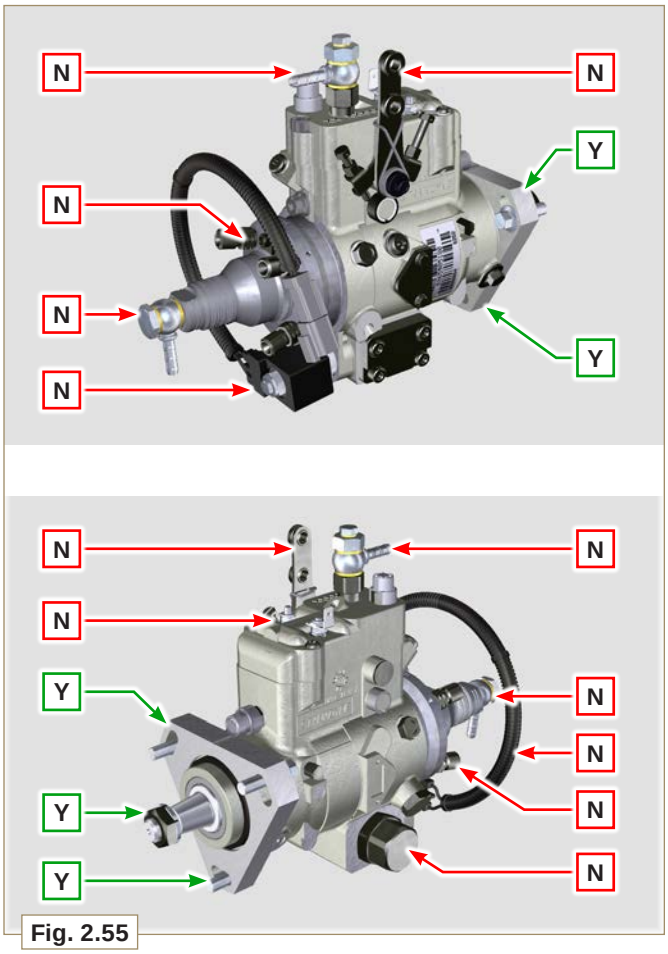


Fig. 2.55

2.17.2 Injector

- Only handle by means of the points marked by **Y**.
- It is forbidden to handle using the points marked by **N**.

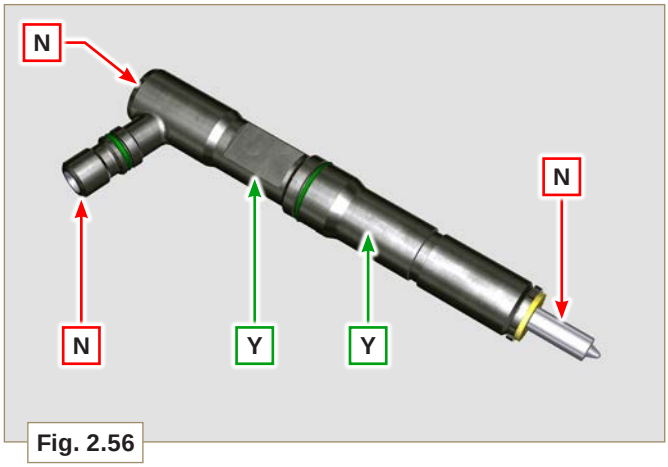


Fig. 2.56

2.17.4 Turbocharger

- Only handle by means of the points marked by **Y**.
- It is forbidden to handle using the points marked by **N**.

Important

- **Refer to Par. 2.18.**

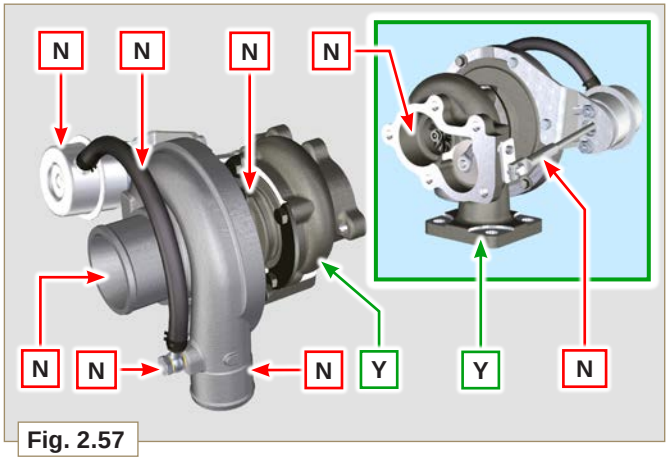


Fig. 2.57

2.18 Turbocharger

2.18.1 What to do and what not to do

What to do:

- Before assembling the turbocharger, make sure that the protection caps are fitted on all openings of the turbo.
- Ensure pre-lubrication of the turbocharger.
- Periodically check that the joints are sealed against oil and air.
- Use lubricating oil according to the specifications described in **Par. 2.4**.
- Check the engine oil level.
- Before switching it off after it has been used, make the engine run idle, or without a load, for approximately 1 minute.
- Ensure that controls and maintenance intervals of the engine are observed as specified in **Tab. 2.8** and **2.9**.
- Make sure that the engine and equipment are used correctly so as not to compromise the life of the turbocharger.

What not to do:

- Do not store turbocharges in damp, wet places if they are not in their original packaging.
- Do not expose the turbocharger to dust and dirt if it is not in its original packaging.
- Do not lift of hold the turbocharger from the actuator rod if it is not in its original packaging.
- Do not apply additives to the lubricating oil and fuel, unless instructed to do so by Kohler.
- Do not increase engine speed, or apply loads, immediately after start-up.
- Do not intervene on the actuator settings **A** (**Fig. 2.79**).
- Do not let the vehicle / engine run at idle speed for more than 20-30 minutes at a time.

2.18.2 Practical operating rules

Users can help to maximise the duration of their turbocharger by following the rules described below.

1 - Start-up
Start the engine at idle speed, or without a load, for approximately one minute. Oil operating pressure is reached within a few seconds and enables the moving parts to warm up and be lubricated.
Immediately increasing the engine speed upon start-up means making the turbocharger run at high speed with suboptimal lubrication, which may compromise the life of the turbocharger.

2 - After maintenance or a new installation
Proceed with pre-lubrication by filling new oil into the oil supply duct **B** until filling it completely.
Start the engine at idle speed, or without a load, for a few minutes in order to ensure that the oil and bearings system operate satisfactorily.

3 - Low temperature air or engine inactivity
If the engine has been inactive for some time, or the air temperature is very low, start the engine at idle speed or without a load for a few minutes.

4 - Engine shutdown
Before switching the engine off after intense activity, one must allow the turbocharger to cool down. One must therefore let the engine run at idle speed or without a load for at least 2 minutes, thus allowing the turbocharger to cool.

5 - Engine at idle speed
Avoid using the engine at idle speed or without a load for long periods (more than 20-30 minutes).
When operating at idle speed or without a load, the turbocharger is at low pressure in the exhaust chamber **C** and air supply **D**; this may cause oil leaks from seals **E** to the extremity of the shaft. Even if this does not cause damage, it can cause blue smoke from the exhaust when the engine speed and load are increased.

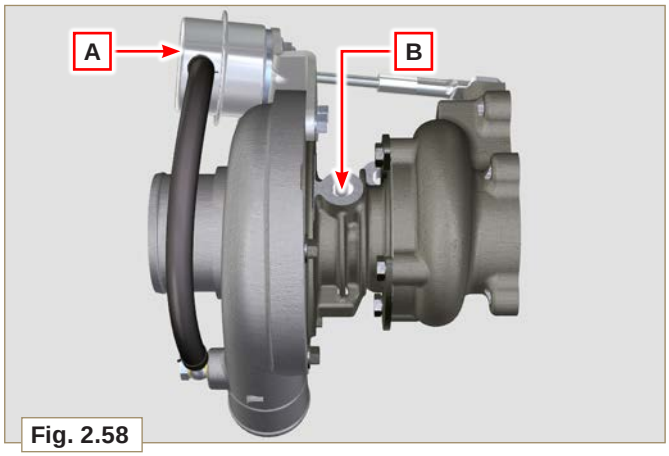


Fig. 2.58

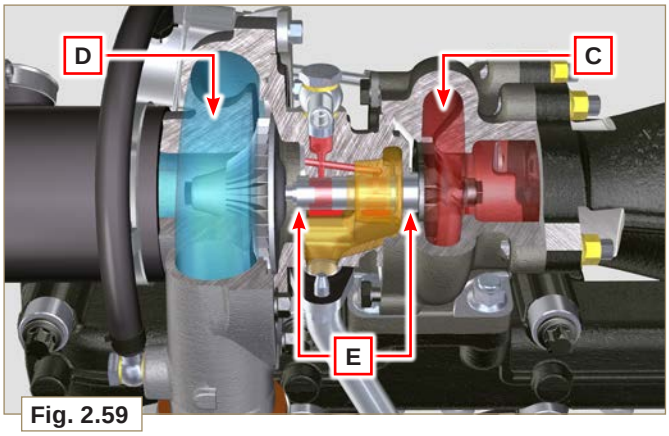


Fig. 2.59

2.18.3 Before installing a new turbocharger

Important

- Do not lift the turbocharger with one hand from the FG box.
- Do not lift turbocharger from Comp hsg side.
- Lift the turbocharger with both hands from FG box.
- Make sure to use clean gloves.
- Handle the turbocharger as indicated in **Par. 2.17.4.**

Fig. 2.60

1 - Avoid lifting from the intake side **G**.

2 - Remove cap guard F and check that there is no excessive shaft axial and radial clearances.

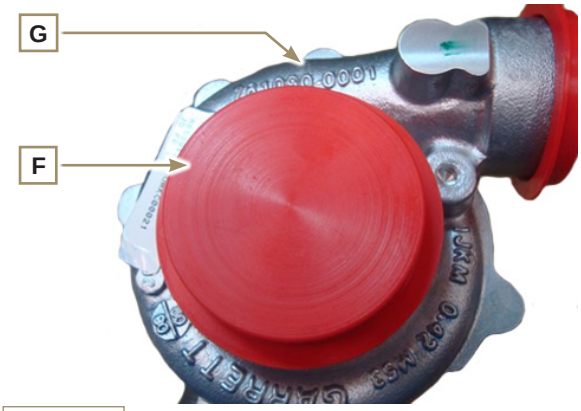


Fig. 2.61

3 - Check for any signs of friction of the turbine on the turbocharger body.

4 - Check for any traces of oil leaks on the turbocharger body.

5 - After having check everything, reapply cap F on intake opening H of the turbocharger and do not remove it until assembly has been completed.

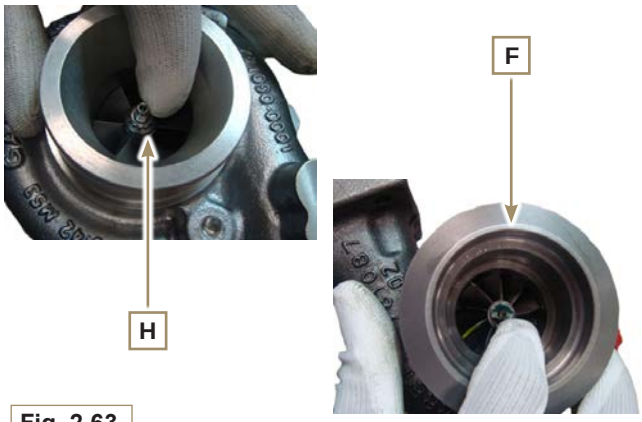


Fig. 2.63

6 - Check the correct assembly of the capscrews and the presence of paint on them.

Fig. 2.62

2.18.4 Installation instructions

1 - Remove the cap guards with care only when assembling.
Handle carefully avoiding erratic movements.

Fig. 2.64

2.18.5 Replacement instructions

Always understand the cause of the breakage of the turbocharger before replacing it.
Correct the cause of the breakage before replacing it with a new turbocharger.
If in doubt, contact KOHLER service department.

Important

- Failure to comply with these instructions can cause damage to the turbocharger and void the warranty.
- Modifying the calibration of the turbocharger damages the turbocharger/engine.
- Always use the correct gaskets, and fit carefully to avoid blocking holes when mounting.
- Refer to the manual of the engine / vehicle, for: the correct type and quantity of oil, the correct tightening of components, instructions and installation.
- It is forbidden to use liquid gaskets or sealants, particularly for the oil inlet/outlet.
- Avoid dirt / debris while installing the turbocharger.
- Before mounting the turbocharger, check that the code of the component is correct for the type of engine, as mounting the wrong turbocharger can damage the turbo / engine and void the warranty.

3.1 Before start-up

- Read the manual carefully and carry out the operations described below in compliance with the instructions specified.
- Periodic inspection and maintenance operations must be carried out as indicated in this manual and under the user's responsibility.

Important

- Only use original spare parts and accessories.
- The use of non-original parts, as well as voiding the warranty, affects the life and performance of the engine, and may be dangerous.
- Non compliance with the operations described in the following pages may result damage to the engine and vehicle on which it is installed, as well as to people and/or property.

3.2 Safety precautions

- The intended use of the engine is in conformity with the machine on which it is mounted.
- Any use of the machine other than that described cannot be considered as complying with its intended purpose as specified by **KOHLER** .
- **KOHLER** declines all responsibility for any change to the engine not described in this manual made by unauthorized **KOHLER** personnel.
- A proper use of the engine, a strict observance of the rules listed below and the rigorous application of all these precautions will avoid the risk of accidents or injuries.
- Those who carry out the use and maintenance on the engine must wear the safety equipment and the accident-prevention guards **Par. 3.4.3**.
- **KOHLER** declines all direct and indirect liability for failure to comply with the standards of conduct contained in this manual.
- **KOHLER** cannot consider every reasonably unforeseeable misuse that may cause a potential danger.

3.3 General remarks

3.2.1 Note for OEM

- When installing the **KDI** engines, always bear in mind that any variation to the functional systems may involve serious failures to the engine.
- Any improvement must be verified at **KOHLER** testing laboratories before application of the engine.
- In the event KOHLER does not approve the type of modification, KOHLER shall not be held responsible for any consequential operation anomalies that the engine may undergo and any damage the engine may cause to persons and things.
- The engine may only be assembled on a machine by personnel specifically trained by **KOHLER** and who work in compliance with the existing documentation.
- The engine has been built to the specifications of a machine manufacturer, and it is his responsibility to ensure that all necessary action is taken to meet the essential and legally prescribed health and safety requirements. Any use of the machine other than that described cannot be considered as complying with its intended purpose as specified by **KOHLER**, which therefore declines all responsibility for accidents caused by such operations.

3.2.2 Note for end user

- The following indications are dedicated to the user of the machine in order to reduce or eliminate risks concerning engine operation and the relative routine maintenance work.
- The user must read these instructions carefully. Failure to do this could lead to serious danger for his personal safety and health and that of any persons who may be in the vicinity of the machine.
- On starting, make sure that the engine is as horizontal as possible, unless the machine specifications differ.
- Make sure that the machine is stable to prevent the risk of overturning.
- The engine must not operate in places containing inflammable materials, in explosive atmospheres, where there is dust that can easily catch fire unless specific, adequate and clearly indicated precautions have been taken and have been certified for the machine.
- To prevent fire hazards, always keep the machine at least one meter from buildings or from other machinery.
- Children and animals must be kept at a due distance from operating machines in order to prevent hazards deriving from their operation.
- Thoroughly wash and clean all the external parts of the engine before performing any operation, in order to avoid the accidental introduction of impurities/foreign bodies. Use only water and/or appropriate products to clean the engine. If cleaning engine with a pressure washer or steam cleaner, it is important to maintain a minimum distance of at least 200mm between the surface to be washed and the nozzle. Avoid directing the nozzle on electrical components, cable connections and sealed rings (oil seals etc). Thoroughly wash and clean the area surrounding the engine following the instructions provided by machine manufacturer.
- Fuel and oil are inflammable. The tank must only be filled when the engine is off. Before starting, dry any spilt fuel.
- Make sure that no soundproofing panels and the ground or floor on which the machine is standing have not soaked up any fuel.
- Fuel vapour is highly toxic. Only refuel outdoors or in a well ventilated place.
- Do not smoke or use open flames when refuelling.
- During operation, the surface of the engine can become dangerously hot. Avoid touching the exhaust system in particular.

- Before proceeding with any operation on the engine, stop it and allow it to cool.
- Always open the radiator plug or expansion chamber with the utmost caution, wearing protective garments and goggles.
- The coolant fluid is under pressure. Never carry out any inspections until the engine has cooled.
- If there is an electric fan, do not approach the engine when it is still hot as the fan could also start operating when the engine is at a standstill.

Important

- The oil must be drained whilst the engine is hot. Particular care is required to prevent burns. Do not allow oil to come into contact with the skin because of the health hazards involved. It is recommended to use an oil intake pump.
- During operations that involve access to moving parts of the engine and/or removal of rotating guards, disconnect and insulate the negative wire (-) of the battery to prevent accidental short-circuits and to stop the starter motor from being energized.
- Check belt tension only when the engine is off.
- Fully tighten the tank cap each time after refuelling. Do not fill the tank right to the top but leave an adequate space for the fuel to expand.
- To start the engine follow the specific instructions provided in the engine and/or machine operating manual. Do not use auxiliary starting devices not originally installed on the machine (e.g. Startpilot).
- Before starting, remove any tools that were used to service the engine and/or machine. Make sure that all guards have been refitted.
- Do not mix fuel with elements such as oil or kerosene. Failure to comply with this prohibition will cause the non-operation of the catalyst and non-observance of the emissions declared by **KOHLER**.
- Pay attention to the temperature of the oil filter when the filter itself is replaced.
- Only check, top up and change the coolant fluid when the engine is off and reached the ambient temperature. Coolant fluid is polluting, it must therefore be disposed of in the correct way.
- Do not use jets of air and water at high pressure on the cables, connectors and electronic injectors.

Important

- Only use the eyebolts **A** installed by **KOHLER** to move the engine (**Fig. 3.1**).
- The angle between each lifting chain and the eyebolts shall not exceed **15°** inwards. **NOTE:** the lifting chain must be vertical for engines equipped with the radiator with Intercooler.
-
- The correct tightening of the lifting brace capscrews is **80Nm**.
- Do not interpose spacers or washers between the eyebolts and engine head.

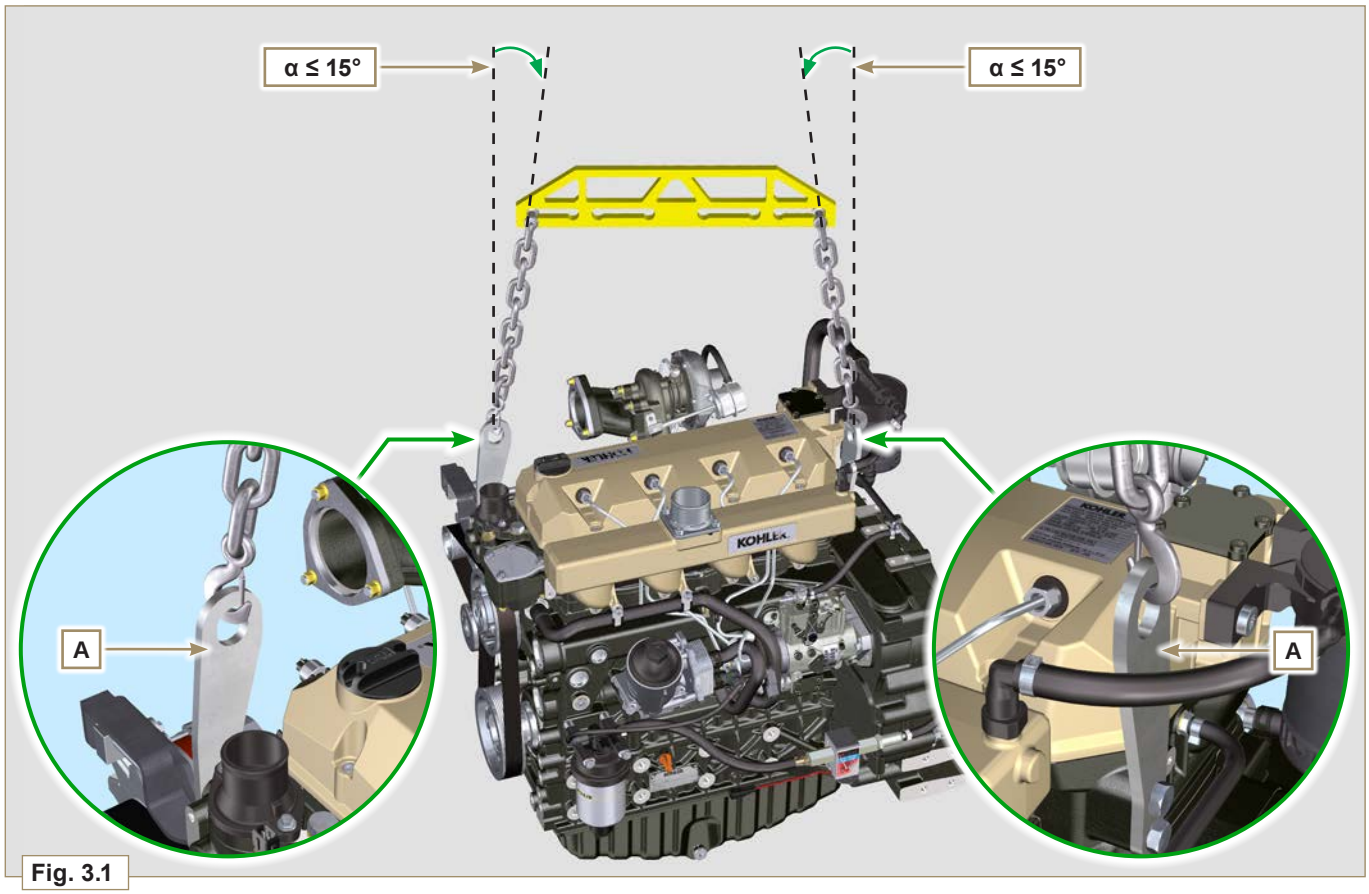


Fig. 3.1

3.4 Safety signal description

- To ensure safe operation please read the following statements and understand their meaning.
- Also refer to your equipment manufacturer's manual for other important safety information.
- This manual contains safety precautions which are explained below.
- Please read them carefully.

3.4.1 Adhesive safety plates

The following is a list of the adhesive safety plates that may be found on the engine, which indicate potential points of danger to the operator (Par. 3.7).

Read the Operation and Maintenance handbook before performing any operation on the engine.

Hot Parts.
Danger of burns.

Presence of rotating parts.
Danger of jamming or cutting.

Presence of explosive fuel.
Danger of fire or explosion.

Presence of steam and pressurized coolant.
Danger of burns.

3.4.2 Warnings

Hereunder is a list of safety warnings that may be found in the manual, which advise you to pay attention when carrying out particular procedures that may be potentially dangerous to the operator or things.

Danger

- This indicates situations of grave danger which, if ignored, may seriously threaten the health and safety of individuals.

Important

- This indicates particularly important technical information that should not be ignored.

Warning

- This indicates that failure to comply with it can cause minor damage or injury.

3.4.3 Safety guards

Hereunder is a list of safety guards that must be worn prior to carrying out any type of operation and to avoid potential harm to the operator.

Use suitable protective gloves before carrying out any type of operation.

Use protective goggles before carrying out any type of operation.

Use earmuffs before carrying out any type of operation.

3.5 Information and safety signals

ACCIDENTAL START

Accidental Starts can cause severe injury or death.

Before working on the engine or equipment, disconnect the battery negative (-) wire.

HOT PARTS

Hot Parts can cause severe burns.

Engine components can get extremely hot from operation.
Do not touch engine while operating or just after stopping.
Never operate the engine with heat shields or guards removed.

ROTATING PARTS

Rotating Parts can cause severe injury.

Stay away while engine is in operation. Keep hands, feet, hair, and clothing away from all moving parts to prevent injury.
Never operate the engine with covers, shrouds, or guards removed.

LETHAL EXHAUST GASES

Carbon Monoxide can cause severe nausea, fainting or death.

Avoid inhaling exhaust fumes and never run the engine in a closed building or confined area.
Carbon monoxide is toxic, odorless, colorless, and can cause death if inhaled.

ELECTRICAL SHOCK

Electrical Shock can cause injury.

Do not touch wires while engine is running.

HIGH PRESSURE FLUID RISK OF PUNCTURE

High Pressure Fluids can puncture skin and cause severe injury or death.

Work on the injection system must be carried out by suitably trained staff wearing protection equipment. Injuries caused by fluid penetration are highly toxic and dangerous.
If an injury occurs, seek immediate medical attention.

EXPLOSIVE FUEL

Explosive fuel can cause fires and severe burns.

Fuel is flammable and its vapours can ignite.
Store fuel only in approved containers, in well ventilated, unoccupied buildings.
Do not fill the fuel tank while the engine is hot or running, since spilled fuel could ignite if it comes in contact with hot parts or sparks from ignition.
Do not start the engine near spilled fuel.
Never use fuel as a cleaning agent.

EXPLOSIVE GAS

Explosive Gas can cause fires and severe acid burns.

Charge battery only in a well ventilated area.
Keep sparks, open flames, and other sources of ignition away from the battery at all times.
Batteries produce explosive hydrogen gas while being charged.
Keep batteries out of the reach of children.
Remove all jewelry when servicing batteries. Before disconnecting the negative (-) ground cable, make sure all switches are OFF.
If ON, a spark will occur at the ground cable terminal which could cause an explosion.

CALIFORNIA WARNING - DECLARATION 65

Engine exhaust from this product contains chemicals known to the State of California to cause cancer, birth defects, or other reproductive harm.

3.6 Safety and environmental impact

Every organisation has a duty to implement procedures to identify, assess and monitor the influence of its own activities (products, services, etc.) on the environment.
Procedures for identifying the extent of the impact on the environment must consider the following factors:

- Disposal of liquids.
- Waste management.
- Soil contamination.
- Atmospheric emissions.
- Use of raw materials and natural resources.
- Regulations and directives regarding environmental impact.

In order to minimise the impact on the environment, **KOHLER** provides some indications to be followed by all those handling the engine, for any reason, during its expected lifetime.

- All components and fluids must be disposed of in accordance with the laws of the country in which disposal is taking place.
- Keep the injection system as well as engine management and exhaust pipes in efficient working order to limit environmental and noise pollution.
- When decommissioning the engine, select all components according to their chemical characteristics and dispose of them separately.

3.7 Location of safety signals on engine

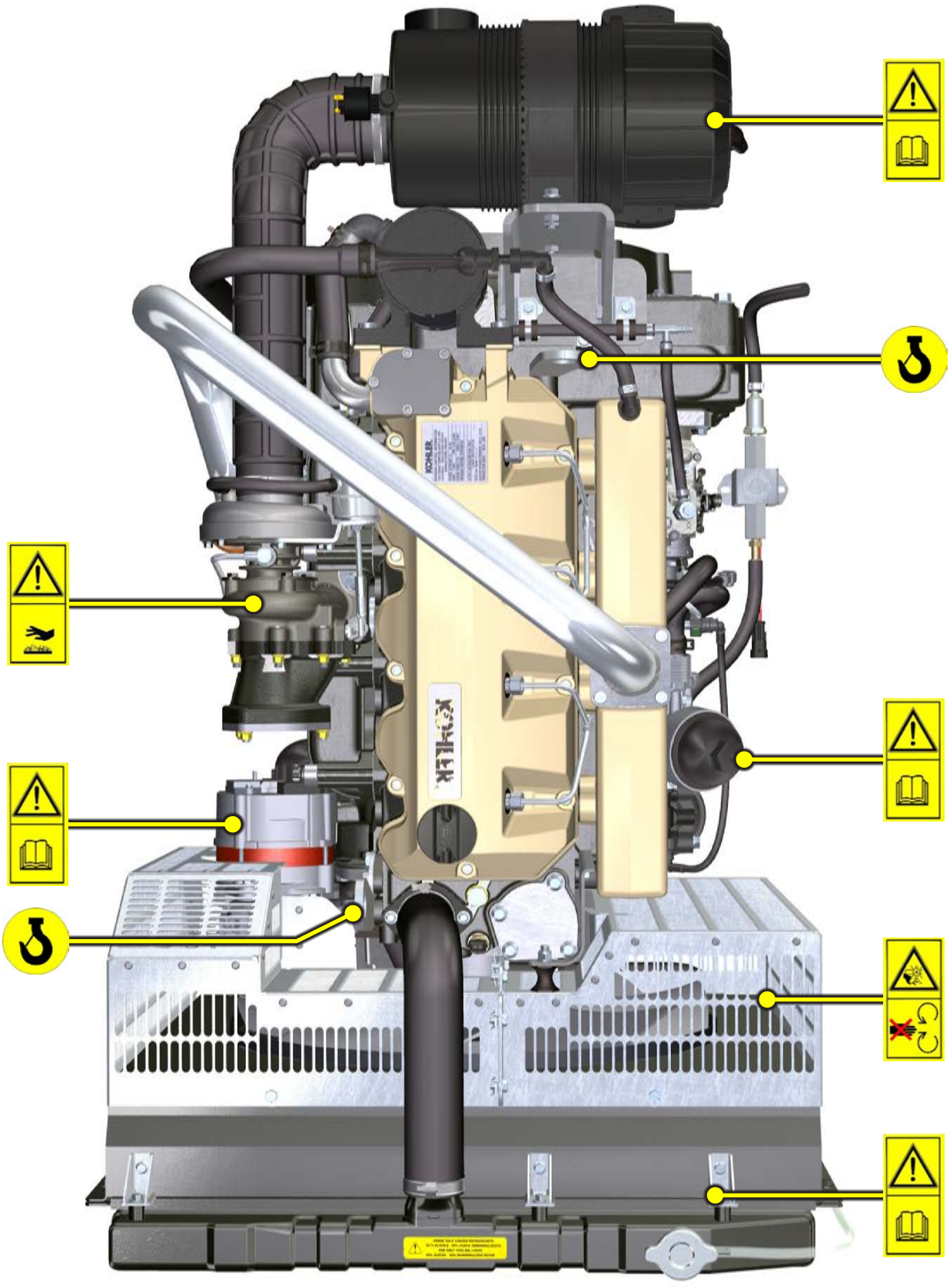


Fig. 3.2

4.1 Product preservation

Important

- If the engines are not to be used for 6 months, they must be protected by carrying out the operations described in Engine storage (up to 6 months) **(Par. 4.2)**.
- If the engine is still not in use after the first 6 months, it is necessary to carry out a further procedure to extend the protection period (more than 6 months) **(Par. 4.3)**.
- If the engine is not to be used for an extended period, the protective treatment procedure must be repeated within 24 months of the previous one.

4.2 Engine storage (up to 6 months)

Before storing the engine check that:

- The environments are not humid or exposed to bad weather. Cover the engine with a proper protective sheet against dampness and atmospheric contaminants.
- The place is not near electric panel.
- Avoid storing the engine in direct contact with the ground.

4.3 Engine storage (over 6 months)

Follow the steps described in Par. 4.2.

1 - Pour protective oil in the carter up to the MAX level.

2 - Refuel with fuel additives for long storage.
The following additives are recommended:
DEFA Fluid Plus (Pakelo Lubricants),
Diesel Treatment (Green Star),
Top Diesel (Bardhal),
STP® Diesel Fuel Injector Treatment.

3 - With expansion tank:
make sure that the coolant is up to the **maximum** level.

4 - Without expansion tank:
Top liquid up until the pipes inside the radiator are covered by about 5 mm.
Do not overfill the radiator, but leave room for the fuel to expand.

5 - Start the engine and run it at idle speed for around 2 minutes.

6 - Bring the engine to 75% of maximum rated speed for 5 to 10 minutes.

7 - Turn off the engine.

8 - Empty out completely the fuel tank.

9 - Spray SAE 10W-40 on the exhaust and intake manifolds.

10 - Seal the exhaust and intake ducts to prevent foreign bodies from entering.

11 - When cleaning the engine, if using a pressure washer or steam cleaning device, avoid directing the nozzle on electrical components, cable connections and sealed rings (oil seals etc).
If cleaning engine with a pressure washer or steam cleaner, it is important to maintain a minimum distance of at least 200mm between the surface to be washed and the nozzle - avoiding absolutely electrical components such as alternators, starter motors and engine control units (ECU).

12 - Treat non-painted parts with protective products.

13 - Loosen the alternator belt **Par. 6.2.1 point 1 e 2**.

If the engine protection is performed according to the suggestions indicated no corrosion damage will be found.

4.4 Engine starting after storage

1 - Remove the protective sheet.

2 - Use a cloth soaked in degreasing product to remove the protective treatment from the external parts.

3 - Inject lubricating oil (no more than 2 cm^3) into the intake ducts.

4 - Adjust the alternator belt tension or replace if there are signs of deterioration.

5 - Refill the tank with fresh fuel.

Warning

- Over time, lubricants and filters lose their properties, so it is important to consider whether they need replacing, also based on the criteria described in **Tab. 2.9**.

6 - Make sure that the oil and the coolant are up to the **maximum** level**.**

7 - Start the engine and run it at idle speed for around 2 minutes.

8 - Bring the engine to 75% of maximum rated speed for 5 to 10 minutes.

9 - Stop the engine and while the oil still hot, perform the operation in **Par. 5.2**.

10 - Replace the filters (air, oil, fuel) with original spare parts.

11 - Perform the operations described in **Par. 10.1**.

12 - Perform the operations described in **Par. 5.1 e Par. 10.2**.

5.1 Coolant

NOTE: Component not necessarily supplied by **KOHLER**.
The representation of the radiator is purely indicative.

Warning

- Before proceeding with operation, carefully read **Par. 3.3.2**.
- Presence of steam pressurized coolant danger of burns.

1 - Undo the cap **A** carefully (circuit under pressure).

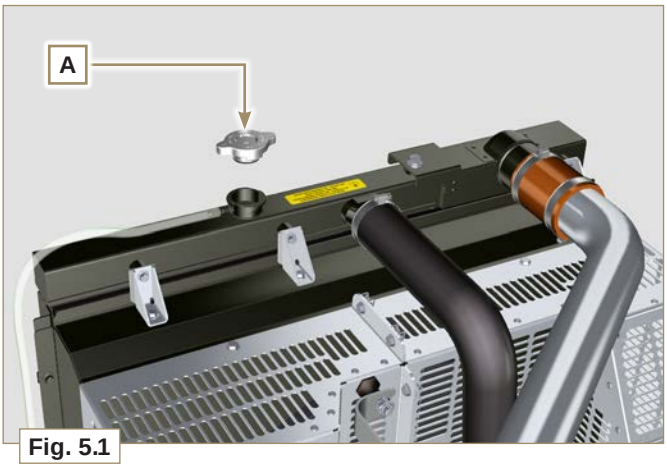


Fig. 5.1

2 - Loosen clamp **F** and remove hose **H** to drain all liquid from the system contained in the engine crankcase ducts into an appropriate container and refer to **Par. 3.6**.

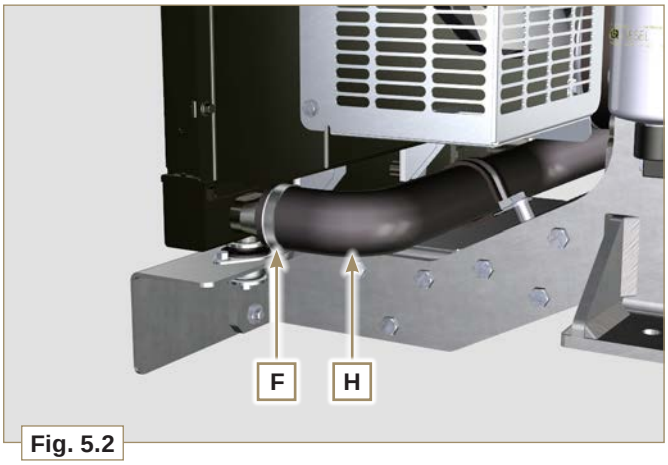


Fig. 5.2

5.2 Engine oil

Important

- Before proceeding with operation, carefully read **Par. 3.3.2**.
- The oil must be drained whilst the engine is hot, which requires particular care to prevent burns. Do not allow oil to come into contact with the skin because of the health hazards involved. It is recommended to use an oil suction pump via the oil dipstick hole **B**.
- Electric/pneumatic screwdrivers are forbidden.

1 - Unscrew cartridge holder cover **C** by performing three complete turns and wait 1 minute.

NOTE: this operation allows to oil contained in the support **G** to flow into the oil sump in the correct way.

2 - Unscrew cartridge holder cover **C** and check that the oil in the lub. oil filter bracket **G** has flowed towards the oil sump (refer to **NOTE** in **Par. 2.10.3**).

3 - Undo the oil filler cap **A**.

4 - Remove the oil dipstick **B**.

5 - Remove the oil drain plug **D** and the gasket **E**. (the oil drain plug is on both sides of the oil sump).

6 - Drain oil in to an appropriate container. (For used oil disposal refer to the **Par. 3.6**).

7 - Replace gasket **E**.

8 - Tighten the drain oil plug **D** (tightening torque at **50 Nm**).

9 - Perform the operations described in **par. 6.4.2** and the operation **5 par. 6.4.3**.

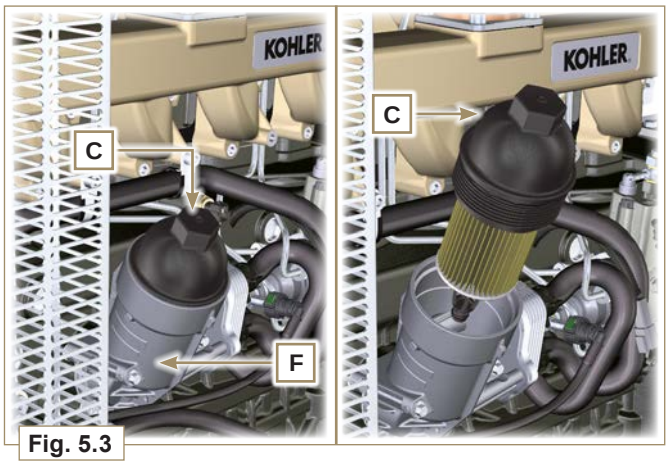


Fig. 5.3

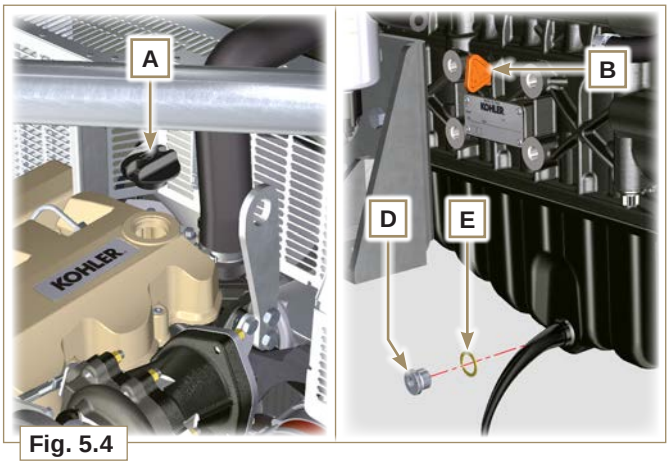


Fig. 5.4

6.1 Injector and injection pump replacement

Important

- Before proceeding with operation, carefully read **Par. 3.3.2**.
- Replace the high pressure pipes after two disassemblies.
- The injectors cannot be repaired but must be replaced.
- Seal all injection component unions as illustrated in **Par. 2.9.7** during disassembly.
- Always replace the gaskets after each disassembly.
- Handle the components as described in **Par. 2.18**.
- Refer to **Par. 1.3** for **operating references** when assembling and disassembling.

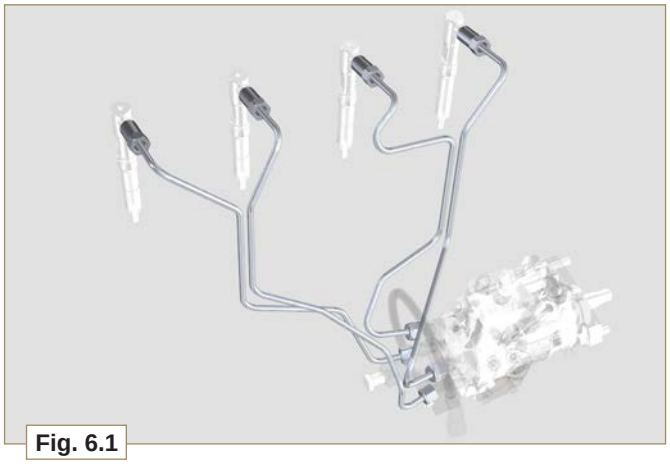


Fig. 6.1

6.1.1 Injection fuel pipes disassembly (injection pump/injectors)

1 - Undo the screws **A**.

2 - Undo the screws **B**.

3 - Remove quick fitting **C**.

4 - Undo the screws **D** and remove the manifold **E**.

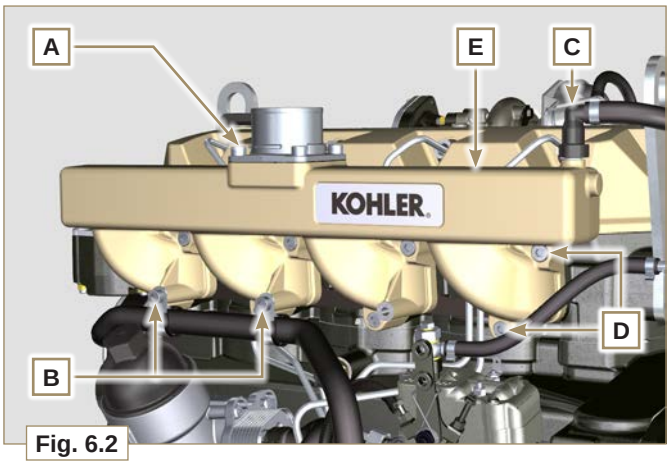


Fig. 6.2

5 - Undo capscrews **H1** and remove clamps **H2** and the rubber element.

6 - Undo the nuts **F**.

7 - Undo the nuts **G**.

8 - Remove the tube **H**.

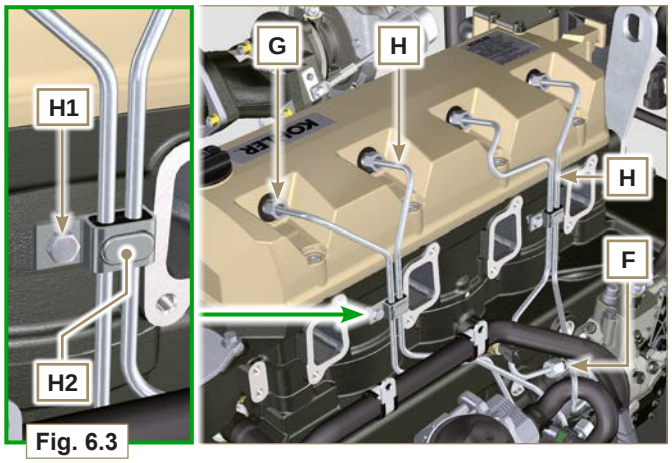


Fig. 6.3

6.1.2 Rocker arms cover disassembly

1 - Undo the screw **L.**

2 - Undo the screw **M.**

3 - Undo the screws **N** and remove the rocker arm cap **P.**

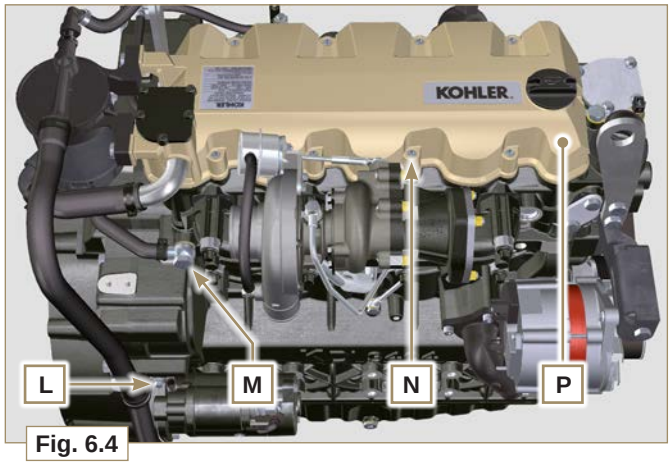


Fig. 6.4

6.1.3 Fuel return pipes disassembly

1 - Undo the screws **Q** and remove hose **R**.

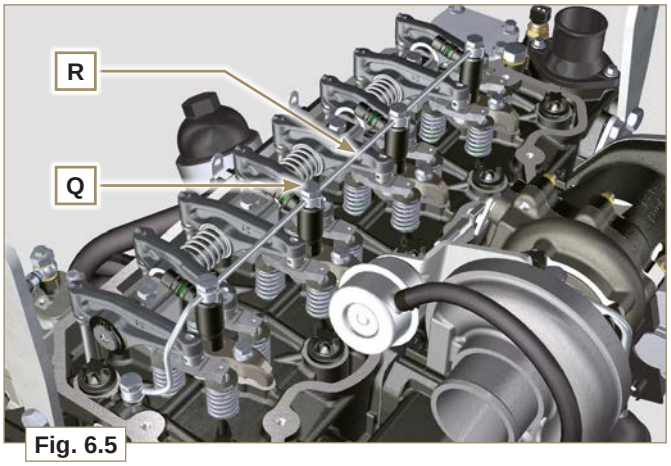


Fig. 6.5

6.1.4 Injectors disassembly

1 - Undo the screw **J** and remove washer **K** and then bracket **X**.

2 - Remove the injector **Z**.

NOTE: Should you be unable to remove the electronic injector (acting only on point **BC**), use an open-ended spanner (⬢ 11 mm), by applying small rotations to unblock the component.

3 - Seal all injection component unions as illustrated in **Par. 2.9.7**.

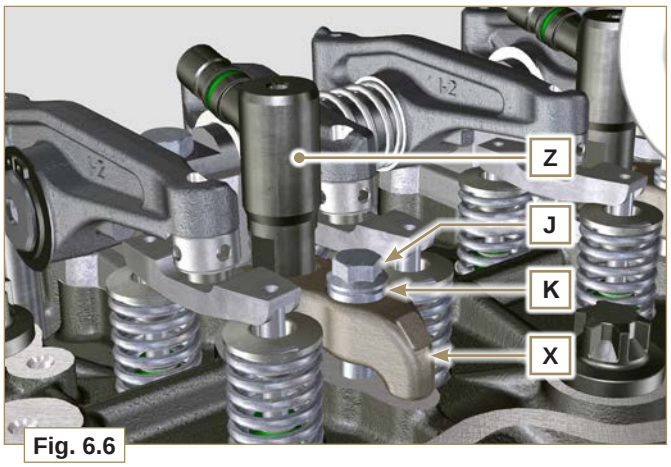


Fig. 6.6

4 - Ensure that gasket **S** has remained in the correct position (**Fig. 6.7**). Otherwise, recover the gasket from inside the electronic injector **V** manifold.

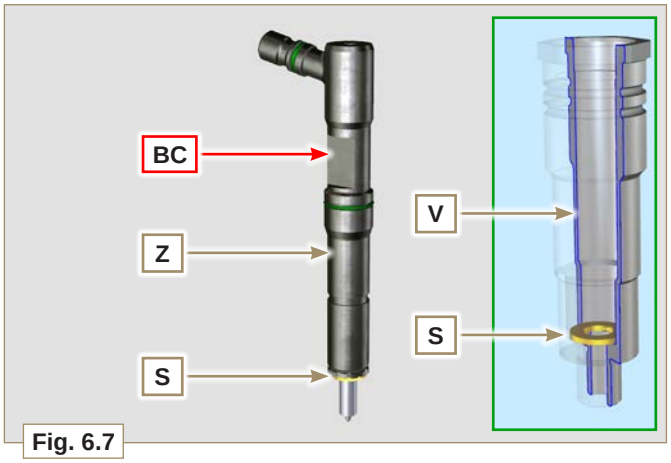


Fig. 6.7

6.1.5 Injection pump disassembly

Important

- Before proceeding with the disassembly, identify the pump code from its identifying name plate (**Pos. 12 - Tab. 2.12**) and remove the cylinder injector 1 (**Par. 1.4 - 6.1.1 - 6.1.2 - 6.1.3 - 6.1.4**).
- Alternatively, you can identify the pump from the online spare parts catalogue (**https://partners.lombardini.it/App/SparepartCatalogue/Default/Catalogue.aspx**).

1 - Insert the tool **ST_30** into the injector **N°1** and fix it with the fixing brace **X**, capscrew **J** and washer **K**.

NOTE: Do not tighten the capscrew **J**.

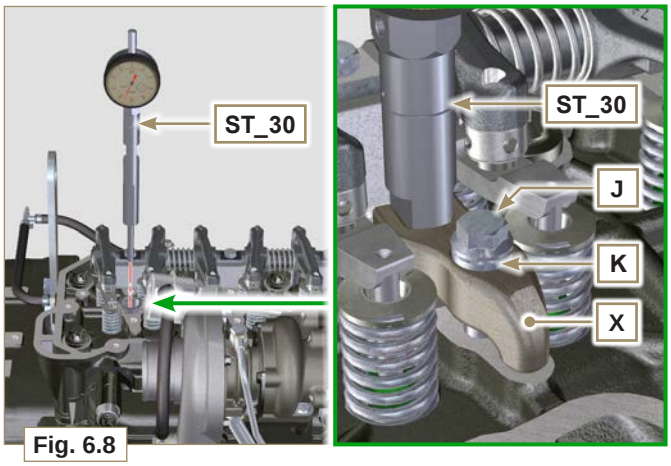


Fig. 6.8

2 - Disassemble the starter motor.

3 - Mount the tool **ST_34** in the seat of the starter motor **Y** and fit it with the two starter motor fixing screws.

4 - Rotate the crankshaft clockwise (**Ref. A** ⟹ **Par. 1.4**) through the **ST_34** tool bringing reference **X** upwards.

NOTE: When positioning reference **X**, make sure cylinder **N° 1** is in compression phase (the valves on piston **N° 1** must all be closed).

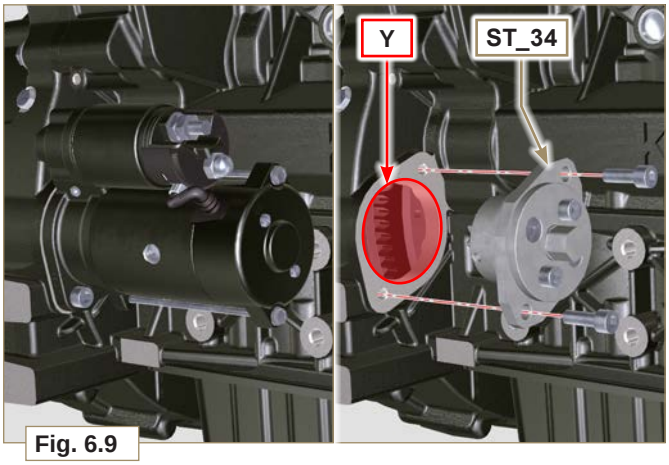


Fig. 6.9

5 - With reference **X** pointed upwards, find the **TDC** through tool **ST_30**, then bring the dial gauge indicator to **0**.

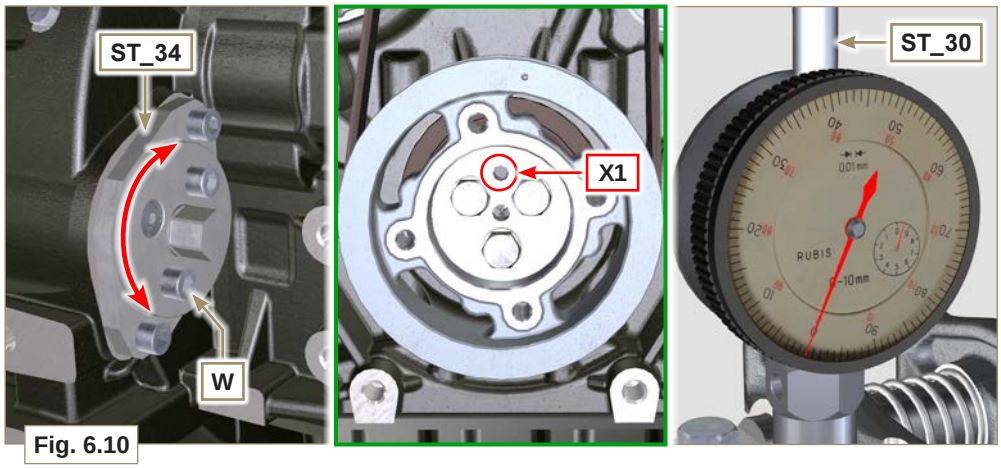


Fig. 6.10

6 - By means of the identified pump code, refer to **Tab. 6.1** to know the advance degrees and the corresponding value to lower the piston.

7 - Having identified the value to lower the piston, rotate the crankshaft anti-clockwise by going beyond the value described in **Tab. 6.1**, once again, rotate the crankshaft clockwise, stopping at the correct advance value by using tool **ST_30** (**Ref. A** ⟹ **Par. 1.4**).

NOTE: The value indicated in **Tab. 6.1** must be reached by rotating the shaft with the piston in compression phase. Use the **ST_34** tool to totate the crankshaft.

Tab. 6.1

PUMP CODE	PISTON LOWERING (mm)	ADVANCE α
ED0065905290-S	0,733	8°
ED0065905430-S	0,562	7°
ED0065905440-S	0,828	8,5°
ED0065905690-S	0,413	6°

8 - Lock the **ST_34** tool through **J** screws and ensure that the crankshaft does not rotate, which would alter the correct advance value. If this happens, repeat the instructions described in points **4**, **5**, **6**, **7** and **8**.

9 - Undo the screws **A1,** remove the plate **B1**.

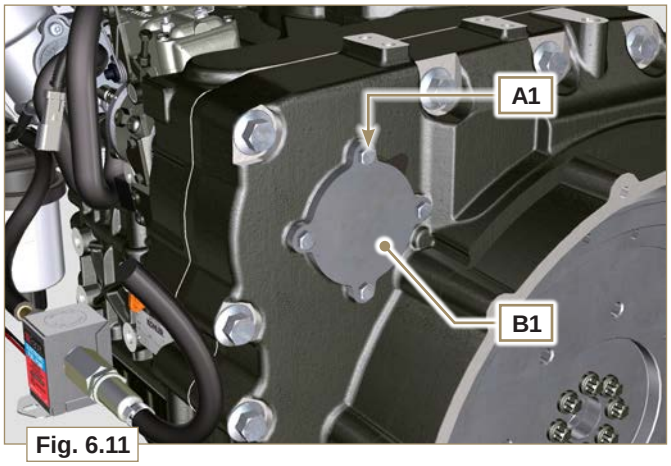


Fig. 6.11

10 - Undo and remove the nut **C1** fixing the injection pump control gear **D1**.

Important

- After removing the nut **C1**, ensure that the correct advance value has remained unchanged on **ST_30**.
- Be careful that the nut **C1** does not fall into the timing cover.

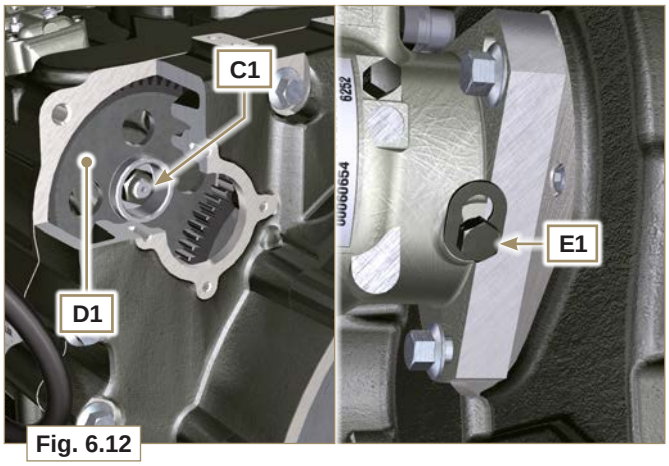


Fig. 6.12

11 - Undo the capscrew **E1** and shift the slotted plate **F1** in the direction of arrow **G1**.

12 - Tighten screw **E1** to block the pump (tightening torque to **12 Nm**).

13 - Screw the tool **ST_13** on the gear **D1**.

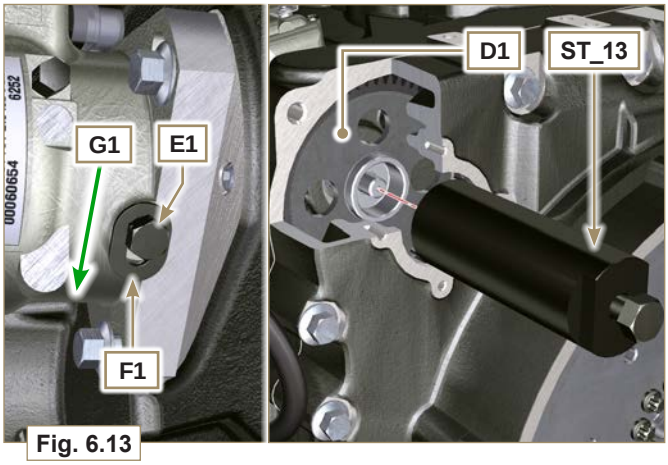


Fig. 6.13

14 - Perform the operations of point **1** of **Par. 5.2.**

15 - Remove quick fitting **N1**.

16 - Loosen capscrews **K1** and **K2** and detach Oil Cooler unit **L1** from crankcase **M1**.

17 - Loosen the screws **J2**.

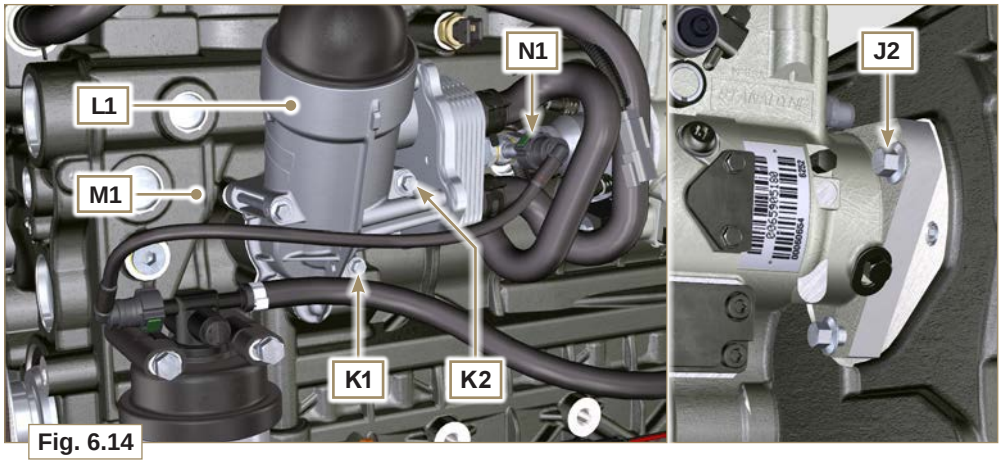


Fig. 6.14

18 - Undo the screw **P1**.

19 - Tighten the screw of tool **ST_13** to disconnect the injection pump **J1** from the high pressure pump control gear **D1**.

20 - Undo the screws **J2** and extract the injection pump **J1**.

21 - DO NOT remove the tool **ST_13.**

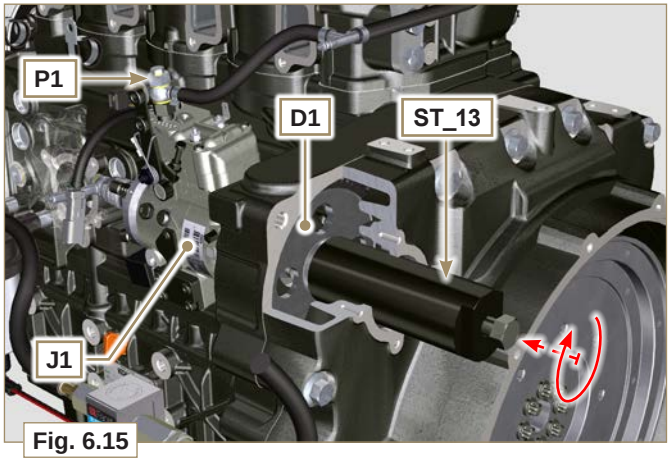


Fig. 6.15

6.1.6 Injection pump assembly

Important

- Before assembling the new pump **J1**, make sure that plate **F1** can move freely and that fastening capscrews **E1** are not loose (the pump sold as a spare part is **supplied with the cylinder injection timing blocked N° 1**).
- **Ensure that the coupling surfaces on shaft Q1 and gear D1 are free from impurities and lubrication residues**.
- Remove the guard cap only when the pipes are reconnected.
- Do not remove the tool **ST_30**.

1 - Mount the injection pump **J1**, inserting the shaft **Q1** in the gear **D1**.

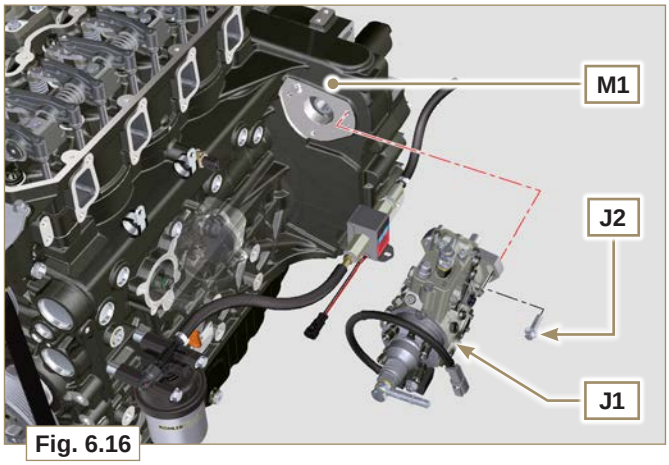


Fig. 6.16

Important

- Always change screws **J2** with new ones or apply **Loctite 2701** to the threads.

2 - Clamp the screws **J2** on the crankcase **M1** (tightening torque at **25 Nm**).

3 - Remove the tool **ST_13**.

4 - Ensure that the correct advance value has remained unchanged, tighten nut **C1** on shaft **Q1** (as shown in **Fig. 6.17**, you are allowed to use a screwdriver to guide nut **C1** onto shaft **Q1** in order to prevent it from accidentally falling inside carter **S1** - tightening torque at **140 Nm**).

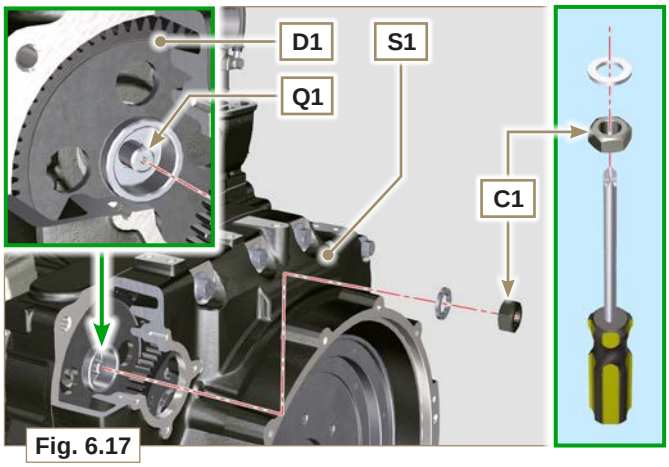


Fig. 6.17

5 - Undo the capscrew **E1** and shift the slotted plate **F1** in the direction of arrow **G2**.

6 - Tighten screw **E1** (tightening torque to **5.5 Nm**).
The injection pump is unlocked.

7 - Remove the tool **ST_30** and **ST_34**.

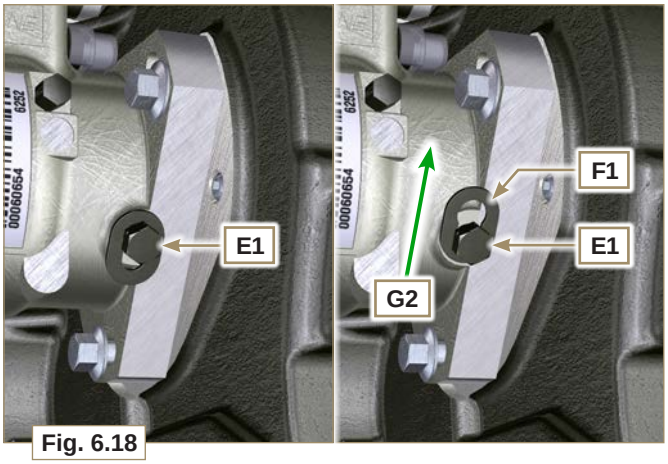


Fig. 6.18

8 - Assemble Oil Cooler **L1** onto crankcase **M1** by means of capscrews **K1** and **K2**.

NOTE: Always replace the gasket **R1, R2** at each assembly.

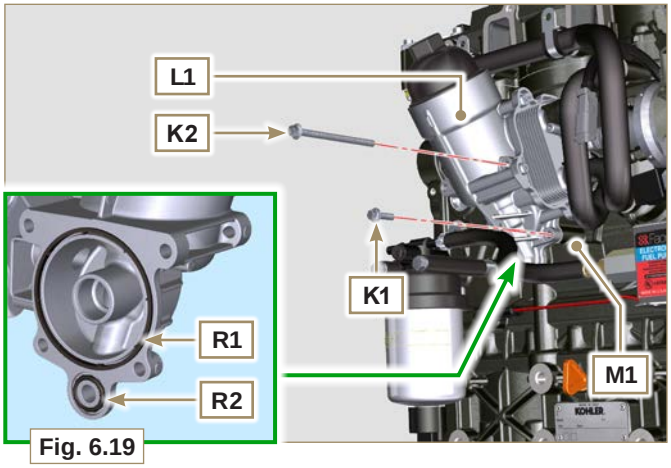


Fig. 6.19

9 - Secure tube **U1** by means of capscrew **P1**, inserting gasket **T1**.

10 - Fit quick coupling **N1** onto pump **J1**.

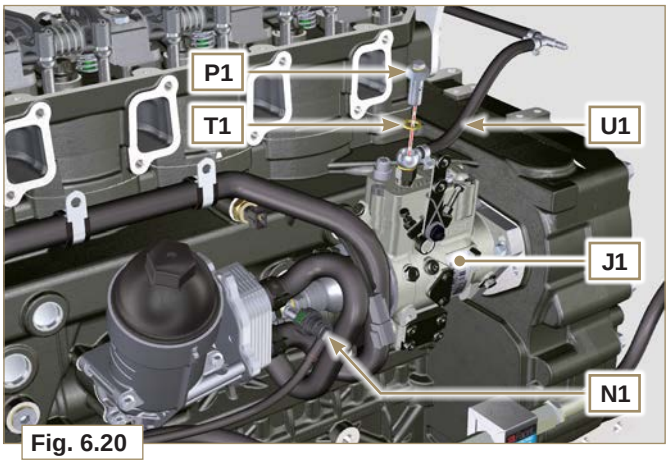


Fig. 6.20

11 - Secure plate **B1** by means of capscrews **A1**, inserting gasket **V1** onto carter **S1** (tightening torque at **10 Nm**).

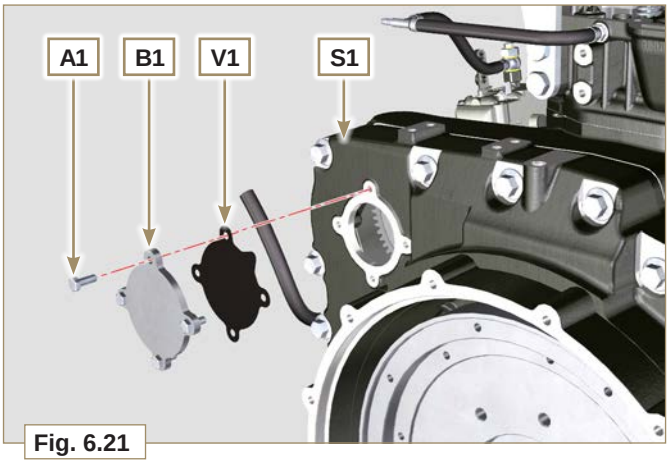


Fig. 6.21

6.1.7 Injector assembly

Important

• To prevent damaging the injection system, the protection caps (**Par. 2.9.7**) must be removed during assembly.

1 - Lubricate the gaskets **W1, W2, S,** and fit them on the injector **Z.**

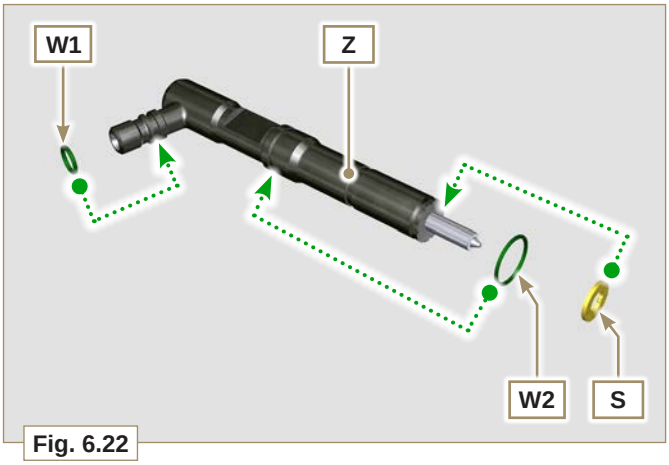


Fig. 6.22

2 - Fit the injector **Z** in the sleeve **V**.

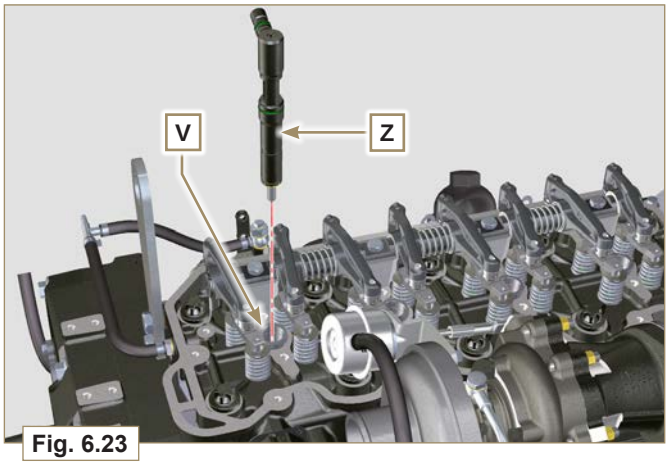


Fig. 6.23

3 - Assemble the parts **P**, **Q**, **R**. and fit the parts so assembled on the injector **Z**.

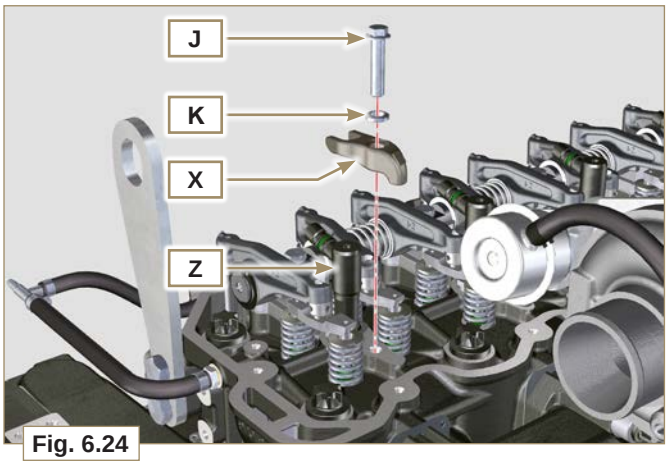


Fig. 6.24

4 - Insert tool **ST_52** on the injectors junctions **Z** (detail **X2)**.

5 - Tighten the screw **J** (tightening torque to **20 Nm** - **Fig. 6.24**).

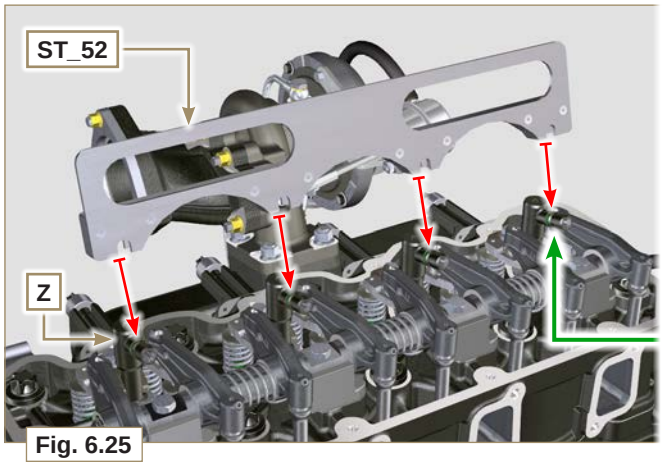
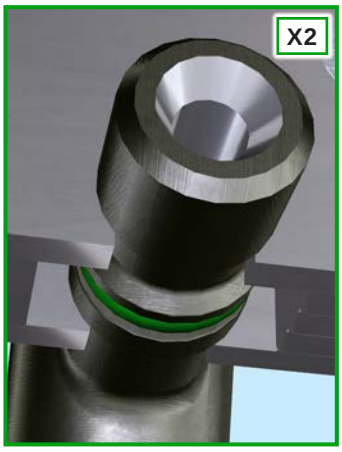


Fig. 6.25



6.1.8 Assembly of the injector return pipes

1 - Position the tube **N** on the injectors **Z** and tighten screws **M** (tightening torque to **14 Nm**).

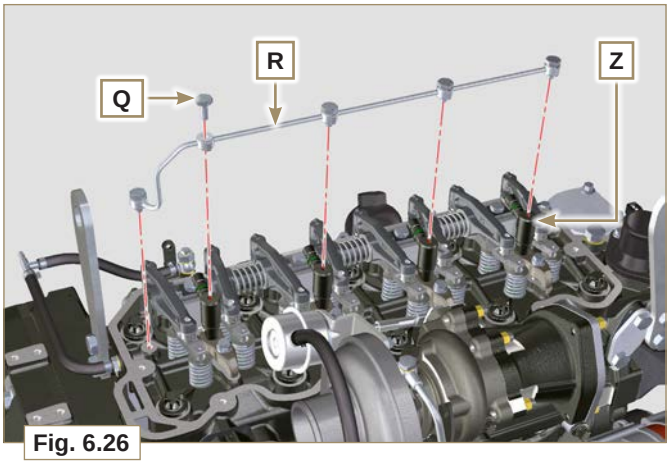


Fig. 6.26

6.1.9 Assembly Rocker arm cover

Important

- The gasket **Z1** between the rocker arm cover and the cylinder head must always be replaced every time it is disassembled.

1 - Position tool **ST_17** onto the head in correspondence with the two fastening holes **9** and **10**.

2 - Position gasket **Z1** and cap **P** on cylinder head **A2** matching the holes of fastening capscrews **N** with the aid of the gudgeon guides **ST_17**.

3 - Attach the rocker arm cover **P** on the head **A2** with the screw **N** adhering to the tightening sequence shown in **Fig. 6.28** (tightening torque to **10 Nm**).

4 - Secure the hose **M2** with the screw **L** (tightening torque to **10 Nm**).

5 - Clamp the fitting **M3** with the screw **M** (tightening torque to **25 Nm**) inserting the gasket **B2.**

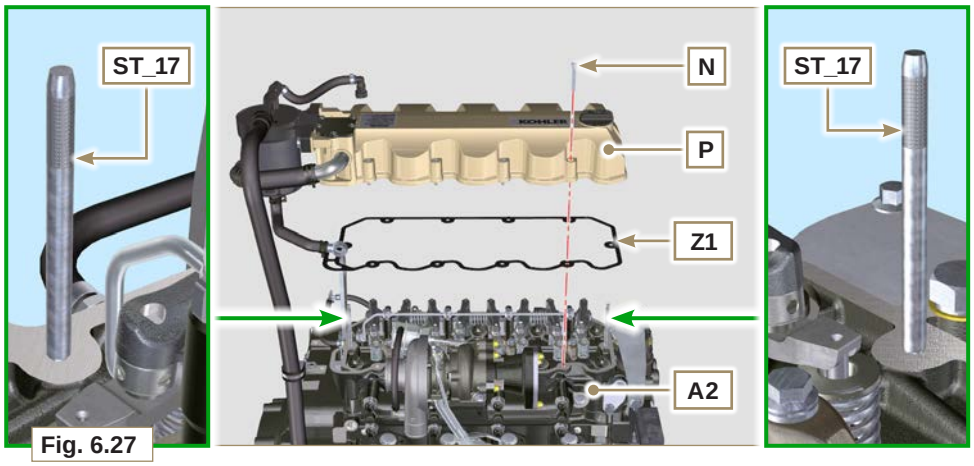


Fig. 6.27

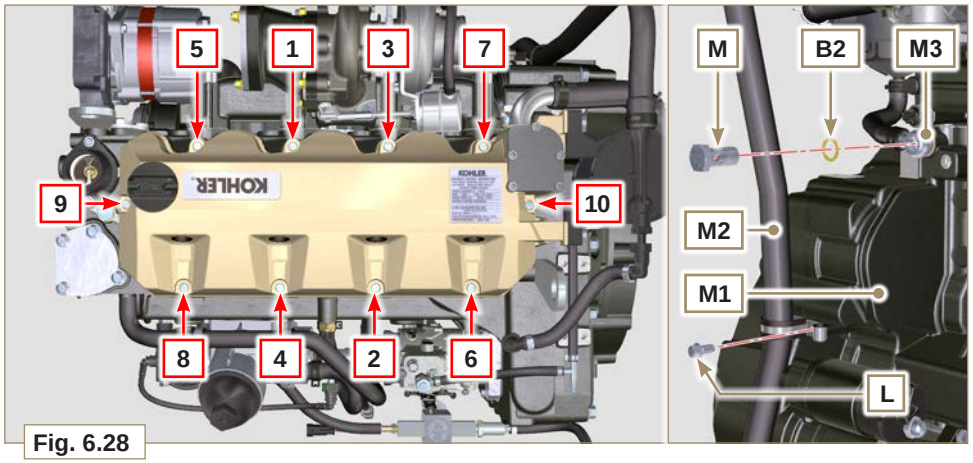


Fig. 6.28

6.1.10 Installation of the fuel injector pipes (pump injector/injectors)

1 - Position pipes **H** on the injectors and on the injector pump.

Important

- Tighten the nuts **F** and **G** manually, without clamping them.

2 - Tighten the nuts **F** and **G** (tightening torque at **25 Nm**).

3 - Secure tubes **H** by means of clamps **H2**, assembling**:**
- **H3** rubber element;
- clamp **H2** on element **H3**;
- secure clamp **H2** by means of capscrew **H4** and nut **H5** (tightening torque at **10 Nm**).

4 - Secure manifold **E** onto cylinder head **A2** by means of capscrews **D**, inserting gasket **C2**.

5 - Secure suction line **E2** onto manifold **E** by means of capscrews **A**, inserting gasket **D2**.

6 - Fit quick coupling **C** onto manifold **E**.

7 - Fasten the pipe **H6** on the manifold **E** with the screws B.

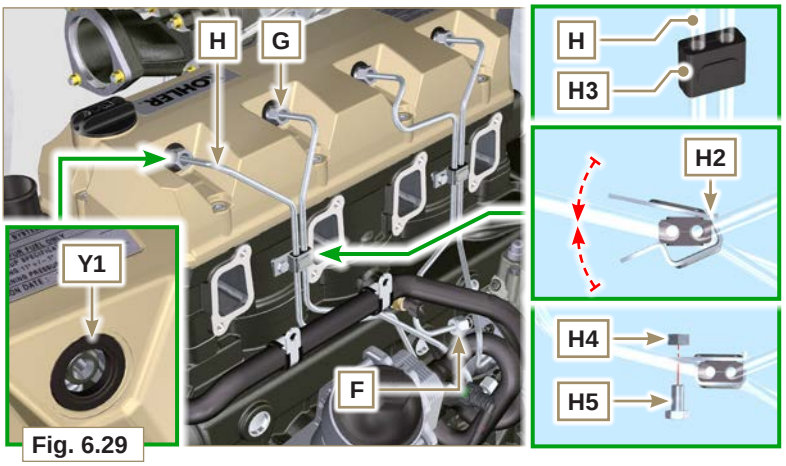


Fig. 6.29

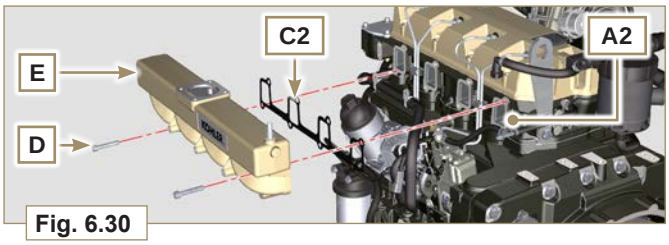


Fig. 6.30

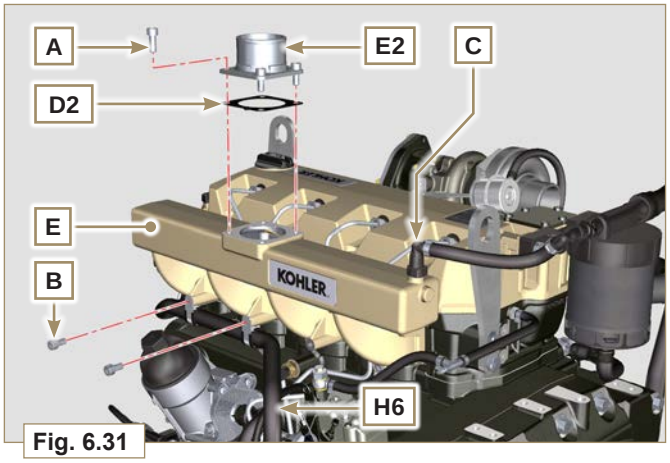


Fig. 6.31

6.2 Coolant pump replacement

6.2.1 Disassembly

NOTE: Perform the operations described in **Par. 5.1**.

Important

- Before proceeding with operation, carefully read **Par. 3.3.2**.
- The coolant pump is not repairable.

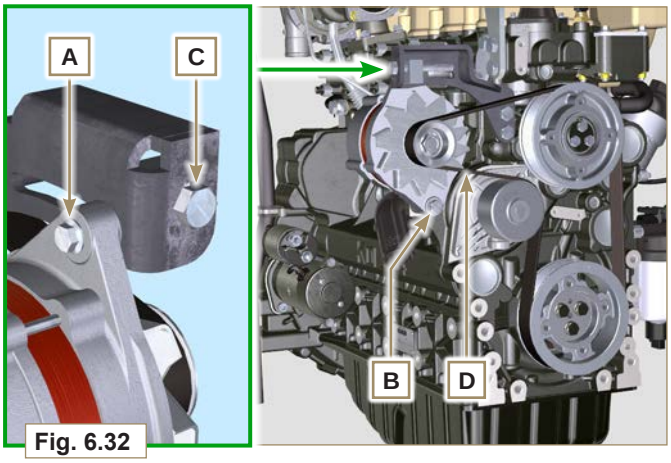


Fig. 6.32

1 - Loosen the screws **A** and **B**.

2 - Loosen capscrew **C** and disconnect voltage from belt **D** and remove belt **D**.

3 - Undo the screws **E** and remove the pulley **F**.

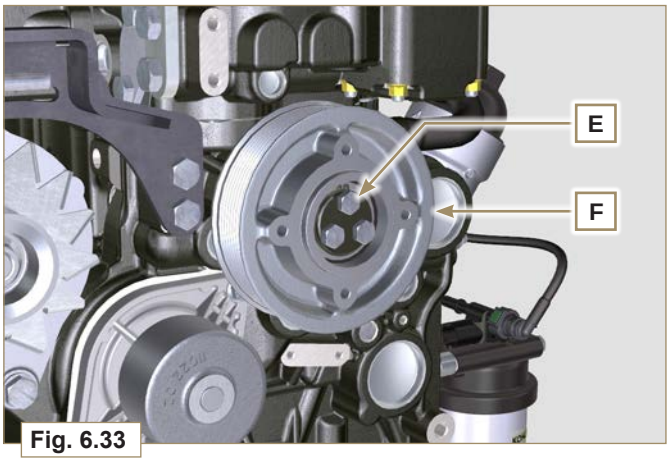


Fig. 6.33

4 - Undo the screws **G** and remove the pump **H** with the relevant gasket.

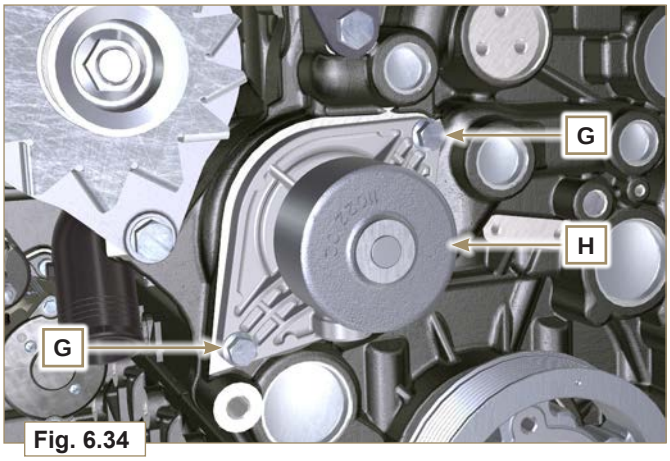


Fig. 6.34

6.2.2 Assembly

Important

- Always replace the gaskets **J**, at each disassembly.
- Always replace the belt **D** after each assembly.

1 - Fit the pump **H** with the screws **G** interposing the new gasket **J** (tightening torque at **25 Nm**).

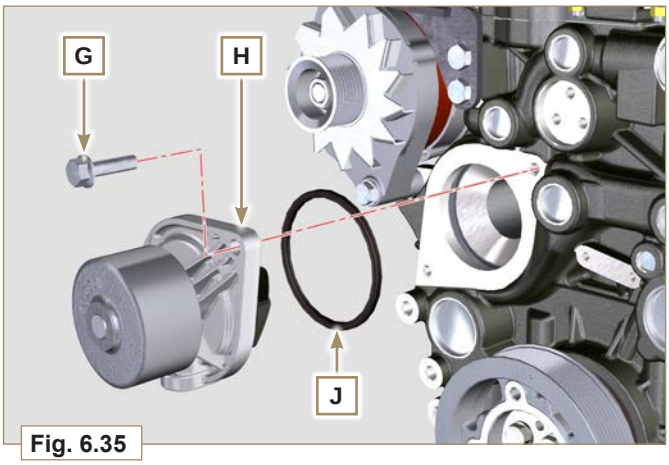


Fig. 6.35

2 - By means of capscrews **E**, secure pulley **F** to crankcase **K** (tightening torque at **25 Nm**).

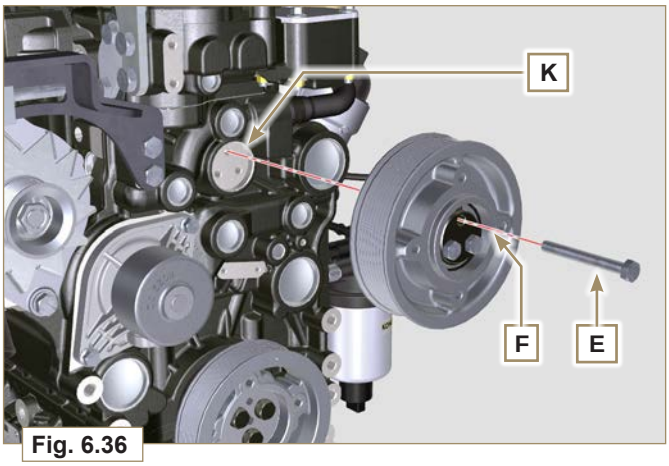


Fig. 6.36

3 - Insert the belt **D** on the pulleys **M**.

4 - Tighten capscrew **C**, bringing capscrew **A** to its stop on the slot of support.

5 - Fit the screw **A** (tightening torque at **25 Nm**).

6 - Fit the screw **B** (**Fig. 6.32** - tightening torque at **45 Nm**).

7 - Start the engine and run it for some minutes, then turn off it and let it cool down at ambient temperature.
Check by the appropriate tool that at point **P** the tension value is between **135** and **178 Hz**.

NOTE: If the belt does not comply with the pre-set voltage values, replace it.

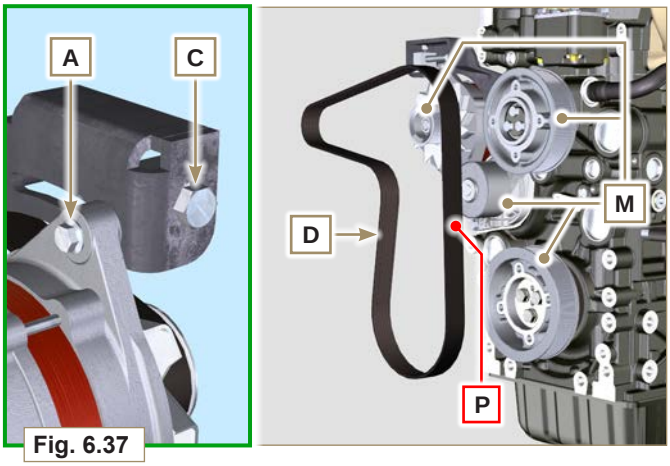


Fig. 6.37

6.3 Oil vapour separator replacement

Important

• Before proceeding with operation, carefully read **Par. 3.3.2**.

6.3.1 Disassembly

1 - Remove quick fitting **A**.

2 - Release the clamps **B** and **C**.

3 - Remove hose **D** from breather body **E**.

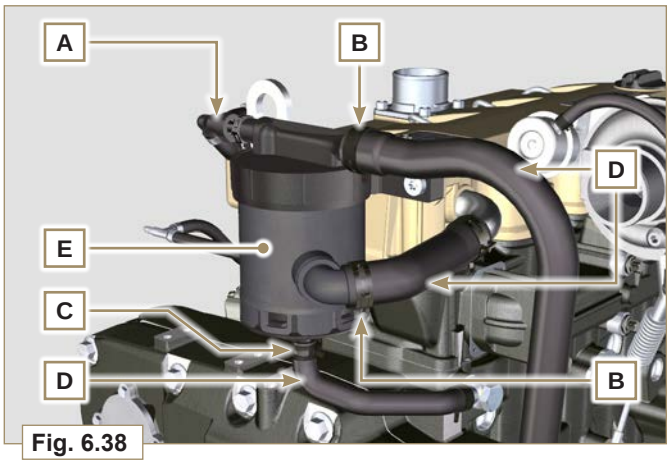


Fig. 6.38

4 - Remove capscrews **F** and remove breather body **E**.

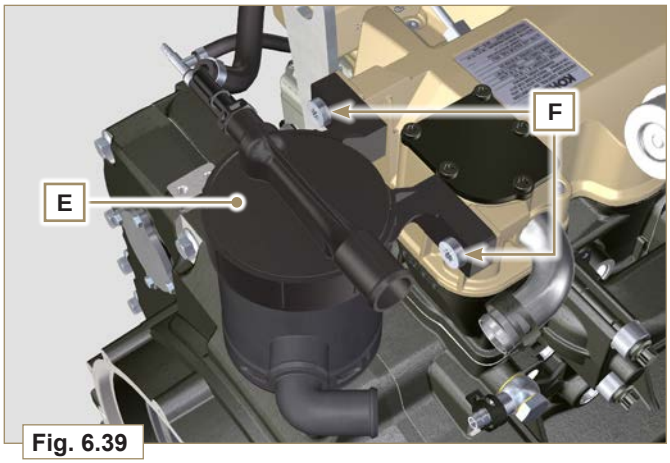


Fig. 6.39

6.3.2 Assembly

1 - Secure breather body **E** by means of capscrews **F** (tightening torque at **22 Nm**).

2 - Fit hose **D** onto breather body **E** (**Fig. 6.38**).

3 - Secure the clamps **B** and **C** (**Fig. 6.38**).

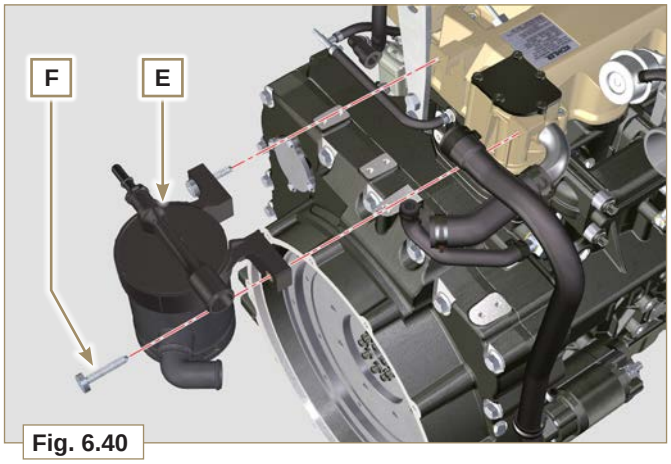


Fig. 6.40

6.4 Oil cooler unit and oil filter replacement

6.4.1 Oil Cooler unit disassembly

Important

- Perform the operations described in **Par. 5.1** and **Par. 5.2**.
- Oil Cooler unit **E** is not repairable.

1 - Release the clamps **A**.

2 - Remove the hoses **B** out of the Oil Cooler unit **E**.

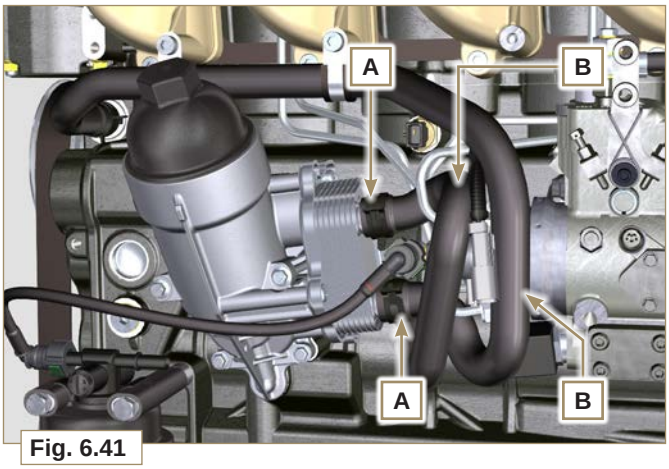


Fig. 6.41

Warning

- Electric/pneumatic screwdrivers are forbidden.
- Use a suitable container to recover any residue oil.

3 - Unscrew cartridge holder cover **H** by performing three complete turns and wait 1 minute.

NOTE: this operation allows to oil contained in the support **E** to flow into the oil sump in the correct way.

4 - Unscrew cartridge holder cover **H** and check that the oil in the lub. oil filter support **E** has flowed towards the oil sump.

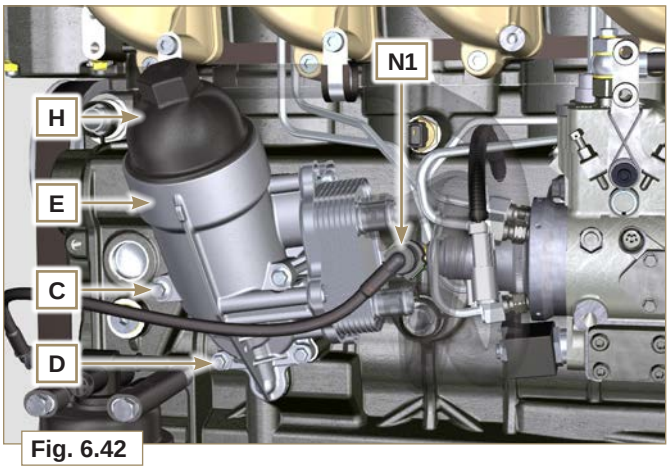


Fig. 6.42

5 - Remove quick fitting **N1**.

6 - Undo the screws **C** and **D** and remove the Oil Cooler unit **E**.

7 - Remove the gaskets **F** and **G** from the Oil Cooler unit **E**.

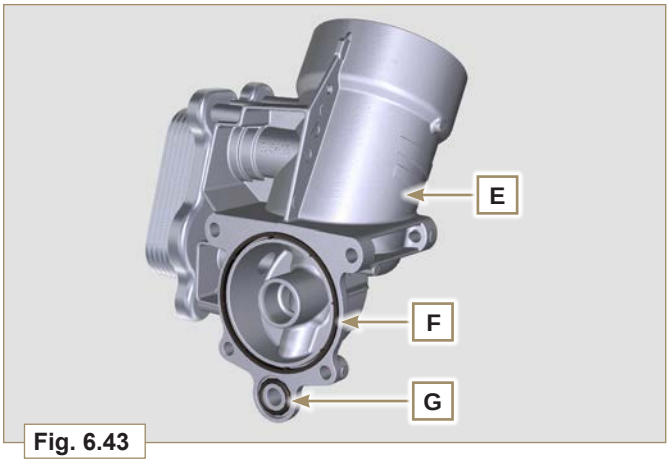


Fig. 6.43

6.4.2 Oil filter cartridge replacement

1 - Remove gaskets **L, M** and **N** from element holder cover **H**.

2 - Remove cartridge **P** from element holder cover **H**.

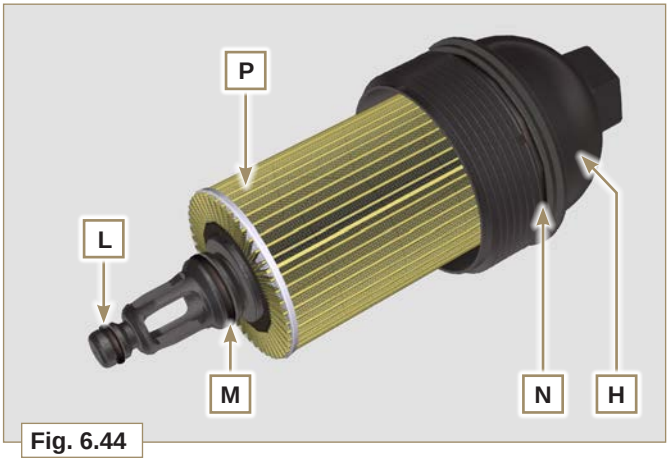


Fig. 6.44

5 - Lubricate and insert gaskets **L, M** and **N** in the **L1, M1** and **N1** seats of element holder cover **H**.

6 - Insert element **P** into element holder cover **H**.

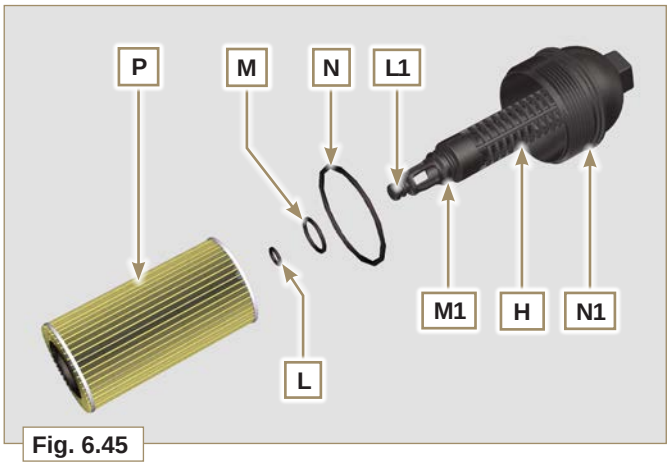


Fig. 6.45

6.4.3 Oil Cooler unit assembly

Important

- In the event of assembly of union **U** on crankcase **S**, (manual tightening torque with Loctite 2701 on the thread).

1 - Check that the surface **Q** on the support **E** and on the crankcase **S** are free from impurities.

2 - Lubricate and insert the gasket **T** on the fitting **U**.

3 - Lubricate and insert the gaskets on the support **E**:
F in seat **F1**;
G in seat **G1**.

4 - Fit the support **R** with the screws **C** and **D** (tightening torque at **10 Nm**).

5 - Insert and tighten the cartridge support **H** on the filter support **E** (tightening torque at **25 Nm**).

6 - Fit the hoses **B** on the support **E** and secure the hoses **B** with the clamps **A**.

7 - Fit quick coupling **N1** onto pump **J1**.

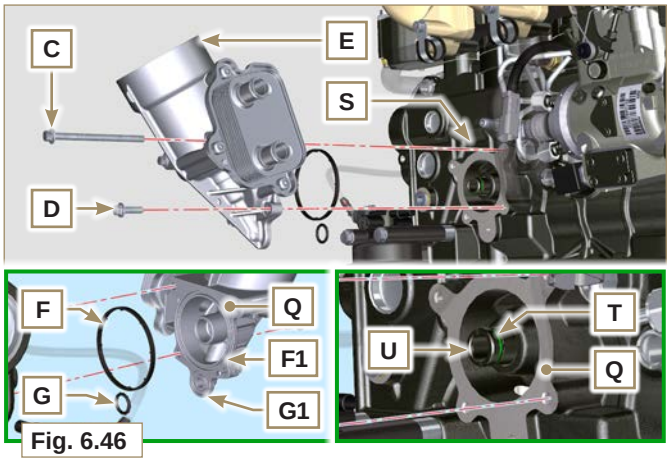


Fig. 6.46

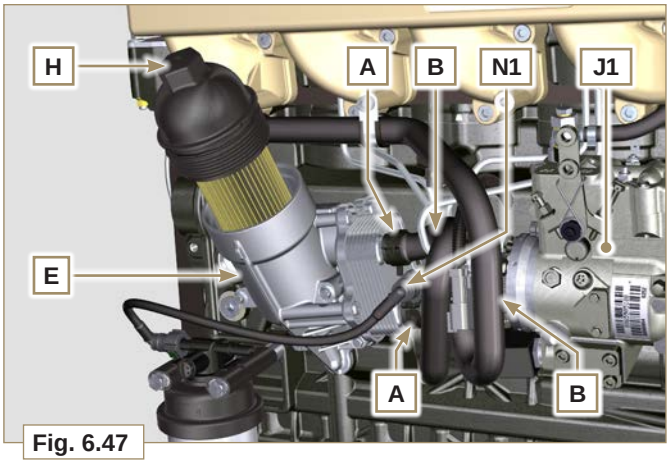


Fig. 6.47

6.5 Fuel filter replacement

6.5.1 Disassembly

Warning

- Before proceeding with operation, carefully read **Par. 3.3.2**.
- The fuel filter is not always mounted in the engine.
- When disassembling, use a suitable container to recover the fuel contained in the cartridge **F**.

1 - Remove quick fitting **N1**.

2 - Release the clamps **A** and pull the pipes **B** out of the support **H**.

3 - Unscrew the cartridge **F** from the support **H**.

4 - Undo the screws **C** and remove the support **H**.

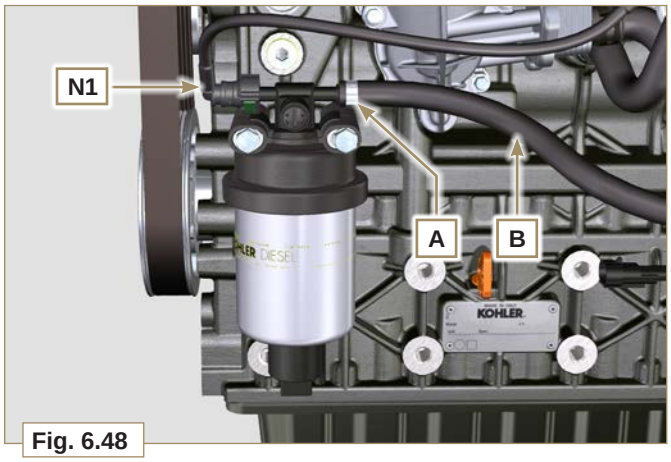


Fig. 6.48

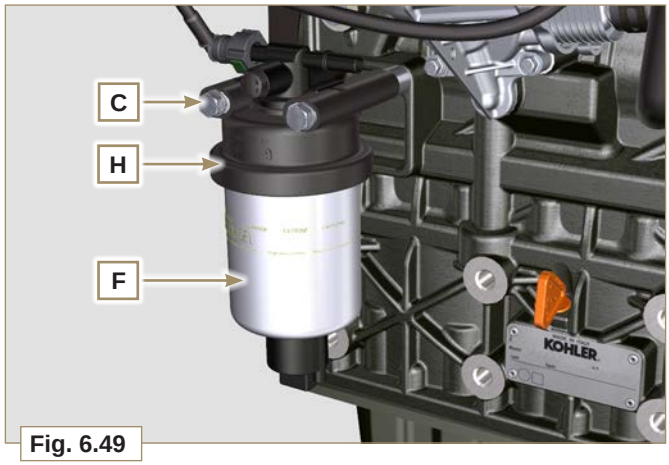


Fig. 6.49

6.5.2 Assembly

1 - Secure fuel filter bracket **H** with capscrews **C** onto crankcase **M**, inserting spacer **L** between **M** and **H** and washer **P** between **H** and **C** (tightening torque at **25 Nm**).

2 - Fit the pipes **B** on the support **H**.

3 - Secure the pipes **B** with the clamps **A**.

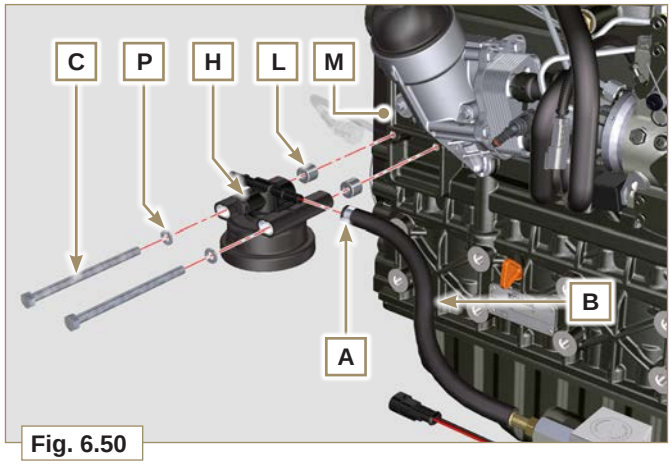


Fig. 6.50

4 - Lubricate the gasket **N** with fuel.

5 - Tighten the cartridge **F** on the support **H** (tightening torque at **17 Nm**).

6 - Fit quick coupling **N1** onto support **H**.

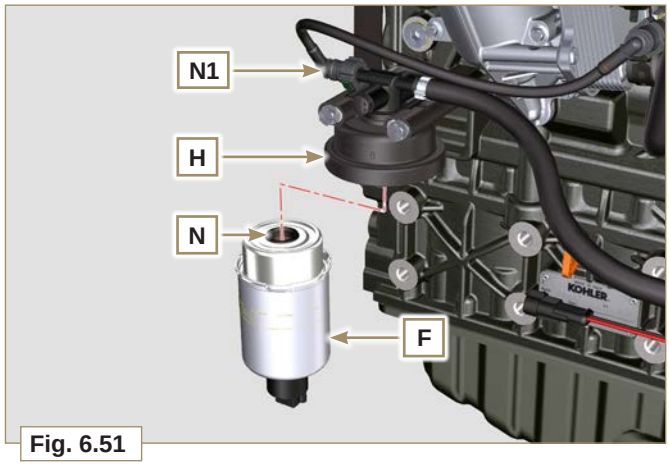


Fig. 6.51

7.1 Recommendations for disassembly

Important

- To locate specific topics, the reader should refer to the **index**.
- The mark (↪) after the title of a paragraph, indicates that the procedure is not required in order to disassemble the engine, however the procedures are featured in order to illustrate the disassembly of components.
- The operator should prepare all equipment and tools in order to enable him to carry out the operations correctly and safely.
- Before disassembly, perform the operation described in **Chap. 5**.
- Before proceeding with operation, carefully read **Chap. 3**.
- In order to operate safely and easily, we recommend positioning the engine on a rotating stand for engine overhauling.
- Seal all injection component unions as illustrated in **Par. 2.9.8** during disassembly
- Protect all disassembled components and coupling surfaces subject to oxidation with lubricant.
- Where necessary, reference to special tools to use during disassembly operations is indicated (e.g. **ST_05**), refer to **KOHLER** diesel special tools.

7.2 Turbocharger disassembly

1 - Unscrew the fittings **A** and remove the pipe **B** with the relative gaskets **C**.

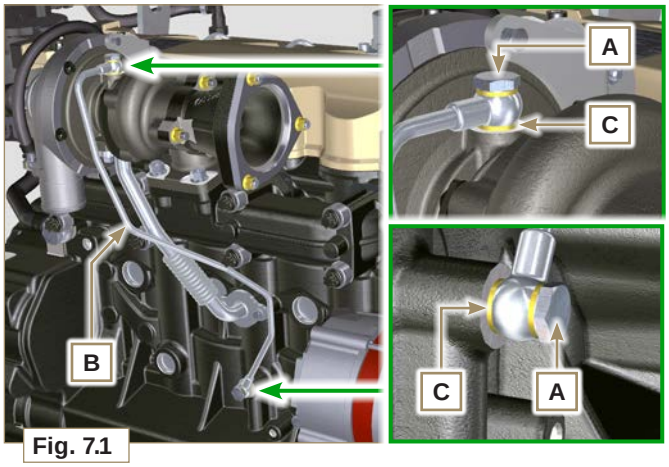


Fig. 7.1

2 - Undo the screws **D** and remove pipe **E** and the relevant gaskets.

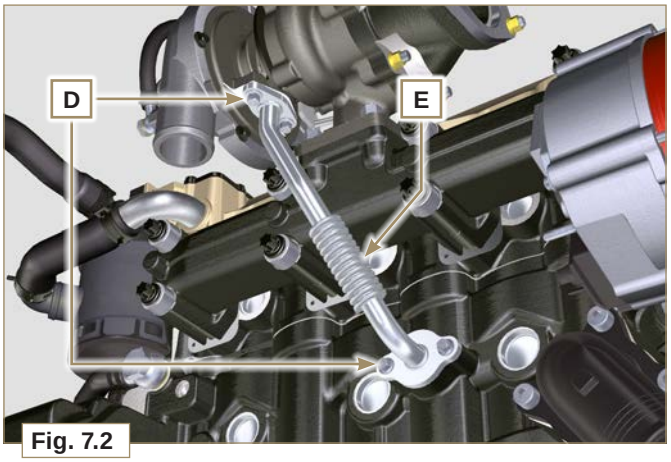


Fig. 7.2

3 - Undo the nuts **F** and remove the turbocharger **G**.

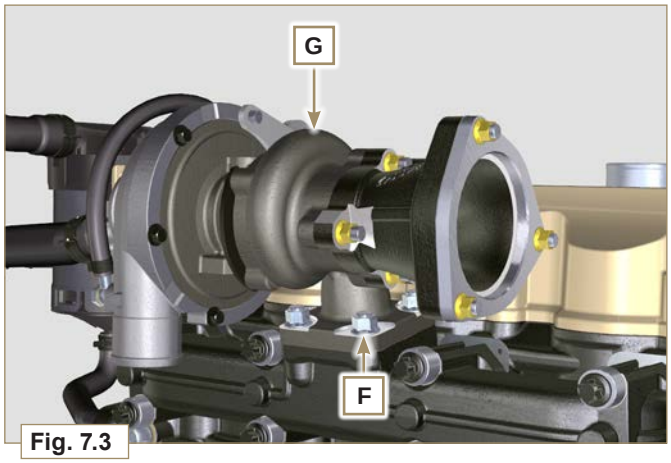


Fig. 7.3

7.3 Coolant recirculation components disassembly

7.3.1 Oil Cooler manifold

1 - Release the clamps **A**.

2 - Undo the screws **B** and remove hoses **C.**

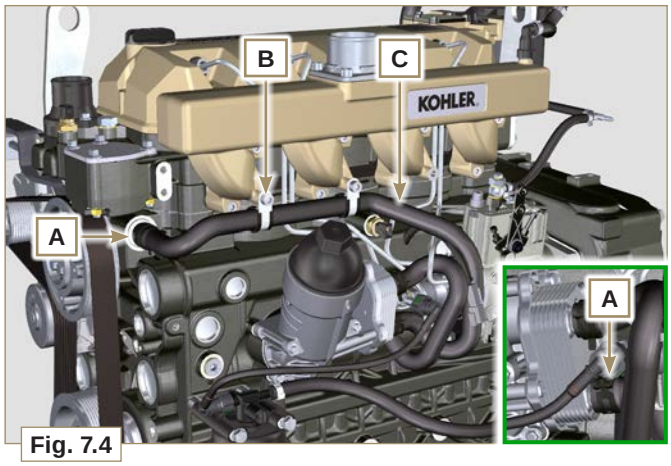


Fig. 7.4

3 - Release the clamps **D** and remove hoses **E**.

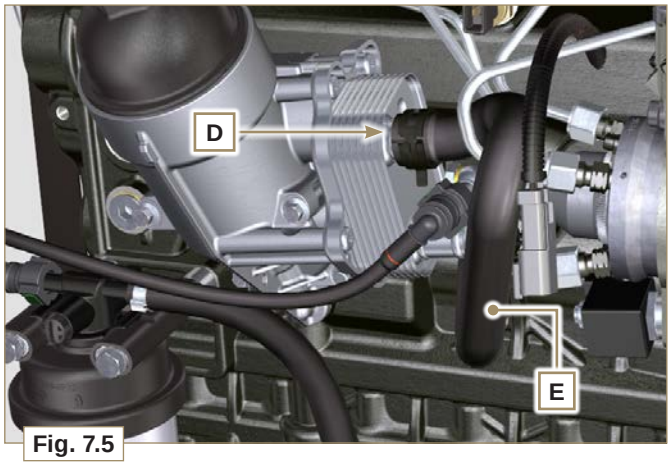


Fig. 7.5

7.3.2 Coolant pump

Important

• The pump **B** is not repairable.

1 - Perform the operations described in **Par. 6.2.1**.

2 - Undo capscrews **F** and remove flange **G** with the relative gasket.

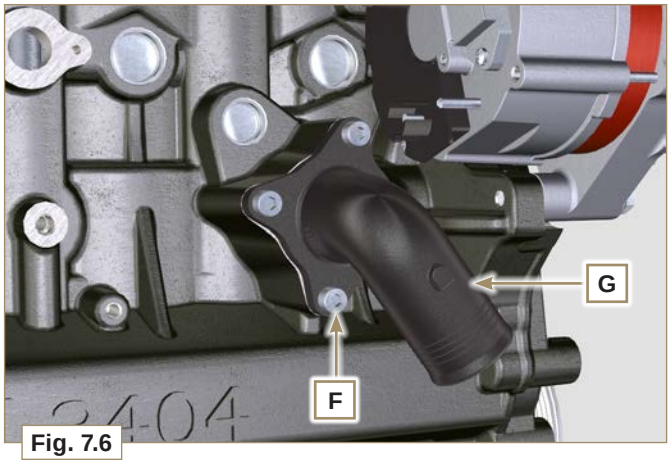


Fig. 7.6

7.3.3 Thermostatic valve

1 - Undo the screws **A** and remove the thermostatic valve cover **B**.

2 - Remove the thermostatic valve **C** and its gasket.

Important

• Always replace the gasket **D** every time it is disassembled.

3 - Check that the air bleeding hole is not clogged or blocked (**Par. 2.11.3**).

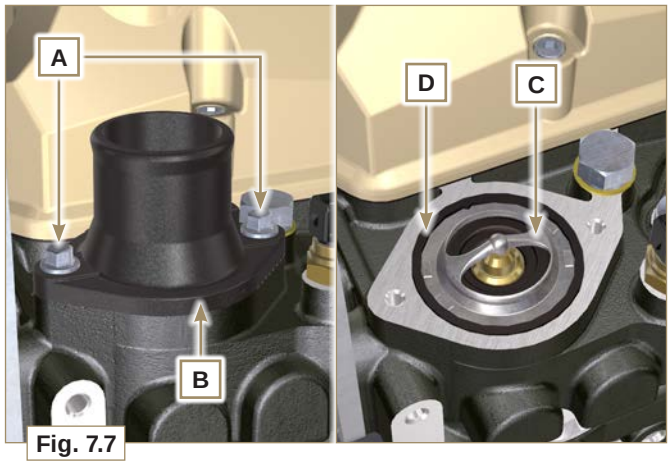


Fig. 7.7

7.4 Electric components disassembly

7.4.1 Starter motor

Important

- The motor is not repairable.

1 - Perform the operations from point **2** to **3** of **Par. 6.1.5**.

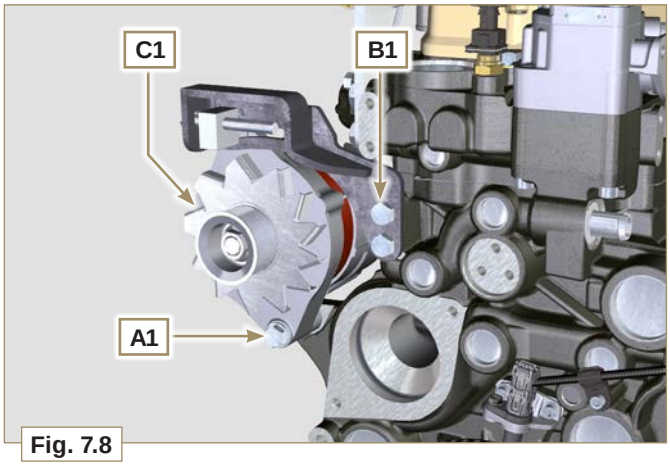


Fig. 7.8

7.4.2 Alternator

1 - Undo the screws **A1** and **B1** and remove the alternator **C1**.

7.4.3 Sensors and switches

Important

- After disassembly, protect the sensors suitably against knocks, dampness and any high temperature sources.
- The sensors and switches cannot be repaired, therefore they must be replaced in the event of anomalies.

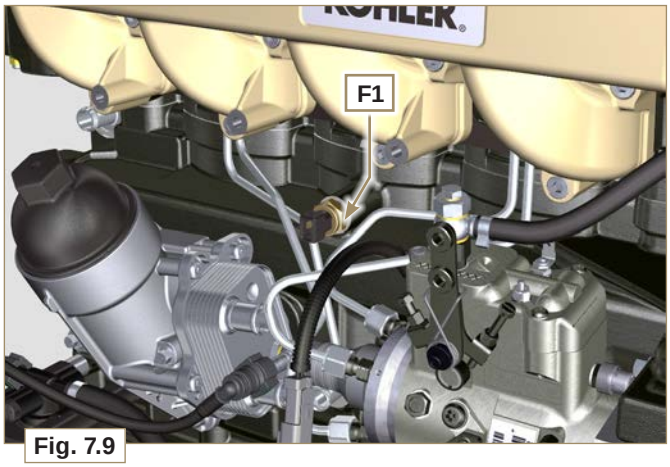


Fig. 7.9

7.4.3.1 Oil pressure switch (↪)

1 - Unscrew and remove the oil pressure switch **F1**.

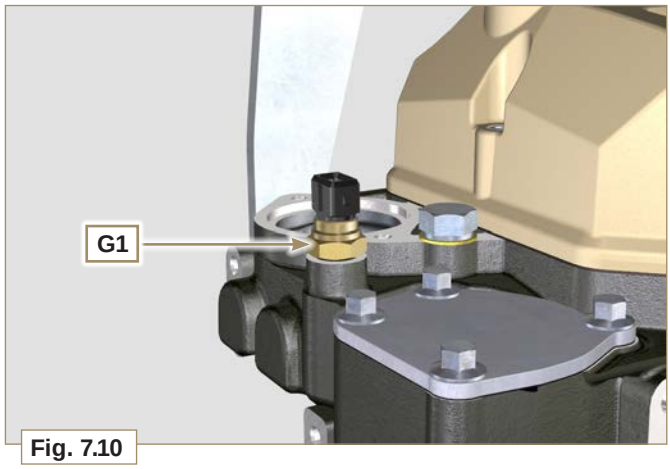


Fig. 7.10

7.4.3.2 Coolant temperature sensor (↪)

1 - Unscrew and remove the coolant temperature sensor **G1**.

7.5 Exhaust manifold disassembly

1 - Remove capscrews **B** and spacers **C**, manifold **D** and gaskets **E**.

2 - Close the openings and manifolds to prevent foreign bodies from entering.

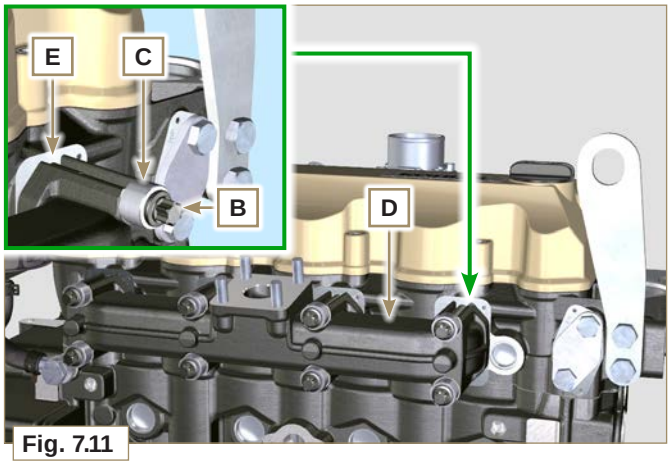


Fig. 7.11

7.6 Fuel system disassembly

Important

- Seal all injection component unions as illustrated in **Par. 2.9.8** during disassembly.

7.6.1 Injection fuel pipes

1 - Perform the operations of **Par. 6.1.1**.

7.6.2 Rocker arms cover

1 - Perform the operations of **Par. 6.1.2**.

7.6.3 Fuel return pipes

1 - Perform the operations of **Par. 6.1.3**.

2 - Perform the operations of point **18** of **Par. 6.1.5**.

3 - Loosen union **A** from cylinder head **B** and remove return line **C**.

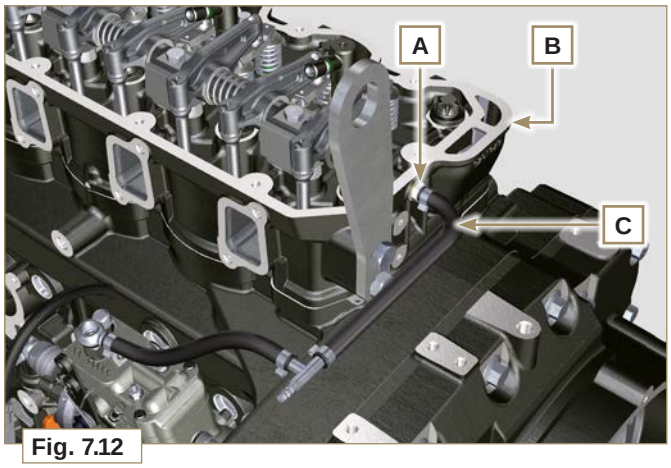


Fig. 7.12

7.6.4 Injectors

1 - Perform the operations of **Par. 6.1.4**.

7.6.5 Injection pump

1 - Perform the operations of **Par. 6.1.5**.

7.6.6 Fuel filter (↪)

1 - Perform the operations of **Par. 6.5.1**.

7.7 Crankshaft pulley disassembly

4 - Undo the screws **A** and remove the pulley **B**.

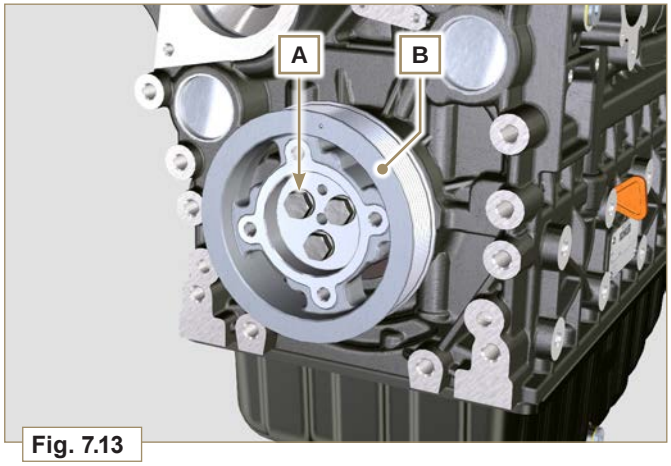


Fig. 7.13

7.8 Flange unit disassembly

7.8.1 Flywheel

Danger

- The flywheel **A** is very heavy. Pay the utmost attention while removing it in order to prevent it dropping or falling, as this may have serious consequences for the operative.

1 - Undo the screws **B** and remove the flywheel **A** by means of tool **ST_43**.

2 - Secure tool **ST_41** onto gear **C** by means of capscrews **B**.

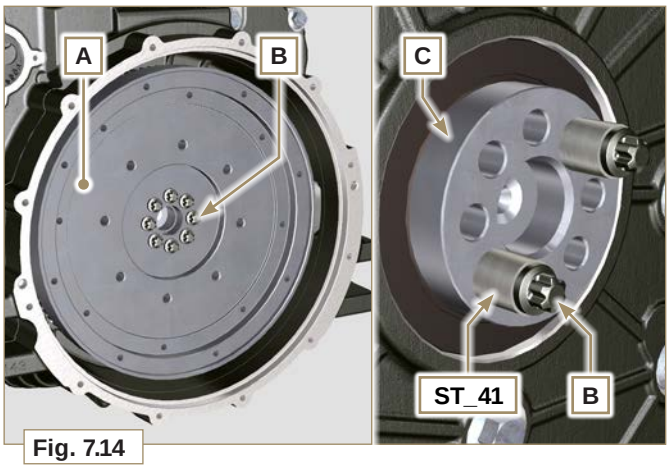


Fig. 7.14

7.8.2 Flange housing

Danger

- The flange housing **D** is very heavy. Pay the utmost attention while removing it in order to prevent it dropping or falling, as this may have serious consequences for the operative.

1 - Undo capscrews **E** by following the order indicated in the figure.

2 - Remove the engine housing **D** by means of tool **ST_44**.

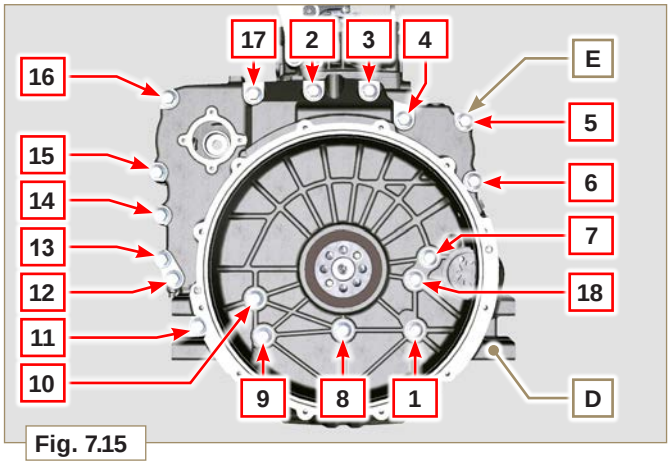


Fig. 7.15

7.9 Lubrication circuit disassembly

7.9.1 Oil pump (↪)

Important

- The oil pump is not repairable.

1 - Undo the screws **A** and remove the pump unit **B**.

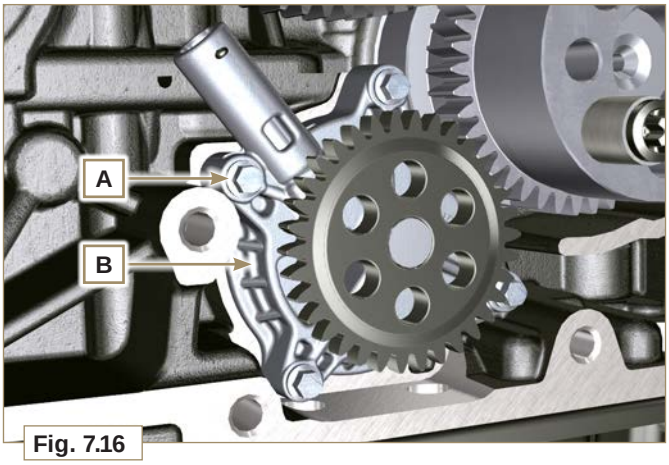


Fig. 7.16

7.9.2 Oil pressure valve (↪)

1 - Remove cotter pin **C**.

2 - Remove disk **D**, spring **E**, piston valve **F** using a magnet.

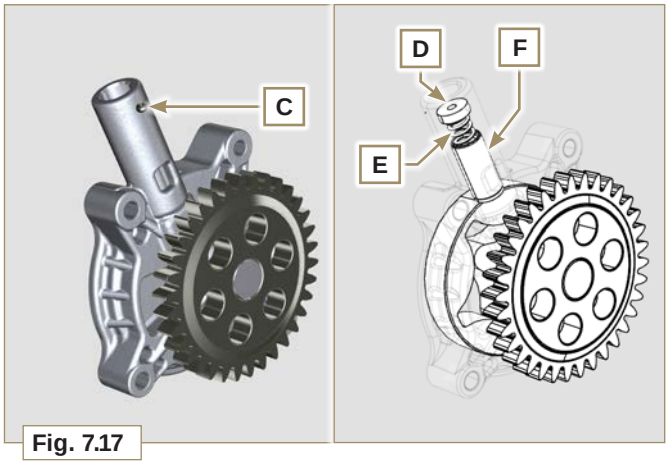


Fig. 7.17

7.10 Cylinder head unit disassembly

7.10.1 Rocker arm pin

1 - Undo the screws **D**.

2 - Remove the rocker arm pin unit **E**.

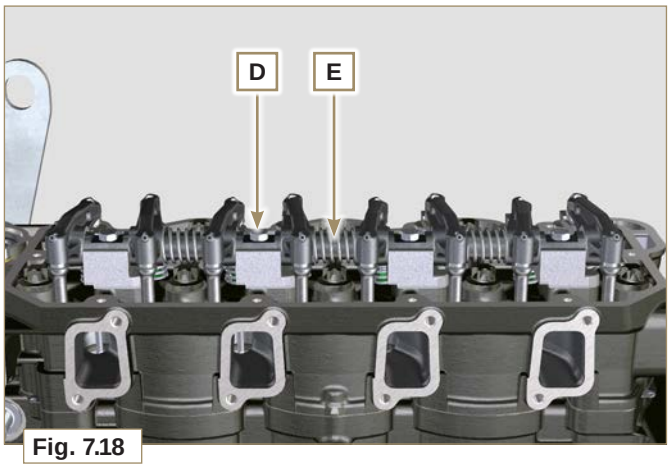


Fig. 7.18

7.10.1.1 Rocker arm (⮑)

1 - Remove the retainer ring **F**.

2 - Remove the shoulder rings **G**.

3 - Remove the rocker arms **H**.

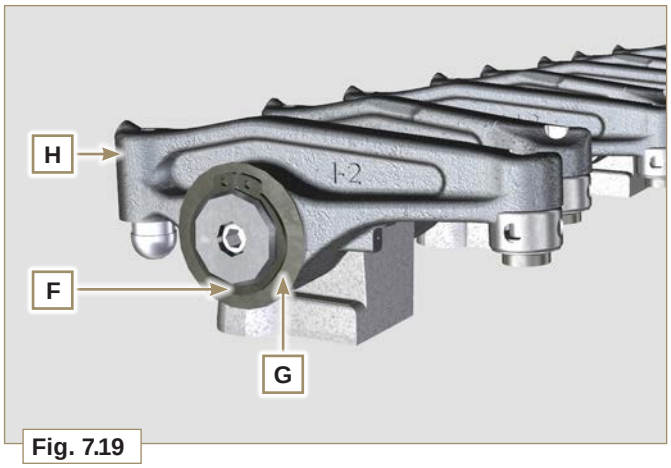


Fig. 7.19

7.10.2 Valve rods and bridges

1 - Remove the valve bridges **M**.

2 - Remove the rocker arm control rods **N**.

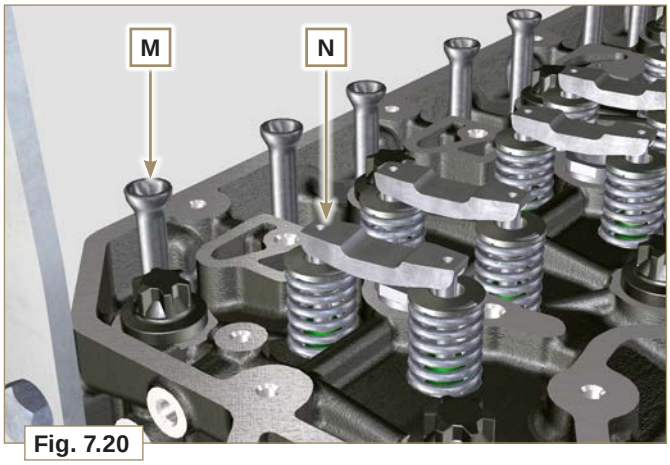


Fig. 7.20

7.10.3 Cylinder head

Important

- The capscrews **P** must be replaced every time they are disassembled.
- **Do NOT** remove the capscrews completely, first loosen them by turning them a whole cycle following the order shown in the figure**.**

1 - Loosen fastening screws **P**, turning them by one turn following the order shown in the figure..

2 - Undo capscrews **P** by following the order indicated in the figure.

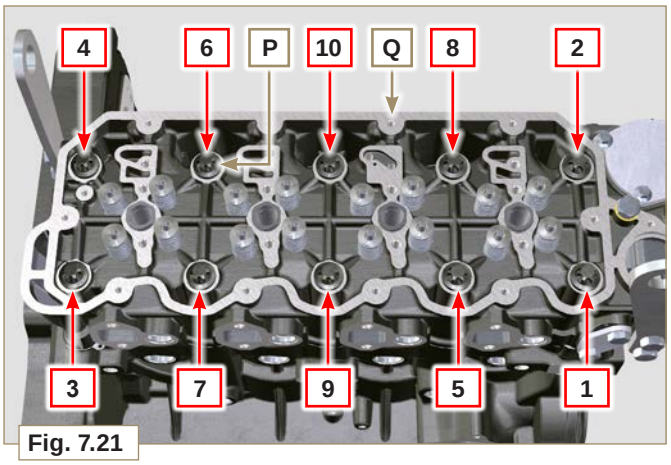


Fig. 7.21

Important

- To lift cylinder head **Q**, only use both eyebolts **Y** provided by **KOHLER** (refer to **Fig. 7.28**).
- When removing the cylinder head **Q** and subsequent disassembly, control, and assembly operations, it is necessary to protect the contact surface **W** of cylinder head **Q** and crankcase **J** against impacts..

3 - Remove the cylinder head **Q**.

4 - Remove the head gasket **R**.

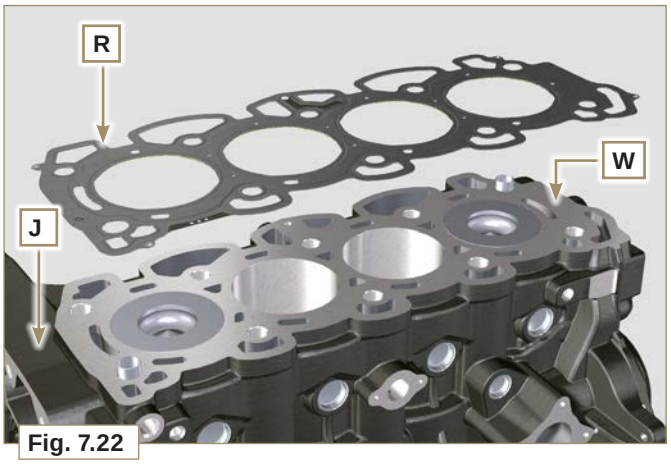


Fig. 7.22

7.10.3.1 Valves (↪)

1 - Mount the tool **ST_07** on the head **Q** fixing it on one of the holes for fixing the rocker arm cover.

NOTE: Change the fixing hole according to the position of the valves to be removed.

2 - Position the tool **ST_07** on the valve as shown in the figure.

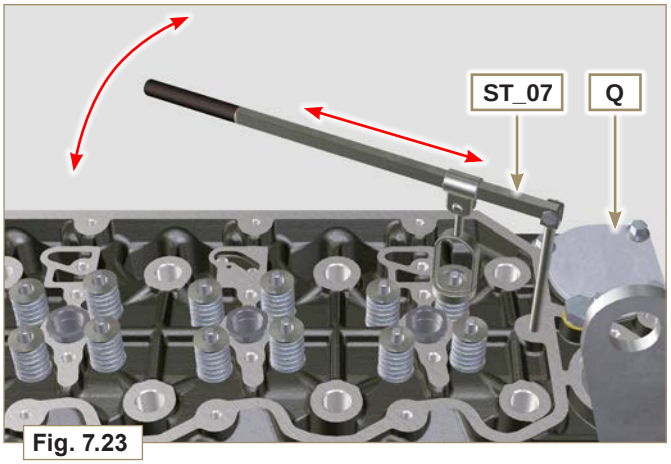


Fig. 7.23

3 - Push the lever of the tool **ST_07** downwards, in order to lower the valve plates **S** in the direction of the arrow **T**, remove cotters **U** using a magnet.

NOTE: Repeat all the operations for all the valves concerned.

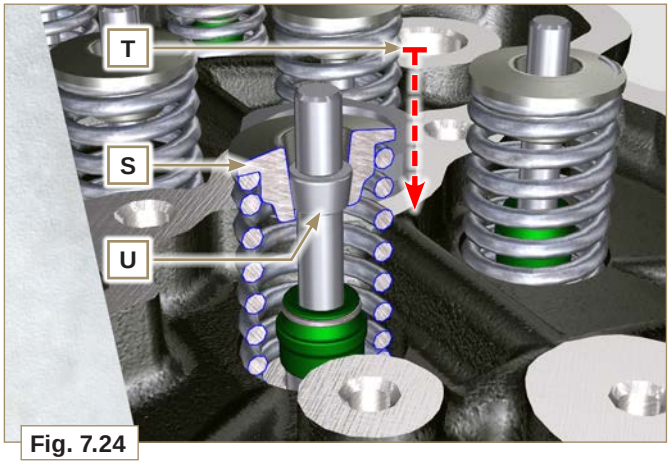


Fig. 7.24

Important

- Before removing the valves, make some marks to record their original position, in order to avoid confusing them when re-assembling (if they are not replaced).

4 - Remove the valves **V**.

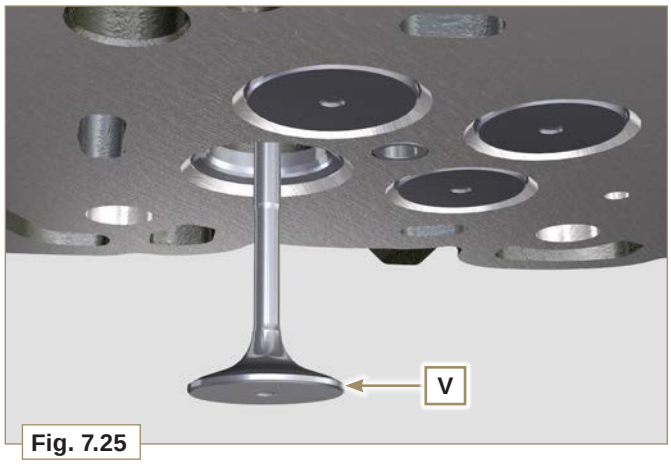


Fig. 7.25

7.10.3.2 Electronic injector sleeves (⮑)

1 - Unscrew and remove the sleeves **Z** from the head **Q**.

2 - Remove the gaskets **J**, **K**.

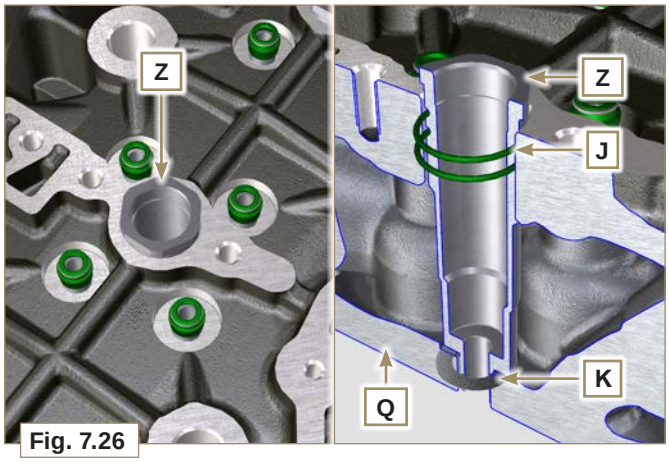


Fig. 7.26

7.10.3.3 Valve stem gasket (⮑)

1 - Remove the gaskets **W**.

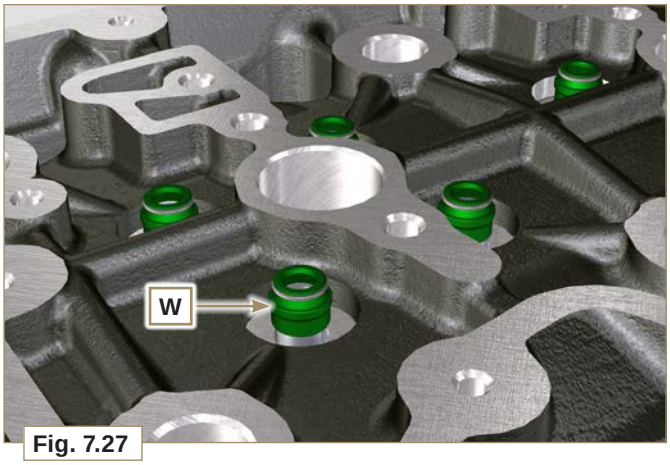


Fig. 7.27

7.10.3.4 Lifting eyebolts (⮑)

1 - Undo the screws **X** and remove the eyebolts **Y**.

2 - Thoroughly wash the cylinder head **Q**.

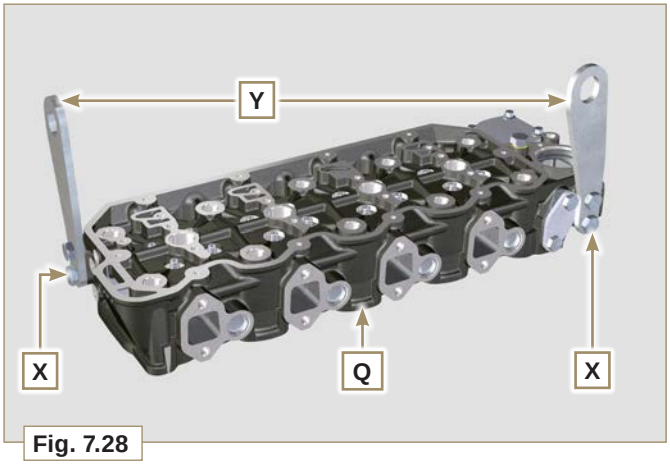


Fig. 7.28

7.11 Oil sump unit disassembly

Important

- For the following operation, turn the engine by bringing the cylinder head surface downwards.

7.11.1 Oil sump

1 - Undo the screws **A**.

2 - Remove the oil sump **B** by inserting a plate between surface **C** of crankcase **D** and oil sump **B**.

3 - Remove the oil dipstick **E**.

Fig. 7.29

7.11.2 Oil suction pipe

1 - Undo the screws **F** and remove the pipe **G**.

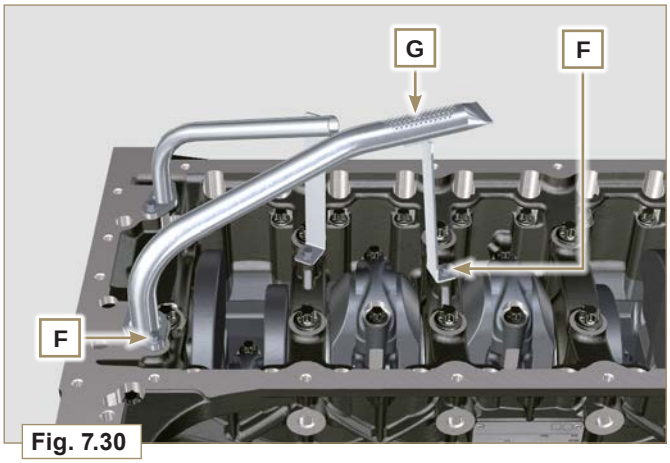


Fig. 7.30

7.11.3 Oil drain pipe (↪)

1 - Undo the screws **H** and remove the pipe **L**.

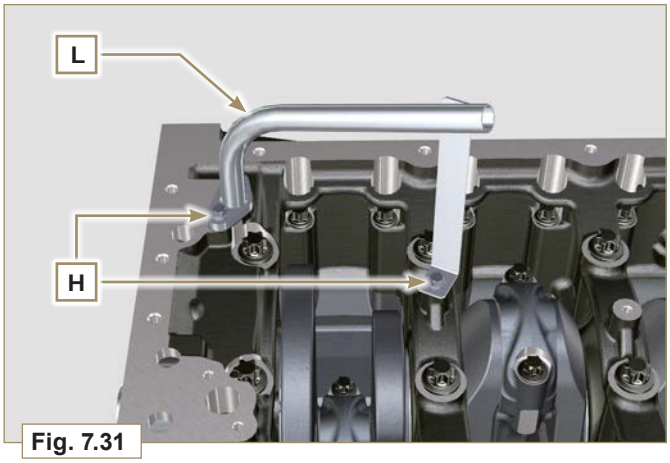


Fig. 7.31

7.12 Engine block disassembly

7.12.1 Piston unit / connecting rod

Important

- Mark some numerical references (cylinder n°) on the connecting rods, connecting rod caps **N**, pistons and gudgeon pins to prevent unintentionally confusing the components not replaced during assembly. Failure to do this may result in engine malfunctions.
- References on connecting rod **M** and cap **N** must only be carried out on a side in correspondence with **K1** and **K2** , as illustrated in **Fig. 7.33**.

1 - Unsrew bolts **M** and remove the connecting rod caps **N**.

NOTE: coupling cap **N** on the connecting rod can be carried out with centring taper pins (**Fig. 7.34**) or broken (**Fig. 7.35** - without centring taper pins).

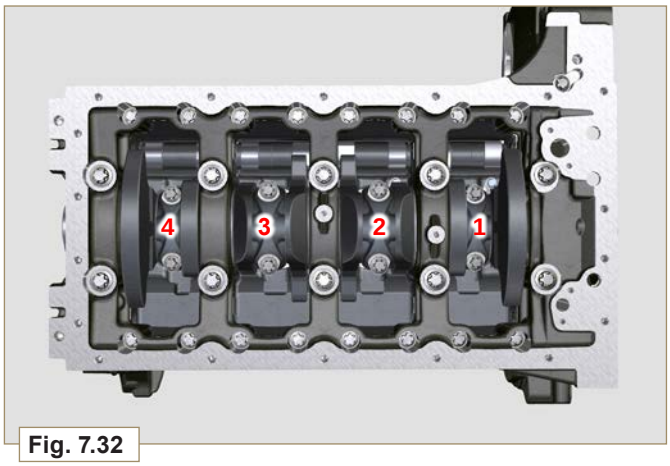


Fig. 7.32

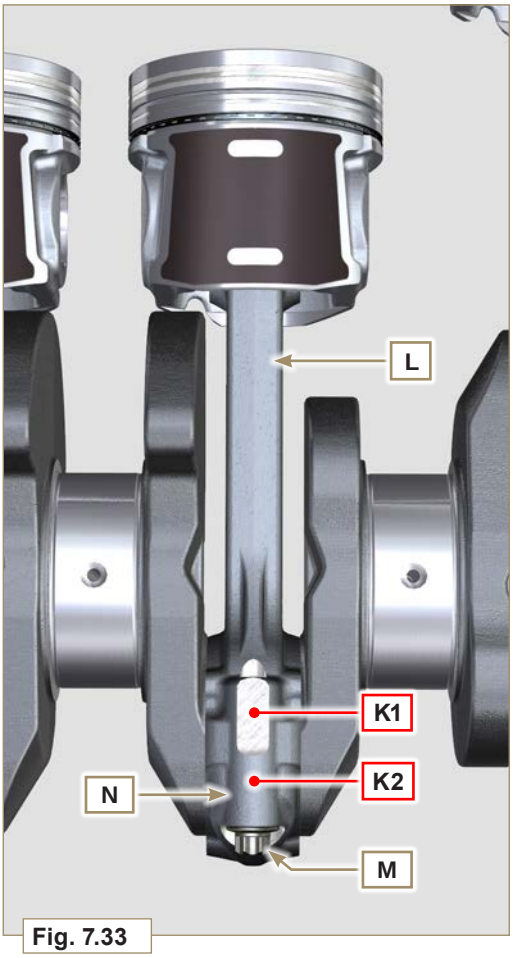


Fig. 7.33


Fig. 7.34


Fig. 7.35

2 - Pull out the connecting rod - piston assembly from position **2** and **3** by manually applying pressure on the connecting rod **M** in the direction of arrow **AK**.

3 - Couple the connecting rod big end caps **L** with the relevant piston and connecting rod unit **M**.

4 - Rotate the crankshaft by 180°.

5 - Repeat points **2 to 5** to disassemble the connecting rod - piston assembly to position **1** and **4**.

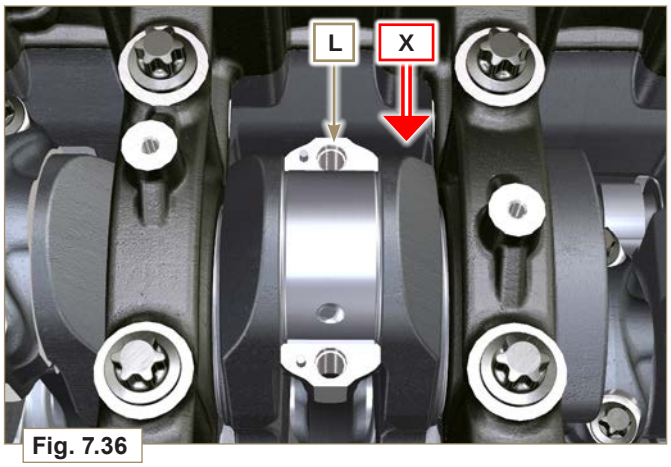


Fig. 7.36

Warning

- The connecting rod half-bearings **Z** are made of special material. Therefore, they must be replaced every time they are removed to prevent seizures.

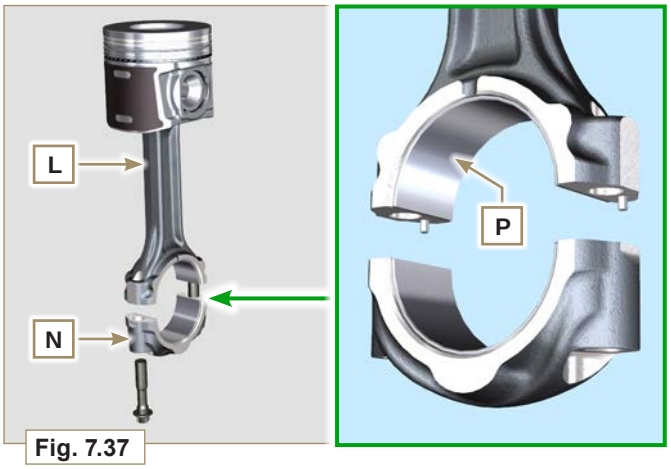


Fig. 7.37

7.12.2 Timing system gear disassembly

1 - Unscrew screws **A** and remove the gear **B**.

2 - Remove the gear **C**.

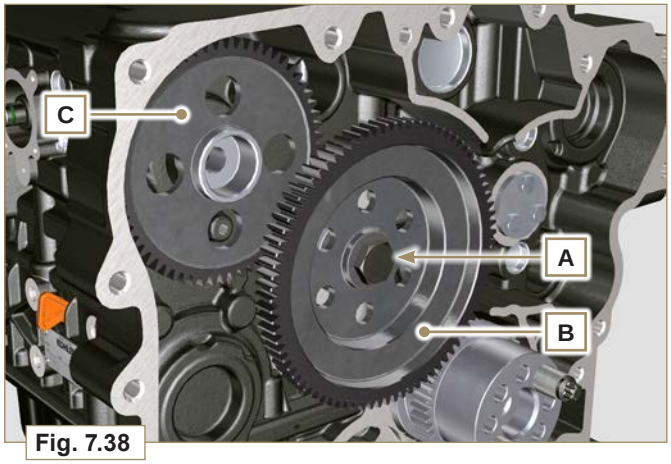


Fig. 7.38

3 - Unscrew screws **D** and remove the gear **E**.

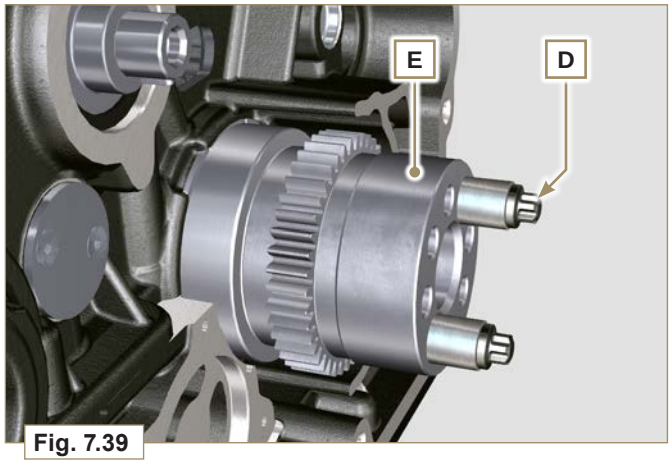


Fig. 7.39

7.12.3 Lower semi-crankcase

Important

- The capscrews **Q** must be replaced every time they are disassembled.
- **Do NOT** remove the capscrews completely, first loosen them by turning them a whole cycle following the order shown in the figure.

1 - Loosen fastening screws Q, turning them by one turn following the order shown in the figure.

2 - Undo capscrews **Q** by following the order indicated in the figure.

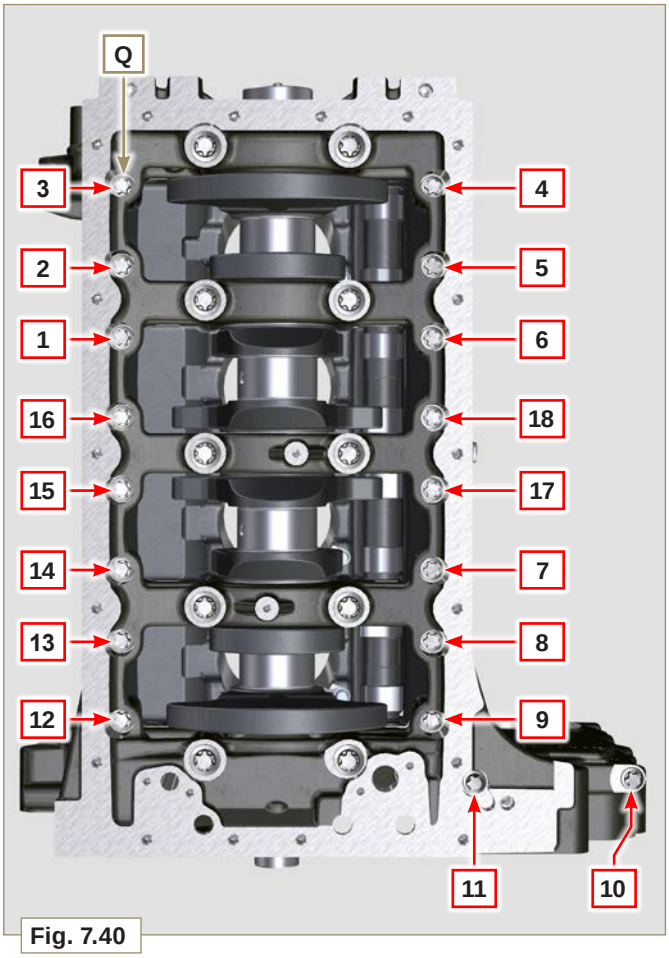


Fig. 7.40

Important

- The capscrews **R** must be replaced every time they are disassembled.
- **Do NOT** remove the capscrews completely, first loosen them by turning them a whole cycle following the order shown in the figure.

1 - Loosen fastening screws **R**, turning them by one turn following the order shown in the figure.

2 - Undo capscrews **R** by following the order indicated in the figure.

3 - Remove the lower semi-crankcase **D1** and store it in a suitable container for washing.

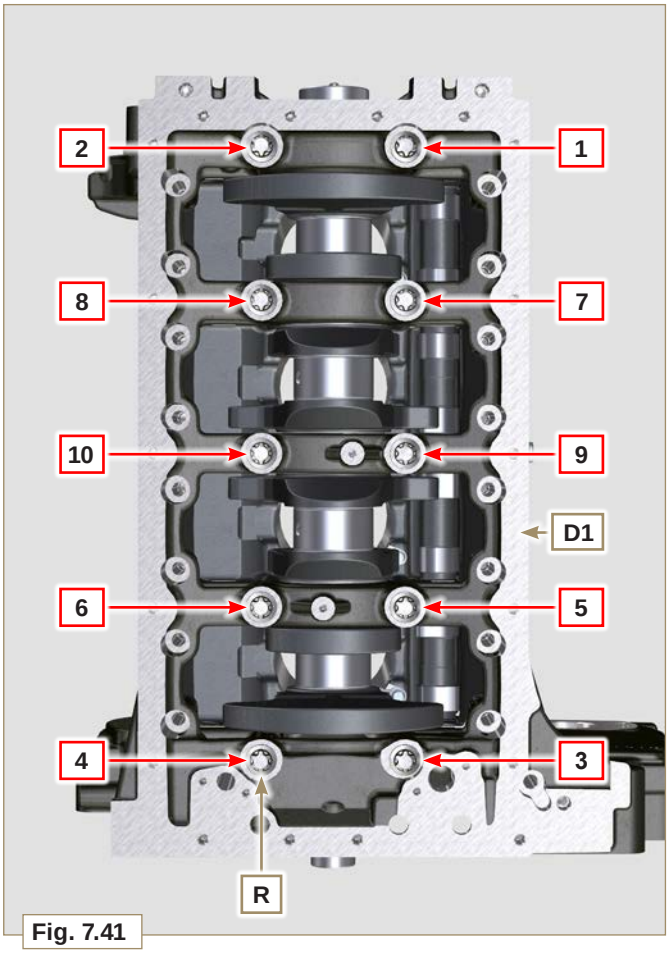


Fig. 7.41

7.12.4 Crankshaft

Remove:

1 - Crankshaft **S**.

2 - The shoulder semi-rings **T**.

3 - Remove gasket **U** from crankshaft **S**.

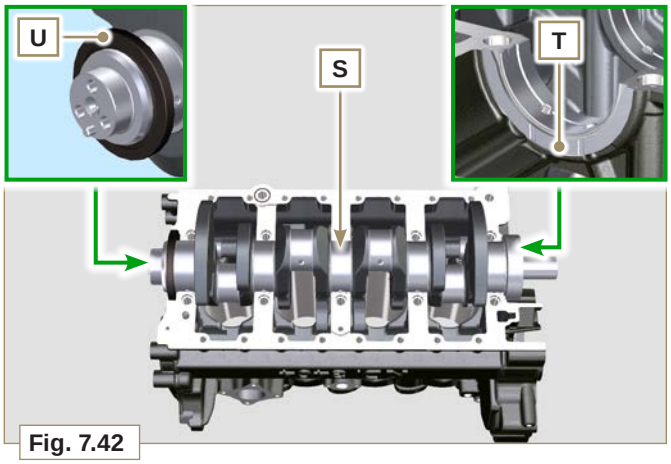


Fig. 7.42

7.12.5 Piston (↪)

1 - Remove the retainer ring **V**.

2 - Remove the pin **Z** to separate the piston **J** from the connecting rod **L**.

Important

- If they are not replaced, keep the components together (connecting rod - piston - gudgeon pin) by using references in order to prevent them from getting mixed up during assembly.

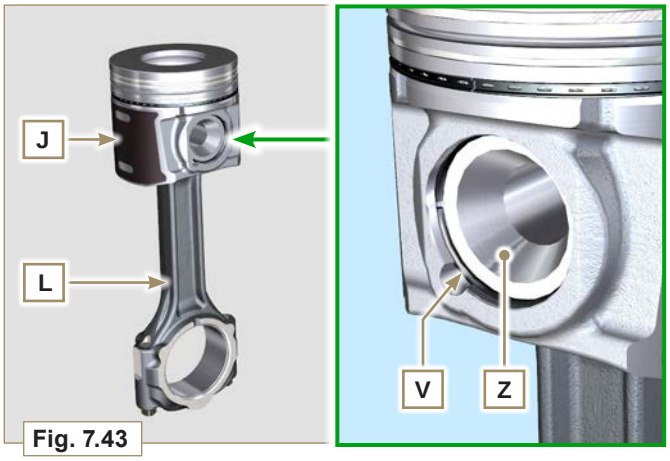


Fig. 7.43

7.12.5.1 Rings (↪)

1 - Remove the rings **K**.

Fig. 7.44

7.12.6 Oil spray nozzles (↪)

1 - Undo the screws **W** and remove the spray nozzles **X** from the upper semi-crankcase **D2**.

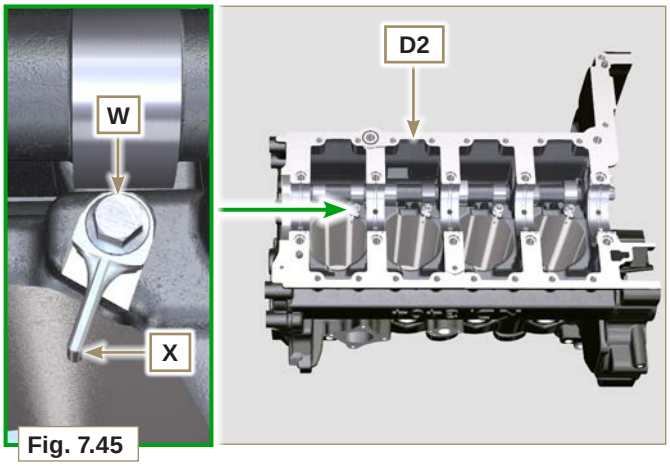


Fig. 7.45

7.12.7 Camshaft

1 - Remove the lock ring **C**.

2 - Extract the camshaft **F** from the upper semi-crankcase **D2**.

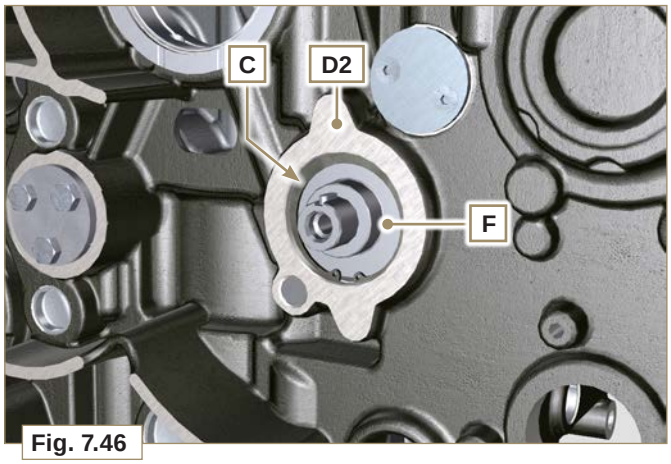


Fig. 7.46

7.12.8 Camshaft tappets

1 - With a magnet, remove the tappets **Y** from the upper semi-crankcase **D2**.

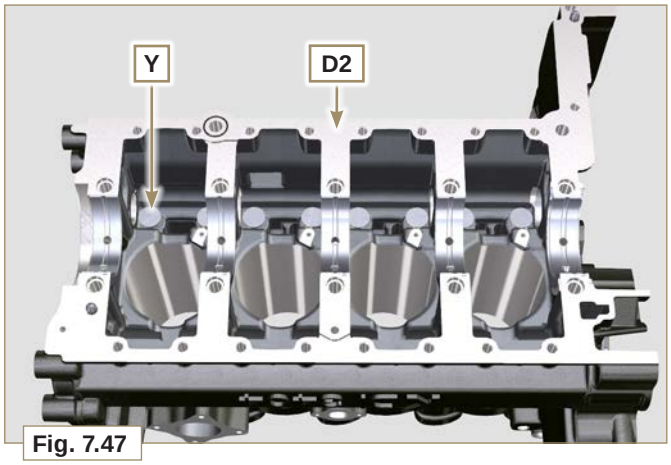


Fig. 7.47

7.12.9 Crankshaft bushings

1 - Remove the crankshaft bushings **A1** from the upper crankcase **D2**.

Important

- The crankshaft half-bearings **A1**, **B1** are made of special material. Therefore, they must be replaced every time they are removed to prevent seizures.

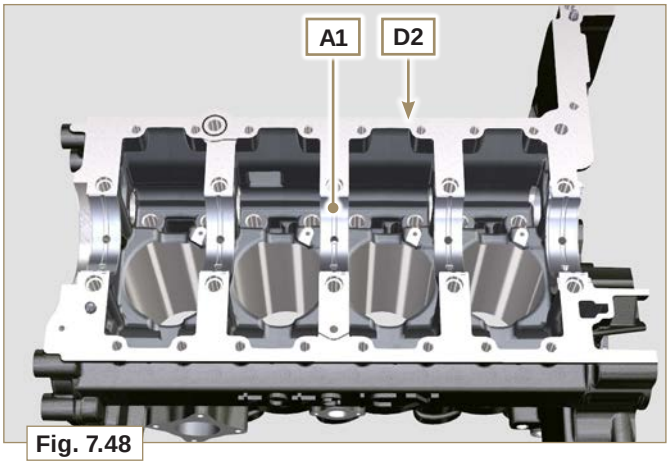


Fig. 7.48

2 - Remove the crankshaft bushings **B1** from the lower semi-crankcase **D1**.

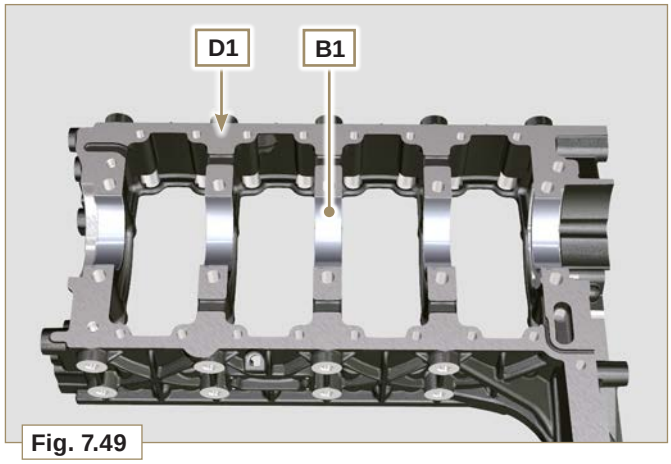


Fig. 7.49

8.1 Recommendations for overhauls and tuning

- The information is laid out in sequence, according to operational requirements, and the intervention methods have been selected, tested and approved by the manufacturer's technicians.
- This chapter describes procedures for checking, overhauling and tuning units and/or individual components.

NOTE: To easily locate specific topics, the reader should refer to the **analytical index** or **chapter index.**

- Before any intervention, the operator should lay out all equipment and tools in such a way as to enable him to carry out operations correctly and safely.
- The operator must comply with the specific measures described in order to avoid errors that might cause damage to the engine.
- Before carrying out any operation, clean the units and/or components thoroughly and eliminate any deposits.
- Do not wash the components with steam or hot water. Use suitable products only.
- Do not use flammable products (petrol, diesel, etc.) to degrease or wash components. Use suitable products only.
- Apply a layer of lubricant over all surfaces of all disassembled components to protect them against oxidation.
- Check the integrity and state of wear of all disassembled components in order to ensure good working condition of the engine.
- When indicated, some components are to be replaced in pairs or together with other parts (e.g. crankshaft half-bearings/ connecting rod, piston complete with rings and gudgeon pin, etc.).
- When indicated, some grinding operations are to be carried out in series (e.g. grinding of cylinders, crankpins, journals, etc.).

8.2 Crankcase

8.2.1 Oil line check

Important

- Replace and assemble the conical cap **A3** in hole **B**, **B1** (tightening torque at **30 Nm**), after having performed cleaning operations.

1 - Remove capscrews **A1** and remove plate **A2** with its gasket.

Use a pipe cleaner in access points **A**, **B**, **B1**, **C**, **D** to clean the oil ducts of crankcase **G**.
Use compressed air to eliminate any residues.

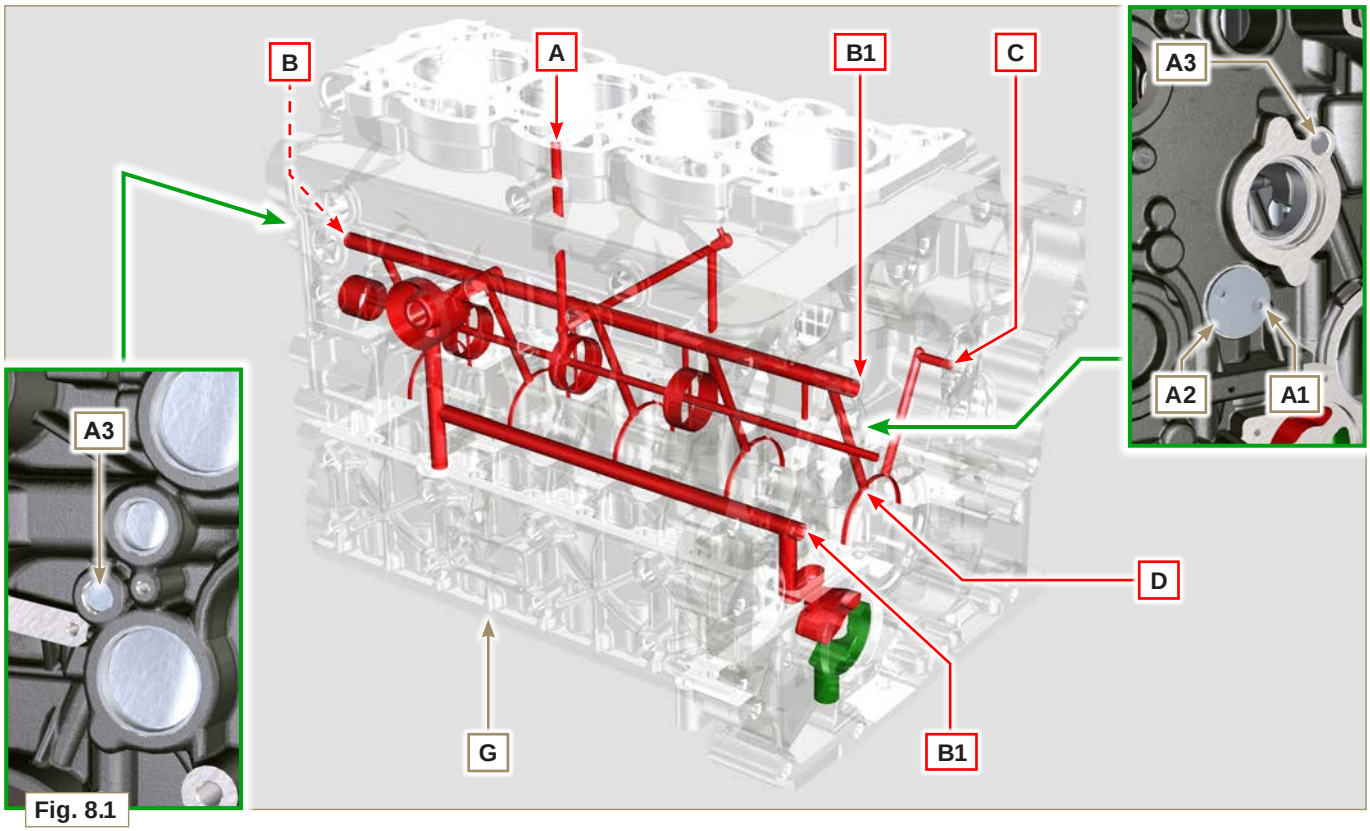


Fig. 8.1

8.2.2 Cylinder check

Position crankcase **G** onto a workbench.
With a dial gauge, measure the diameter in correspondence to points **J**-**M**-**N** (**Fig. 8.2**) lengthwise and diagonally with regard to axis **H** of the crankshaft.
If ovalisation or wear detected in a single point in **J**-**M**-**N** is greater than +0.05 mm with regard to the value in **Tab. 8.1**, you are required to perform grinding operations on all cylinders **F**.
Refer to **Tab. 8.1** to establish the clearance value of cylinders subjected to grinding operations.

Important

- Grinding is prohibited before **10000 h** of operation on all engines provided with an EPA name plate (refer to **Par. 1.3**).
- The grinding involved is of +0.20, +0.50 and + 1 mm.
- Cylinder grinding operations must observe **KOHLER** SPECIFICATIONS - cod. ED0035612500.
- Grinding must be strictly performed on all cylinders **F**.

Tab. 8.1 details the dimensional values of new components only.

(1) The increase of +0.20 mm, may already be present on the engine.

Tab. 8.1 *Grinding values*

PISTON	Ø CYLINDER (± 0.007 mm)	Ø PISTON (± 0.007 mm)	CLEARANCE VALUE (mm)
STD	96.010	95.950	0.046 - 0.074
+0.20 (1)	96.210	96.150	
+0.50	96.510	96.450	
+1.00	97.010	96.950	

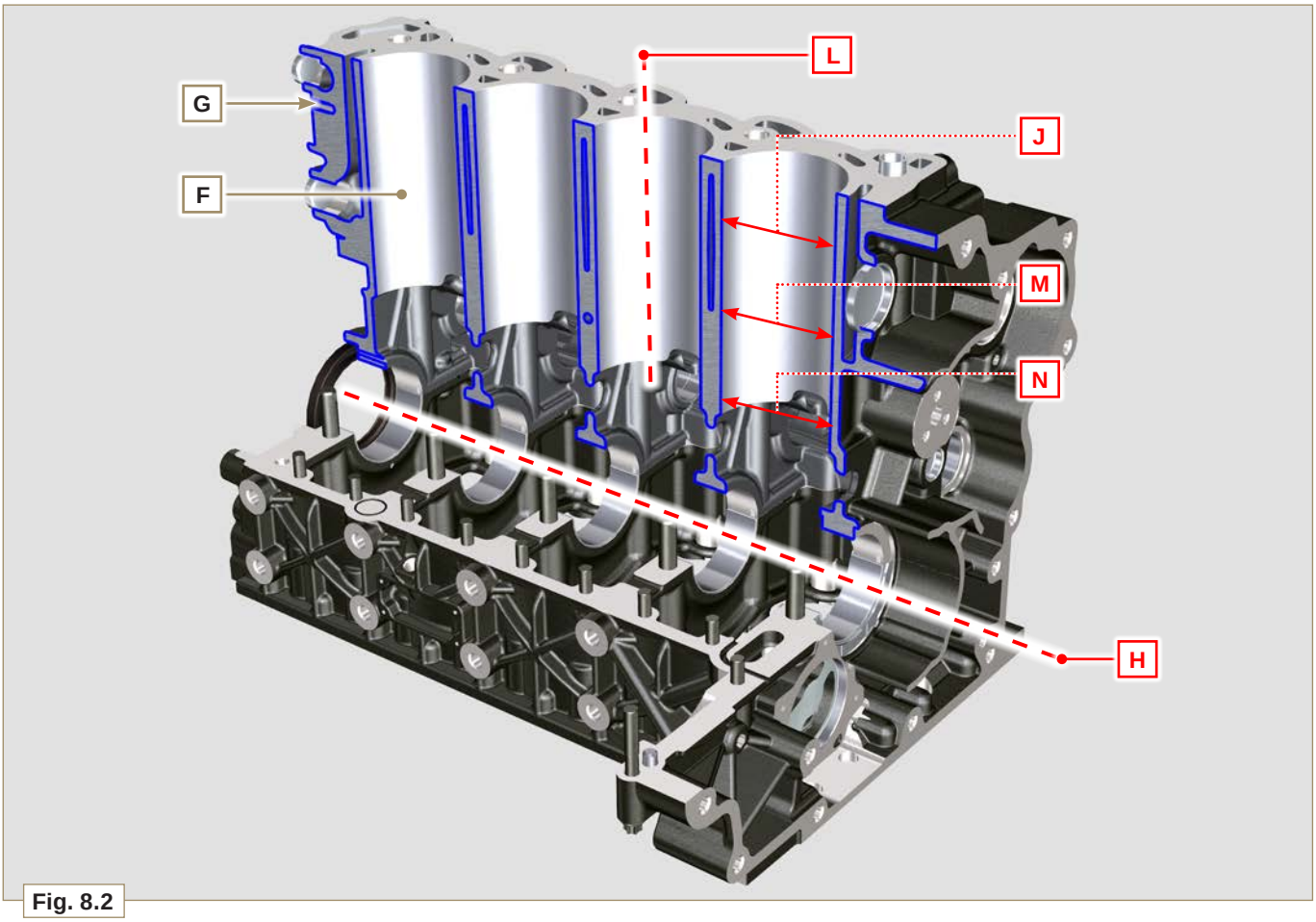


Fig. 8.2

8.2.3 Camshaft housing check

Use an internal dial gauge to measure the diameters of housings W - K - Y - Z.
With a micrometer, measure the diameters of gudgeon pins W1 - K1 - Y1 - Z1 (**Fig. 8.4**).
According to the values measured, calculate the clearance between the housing and gudgeon, which is to observe the values in **Tab. 8.2**.

The **MAX** value of wear allowed is 0.120 mm.

Important

- **Tab. 8.2** details the dimensional values of new components only.

Tab. 8.2 *Housing and camshaft gudgeon dimensions.*

REF.	DIMENSIONS (mm)	CLEARANCE VALUE (mm)
W	47.500 - 47.525	0.060 - 0.105
W1	47.420 - 47.440	
K	47.000 - 47.025	0.060 - 0.105
K1	46.920 - 46.940	
Y	46.500 - 46.525	0.060 - 0.105
Y1	46.420 - 46.440	
Z	35.000 - 36.025	0.060 - 0.105
Z1	34.920 - 35.940	

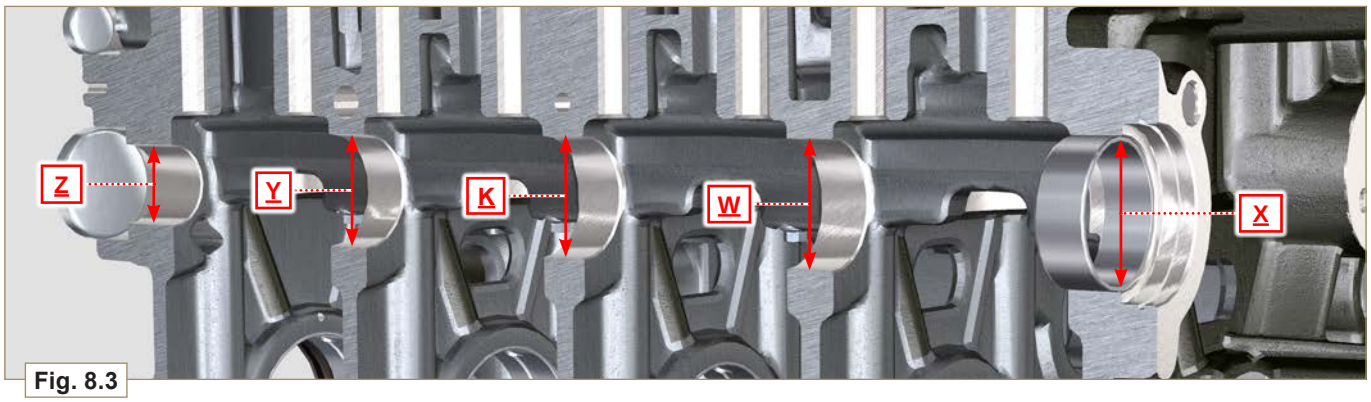


Fig. 8.3

8.2.4 Camshaft control

With a micrometer, measure the maximum dimensions of intake camshaft R and exhaust camshaft S (**Tab. 8.3**).
The MAX value of wear allowed is 0.1 mm.

Important

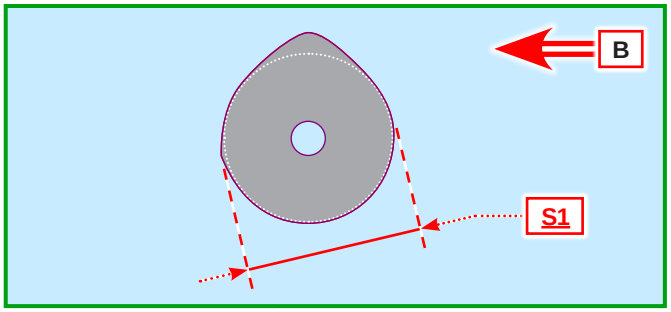
- **Tab. 8.3** details the dimensional values of new components only.

Tab. 8.3 *Camshaft dimensions*

REF.	CODE (P)	DIMENSIONS (mm)
R		40.495 - 40.433
S		39.175 - 39.113
S1	P = ED0010101820-S	35.666 - 35.616
S1	P = ED0010101730-S	35.564 - 35.514

8.2.5 Camshaft control with internal EGR

The internal EGR is available only for **Stage IIIA** or **Tier 3** engines provided with "**CE**" approval (**Par. 1.2**) or "**EPA**" name plate (**Par. 1.3**). With a micrometer, measure the dimensions of the **S1** quota (**Tab. 8.3**) on all of cams **S** (the **S1** quota varies according to the code of camshaft **P** - refer to the spare parts catalogue to identify the code of camshaft **P**). Replace camshaft **P** if the **S1** quota does not comply with the value on **Tab. 8.3**.



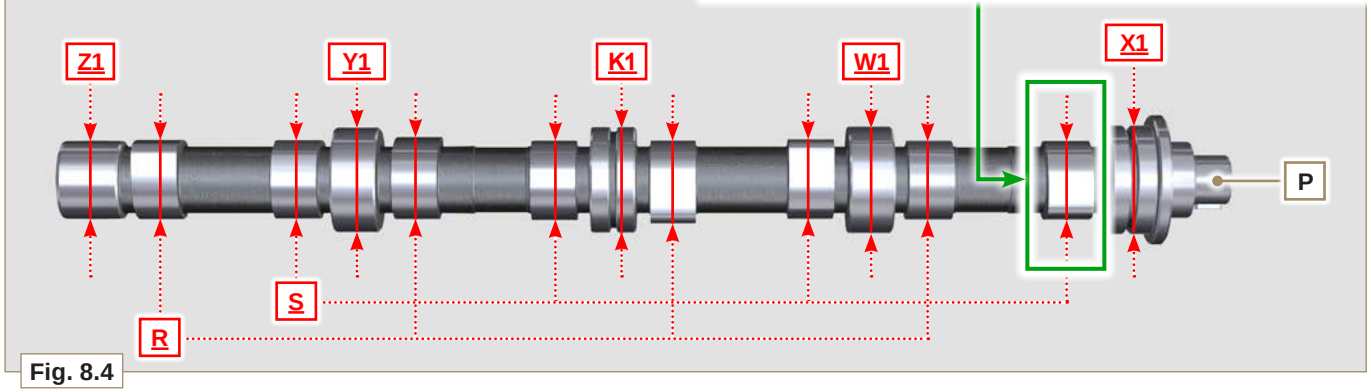


Fig. 8.4

8.3 Tappets and tappet housings

8.3.1 Tappets check

Use a surface plate and a dial gauge as shown in **Fig. 8.5**.
Check the perpendicularity of the plate **C**, making the tappet **D** rotate in the direction of the arrow.
The **MAX** value of wear allowed is 0.02 mm.

With a gauge, check the length of value **A** and **B** (**Tab. 8.4**).
The **MAX** value of wear allowed is 0.08 mm

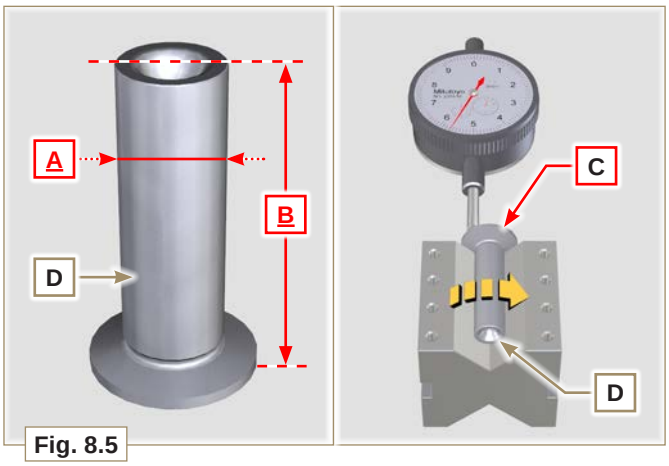


Fig. 8.5

8.3.2 Tappet housing check

Use an internal dial gauge to measure the diameter of the tappet housings **X**.
value of **A** detected (**Par. 8.3.1**) calculate the clearance value (**Tab. 8.4**).
If the clearance values are not observed, replace the worn component.

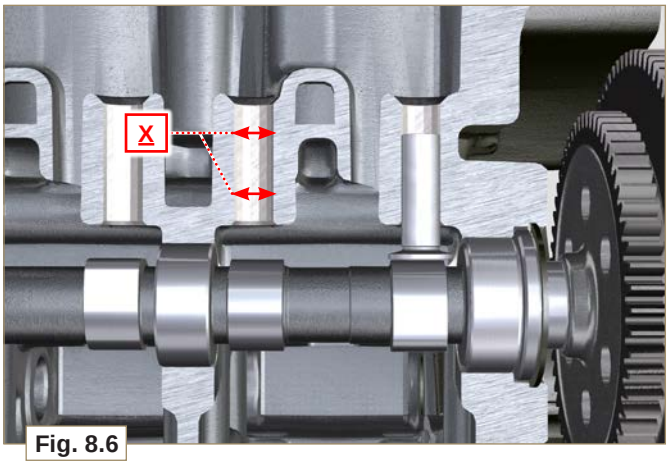


Fig. 8.6

Important

- **Tab. 8.4** details the dimensional values of new components only.

Tab. 8.4 *Tappets and tappet housing dimensions.*

REF.	DIMENSIONS (mm)	CLEARANCE VALUE (mm)
A	14.984 - 14.966	0.016 - 0.052
X	15.000 - 15.018	
B	47.5	...

8.4 Crankshaft

8.4.1 Dimensional check and overhauling

Wash the crankshaft thoroughly using suitable detergent. Insert the pipe cleaner into all lubrication ducts **B** and blow compressed air to free them completely from any dirt residues. Check the state of wear and integrity of journals **C** and connecting rod **D**.

Perform the operations described in **Par. 9.3.1** and **Par. 9.3.5** - except points **2, 3, 5, 9** and **10.**

Tighten capscrews **J (Fig. 9.9)** and **K (Fig. 9.10)** observing the cycles, tightening, and subsequent rotation.
Cycle 1 - Screw J - Torx M14x1,5 - Torque 60 Nm. (Fig. 9.9)
Cycle 2 - Screw K - Torx M10x1.25 - Torque 30 Nm. (Fig. 9.10).

Measure the crank pins **A1** with a micrometer, and using a dial gauge measure the internal diameter of the connecting rod half-bearings **A2**. Measure the main journals **B1**, with a micrometer, and using a dial gauge measure the internal diameter of the crankshaft half-bearings **B2**. If the values described in **Tab. 8.5** do not correspond, proceed with grinding all gudgeon pins **A1** e **B1**.

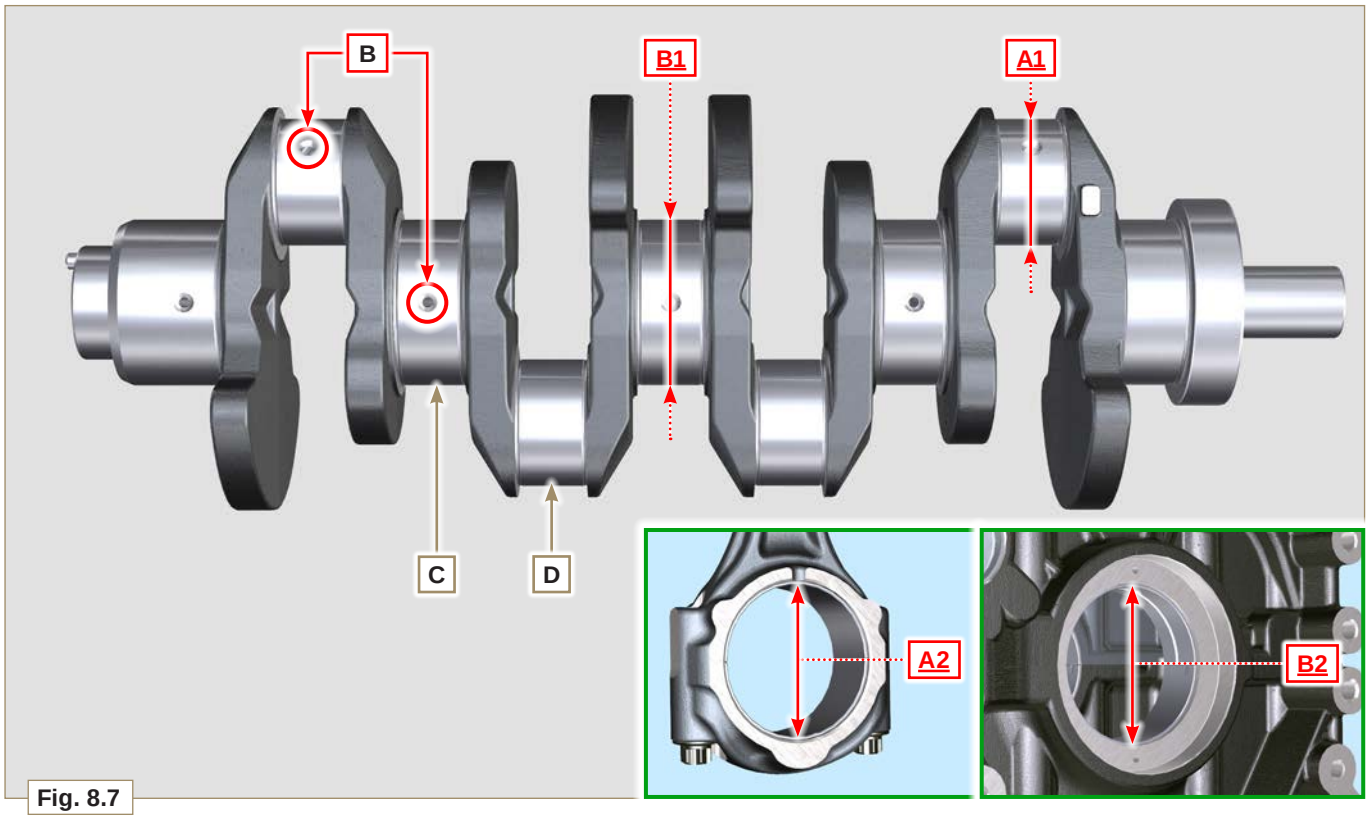


Fig. 8.7

Important

- The crankshaft and connecting rod must be replaced every time they are assembled to prevent seizure, as they are made of special lead-free material.
- The MAX allowed value of wear for **A1** e **A2** is 0.120 mm.
- The MAX allowed value of wear for **B1** e **B2** is 0.120 mm.
- To grind the crankshaft, a decrease in diameter of the half-bearings and connecting rod is provided for at 0.25 mm and 0.50 mm, to grind gudgeon pins **A1** and **B1**, measure the values of diameters **A2** and **B2** by assembling the decreased half-bearings, define the diameter to grind of pins **A1** and **B1**, observing the clearance indicated in **Tab. 8.5**.
- **Tab. 8.5** details the dimensional values of new components only.

Tab. 8.5 *Connecting rod and journal diameter*

REF.	DIMENSIONS (mm)	CLEARANCE VALUE (mm)
A1	60.980 - 61.000	0.034 - 0.09
A2	61.034 - 61.069	
B1	79.978 - 80.000	0.036 - 0.104
B2	80.036 - 80.082	

8.4.2 Checking the axial clearance of the crankshaft

Perform the operations described in **Par. 9.3.1**, **9.3.4** and. **Par. 9.3.5** - except points **2, 3, 5,** and **10**.
Tighten capscrew **J (Fig. 9.9)** observing the cycles, tightening, and subsequent rotation.
Cycle 3 - Screw J - Torx M14x1,5 - Torque 45°. (Fig. 9.9)
Cycle 4 - Screw J - Torx M14x1,5 - Torque 45°. (Fig. 9.9)

Using a dial gauge, measure the axial shift of crankshaft **E**.
Axial shift must be a **MIN** of 0.18 mm and **MAX** 0.38 mm..
If the values measured do not correspond, replace shoulder rings **D**.

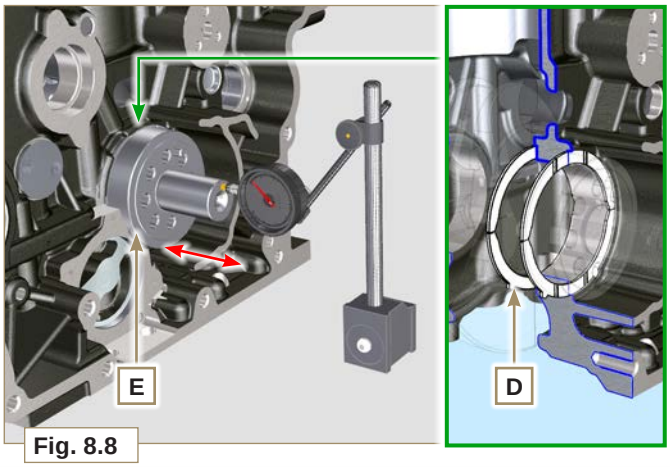


Fig. 8.8

8.5 Connecting rod - piston assembly

8.5.1 Connecting rod dimensions check

Important

- Before assembling the connecting rod and pistons (**Par. 9.3.7** and **9.3.8**), check that the difference in weight between the complete connecting rod and piston units do not exceed **15** gr to prevent weight imbalances during rotation of the crankshaft and consequent damage.
- Mark some references on the connecting rods, caps **Q**, pistons and gudgeon pins to prevent unintentionally confusing the components during assembly. Failure to do this may result in engine malfunctions..
- Connecting rod half-bearings **S** must be replaced at each assembly.

Check that the contact surfaces are perfectly clean and intact.

Assemble the connecting rod cap **Q** to the connecting rod with the half-bearings **S** and tighten capscrews **P** (tightening torque at **28 Nm**).
With a dial gauge, measure diameters **B** and **D**.
The **MAX** allowed value of wear for **B** and **D** is 0.06 mm.


Fig. 8.9

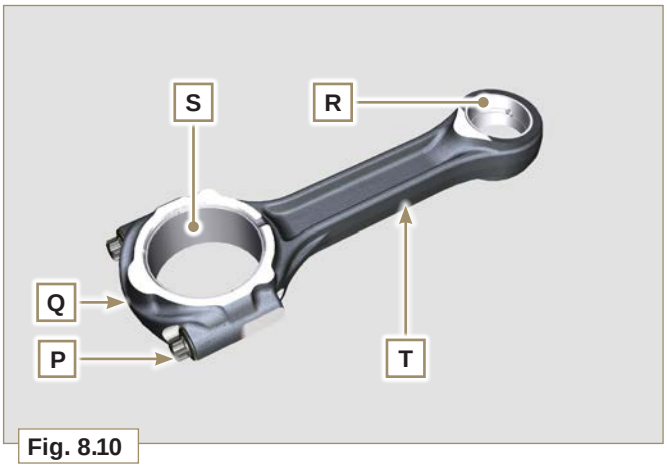


Fig. 8.10

Tab. 8.6

REF.	DIMENSIONS (mm)	CLEARANCE VALUE (mm)
A	192.980 - 193.020	
B	37.025 - 37.015	0.015 - 0.030
C	36.995 - 37.000	
D	61.034 - 61.069	
E	74.000 - 74.300	
F	33.950 - 33.990	

Important

- **Tab. 8.6** details the dimensional values of new components only.
- Check that the connecting rod and crankshaft half-bearings are coupled properly.
- Refer to the warnings in **Par. 8.4.1** for value **D** decreased.
- If the clearance value between **B** and **D** is not observed, you are required to replace bearing **R** (**Fig. 8.10**).

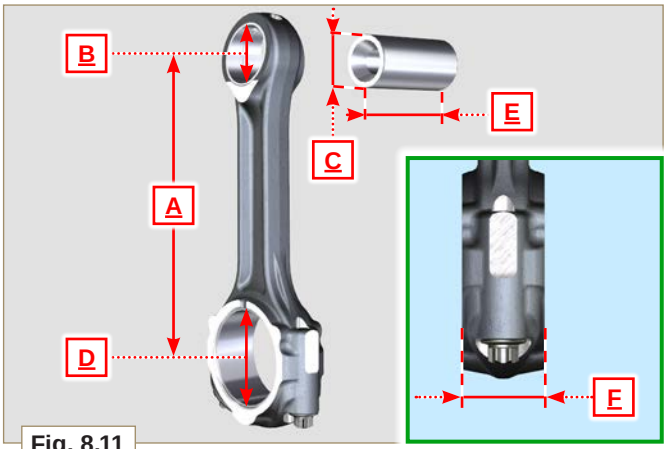


Fig. 8.11

Measure value **A**, **C**, **D**, **E** and **F** and confront them with those described in **Tab. 8.6**.
If the measured values do not follow those described in **Tab. 8.6**, replace connecting rod **T**.

8.5.2 Checking the gudgeon pin-pin axes are parallel

Lubricate gudgeon pin **A** and bearing **R** (**Fig. 8.10**).
Insert the gudgeon pin into bearing **R**.
Use a dial gauge to check the axis parallelism of the connecting rod big end and small end.
The parallelism deviation (value **V**) measured at the tip of the gudgeon pin, must be a **MIN** of 0,015 and **MAX** of 0,030 mm.
If the parallelism values do not comply with the specified ones, replace the connecting rod **T**.

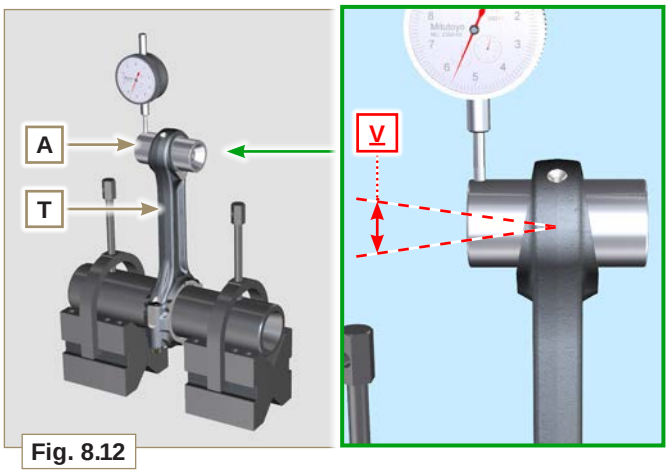


Fig. 8.12

8.5.3 Piston rings check

Insert ring **U** into the cylinder, measure value **H** (distance between the points of ring **U**).
Repeat for all the seal rings.
If the measured value **H** does not correspond to the values indicated in the table (**Tab. 8.7**), replace the seal rings **U**.

Important

• Seal rings cannot be replaced separately.

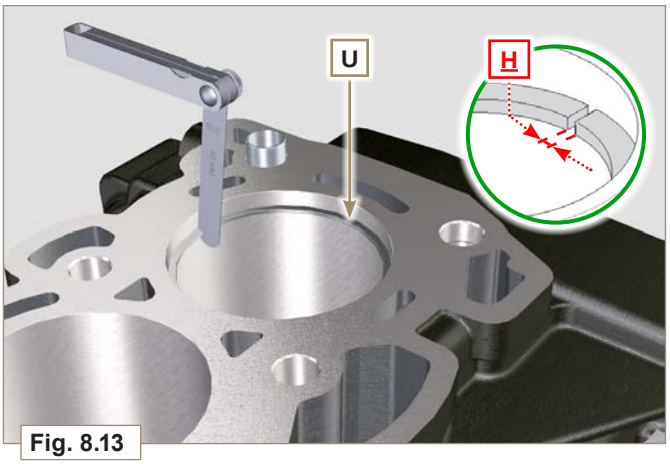


Fig. 8.13

Tab. 8.7

RINGS	H (mm)
U1	0.30 - 0.15
U2	0.50 - 0.70
U3	0.20 - 0.40

NOTE: refer to **Fig. 8.17** to locate the rings.

8.5.4 Piston dimension check

Clean the piston thoroughly.
Measure the diameter of the piston at 12 mm (quota **L**) from the base of the skirt in correspondence with the graphite lubrication windows **M**.
Refer to **Tab. 8.8** to establish the clearance value of the pistons with a decreased diameter.
In correspondence with point **W**, there are:
3 digits for the STD piston;
3 digits followed by R for a piston with an increased diameter of 0.20 mm;
+0.5 for a piston with an increased diameter of 0.50 mm
+1 for a piston with an increased diameter of 1.00 mm;

If clearance between cylinder and piston is greater than 0,074 mm, the piston and seal rings must be replaced.

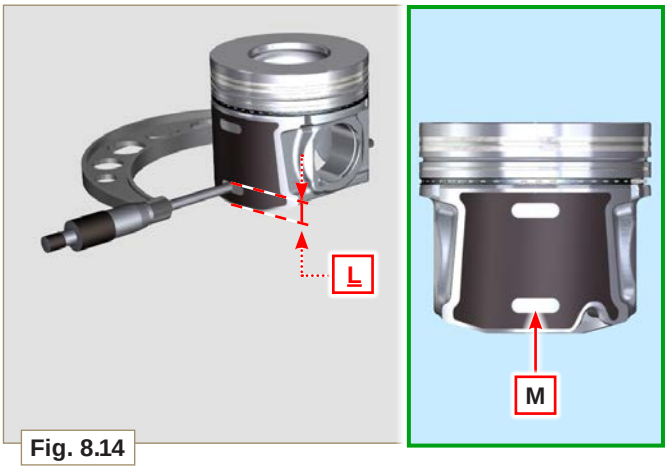


Fig. 8.14

Important

• **Tab. 8.8** details the dimensional values of new components only.

Tab. 8.8

PISTON	Ø CYLINDERS (± 0.007 mm)	Ø PISTON (± 0.007 mm)	CLEARANCE VALUE (mm)
STD	96.010	95.950	0.046 - 0.074
+0.20	96.210	96.150	
+0.50	96.510	96.450	
+1.00	97.010	96.950	

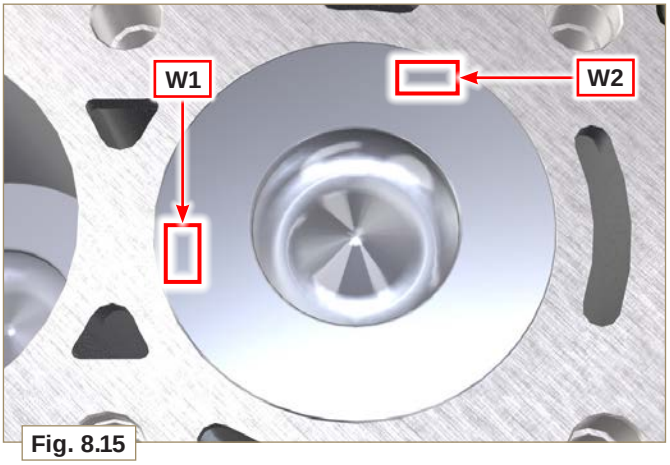


Fig. 8.15

Important

- With a feeler gauge, measure the clearance of the seal ring in the respective seat (value L1, L2 e L3).
- If the clearance does not comply with the values shown in the table (**Tab. 8.9**), replace the seal rings and the piston.

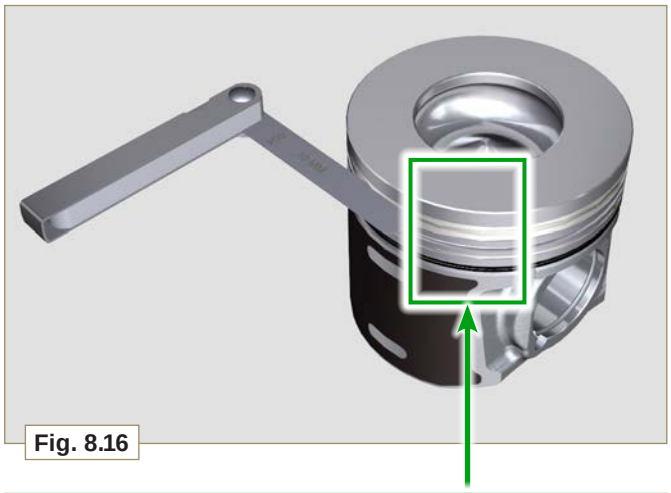


Fig. 8.16

Tab. 8.9

SEAL RINGS	CLEARANCE VALUE (mm)
U1 (L1)	0.110 - 0.150
U2 (L2)	0.070 - 1.115
U3 (L3)	0.030 - 0.070

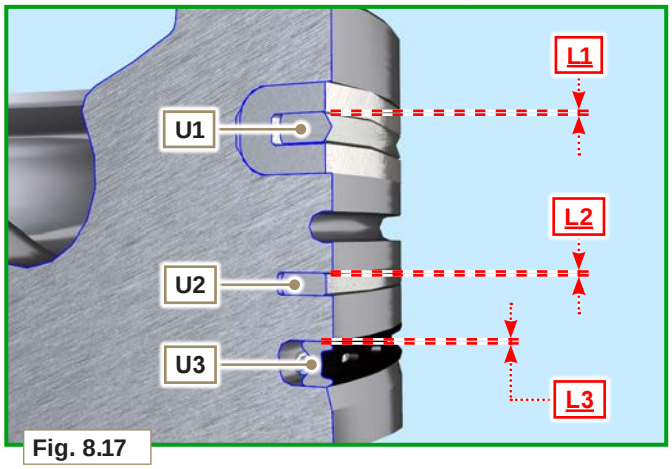


Fig. 8.17

8.6 Cylinder head

8.6.1 Flatness check

Put the cylinder head on a surface plate and, with a dial gauge, check the flatness of surface **C**.

The **MAX** value of allowable irregularity of surface C is 0.10 mm.
If the value is not observed, you are required to grind surface **C**.
The **MAX** removal allowed is 0.20 mm.

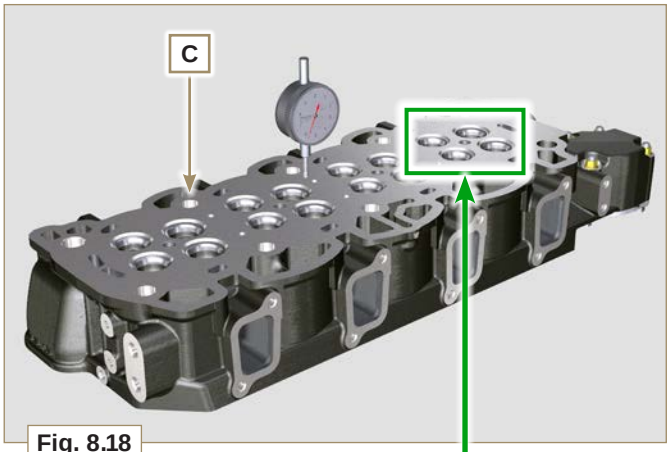


Fig. 8.18

Important

- Grinding is to be performed with sleeves **A** of the injectors assembled.
- Grinding is prohibited on all engines provided with an EPA name plate (refer to **Par 1.3**).

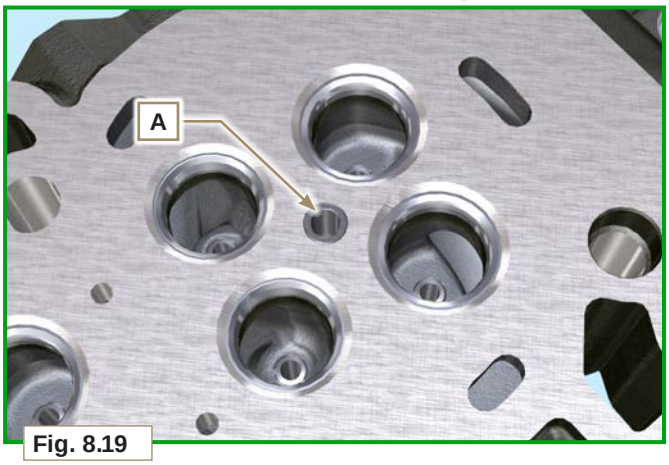


Fig. 8.19

8.6.2 Valve seats check

Thoroughly clean the valves and their seats with.
Measure indentation **B** of each valve with regard to the cylinder head surface **C**, which is to be a **MIN** of 0.50 mm and **MAX** of 0.53 mm.

The **B** **MAX** indentation allowed on worn components is 0.90 mm.

If the measured value does not correspond with the values indicated, replace the worn component.

Important

- The seats must be worked after driving to reach value **B**, go to a rectification workshop for such operations.

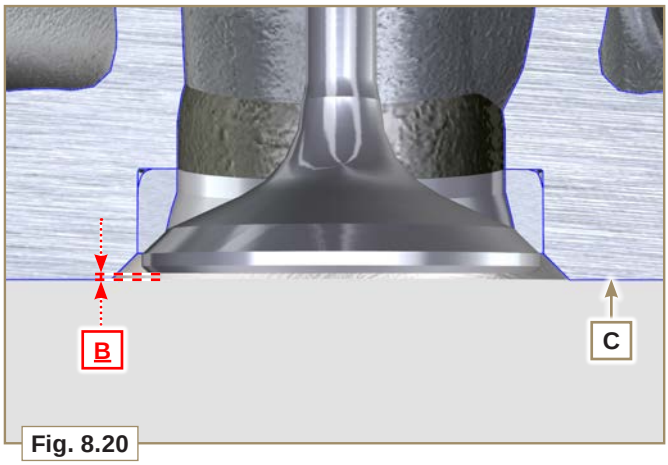


Fig. 8.20

8.6.3 Valve springs

Use a gauge to measure the free length **Z**.

Using a dynamometer, subject the spring to two different forces and check that the length of the spring corresponds to the values indicated in the **Tab. 8.10.**

Tab. 8.10

WEIGHT (kg)	LENGTH (mm)	
0	Z	42.50
20,4	Z1	33.00
42,8	Z2	23.80

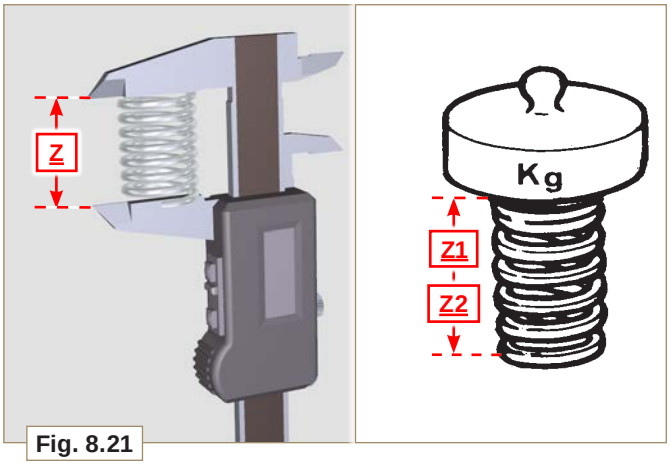


Fig. 8.21

8.6.4 Valve guides check

Measure the diameters **D** and **E** of the rods and guides valve (**Tab. 8.11**).

The **MAX** allowed value of wear for **D** and **E** is 0.10 mm.

Observe values **G** from surface **F** when assembling guides **H** (**Tab. 8.11**).

Important

- Carry out the measurements in different points to detect any ovalisation and/or concentrated wear.
- **Tab. 8.11** details the dimensional values of new components only.

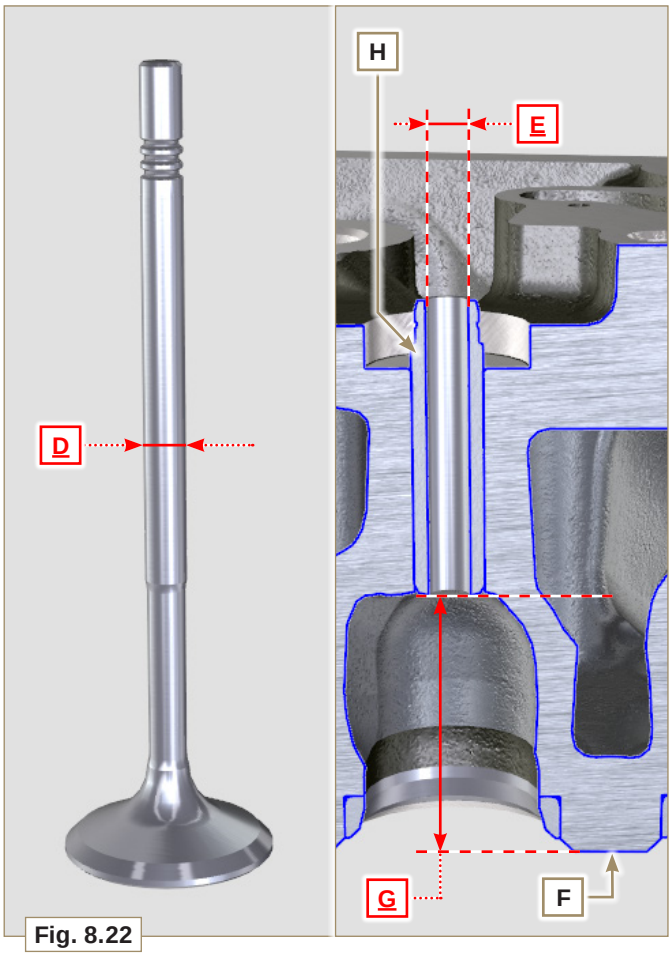


Fig. 8.22

Tab. 8.11 *Valve stem - valve guide dimensions*

REF.	DIMENSIONS (mm)	CLEARANCE VALUE (mm)
D	5.978 - 5.990	0.040 - 0.064
E	6.030 - 6.042	
G	38.300 - 38.700	

8.6.5 Valve guides replacement

The intake and exhaust guides are both made out of grey iron with pearlitic phosphoric matrix and they have the same dimensions:
The guides are press-fit assembled; assembly is possible by cooling the guides with the aid of liquid nitrogen.

Before assembling a new guide, measure value **L** and **M**, calculate the press-fit value, which must observe the values in **Tab. 8.12**.

Observe values **G** from surface **F** when assembling guides **H** (**Tab. 8.11 - Fig. 8.22**).

Important

- The guides must be worked for value **E** (**Tab. 8.11 - Fig. 8.22**) after driving. Contact a rectification workshop for such operations.

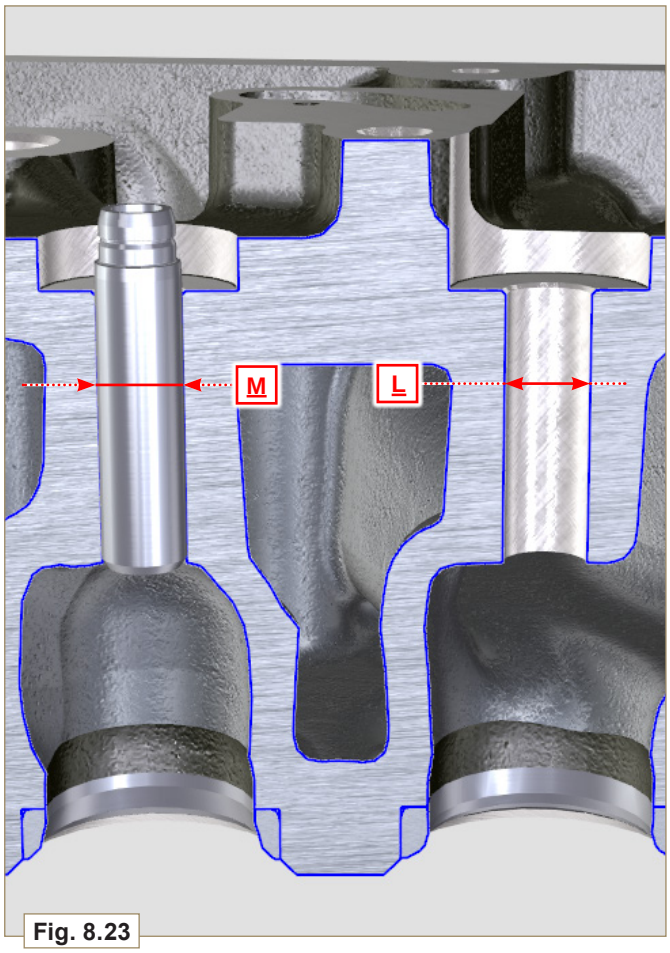


Fig. 8.23

Tab. 8.12 ***Guide valve - guide seat valves dimensions***

REF.	DIMENSIONS (mm)	PRESS-FIT VALUE (mm)
L	10.000 - 10.015	0.030 - 0.054
M	10.045 - 10.054	

8.6.6 Rocker arm check

Measure values **W1** in correspondence with holes **M** located on rocker arm gudgeon **L** (seen from **B** in **Fig. 8.25**).
Measure values **W2** (**Fig. 8.26**).
Based on the values measured, calculate the clearance between **W1** and **W2**, which is to observe the values in **Tab. 8.13**.
Check that all oil pipes **N** and **M** are free from impurities or obstructions.

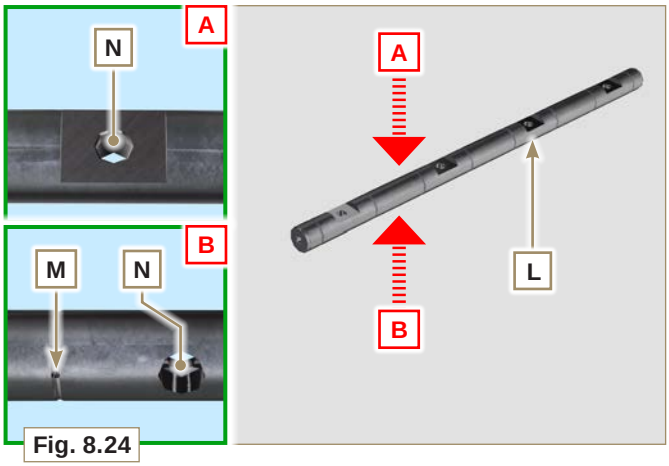


Fig. 8.24

Tab. 8.13

REF.	DIMENSIONS (mm)	CLEARANCE VALUE (mm)
W1	22.005 - 22.015	0.025 - 0.056
W2	22.040 - 22.061	

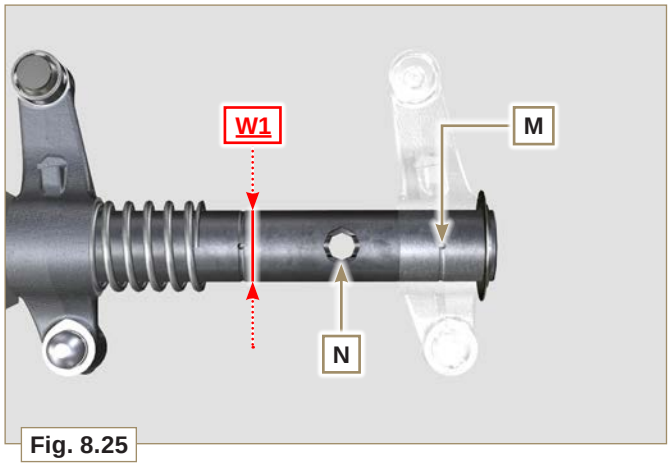


Fig. 8.25

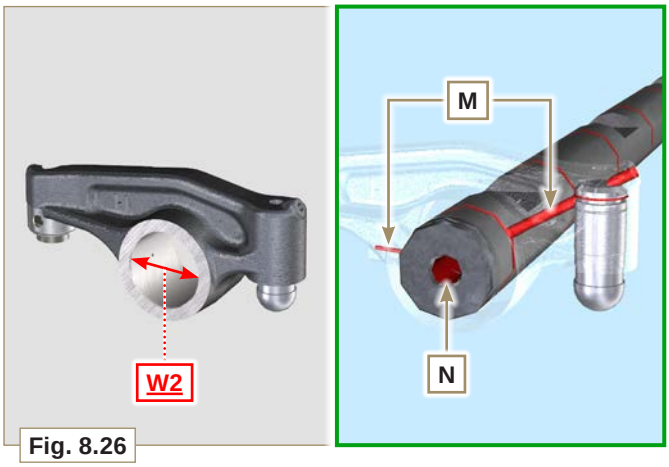


Fig. 8.26

8.7 Oil pump check

8.7.1 Dimensional and visual check

Measure clearance value **B** between the rotor teeth, the value of allowable wear is **MAX** 0.28 mm.

Important

- Should the results from checks carried out not be in accordance with the conditions described, replace the oil pump **A**.

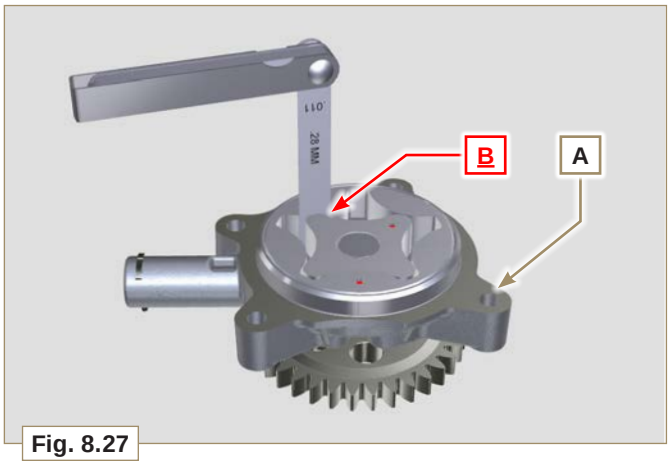


Fig. 8.27

8.7.2 Oil pressure valve check

Measure the free length **F** of spring **D**, which must be 47.5 mm. If the measured value does not correspond to the value indicated, replace spring **D**.

Tab. 8.14

POS.	DESCRIPTION
B	Plug
C	Gasket
D	Spring
E	Piston

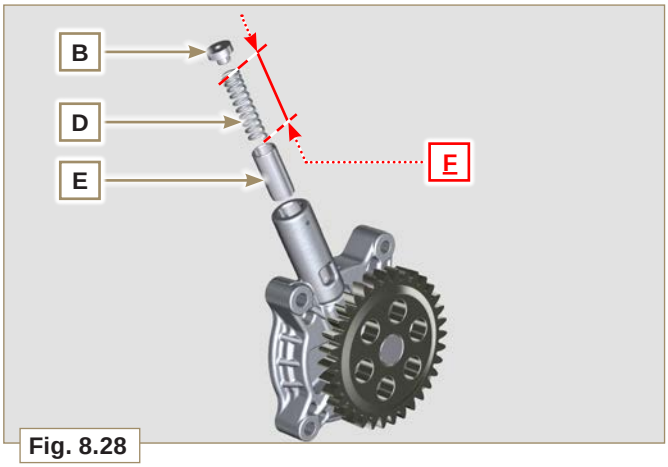


Fig. 8.28

9.1 Information on engine configuration

- In this chapter, the engine is represented as "BASE CONFIGURATION" (refer to **Para 1.4 - 1.5**).
- For the assembly of components not described in this chapter refer to **Chapter 11**.
- The following are the components described in **Chapter 11**.

11.1 Heater (replacement)

11.2 Air filter (cartridge replacement)

11.3 Cooling circuit (replacement)

9.2 Assembly recommendations

- The information is laid out in sequence, the intervention methods have been selected, tested and approved by the manufacturer's technicians.
- This chapter describes the installation procedures for the assemblies and/ or individual components which have already been checked, overhauled or possibly replaced with original spare parts.
- Where necessary, reference to special tools during assembly operations refer to **KOHLER** diesel special tools. Here in after in **Tab. 9.1** an example of a special tool (**ST_05**).

Tab. 9.15

SPECIAL TOOLS			
"ST"	Picture/Draw	DESCRIPTION	PART NUMBER
ST_05		Six Nicks SN8	ED0014603650-S

Important

- To easily locate specific topics, the reader should refer to the **analytical index** or **chapter index**.
- Before proceeding with operation, carefully read **Chap. 3**.

- The operator must check that:
  - the components, the assemblies, the coupling surfaces of the parts are washed, clean and thoroughly dried;
  - the coupling surfaces are undamaged;
  - the equipment and tools are ready so that all work can be carried out correctly and safely;
  - ensure that the working environment is safe.

- The operator must:
  - carry out the procedures smoothly and safely. It is thus recommended to install the engine on a special rotating stand used when servicing engines to ensure the safety of the operator and the other individuals involved.
  - tighten the assemblies and / or components in a criss-cross or alternating pattern, initially with a value lower than that pre-set, and then subsequently, with the tightening torque specified in the procedure.
  - replace all seal gaskets after each assembly for all components on which they are provided.

9.3 Engine block assembly

9.3.1 Crankshaft bushings

Important

- Execute the procedure in **Par. 8.2.1** and **8.2.2**, before proceeding with assembly.
- The crankshaft half-bearings are made of special material. Therefore, they must be replaced every time they are assembled to prevent seizures.

1 - Fit the new half-bearings **A1** onto the crankcase upper half **B1** adhering to the reference notches **C**.

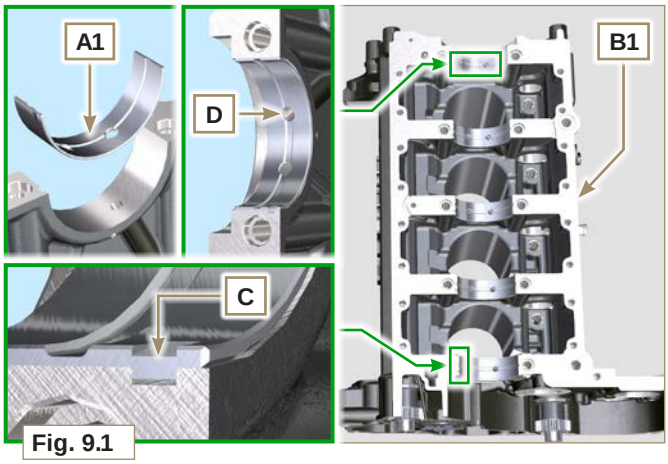


Fig. 9.1

Important

- After the half-bearings are fitted, check that the lubrication holes **D** correspond with the crankcase grooves **B1**.
- The lower and upper half bearings **CANNOT** be singularly replaced, and both halves must be replaced together.

2 - Fit the new half-bearings **A2** onto the lower crankcase **B2** using the reference notches **C**.

3 - Lubricate the half-bearings **A1** and **A2** with oil.

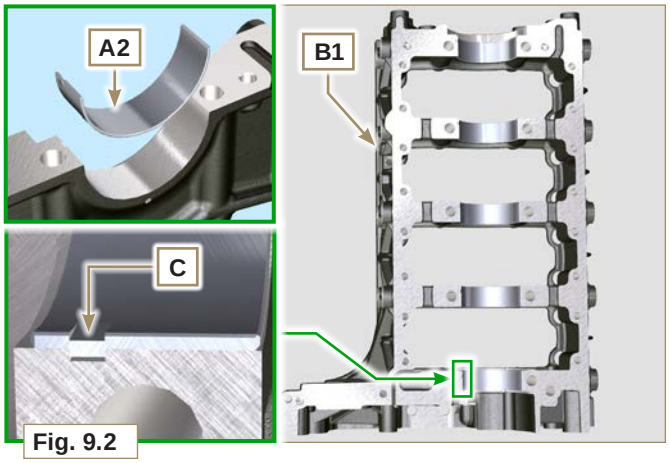


Fig. 9.2

9.3.2 Tappets

1 - Lubricate the tappets **E** with oil.

2 - Insert the tappets **E** into the housings **F** of the upper crankcase **B1**.

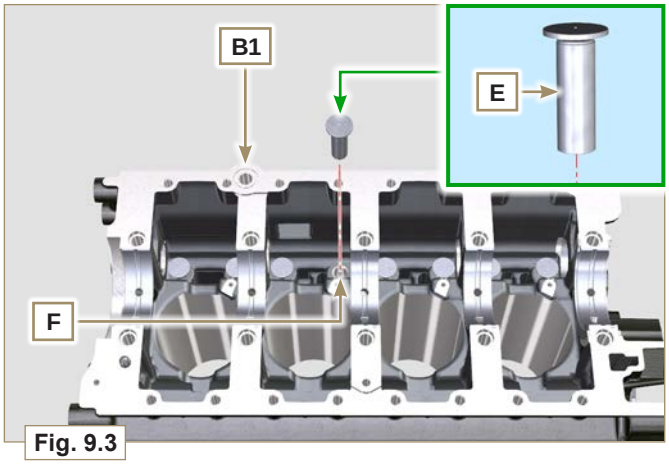


Fig. 9.3

9.3.3 Oil spray nozzles

1 - Insert the sprayers **G** onto the upper crankcase **B1** manually screwing the screw fittings **H**.

2 - Ensure that the spray nozzles **G** are inserted correctly in their seat, as shown in detail **L** and tighten the connecting screws **H** (tightening torque of **10 Nm**).

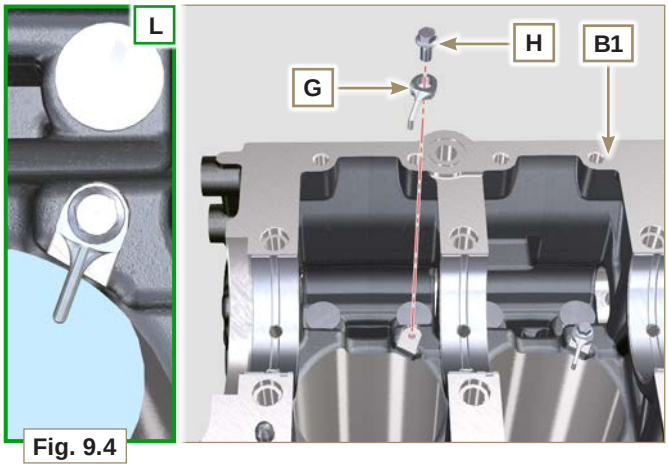


Fig. 9.4

9.3.4 Crankshaft

Important

• Carry out the checks described in **Par. 8.4.1** and **Par. 8.4.2.**

1 - Check that the crankshaft half-bearings **A1** are mounted correctly on the upper crankcase **B1**.

2 - Lubricate the main journal and crankpin **J**, with oil.

3 - Insert the crankshaft **M** into its seat on the upper crankcase **B1**.

4 - Insert the 2 shoulder half-rings **N1**, between the crankshaft **M** and the upper crankcase **B1** (**Q** detail).

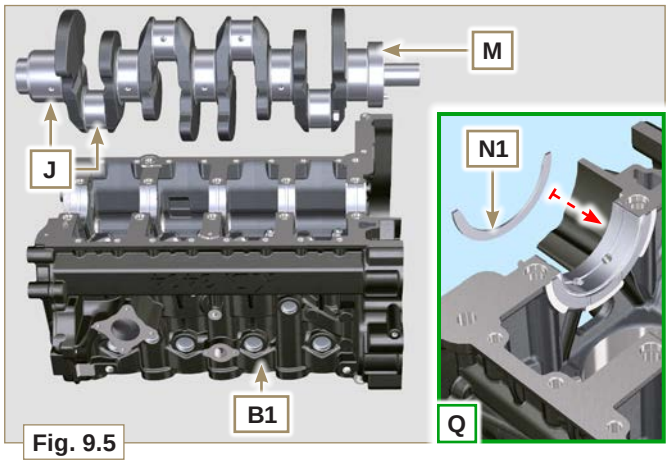


Fig. 9.5

9.3.5 Lower semi-crankcase

1 - Check that the coupling surfaces **P** are free from dirt and grit.

2 - Spread a bead of **Loctite 5660** of approx **1,5 mm** thickness on the surface **P** of the upper crankshaft half **B1** being careful not to block the oil feed grooves **X** and the return oil sump **Y**.

3 - Insert gasket **S** into the seat of crankcase **B1**.

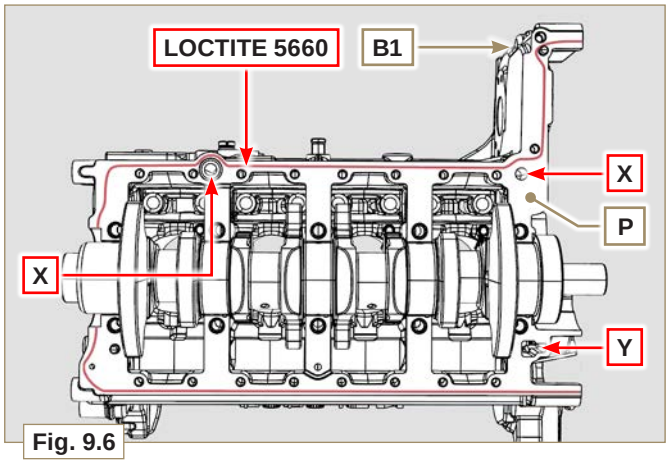


Fig. 9.6

4 - Check that the crankshaft half-bearings **A2** are mounted correctly on the lower crankcase **B2**.

5 - Assemble the 2 shoulder half-rings **N2** onto the lower crankcase **B2** applying two drops of grease to keep them in their seat.

6 - Join the two crankshaft halves **B1** and **B2** observing the guide pins **T**.

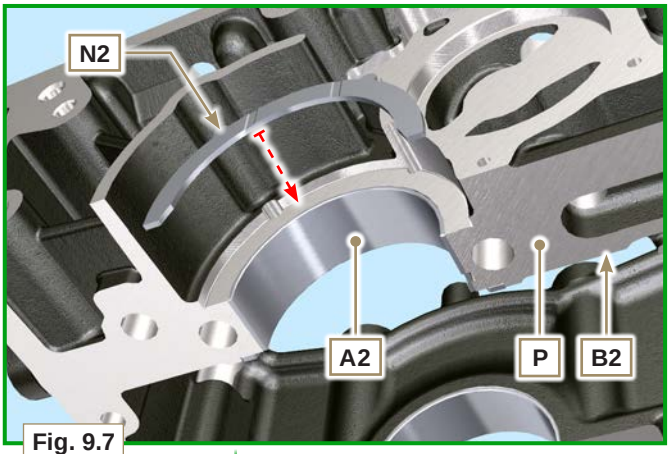


Fig. 9.7

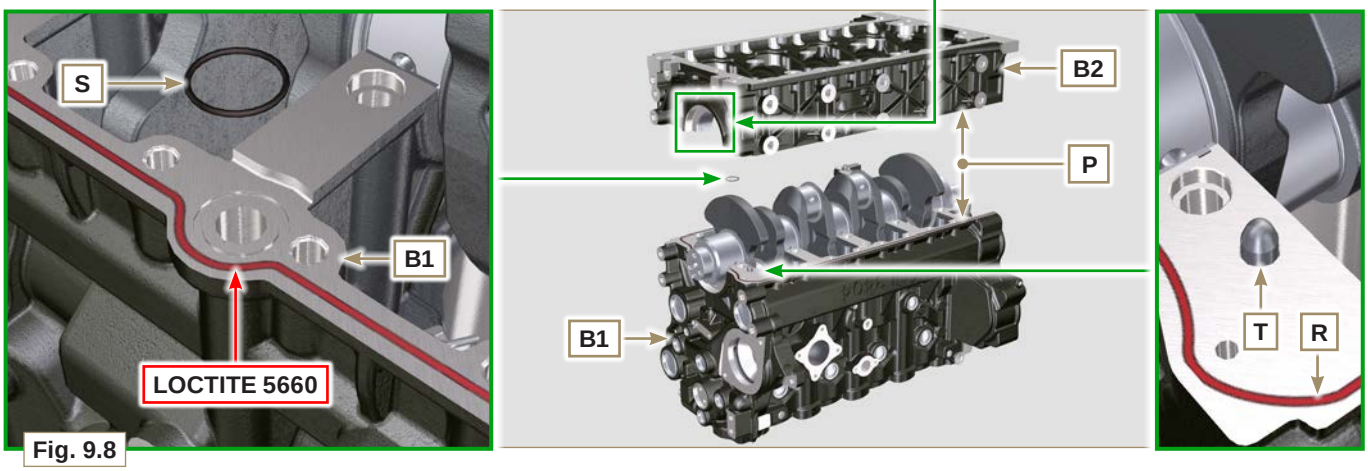


Fig. 9.8

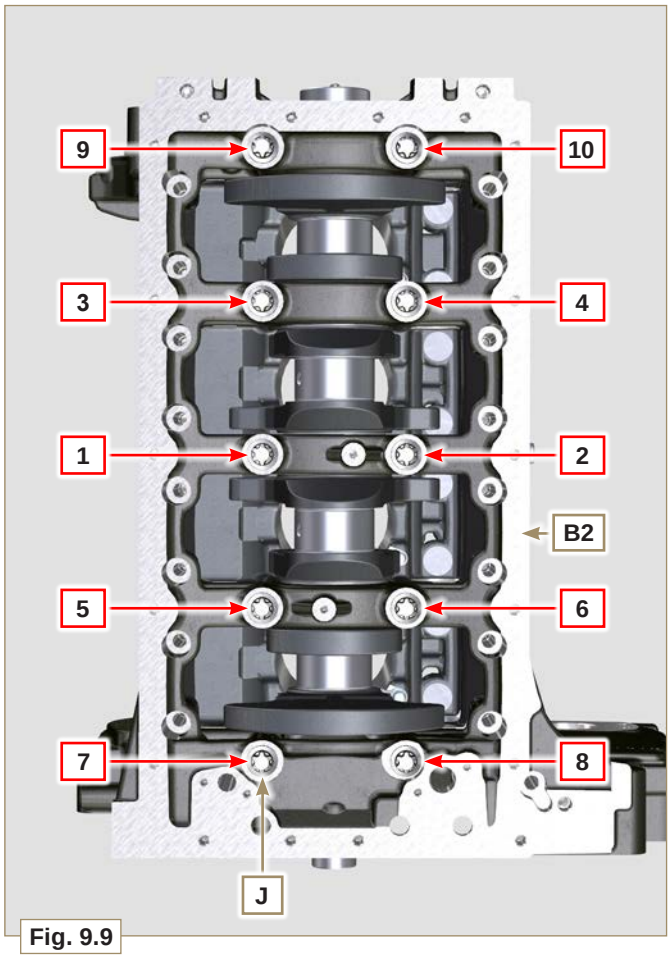


Fig. 9.9

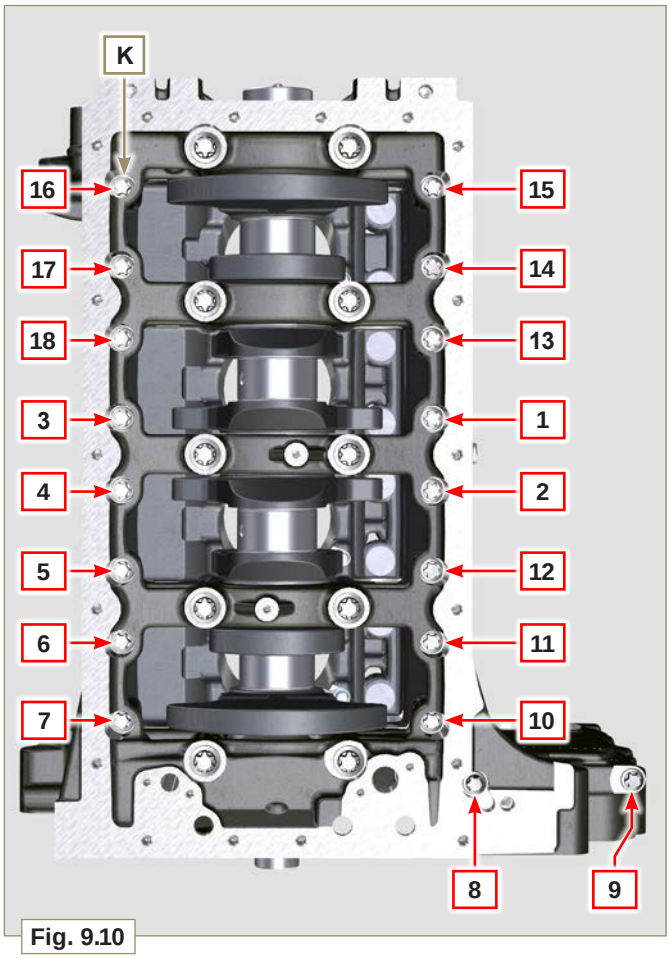


Fig. 9.10

Tab. 9.16

CYCLE	SCREWS	TORQUE
1	J - Torx M14x1,5	60 Nm
2	K - Torx M10x1.25	30 Nm
3	J - Torx M14x1,5	45°
4	J - Torx M14x1,5	45°

Important

- The fastening bolts **J**, **K** must be replaced every time they are assembled.
- Failure to adhere to the bolt fixing procedures may compromise the functionality of the engine, and also may cause damage to persons and property.
- Tighten capscrews **J**, **K** observing the cycles, tightening, and subsequent rotation as indicated in **Tab. 9.2**.

7 - Apply "Molyslip AS COMPOUND 40" on the threads and under the head of capscrews **J** and **K** and manually tighten them until their stop.

8 - Tightening the screws **J**, **K** strictly following the sequence indicated in the **Fig. 9.9** or **Fig. 9.10** and the tightening torque indicated in the **Tab. 9.2**.

9 - Check that crankshaft **M** rotates smoothly.

10 - Insert gasket **W** into the seat of crankcase **B** (**ST_47**).

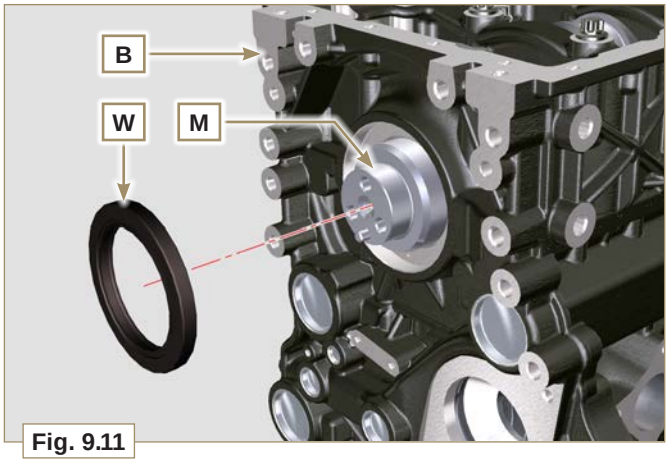


Fig. 9.11

9.3.6 Camshaft

1 - Lubricate the pins **S2**, the cams **S3** of the camshaft **S1**, all the housing **Q1** with oil.

2 - Insert the camshaft **S1** all the way into its housing **Q1**.

3 - Fit the lock ring **S4** on to the crankcase **B** to hold the position of the camshaft **S1**.

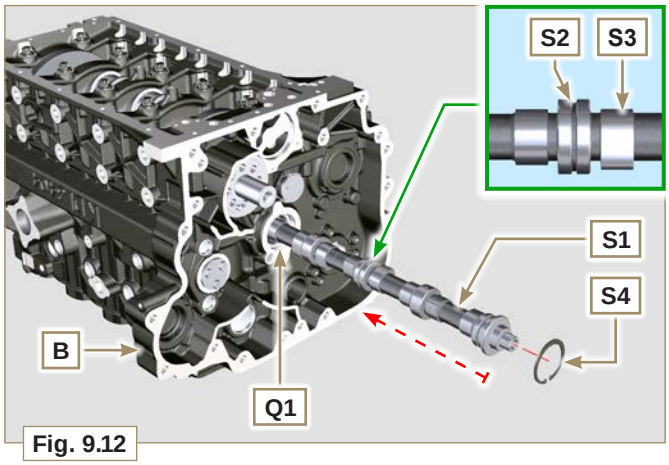


Fig. 9.12

9.3.7 Timing system gear assembly

1 - Check that the pin **P1** is correctly fitted on the crankshaft **M**.

2 - Position the gear **M1** on the crankshaft **M** respecting the reference with pin **P1**.

3 - Fully tighten the screw **N1** interposing tool **ST_41** between **N1** and **M1**.

4 - Position the gear **R1** on the camshaft **S1** observing the marks **T1** of the gear **M1**.

Important

- Failure to comply with the marks **T1** on the gears **M1** and **R1** causes engine malfunction and serious damage.
- Fastening capscrew **R2** must be replaced every time it is assembled.

5 - Assemble gear **R1** by means of capscrew **R2** (tightening torque **100 Nm**).

6 - Check that crankshaft **M** rotates smoothly.

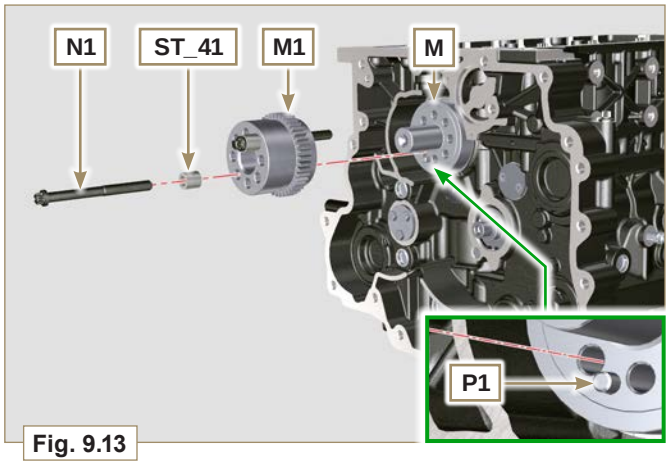


Fig. 9.13

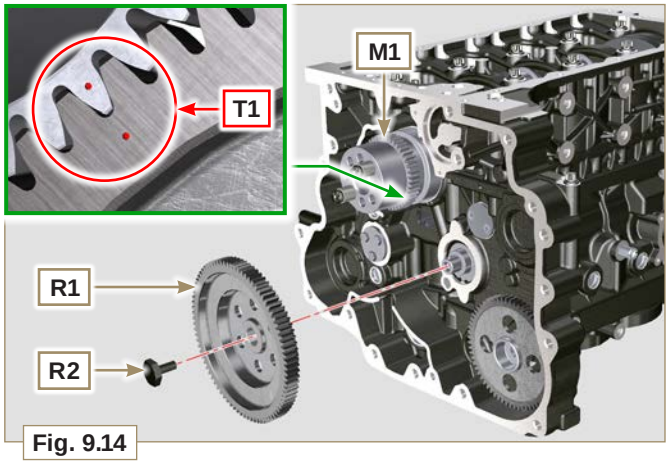


Fig. 9.14

9.3.8 Piston rings

1 - Perform the operations described in **Par. 8.5.3**.

2 - Put the scraper ring **Z3** onto the piston **Z**.

3 - Put the 2° seal ring **Z2** on the piston **Z**.

4 - Put the 1° seal ring **Z1** onto the piston **Z**.

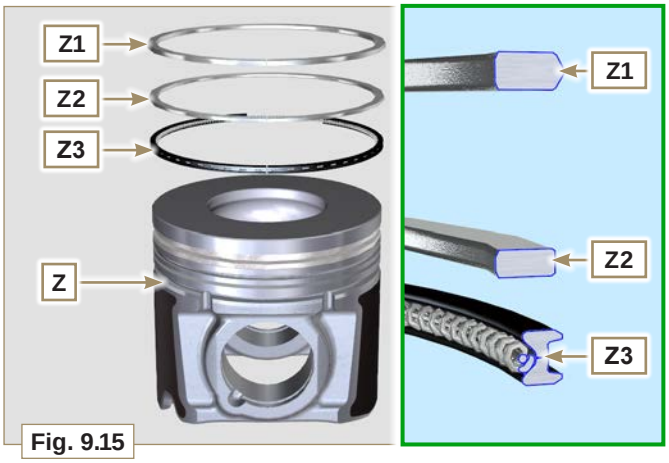


Fig. 9.15

5 - Perform the operations described in **Par. 8.5.4**.

6 - Align the piston rings with the opening of the centre of the hole for the gudgeon pin **C1**.

7 - Lubricate the piston skirt and piston rings with oil.

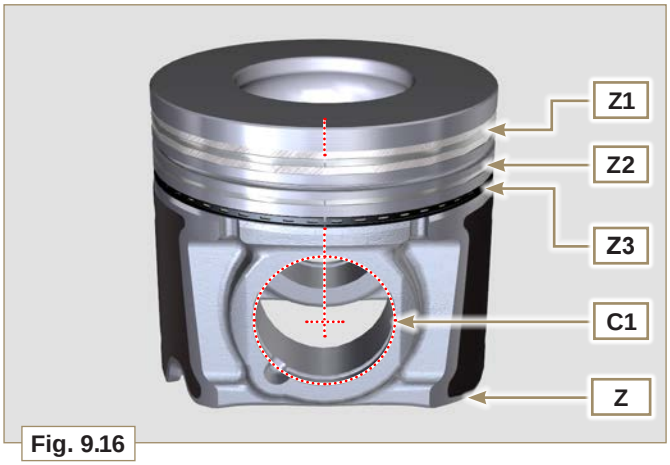


Fig. 9.16

9.3.9 Piston

Important

- The fastening bolts **E1** must be replaced every time they are assembled.
- Before proceeding to the assembly of the piston and connecting rod, carry out the checks described in **Par. 8.5.1,**
- Always replace the bearings **D1** after each assembly.
- Mate components respecting references at **Par. 7.12.5**.

1 - Loosen the screws **E1** and remove the connecting rod cap **F1**.

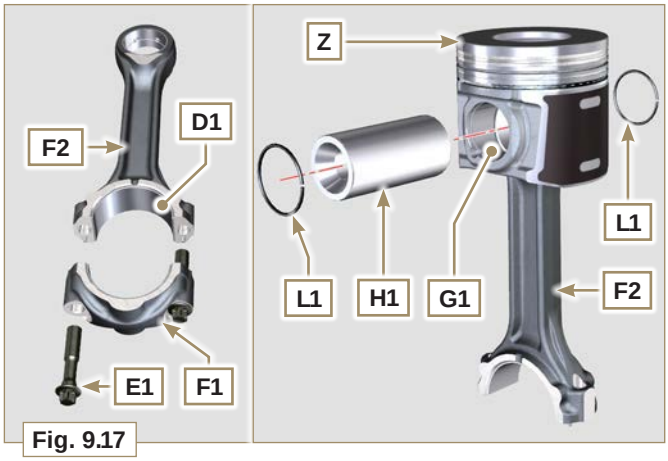


Fig. 9.17

2 - Insert the connecting rod **F2** into the piston **Z** and align the seats **G1**.

3 - Insert the gudgeon pin **H1** into the seat **G1** for the assembly of the connecting rod and piston unit.

4 - Insert the lock rings **L1** inside the seat **G2** of the piston **Z** to lock the gudgeon pin **H1**.

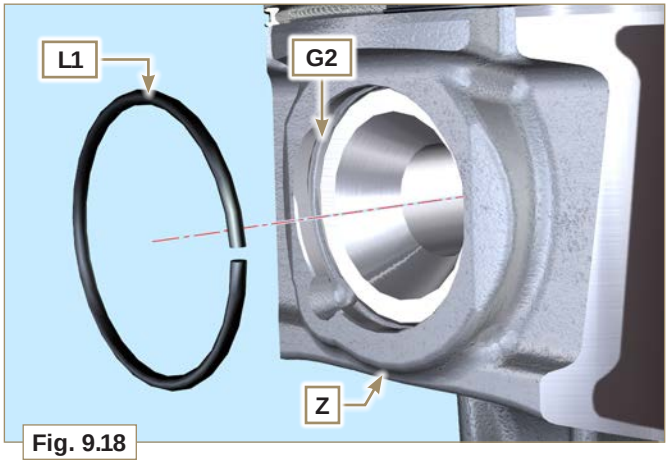


Fig. 9.18

9.3.10 Piston and connecting rod assembly

Important

- Before assembling the piston and connecting rod assemblies, execute the controls described in **Par. 8.5.**

1 - Rotate the crankshaft **M** by moving the crankpin **J1** to a TDC position of the affected cylinder.

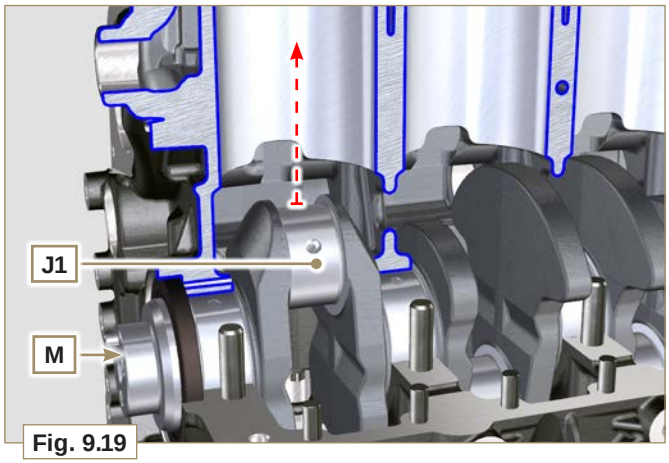


Fig. 9.19

2 - Lubricate the piston skirt and rings **Z**.

3 - Check that the half-bearing **U1** is mounted correctly and lubricate it thoroughly.

4 - Using the piston ring compression pliers, insert the piston inside the cylinder **W1** by around 10mm (height **T2**).

Important

- Make sure you are at the stage described in **Point 1**.
- Piston **Z** must be assembled with notch **K1** on the side of the skirt facing oil spray nozzles **G**.

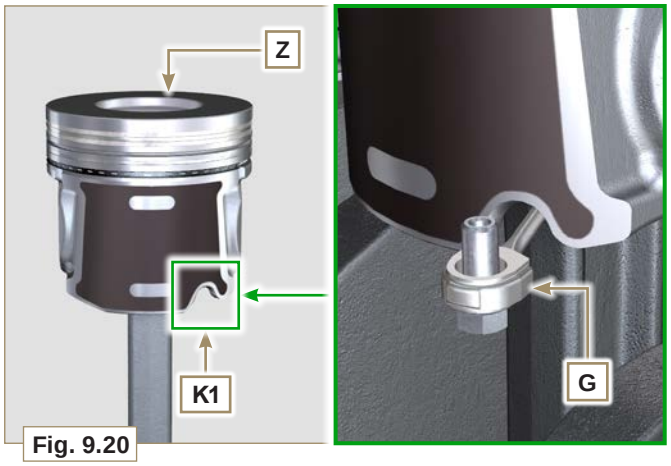


Fig. 9.20

5 - Rotate the piston **Z** by **10°** counter-clockwise with respect to its correct assembly position (**Fig. 9.21** - height **T3**).

NOTE: Doing this prevents the impact between the connecting rod **F2** and the sprayer **G**.

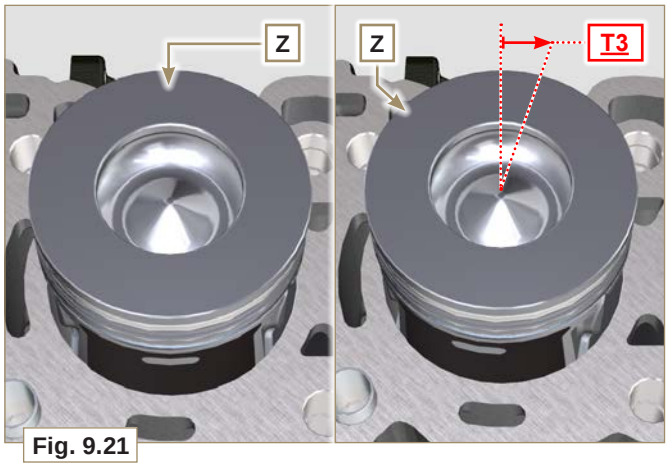


Fig. 9.21

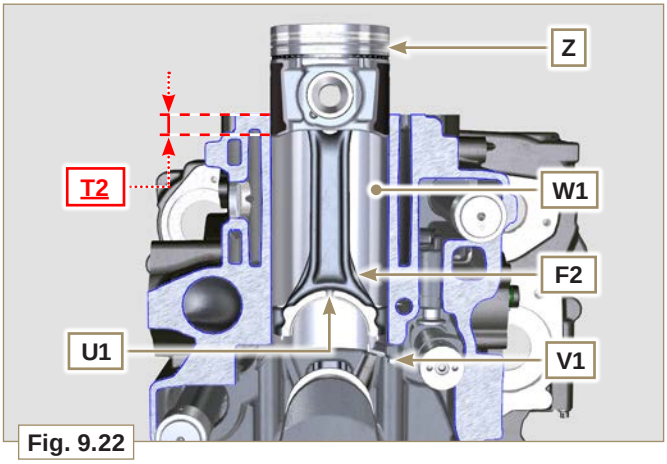


Fig. 9.22

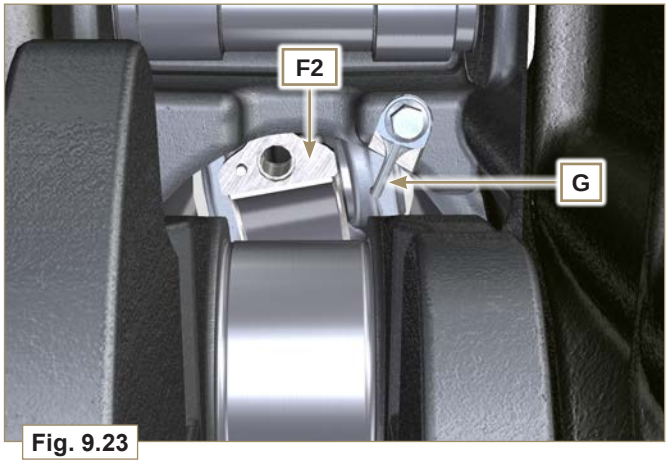


Fig. 9.23

Important

- Leave the ring compressor assembled on the piston.

6 - Push piston **Z** downwards without introducing the segments in the cylinder, rotate piston **Z** by 10° in a clockwise direction (value **T3** – correct assembly position).

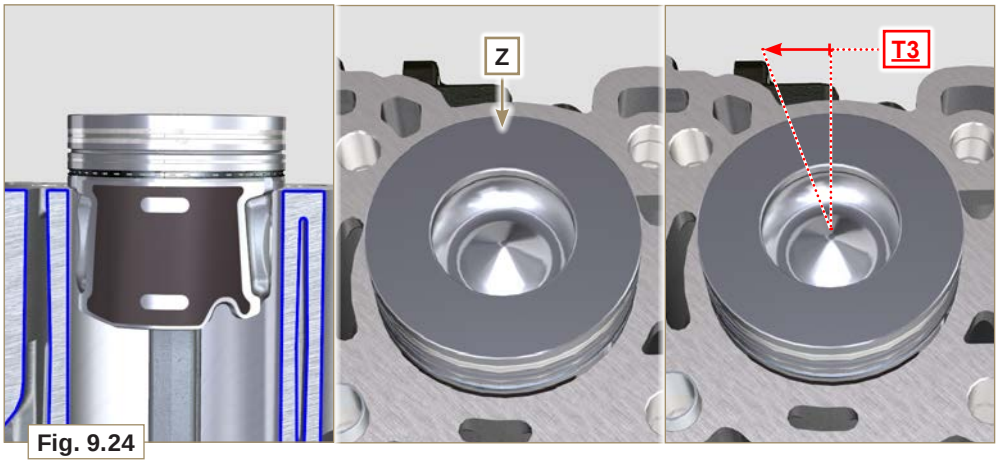


Fig. 9.24

7 - Push the piston **Z** downwards by centering the crankpin **J1** with the connecting rod **F2**.

8 - Rotate the crankshaft **M** by moving the crankpin **J1** to a BDC position of the affected cylinder.

9 - Push the piston **Z** downwards by centering the crankpin **J1** with the connecting rod **F2**.

10 - Turn the crankcase on support to assemble the con rod capp **F1**.

11 - Check that the half-bearing **U1** is mounted correctly on the connecting rod cap **F1**.

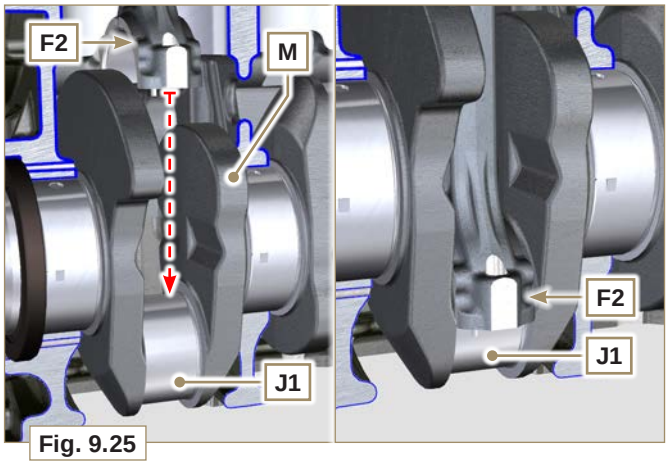


Fig. 9.25

Important

- Check that the break levels of connecting rod cap **F1** coincide perfectly onto connecting rod **F2** before screwing on and tightening capscrews **E1**.

12 - Couple the connecting rod cap **F1** to the connecting rod **F2** using the marks made at disassembly **Par. 7.12.1**).

13 - Apply "Molyslip AS COMPOUND 40" on the threads and under the head of capscrew **E1** and manually tighten them until their stop.

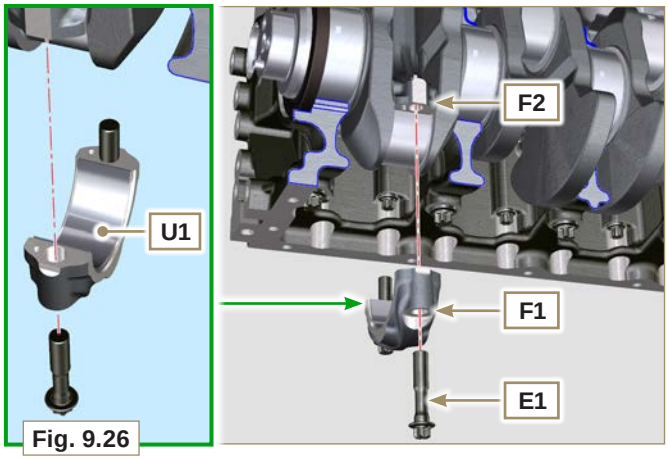


Fig. 9.26

Important

- Failure to adhere to the assembly procedures may compromise the functionality of the engine, and also cause damage to persons and property.

14 - Tighten the screws **E1**, alternately, strictly following the tightening torques indicated (**Tab. 9.3**).

15 - Repeat the operations from **1** to **14** for each cylinder.

16 - Check that the connecting rods have axial play and the crankshaft **M** rotates smoothly.

NOTE: After the check carried out at point **16**, position the shaft **M** with the first cylinder to TDC.

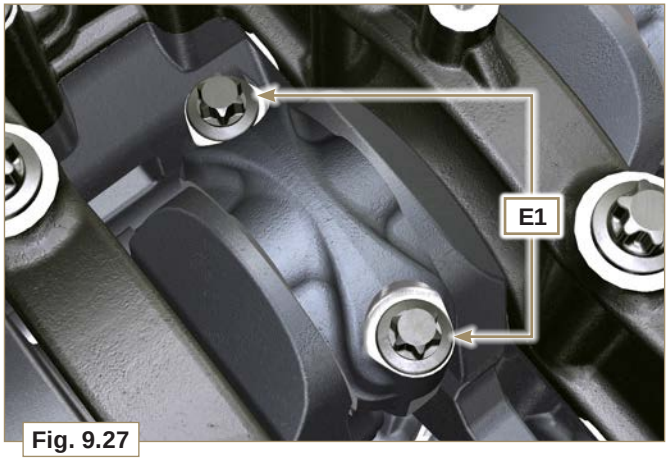


Fig. 9.27

Tab. 9.17

CYCLE	SCREWS	TORQUE
1	E1	28 Nm
2	E1	30°
3	E1	30°

9.4 Oil sump unit assembly

9.4.1 Oil drain pipe

Important

- It is mandatory to replace the gasket **D** after each assembly.
- Always replace capscrews **B** with new ones or alternatively apply **Loctite 2701**.

1 - Secure the hose **A** on the crankcase **C** with the screws **B** inserting the gasket **D** (tightening torque **10 Nm**).

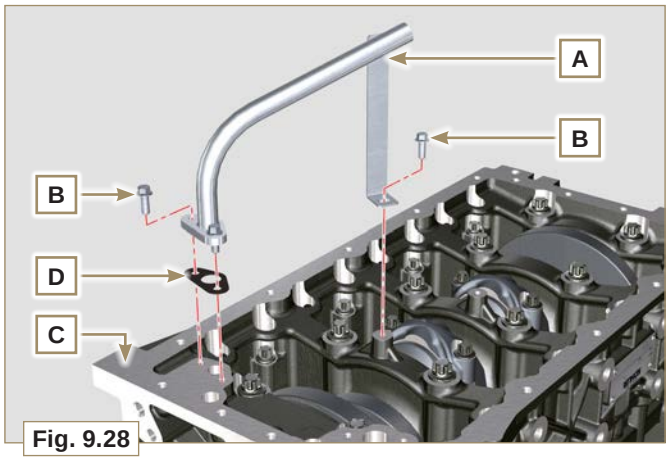


Fig. 9.28

9.4.2 Oil suction pipe

Important

- It is mandatory to replace the gasket **F** after each assembly.
- Always replace capscrews **B** with new ones or alternatively apply **Loctite 2701**.

1 - Secure the hose **E** on the crankcase **C** with the screws **B** (tightening torque **10 Nm**) fitting the gasket **F**.

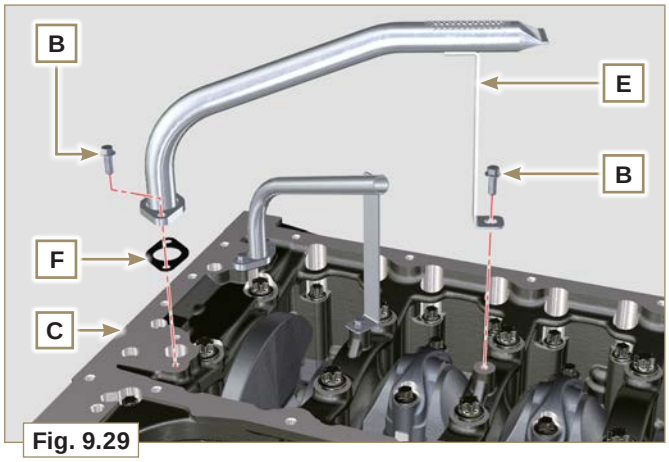


Fig. 9.29

9.4.3 Oil Sump

1 - Ensure that the contact surfaces **G** of the oil sump **H** and the crankcase **C** are completely clean.

2 - Apply a bead of approx. **2.5 mm** of sealant (**Loctite 5660)** on the surface **G** of the crankcase **C**.

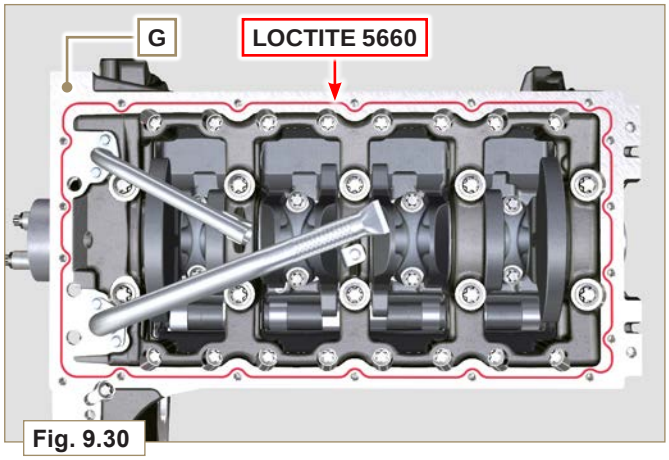


Fig. 9.30

3 - Position the oil sump **H** on the crankcase **C** in line with the fastening holes (use the aid of tool **ST_18**).

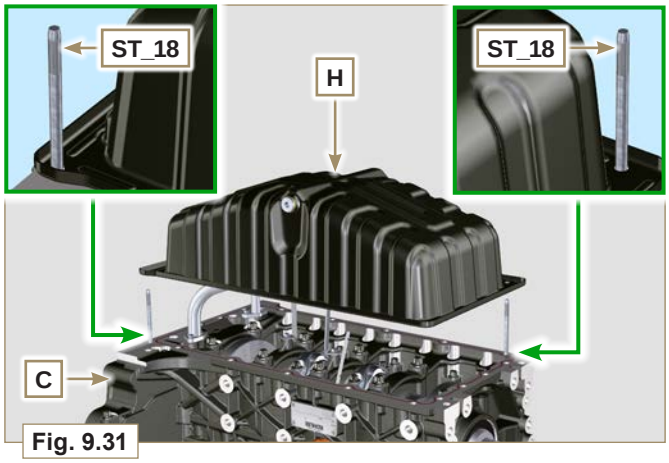


Fig. 9.31

Important

- Tighten the screws **L**, strictly following the sequence and tightening torque indicated.

4 - Fix oil sump **H** by means of the screws **L** following the sequence indicated (tightening torque **25 Nm**).

5 - After tightening of the screw **n° 10**, loosen screw **n°1** and re-tighten it to the torque value specified in step **4**.

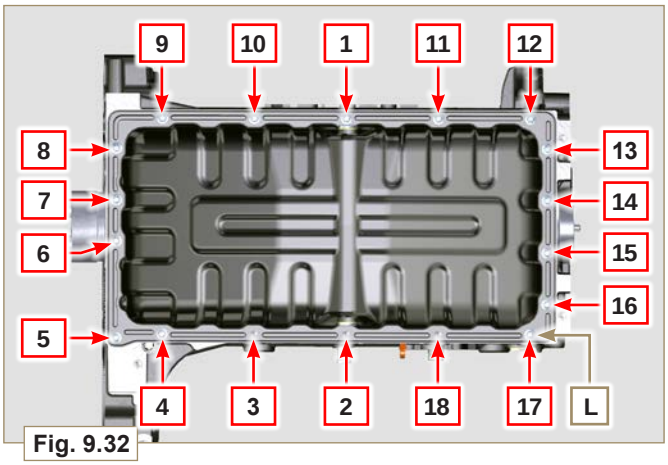


Fig. 9.32

9.5 Cylinder head unit assembly

9.5.1 Valve stem gasket

Important

- Carry out the checks described in **Par. 8.6.4** before proceeding with the following operations.
- Always replace gasket **A** with every assembly.
- Lubricate the gaskets **A** on the inside.

1 - Fit the gaskets **A** on the valve guides **B** using the tool **ST_08**.

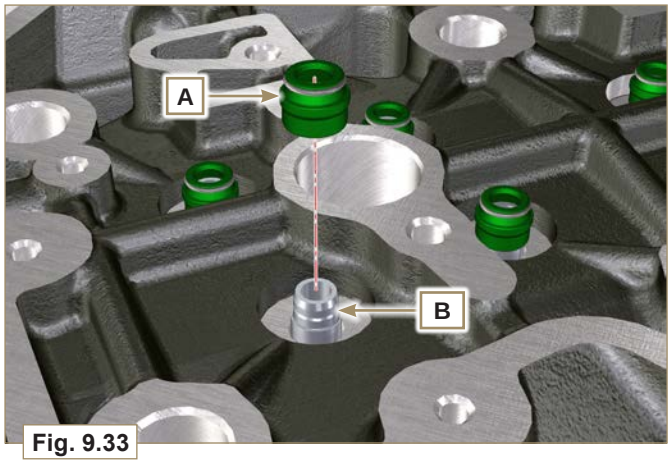


Fig. 9.33

9.5.2 Injector sleeves (↪)

1 - Insert the seals **C** in the seats of the sleeve **D**.

2 - Insert the seal **E** with the convex side facing upward at the base of the sleeve **D**.

3 - Lubricate the gaskets **C**.

4 - Insert and carefully screw the sleeve **D** into the seat of the head **F**.

NOTE: The sleeve **D** must not protrude above the surface of the head **G**.

5 - Clamp the sleeve **D** (tightening torque at **30 Nm**).

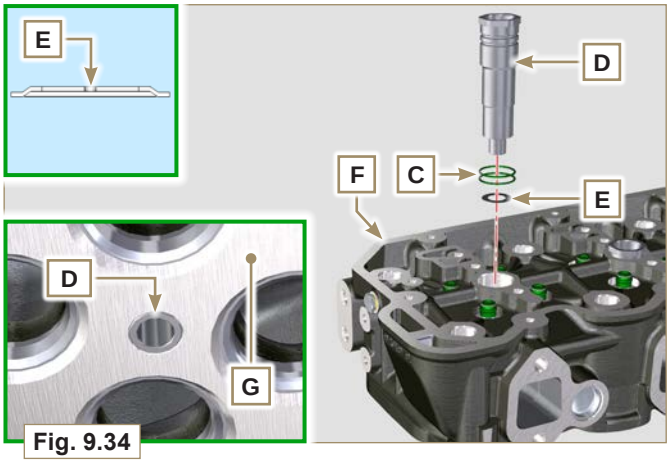


Fig. 9.34

9.5.3 Injectors projection

1 - Perform the operations of **Par. 6.1.7**.

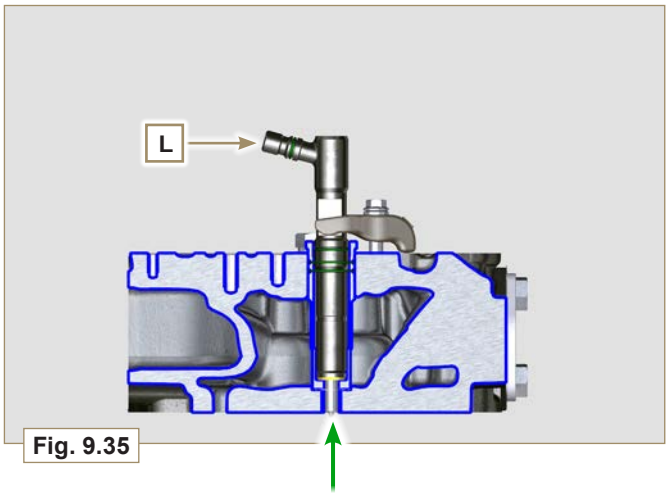


Fig. 9.35

2 - Check, using **ST_03** tool (**Fig. 9.36**), the projection of the injector, which must range between 1.68 ÷ 2.42 mm.

NOTE: if the value detected does not correspond, replace gasket **Q** with a different thickness

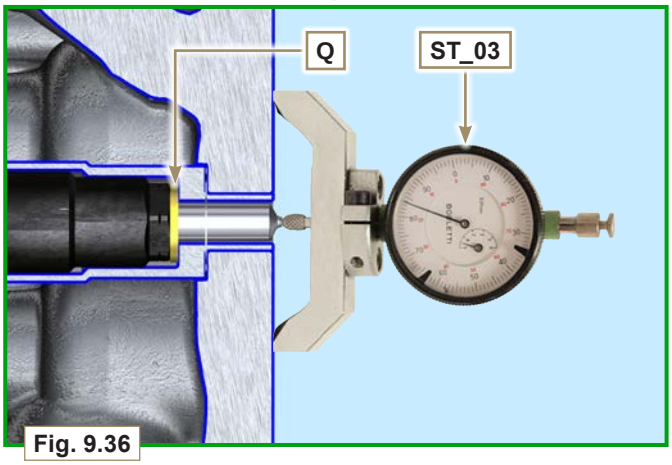


Fig. 9.36

9.5.4 Valves

1 - Pre-lubricate and insert the valves **X** into the head **F** taking care to fit them in the original positions as per the reference marks made in **Par. 7.12.4.1**.

2 - Position the spring **Y** on the seat of the head **F**.

3 - Position the disk **S** on the spring **Y** centering the valve **X**.

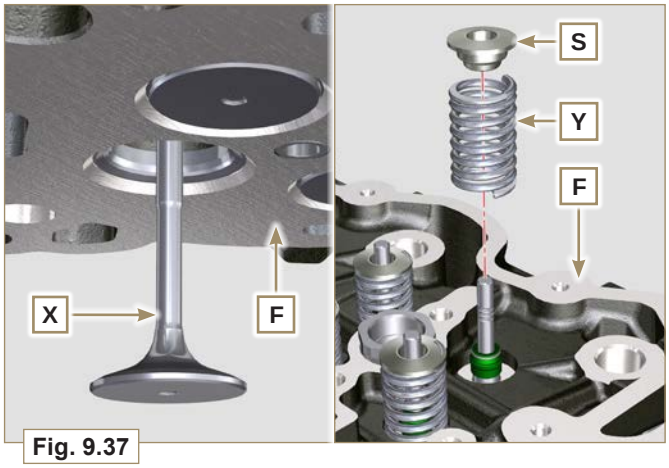


Fig. 9.37

4 - Mount the tool **ST_07** on the head **F** fixing it on one of the holes for securing the rocker arm cover.

NOTE: Change the fixing hole according to the position of the valves to be fitted.

5 - Position the tool **ST_07** on the valve as shown in **Fig. 9.38**.

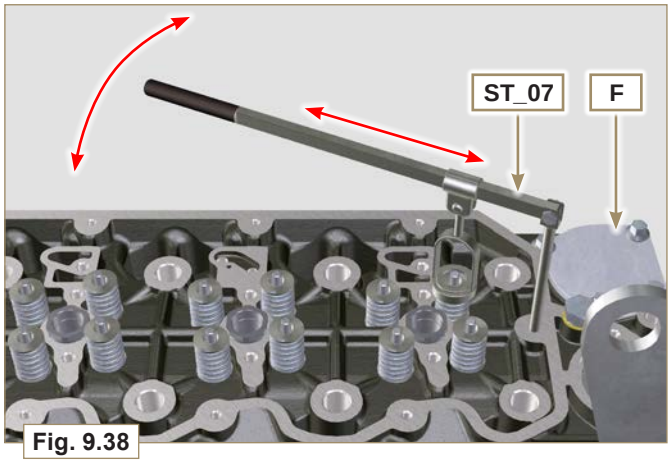


Fig. 9.38

6 - Push the lever of the tool **ST_07** downwards, in order to lower the valve disks **S** in the direction of the arrow **AK**, and insert the valve cotters **AJ** inside the disk **S**.

7 - Check that the valve cotters **AJ** are properly mounted on the valve seats **X** and release the tool **ST_07**.

NOTE: repeat all the steps for the relevant valves and remove the tool **ST_07**.

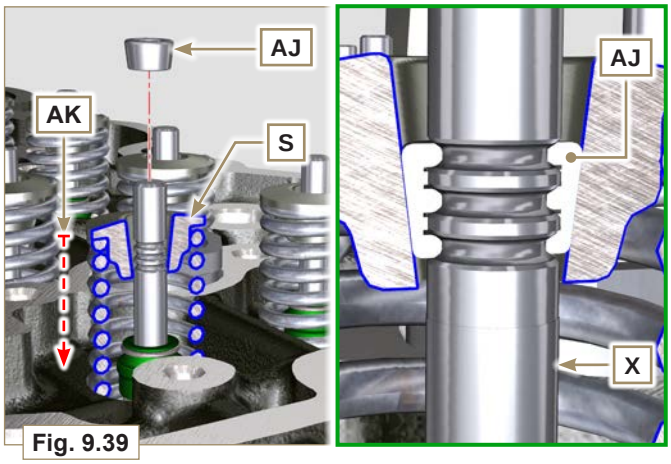


Fig. 9.39

9.5.5 Cylinder head

1 - Fix the eyebolts **AW** with the screws **AX** onto the head **F** (tightening torque of **80 Nm**).

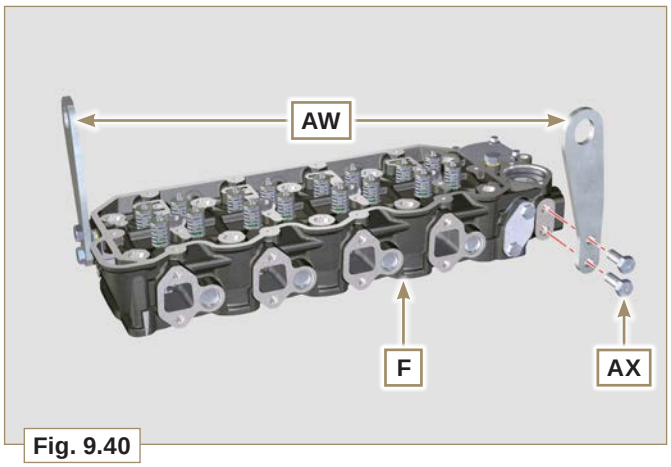


Fig. 9.40

2 - Position the piston **P** at the TDC.

3 - Position the tool **ST_03** on the crankcase surface of the head and measure the piston protrusion **P** from head level **K** in 4 diametrically opposed points **R**.
Repeat the operation for all pistons **P** and take note of the highest average value, determining value **S** (**Tab. 9.4**).

4 - Based on the value detected at point **3**, select the relevant gasket **T** as shown in the **Tab. 9.4** (**Fig. 9.42** detail **U**).

5 - Check that the crankcase surface **K** and the gasket **T** are completely free of dirt and grit.

Important

• The head gasket must be replaced for each assembly.

6 - Position the gasket **T** on the surface **K** with reference to the centering bushings **J**.

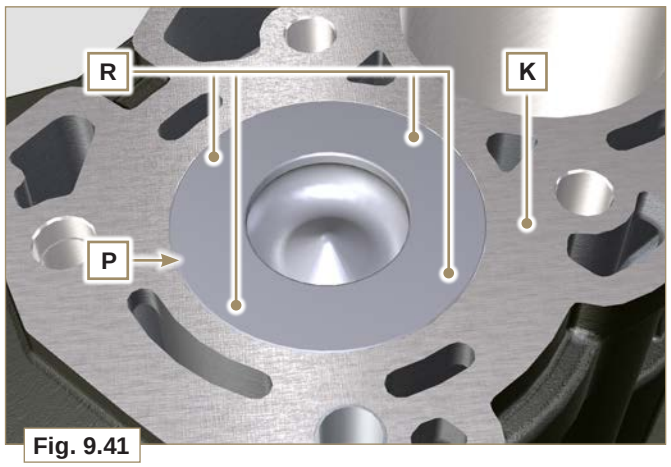


Fig. 9.41

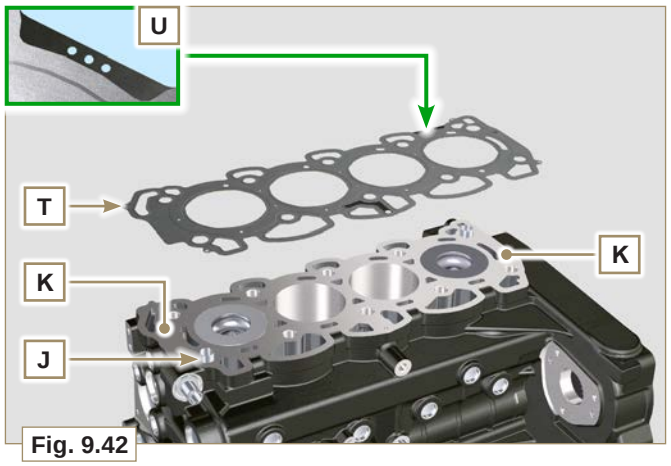


Fig. 9.42

Tab. 9.18

S (mm)	Hole number
0.030 - 0.126	1
0.127 - 0.250	2
0.251 - 0.375	3

7 - Check that the surface head **W** is free from impurities.

8 - Position the head **F** on the crankcase **Z** with reference to the centering bushings **J**.

Important

- The fastening bolts **V** must be replaced every time they are assembled.
- Failure to adhere to the bolt fixing procedures may compromise the functionality of the engine, and also may cause damage to persons and property.
- Tighten capscrews **V** observing the cycles, tightening, and subsequent rotation as indicated in **Tab. 9.5**.

9 - Apply "Molyslip AS COMPOUND 40" on the threads and under the head of capscrew V and manually tighten them until their stop.

10 - Secure the head **F** by tightening the screws **V** strictly following the sequence indicated in the **Fig. 9.44** and the tightening torque and pauses between cycles indicated in the **Tab. 9.5**.

Tab. 9.19

CYCLE	TORQUE	PAUSE
1	28 Nm	3"
2	30°	3"
3	30°	10"
3	30°	...

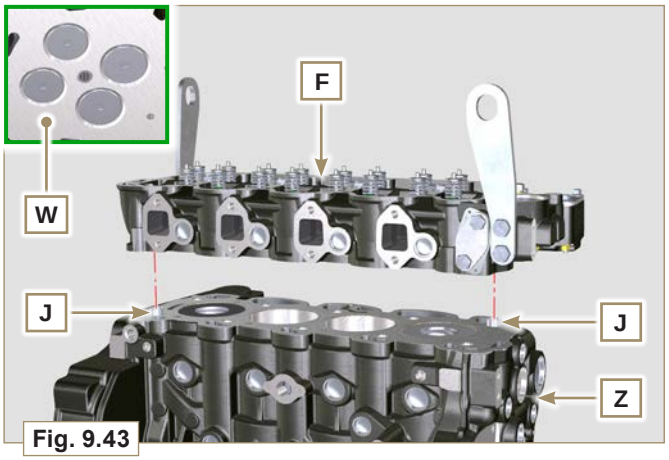


Fig. 9.43

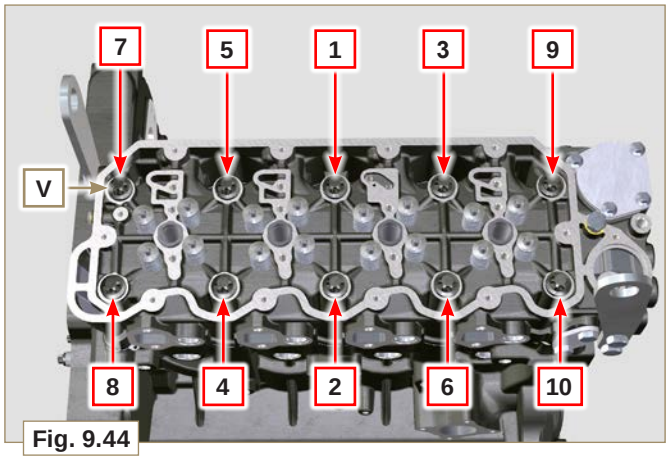


Fig. 9.44

9.5.6 Rods and valve bridges

1 - Insert the rocker control rods **AA** into the niches of the head **F**.

Important

- Properly centre the rods **AA** into the spherical housing of the camshaft tappets **AB**.

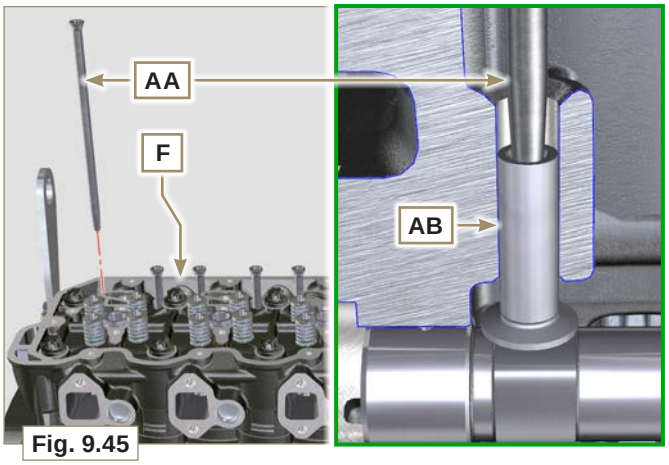


Fig. 9.45

2 - Mount the valve bridge **AC** on to the pairs of discharge and suction valves.

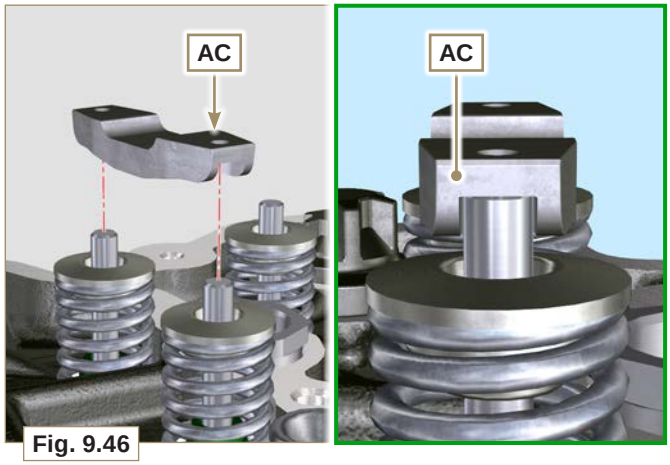


Fig. 9.46

9.5.7 Rocker arms

Important

- The suction rocker arm **AT** is shorter than the discharge arm **AR**.

1 - Fit the lock ring **AM** into the seat **AN** of the rocker arm pin **AH**.

2 - Position the pin **AH** with the surface **AP** facing upwards and insert the 2 shoulder rings **AQ**.

3 - Insert in sequence the suction rocker arm **AR**, the holder **AS** and the discharge rocker arm **AT** in the pin **AH**.

4 - Insert the spring **AU** in the pin **AH**.

5 - Repeat points **3**, **4** for all the rocker arms.

NOTE: Support **AV**, which contains taper pin **BV**, must be assembled in correspondence with **cylinder n° 3**.

6 - Insert 2 shoulder rings **AQ** and the lock ring **AN** to lock all the components inserted in the pin **AH**.

NOTE: The spring **AU** ensures that the supports **AS** and **AV** are kept in place .

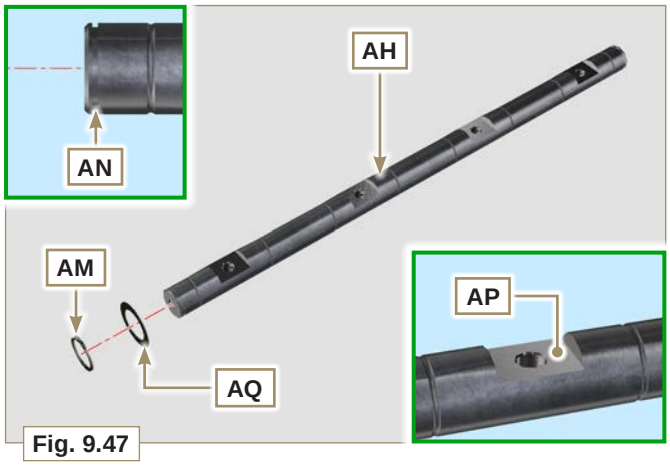


Fig. 9.47

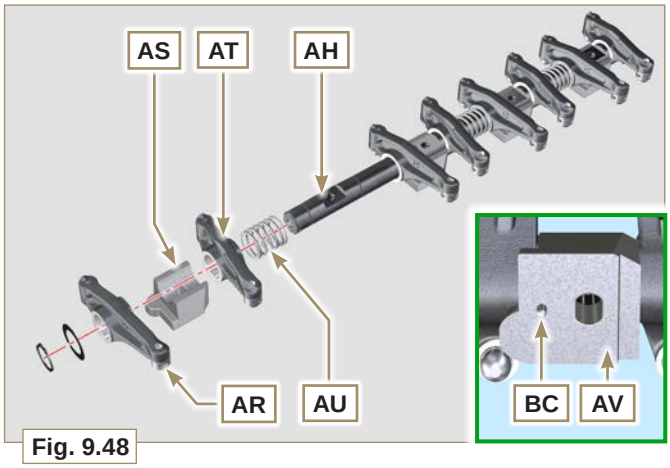


Fig. 9.48

9.5.8 Rocker arm pin assembly

Important

- Position the rocker arm pin assembly **BB** on a level to align all the support surfaces.
- Check that the pistons are positioned half way between the TDC and BDC. As seen from **A** ⟹ (**Par. 1.4**) turn the crankshaft anticlockwise by 90°, complying with TDC of the **1st cylinder,** positioning taper pin **BP** of the crankshaft as shown in **Fig. 9.49**.

1 - Position rocker arm shaft unit **BB** on cylinder head **F**, complying with the taper pin **BC** reference with hole **BF** of cylinder head **F**.

2 - Check the correct positioning of all the rocker arms and the u-bolt control valves (detail **BD**).
House the tappet in the seat of the rocker arms control rod.

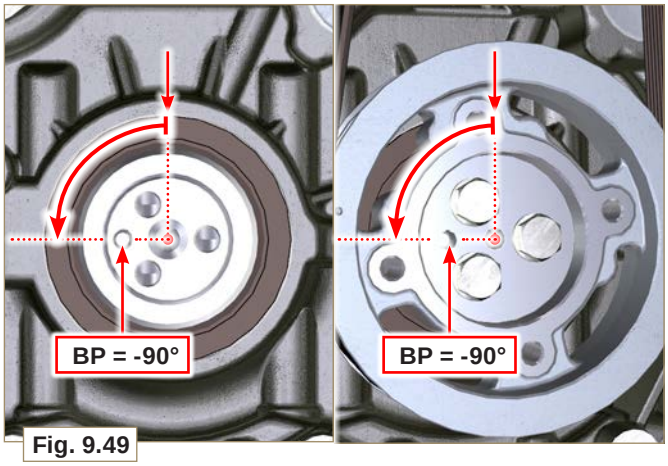


Fig. 9.49

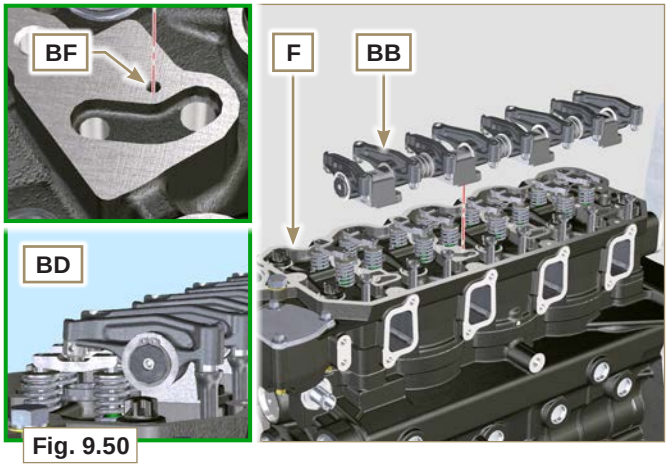


Fig. 9.50

3 - Secure the rocker arm pin **BB** tightening the screws **BE** (tightening torque to **40 Nm**). Adhere to the screw tightening sequence **BE** as shown in **Fig. 9.51**.

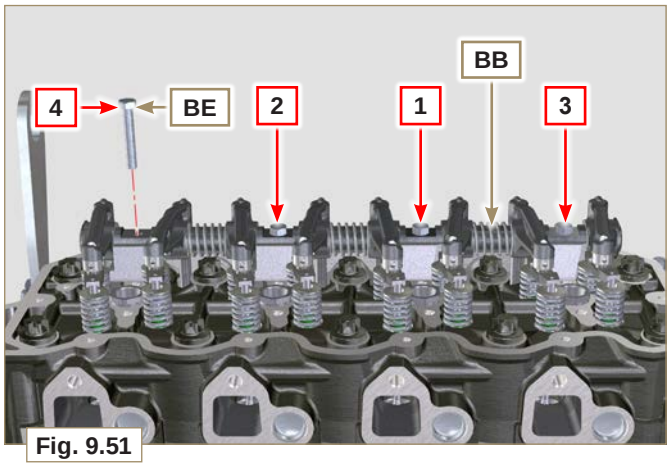


Fig. 9.51

9.6 Assembly lubrication circuit

9.6.1 Oil pressure relief valve

1 - Lubricate the piston **N** and fully insert it in the seat **P**.

2 - Insert the spring **Q** in the piston **N**.

3 - Insert disk **R** onto spring **Q**.

4 - Insert cotter pin **S** in the provided seat of oil pump **T** to lock components **N, Q**, and **R**.

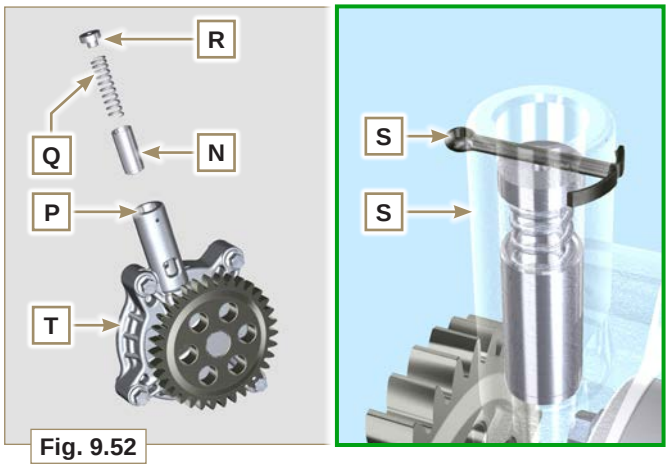


Fig. 9.52

9.6.2 Oil pump

NOTE: Carry out the checks described in **Par. 8.7** before proceeding with the following operations.

1 - Check that all contact surfaces between **T**, **V** are free of impurities – scratches - dents.

2 - When assembling, do not use any type of gasket between **T** and **V**.

3 - Thoroughly lubricate the seat of the rotors on oil pump **T**.

4 - Make sure the external rotor is assembled correctly with Ref. **U** visible, as shown in the picture (or refer to **Par. 2.10.2**).

5 - Fasten the oil pump cover **T** on the crankcase **V** with the screws **X** (tightening torque **10 Nm**).

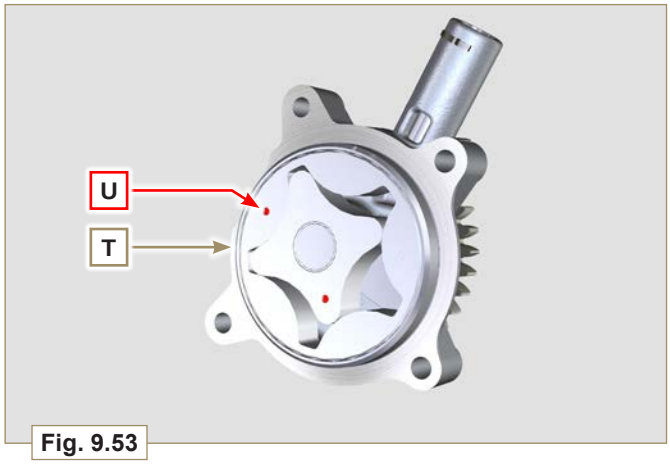


Fig. 9.53

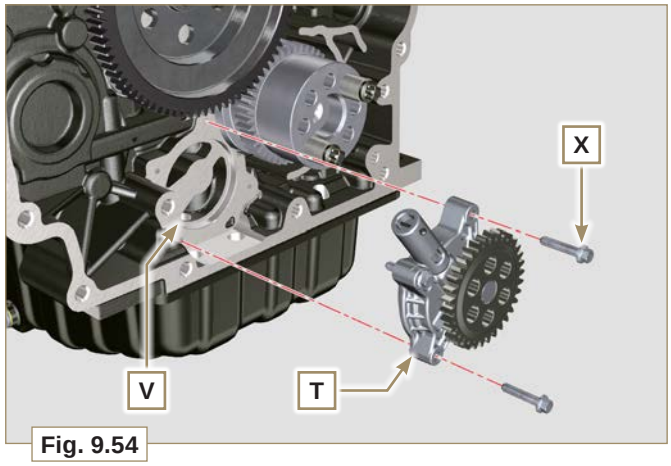


Fig. 9.54

9.7 Flange unit assembly

9.7.1 Bell housing

Danger

- Bell **A** is very heavy; pay special attention during assembly operations to avoid dropping and causing serious risks to the operator.

1 - Apply a bead of approx. **2.5 mm** of sealant (**Loctite 5660)** on the surface **B** of the bell **A**.

2 - Assemble bell **A** onto crankcase **D**, complying with reference taper pins **E** (**ST_45**).

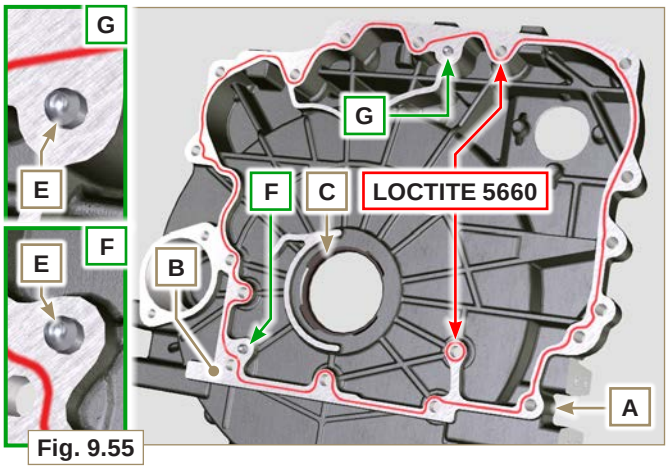


Fig. 9.55

Important

- Failure to adhere to the assembly procedures may compromise the functionality of the engine, and also cause damage to persons and property.
- Always replace and lubricate the gasket **C** with oil, every time they are assembled (the gasket **C** is to be mounted after the operation at point 4, **ST_47**).

3 - Apply the screws **F** by hand without tightening them.

4 - Tighten the screws **F** following the tightening sequence indicated (tightening torque **75 Nm**).

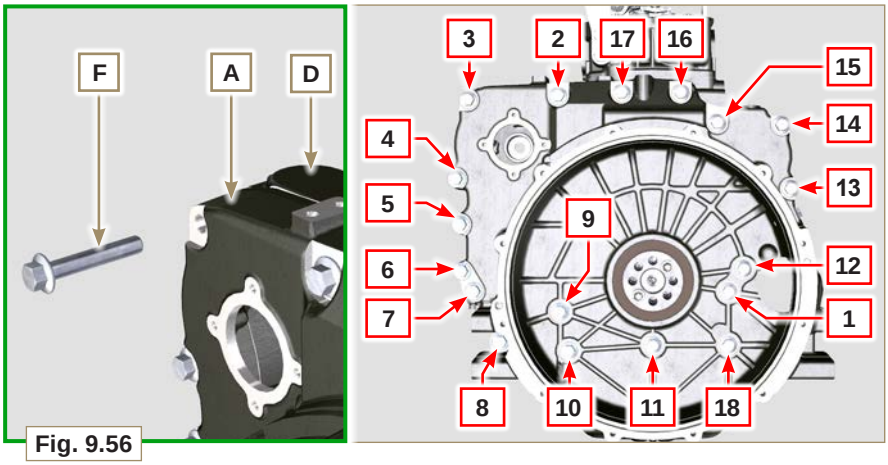


Fig. 9.56

9.7.2 Flywheel

Danger

- Flywheel **H** is very heavy; pay special attention during assembly operations to avoid dropping and causing serious risks to the operator.

1 - Loosen capscrews **G** and remove tool **ST_41**.

2 - Position flywheel **H** onto crankshaft **L** by means of tool **ST_43 - ST_46**.

3 - Apply "Molyslip AS COMPOUND 40" on the threads and under the head of capscrews **G** and manually tighten them until their stop.

4 - Secure flywheel H with capscrews G (tightening torque **60 Nm**).

5 - Once again, tighten capscrews G (2 cycles with tightening torque **130 Nm**).

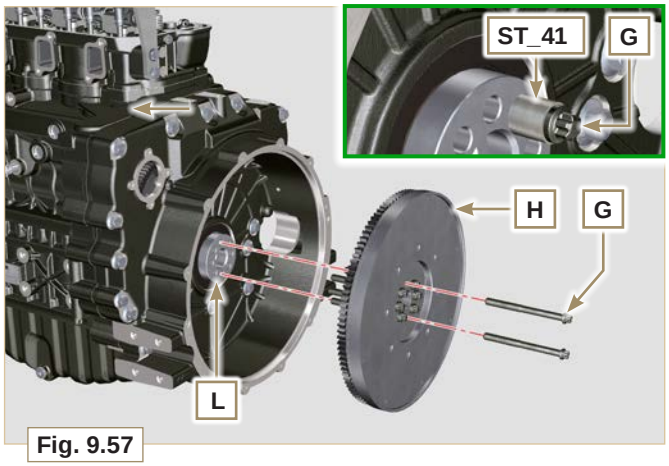


Fig. 9.57

9.8 Fuel system assembly

Important

- Remove the protective caps from all the components of the fuel circuit just before assembly just before assembly (**Par. 2.9.8**).

9.8.1 High-pressure injection pump

1 - Follow operations **1, 2, 3, 4, 5, 6, 7** and **8** of **Par. 6.1.5**.

2 - Follow operations **1, 2, 3, 4, 5, 6, 7** and **10** of **Par. 6.1.6**.

9.8.2 Injectors

Important

- To prevent damaging the injection system, the protection caps (**Par. 2.9.7**) must be removed during assembly.

1 - Follow operations of **Par. 6.1.7**.

9.8.3 Fuel return pipes

1 - Tighten union **A** onto cylinder head **B**, inserting the relative gasket.

2 - Perform the operations of point **18** of **Par. 6.1.5**.

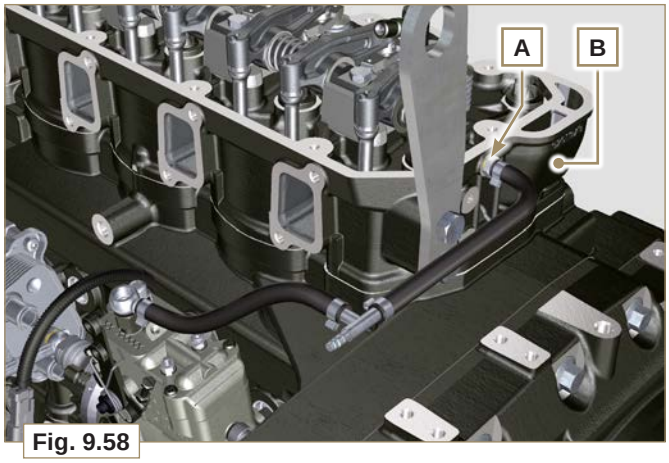


Fig. 9.58

9.8.4 Rocker arms cover

1 - Perform the operations of **Par. 6.1.9**.

9.8.5 Injection fuel pipes

1 - Perform the operations of **Par. 6.1.10**.

9.8.6 Fuel filter

1 - Perform the operations of **Par. 6.5.2**.

9.9 Crankshaft pulley assembly

1 - Check that the pin **A** is mounted properly on the crankshaft **B**.

2 - Position the pulley **C** on the crankshaft **B** using the pin mark **A**.

3 - Apply "Molyslip AS COMPOUND 40" grease onto the thread and under the head of capscrew **D**.

4 - Fix the pulley **C** with the screw **D** (tightening torque of **100 Nm**) and remove special tool **ST_34**.

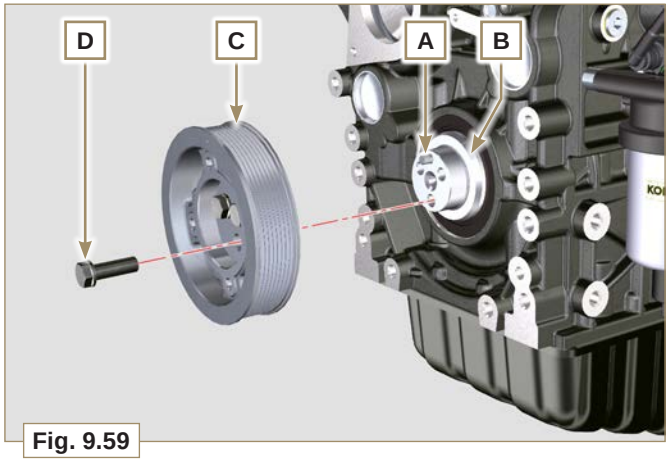


Fig. 9.59

9.10 Coolant circuit assembly

9.10.1 Thermostatic valve

Important

• Always replace the gasket **A** after each assembly.

1 - Check the condition of the seal gasket **A** and fit it on the thermostatic valve **B**.

2 - Position the thermostatic valve **B** in the seat on the head **C** (detail **D**).

3 - Secure the cover **E** with the screws **F** on the head **C** (tightening torque of **10 Nm**).

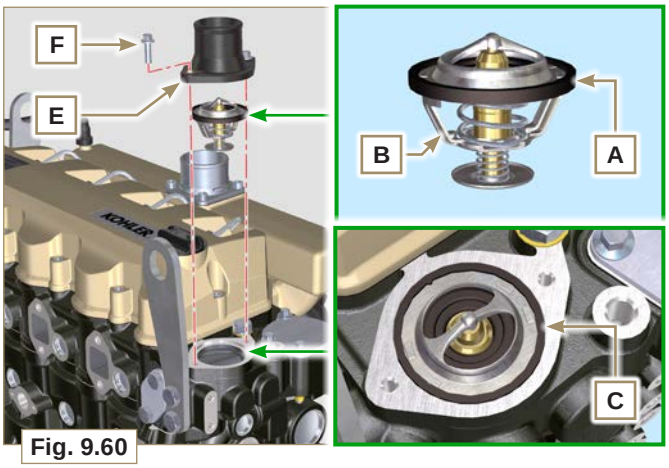


Fig. 9.60

9.10.2 Coolant pump

Important

• Always replace the gasket **L** every time it is assembled.

1 - Secure the flange **G** with the screws **H** interposing the gasket **L** onto the crankcase **M** (tightening torque of **25 Nm**).

2 - Perform the operations **1** and **2** of **Par. 6.2.2**.

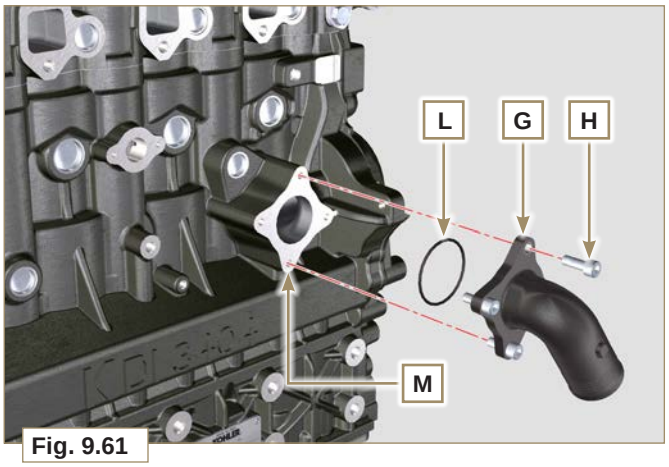


Fig. 9.61

9.10.3 Oil Cooler hoses

1 - Secure hose **N** on Oil Cooler **P** and on crankcase **M** by means of clamps **Q**.

2 - Position and secure hose **R** by means of clamp **S** on Oil Cooler **P** and on crankcase **M**.

3 - Secure clamps **T** on manifold **U** by means of capscrews **V** in points **X** (tightening torque **10 Nm - ST_06**)..

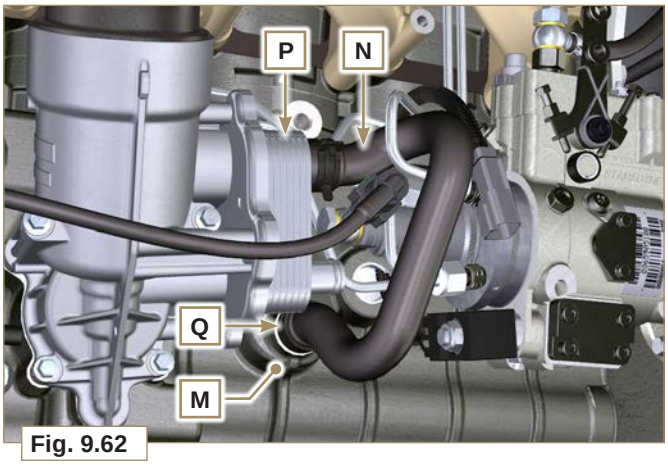


Fig. 9.62

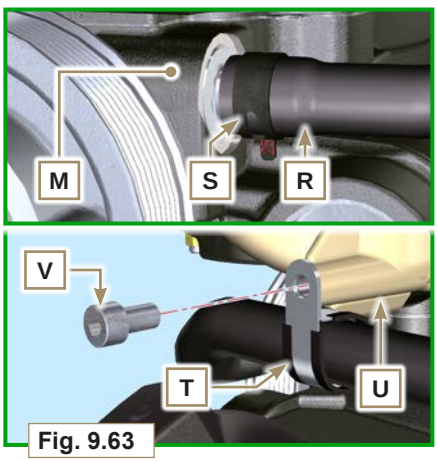
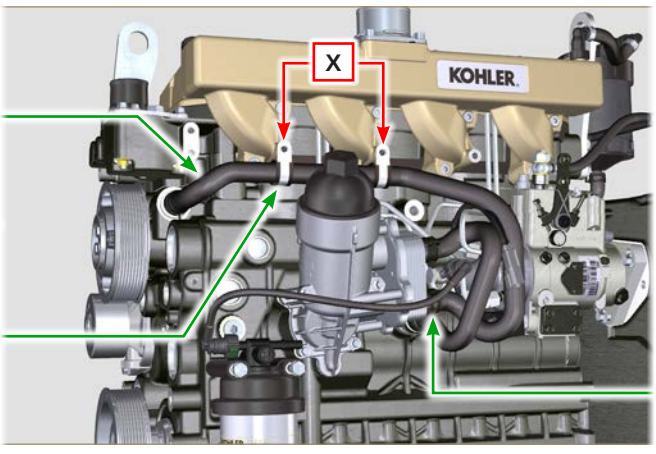
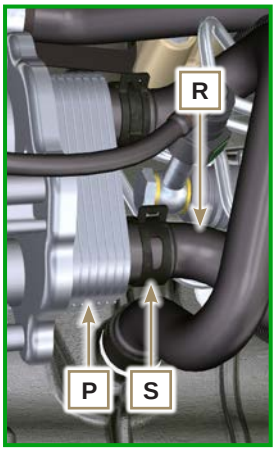


Fig. 9.63





9.11 Exhaust manifold assembly

Important

- Replace the metal gaskets **A** every time they are assembled.

1 - Check that the contact surfaces **D** are free from impurities.

2 - Position manifold **E** onto cylinder head **G** by manually tightening capscrews **F**, inserting:
- gaskets A between cylinder head **G** and manifold **E**;
- spacers H between capscrews **F** and manifold **E**..

3 - Secure manifold **E** onto cylinder head **G** by means of capscrews **F** (tightening torque **25 Nm**).

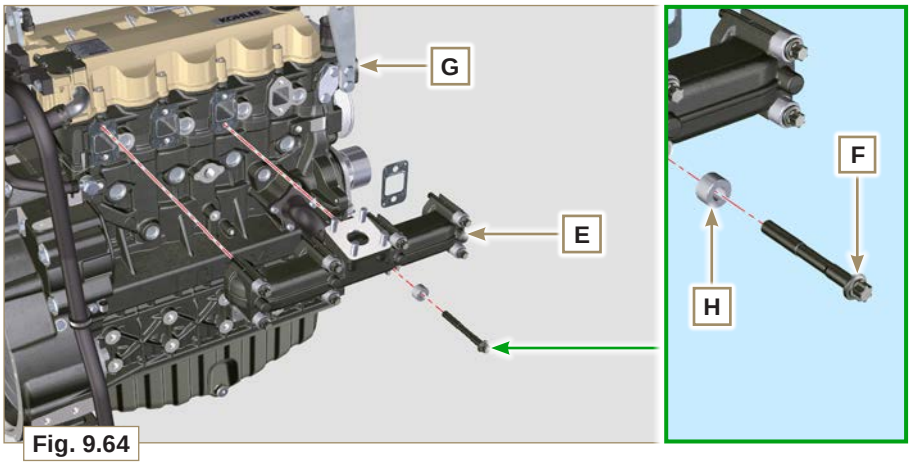


Fig. 9.64

9.12 Turbocharger Assembly

Important

- Before proceeding, perform the operation described in **Par. 2.18**.
- Ensure that tube **C** is not clogged.
- Always replace the gaskets **A**, **B, Q** at each assembly.
- Remove the plastic or foam caps from the turbo compressor before assembling.

1 - Check that the contact surfaces **D** are free from impurities deformations or cracks, otherwise replace damaged component.

2 - Position the turbo-compressor **E** on the bolts **F** on the manifold **G**.

3 - Fasten the turbo-compressor **E** with the nuts **H** (tightening torque of **25 Nm**).

4 - Fasten the pipe **C** with the screws **M** to the turbo-compressor **E**.

5 - Fasten the pipe **C** with the screws **N** on the crankcase **P**.

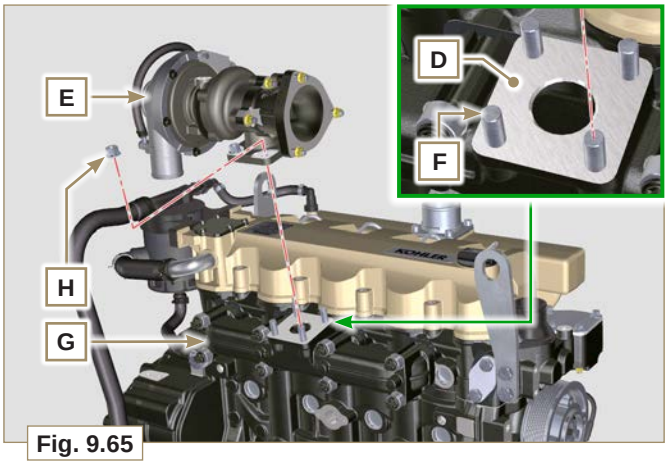


Fig. 9.65

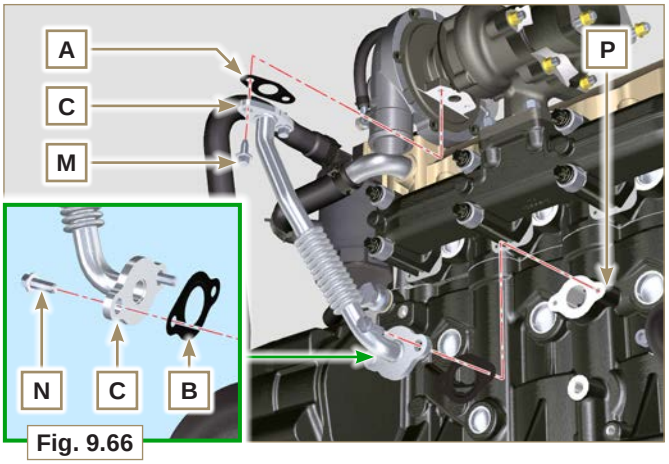


Fig. 9.66

Important

- Always replace the gasket **Q** after each assembly.
- Before assembly of the tube **R**, perform the operation described in **Par. 2.18.2** - **Point 2**.
- Ensure that tube **R** is not clogged.

6 - Fasten the pipe **R** with the fittings **S** on the turbo-compressor **E** and on the crankcase **P** (tightening torque of **15 Nm**).

Insert the gaskets **Q** between:
- **S** and **R**;
- **E** and **R**;
- **P** and **R**.

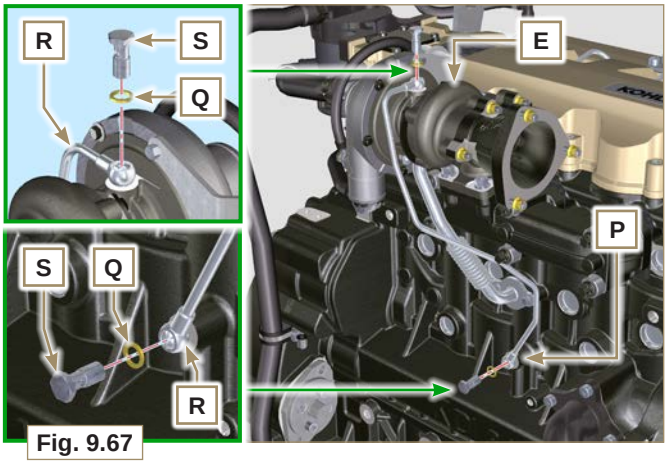


Fig. 9.67

9.13 Electric component assembly

9.13.1 Sensors and switches

9.13.1.2 Coolant temperature sensor

1 - Secure the sensor **A** onto the head **B** (tightening torque of **20 Nm**).

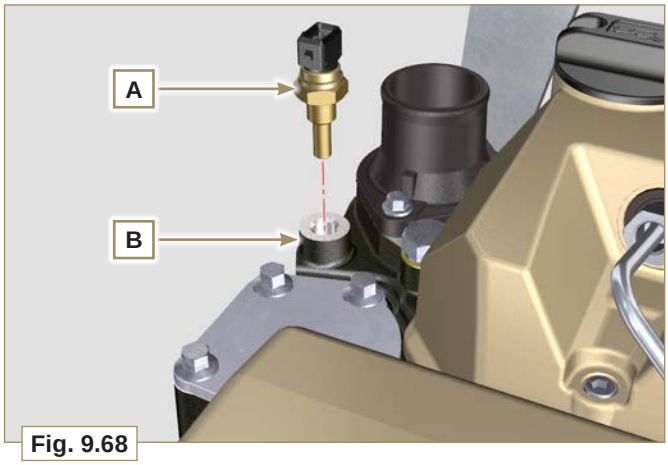


Fig. 9.68

9.13.1.3 Oil Pressure Switch

1 - Clamp the oil pressure switch **C** on the crankcase **D** (tightening torque at **35 Nm**).

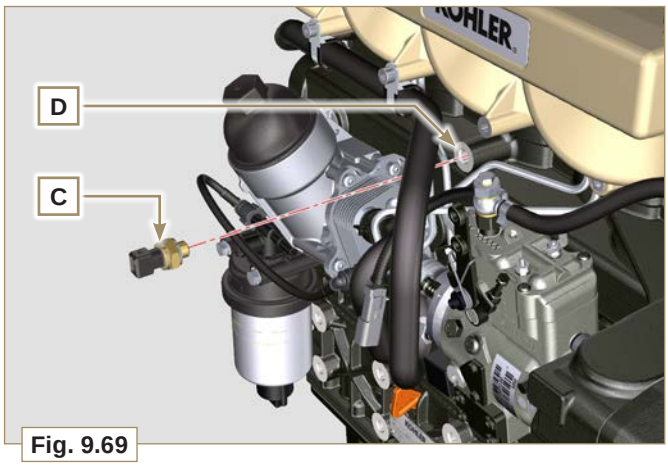


Fig. 9.69

9.13.2 Alternator

1 - Insert the washer **E** onto the screw **F**.

2 - Insert the screw **F** onto the alternator **G**.

3 - Secure the bracket **H** and the alternator **G** using the screws **L, F** onto the crankcase **M**.

4 - Follow operations **3, 4, 5, 6** and **7** of **Par. 6.2.2**.

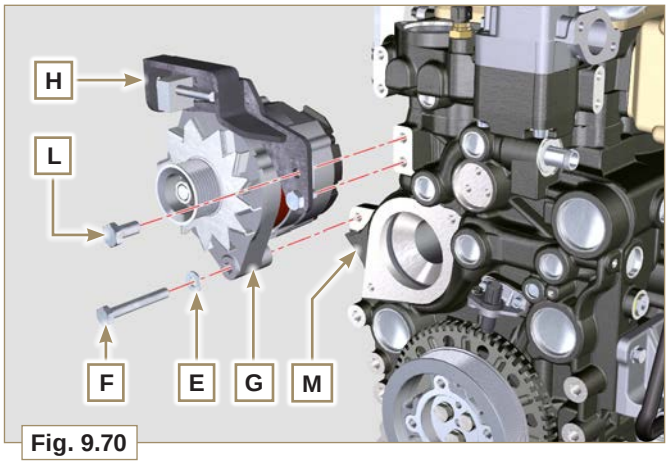


Fig. 9.70

9.13.3 Starter Motor

1 - Secure motor **N** by means of capscrews **P** (tightening torque at **45 Nm**).

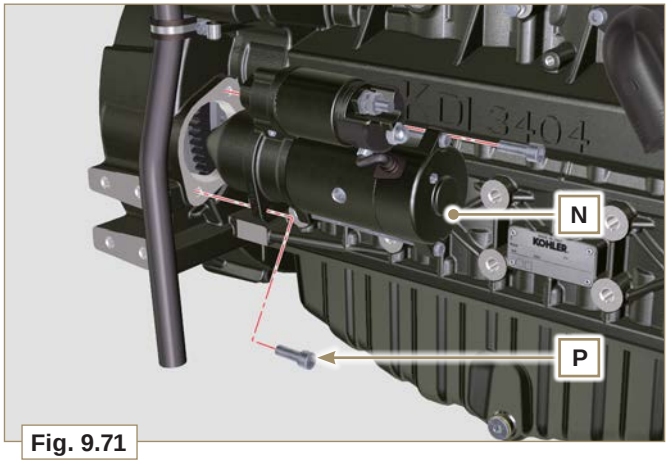


Fig. 9.71

9.14 Tightening torques and the use of sealants

Tab. 9.20 * *Alternatively to the capscrew replacements, with "Dri-loc"*

BASE CONFIGURATION			
SHORT BLOCK			
Component	Thread (mm)	Torque (Nm)	Sealer
Oil sprays fastening capscrew	M6x1	10	
Lower crankcase fastening capscrew	**M14x1.5**	**3 cycles**	
1st Cycle		60	
2nd Cycle		+45°	
3rd Cycle		+45°	
Lower crankcase fastening capscrew	**M10x1.25**	**30**	
Connecting rod screw	**M11x1**	**3 cycles**	
1st Cycle		28	
2nd Cycle		+30°	
3rd Cycle		+30°	
Coolant drain hole closing cap	M16x1.5	50	
Main oil delivery line closing plate	M6x1	15	
Intermediate idle gear cap fastening screw	M8x1	25	
Camshaft gear fastening screw	M10x1	100	DRI LOC 2040
OIL SUMP ASSEMBLY			
Component	Thread (mm)	Torque (Nm)	Sealer
Oil suction hose fastening capscrew	M6x1	10	Loctite 2701*
Oil return pipe fastening screw	M6x1	10	Loctite 2701*
Oil sump fastening capscrew	M8x1	25	
Oil drain cap	M18x1.5	30	
ENGINE CYLINDER HEAD ASSEMBLY			
Component	Thread (mm)	Torque (Nm)	Sealer
Air bleeding cap (Rev. 00)	M6x1	6	
Air bleeding cap (Rev. 01)	M14x1,5	50	
Lifting brace fastening capscrew	M8x1.25	80	
Injector manifold	M12x1	30	
Cylinder head fastening capscrew	**M12x1.25**	**4 cycles**	
1st Cycle		75	
2nd Cycle		+90°	
3rd Cycle		+90°	
4th Cycle		+90°	
Rocker arm gudgeon fastening capscrew	M8x1,25	40	
Rocker arm cover fastening capscrew	M6x1	10	
LUBRICATION CIRCUIT			
Component	Thread (mm)	Torque (Nm)	Sealer
Oil vapour separator support fastening capscrew	TG8	22	
Oil steam separator return tube drilled fastening screw (on crankcase)	M16x1.5		
Oil filter fastening union	M20x1.5	15	Loctite 2701*
Oil cooler fastening capscrew	M6x1	10	
Cartridge-holder cover	...	25	
Oil pump fastening screw	M6x1	10	
FLANGE ASSEMBLY (1ST PTO)			
Component	Thread (mm)	Torque (Nm)	Sealer
Flange bell fastening capscrew	M12x1,75	75	
Flywheel fastening capscrew	**M12x1,25**	**3 cycles**	
1st Cycle		60	
2nd Cycle		130	
3rd Cycle		130	

* *Alternatively to the capscrew replacements, with "Dri-loc"*

***** *Alternatively to the capscrew replacements, with "Dri-loc"***

INJECTION SYSTEM			
Component	Thread (mm)	Torque (Nm)	Sealer
Fuel filter fastening capscrew	M8x1.25	25	
Injector brace fastening capscrew	M8x1.25	20	
Injector side injection tube nuts	M12x1.5	25	
Injection pump side injection tubes nuts	M12x1.5	25	
Injection pump fastening capscrew	M8x1.25	25	Loctite 2701*
Gear fastening nut on fuel injection pump	M14x1.5	140	
Screw for cover over injection pump shaft nut (on bell housing)	M6x1	10	
INTAKE MANIFOLD			
Component	Thread (mm)	Torque (Nm)	Sealer
Manifold fastening screw	M8x1.25	25	
Intake flange fastening capscrew	M8x1.25	25	
CRANKSHAFT PULLEY ASSEMBLY (2ND PTO)			
Component	Thread (mm)	Torque (Nm)	Sealer
Crankshaft pulley fastening capscrew	M12x1.75	100	Molyslip
COOLANT CIRCUIT			
Component	Thread (mm)	Torque (Nm)	Sealer
Coolant tube clamp fastening capscrew (Oil Cooler return)	TG8	22	
Thermostatic valve cover fastening capscrew	M6x1	10	
Coolant pump fastening capscrew	M8x1.25	25	
Blower fastening capscrew	M8x1.25	25	
EXHAUST MANIFOLD			
Component	Thread (mm)	Torque (Nm)	Sealer
Exhaust manifold fastening screw	M10x1.5	50	
TURBO COMPRESSOR			
Component	Thread (mm)	Torque (Nm)	Sealer
Oil return tube fastening capscrew	M6x1	10	
Oil supply tube fastening capscrew	M10x1	15	
Turbine fastening stud (on manifold)	M10x1.5	30	
Exhaust fastening stud (on turbine)	M8x1.25	25	
Exhaust flange fastening stud (on turbine)	M10x1.5	30	
Exhaust flange fastening nut (on turbine)	M8x1.25	25	
ELECTRICAL COMPONENTS			
Component	Thread (mm)	Torque (Nm)	Sealer
Coolant temperature sensor	M12x1.5	20 max.	
Oil pressure switch	M12x1.5	35	
Alternator fastening capscrew	M10x1.5	45	
Alternator fastening capscrew	M8x1.25	25	
Alternator brace fastening screw	M12x1.75	75	
Starter motor fastening capscrew	M10x1.5	45	
Supply cable fastening nut (starter motor)	M10x1.5	15	

***** *Alternatively to the capscrew replacements, with "Dri-loc"***

***** *Alternatively to the capscrew replacements, with "Dri-loc"***

OPTIONAL COMPONENTS (CHAP. 11)			
HEATER			
Component	Thread (mm)	Torque (Nm)	Sealer
Flange intake with heater fastening capscrew	M8x1.25	25	
COOLING CIRCUIT			
Component	Thread (mm)	Torque (Nm)	Sealer
Blower fastening capscrew	M6x1	10	
Radiator support fastening capscrew (on crankcase)	M12x1.75		
Shroud radiator fastening capscrew	M6x1	10	
Radiator central brace fastening screw	M10x1.5		
Radiator on anti-vibrating	M8x1.25	25	
Vibration-damping nut fixing (on radiator support)	M8x1.25	25	
Anti-vibrating and brace fastening capscrew (upper)	M8x1.25	25	
Upper brace fastening capscrew (on engine cylinder head)	M8x1.25	25	
Side bulkheads fastening capscrew	M6x1	10	

***** *Alternatively to the capscrew replacements, with "Dri-loc"***

* ***Alternatively to the capscrew replacements, with "Dri-loc"***

10.1 Engine oil

Warning

- Before proceeding with operation, carefully read **Par. 3.3.2**.

1 - Loosen the oil filler cap **A**.

2 - Add the type and amount of oil recommended (**Tab. 2.2**).

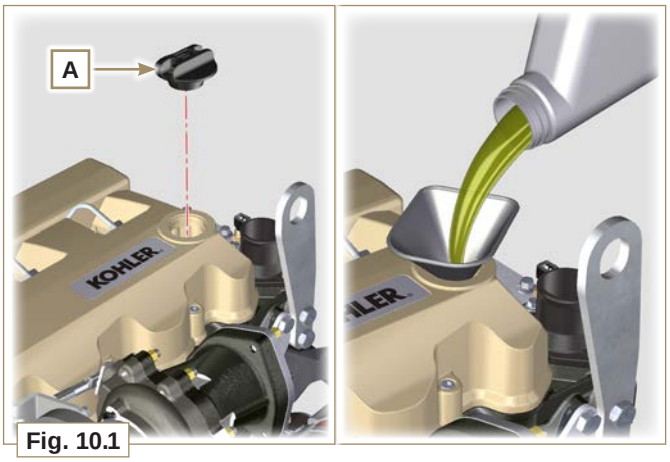


Fig. 10.1

3 - Remove the oil dipstick **B** and check that the level is up to but does not exceed the **MAX**.

Important

- Do not use the engine with the level of oil below **MIN** or above **MAX**.

4 - If the oil level is not at **MAX**, insert more oil until the **MAX** level is reached as indicated on the dipstick.

5 - Re-tighten the cap **A**.

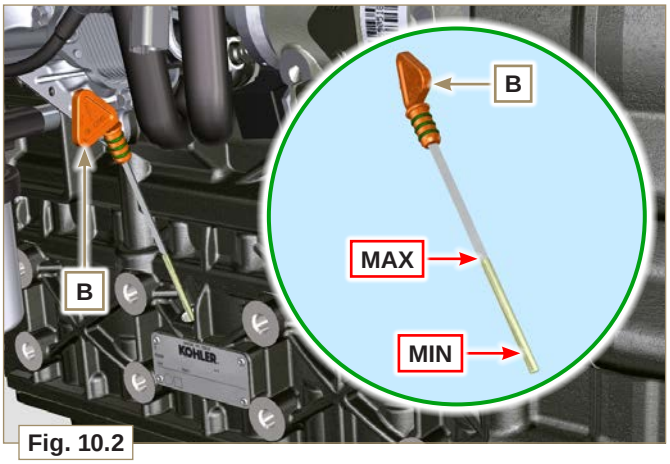


Fig. 10.2

10.2 Coolant

Warning

- Before proceeding with operation, carefully read **Par. 3.3.2**.

1 - Fit tube **A** onto radiator **B** and secure it with clamp **C**.

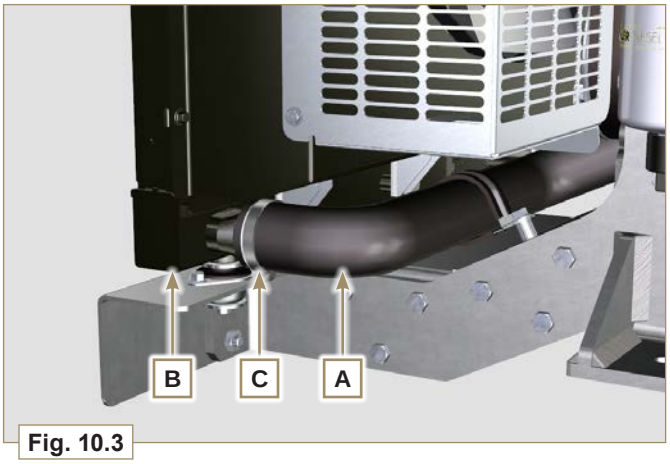


Fig. 10.3

2 - Refill the radiator with coolant (refer to **Par. 2.6** for the liquid specifications).

3 - Top liquid up until the pipes inside the radiator are covered by about 5 mm.

4 - For engines equipped with separate expansion tank, pour in fluid until reaching the max level mark.

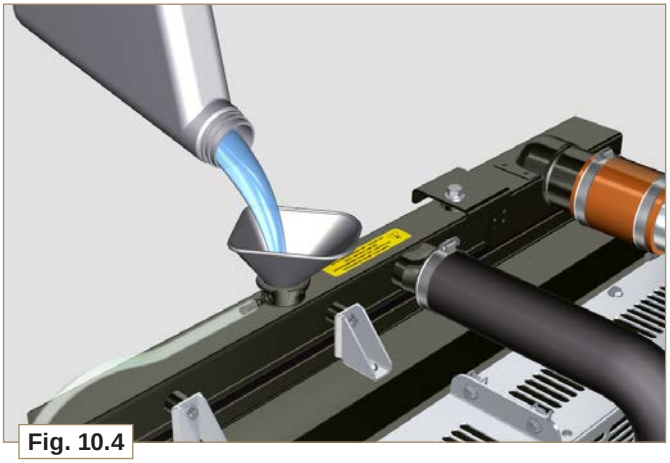


Fig. 10.4

5 - Loosen the screw **F** on the head **G**, release any air and tighten the screw (**Fig. 10.7**); Tightening torque:
- **8 Nm** for screw **M6 (Rev. 00)**;
- **30 Nm** for screw **M12 (Rev. 01)**.

6 - Start the engine without the radiator cap **D** or the expansion tank cap **B**.

7 - Keep the engine at idle speed or without a load until the cooling liquid level goes down and becomes steady (the waiting times varies according to the ambient temperature).

8 - Turn off the engine and allow it to cool.

9 - If there is an expansion tank top liquid up to the mark **MAX**.

10 - Without expansion tank top liquid up until the pipes inside the radiator are covered by 5 mm. Do not overfill the radiator, but leave room for the fuel to expand.

11 - Tighten the radiator cap **D** or the expansion tank cap **B**.

Warning

- Before starting make sure that the radiator cap and expansion tank cap, if present, are installed correctly to avoid loss of liquid or vapour at high temperatures.

12 - After a few hours of operation stop the engine and allow it to cool.
Check and top up the coolant liquid.

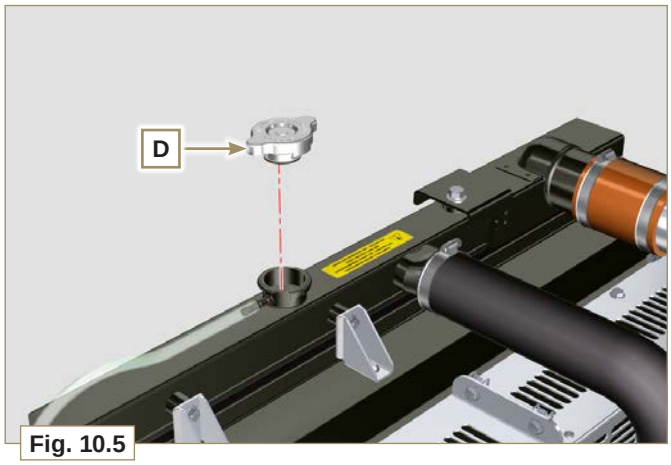


Fig. 10.5

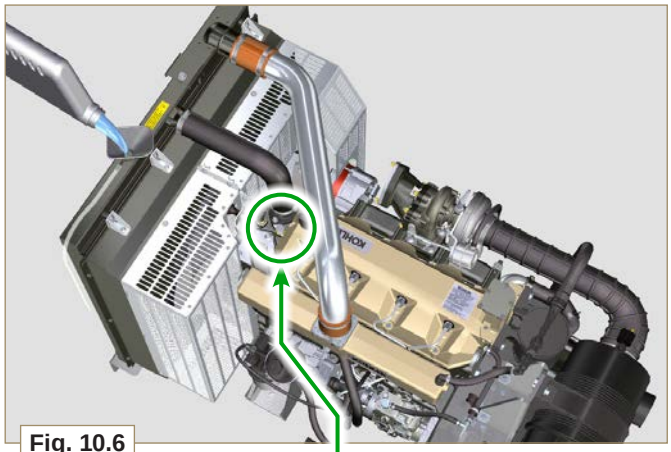


Fig. 10.6

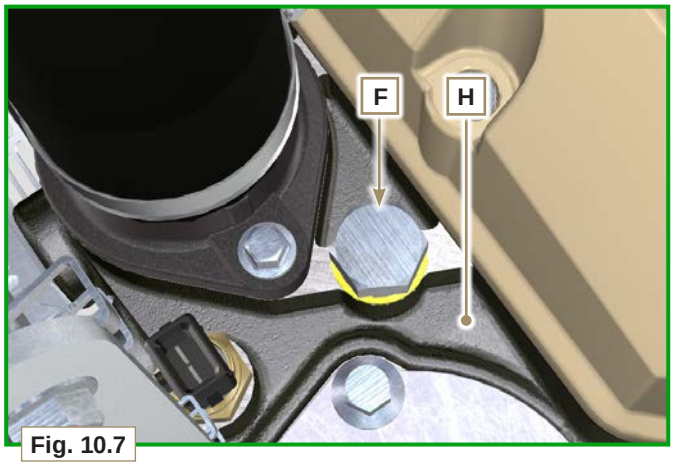


Fig. 10.7

11.1 Heater (replacement)

11.1.1 Disassembly

1 - Undo the screws **A** and the relevant washers.

2 - Remove the flange **C**.

3 - Remove the heater **E** and the relevant gaskets **F**.

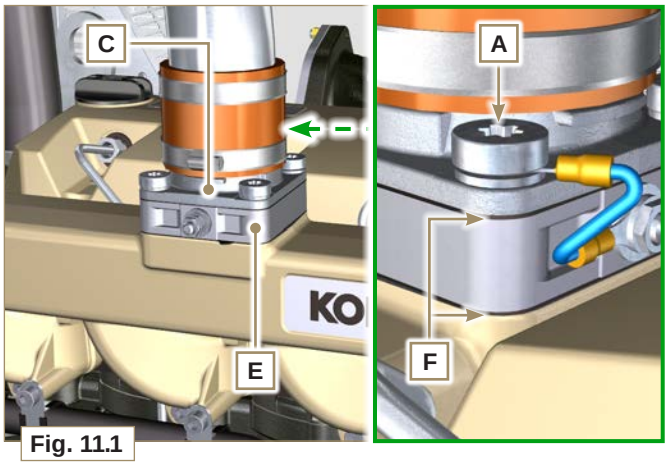


Fig. 11.1

11.1.2 Assembly

Important

• Always replace gaskets **F**, with each assembly.

1 - In sequence, fit the manifold **G** with the gasket **F**, the new heater **E**, the second gasket **F**, the flange **C**, the washers **H**, the cable **B** and the screws **A**.

2 - Secure the flange **C** with the screws **A** (tightening torque at **22Nm**).

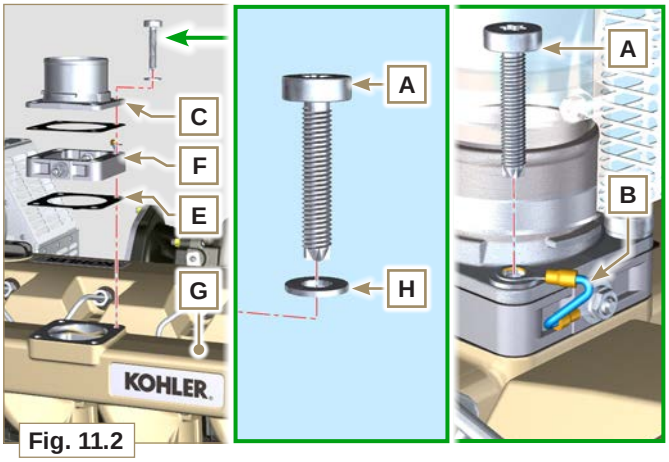


Fig. 11.2

11.2 Air filter (cartridge replacement)

1 - Release the two hooks **A** and remove the cover **B** from the body **C**.

2 - Remove the cartridges **D.**

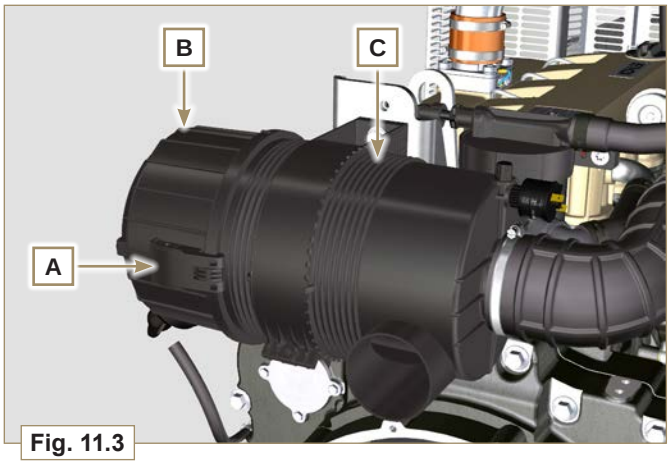


Fig. 11.3

3 - Insert the new cartridge **D** and both of them inside the filter body **C**.

4 - Secure the cover **B** via the hooks **A**.

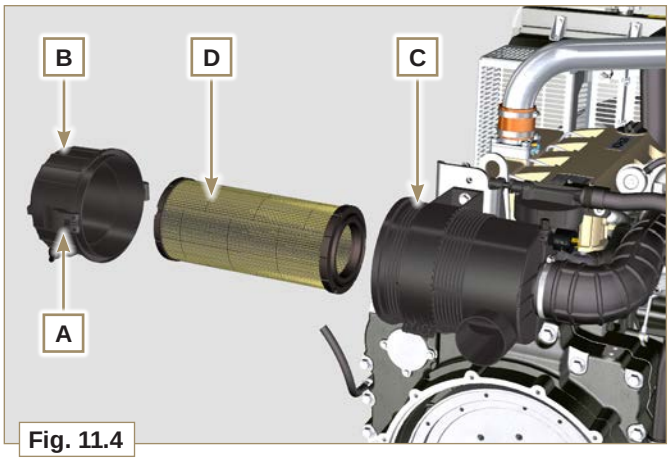


Fig. 11.4

11.3 Cooling circuit (replacement)

11.3.1 Radiator disassembly

1 - Release the clamp **A1, A2**.

2 - Disconnect hose **B** from radiator **C**.

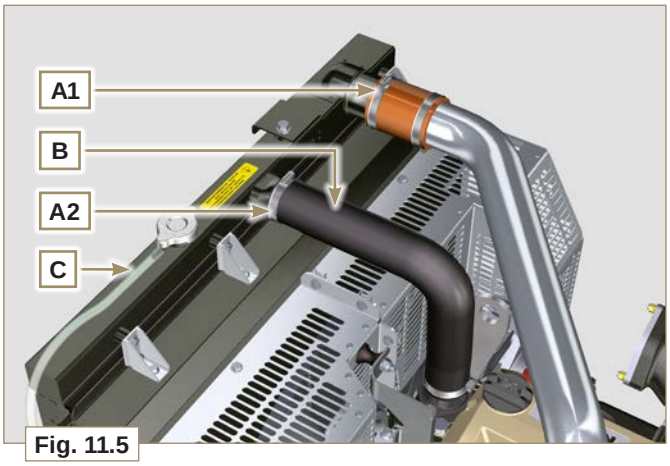


Fig. 11.5

3 - Release the clamp **A3, A4**.

4 - Disconnect hose **D** from radiator **C.**

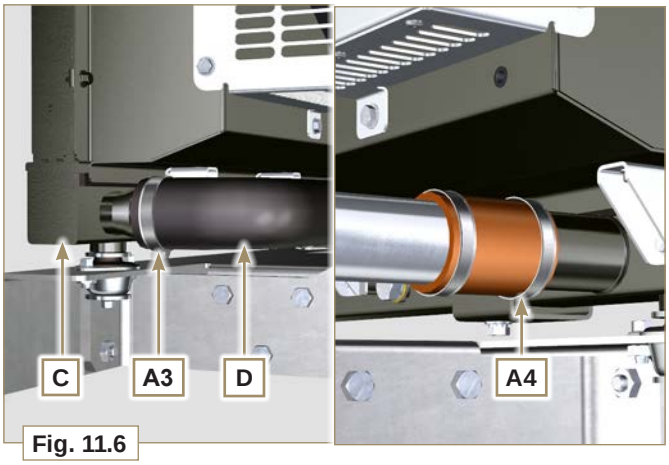


Fig. 11.6

5 - Loosen all capscrews **E1**, **E2** and **E3**.

6 - Release nut **F**.

7 - Remove floodgates **G1** and **G2**.

8 - Loosen capscrews **K**.

9 - Disconnect radiator **C** from hoses **H1** and **H2**, being careful not to deform tubes **J1** and **J2**.

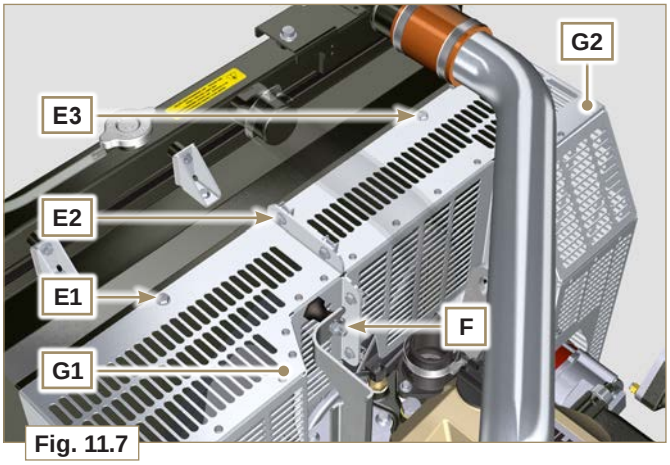


Fig. 11.7

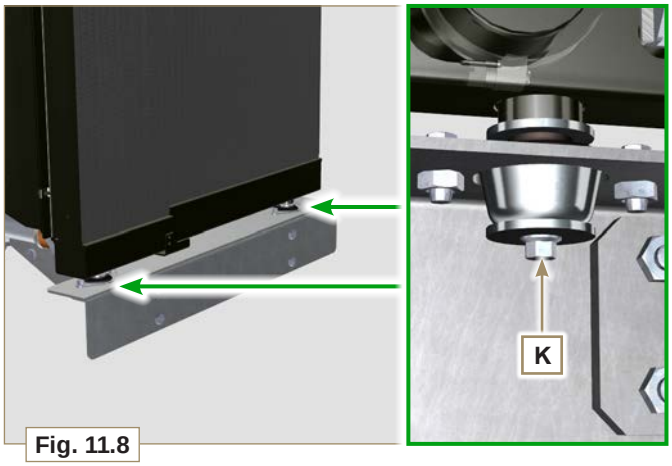


Fig. 11.8

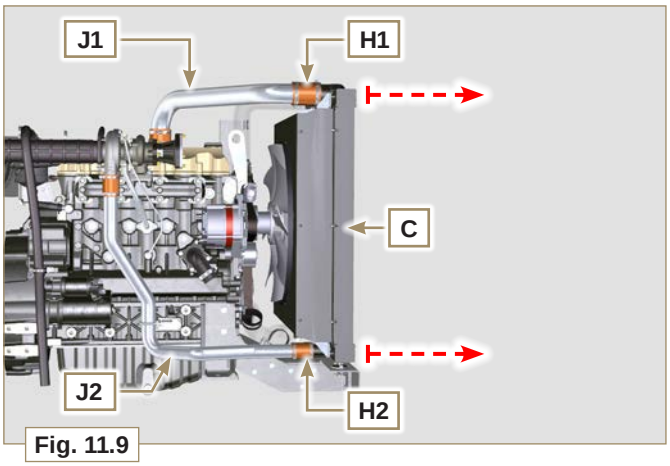


Fig. 11.9

11.3.2 Fan disassembly

1 - Undo the screws **P** and remove the fan **R**.

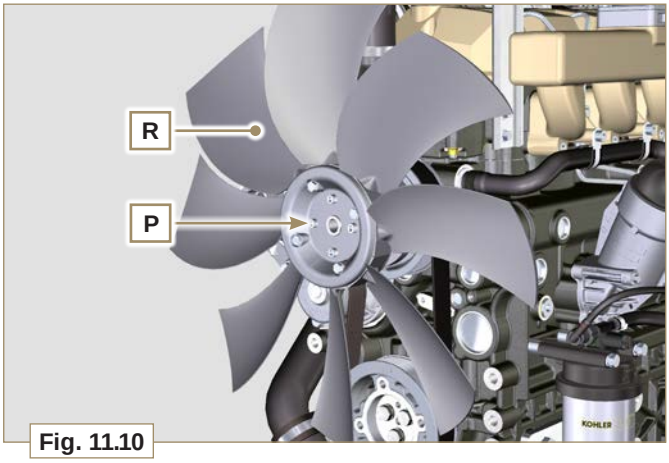


Fig. 11.10

11.3.3 Fan assembly

1 - Assemble the fan **R** on the pulley **U.**

2 - Fasten the fan **R** by using the screws **P** (tightening torque at **10 Nm**).

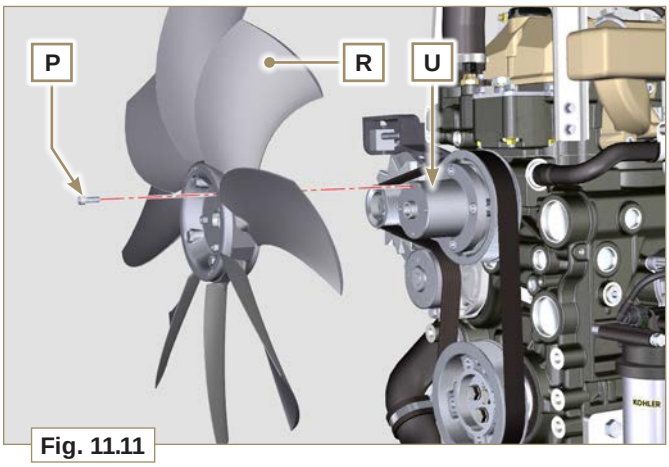


Fig. 11.11

11.3.4 Radiator assembly

1 - Fit radiator **C** onto hose **H2**, being careful not to deform tube **J2**.

2 - Centre radiator **C** onto vibration-dampening devices **V**.

3 - Secure radiator **C** onto vibration-dampening devices **V** by means of capscrews K (tightening torque at **25 Nm**).

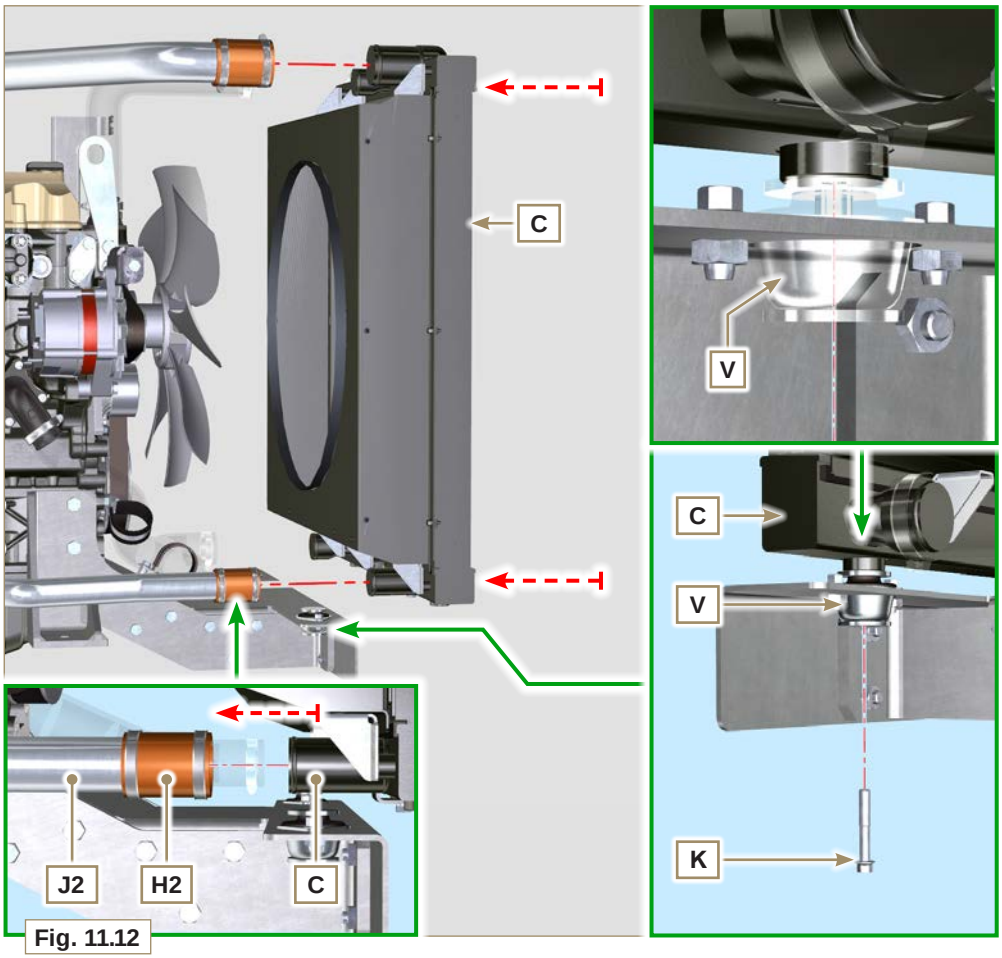


Fig. 11.12

4 - Position floodgate **G1** onto radiator **C**.

5 - Secure all capscrews **E1**.

6 - Place floodgate **G2** onto radiator **C**.

7 - Secure all capscrews **E3** and **E2**.

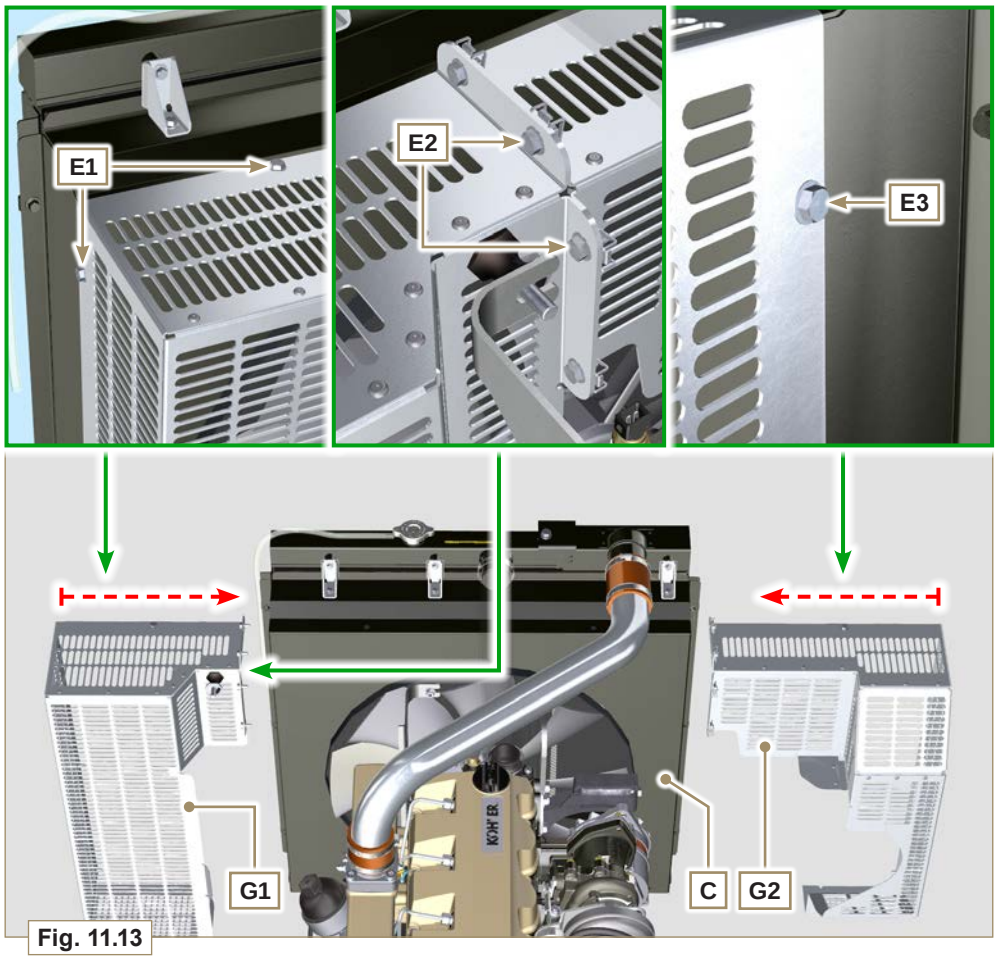


Fig. 11.13

8 - Fit hose **H1** onto radiator **C**, being careful not to deform tube **J1**.

NOTE: Make sure vibration-dampening device **V2** is correctly installed in its place on brace **S**.

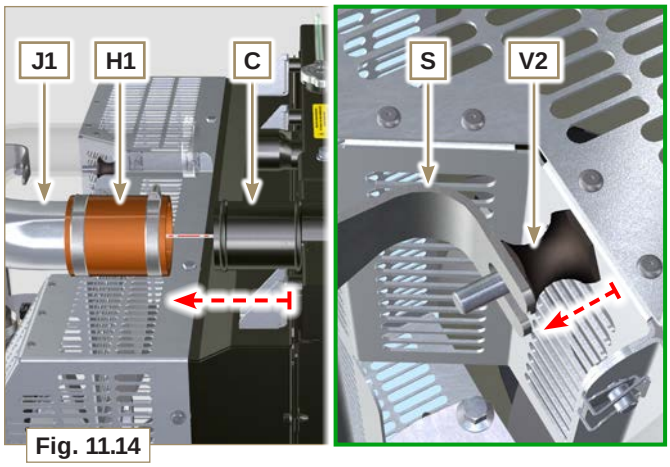


Fig. 11.14

9 - Secure vibration-dampening device **V2** onto brace **S** by means of nut **F**, inserting washer **F1** (tightening torque at **25 Nm**).

10 - Secure hoses **B** and **D** by means of clamps **A2** and **A3** (**Fig. 11.5 - 11.6**).

11 - Secure hoses **H1** and **H2** by means of clamps **A1** and **A4** (**Fig. 11.5 - 11.6**).

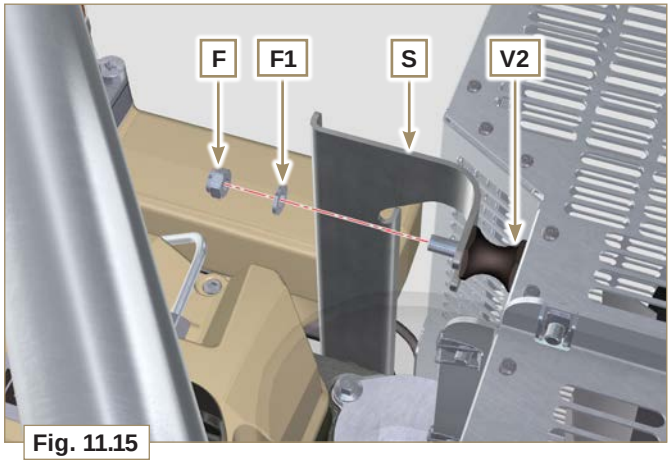


Fig. 11.15

Warning

- Before proceeding with operation, carefully read **Par. 3.3.2**.

12.1 Waste Gate opening valve regulation

Important

- Regulation must not be carried out with the engine running. During the procedure in **point 5**, pay special attention not to bend rod **H**.

1 - Disconnect the hose **A** from the turbocharger.

2 - Connect a pressure reducer **C** to the network of compressed air.
The air pressure in the network must be set to 2.0 bar.

3 - Position dial gauge **D** in such a way that feeler **F** rests on the Waste Gate rod control valve extremity **H** (point **E**).

4 - By using reduction gear C send air to the Waste Gate actuator control L in order to move rod H forward by **1 mm** (value **M** to check on dial gauge D **D**). Pressure read on reduction gear **C** must be: **2500 mbar**.

5 - If pressure is less or more than the indicated value, proceed as follows:
- Undo lock nut **G** from rod **H**.
- Remove the retainer cotter pin (point **E**) and disconnect rod **H** from the Waste Gate control lever.
- Tighten to increase or loosen to decrease (the pressure) of the ring nut of rod **H** until reaching the corrected calibration.
- Redo lock nut **G**.
- Reconnect rod H and assemble the cotter pin point **E**.

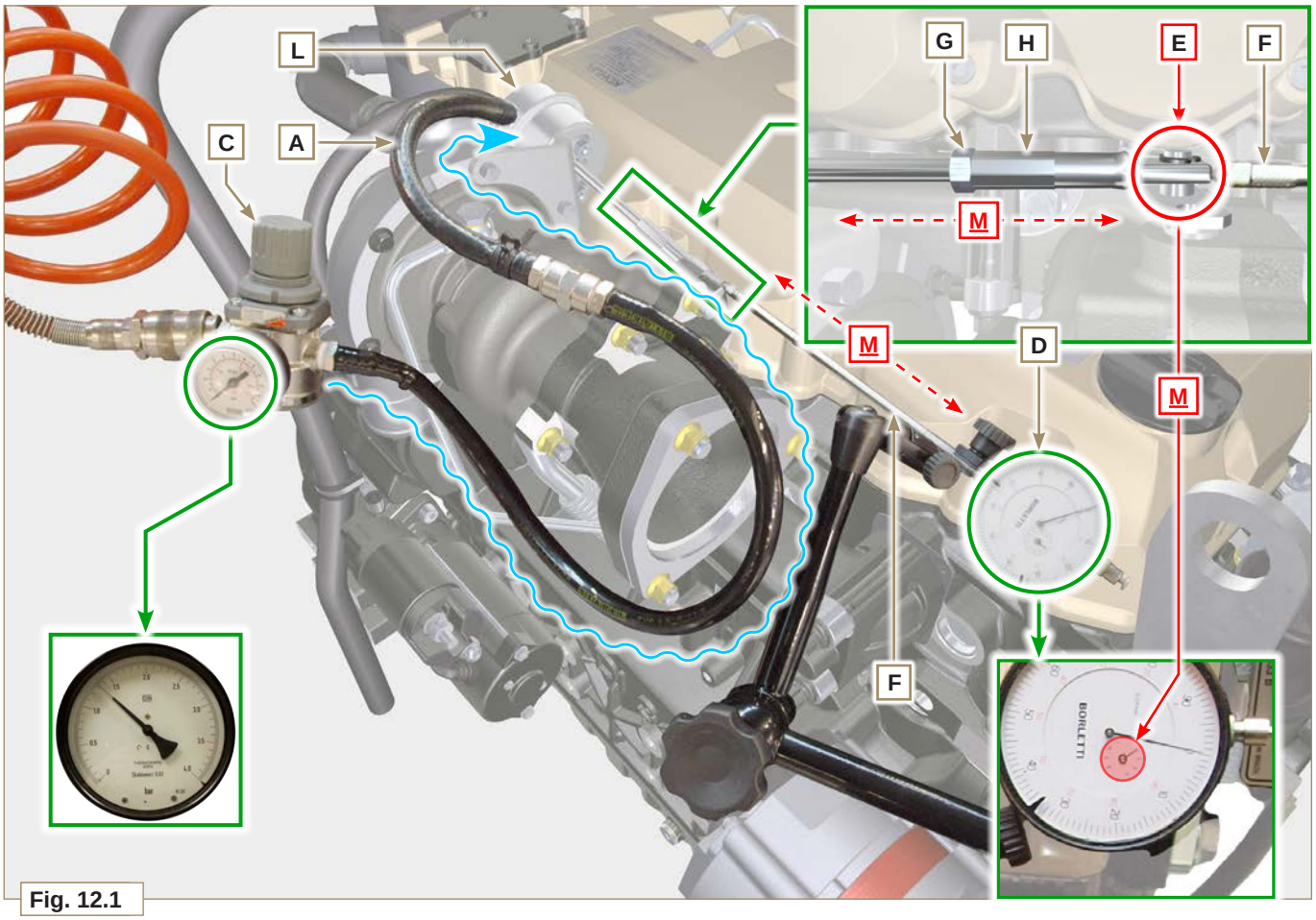


Fig. 12.1

12.2 Air filter check

1 - Hose **A** must be completely clean and not damaged.

2 - Air filter cartridge **B** and its housing **C** must be completely clean and free from impurities.

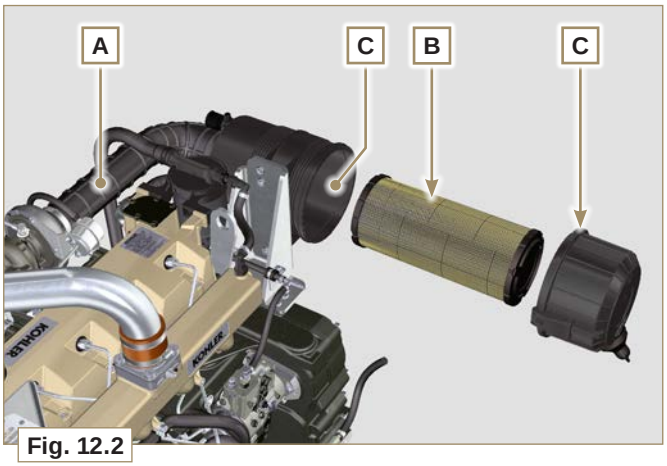


Fig. 12.2

12.3 Oil steam separator check

1 - Loosen clamp **B** and remove hose **C** from separator **A**.

2 - Remove rapid fitting **D** from separator **A**.

3 - Start the engine at idle speed or without a load and check if air comes out from unions **A1** and **A2**.

NOTE: If what is described in **Point 3** does not occur, proceed with cleaning or replacing oil separator **A** and all connecting hoses. Repeat the operation from **point 3**.

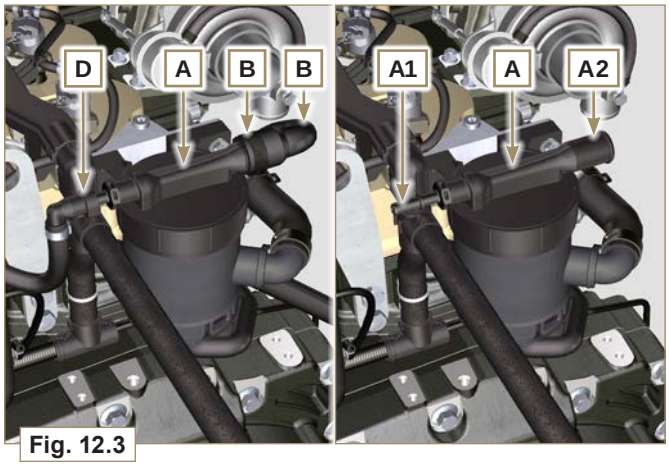


Fig. 12.3

12.4 Rubber hoses and manifolds check

The check is carried out by applying slight deflection or bending along the tube/hose and next to the hose clamps.

Components must be replaced if they have clear signs of cracks, tears, cuts, leaks, or do not retain a certain degree of elasticity.

1 - Check the condition of all hoses and rubber tubes highlighted in red in **Fig. 12.4 - 12.5**.

2 - Check whether there are any leakages of air, coolant, oil or fuel next to their connections.

NOTE: Refer to the technical documentation of the machine for components that are not shown in the figure.

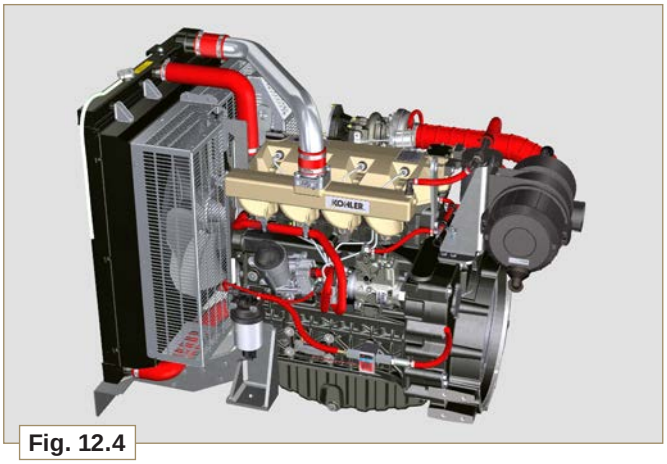


Fig. 12.4

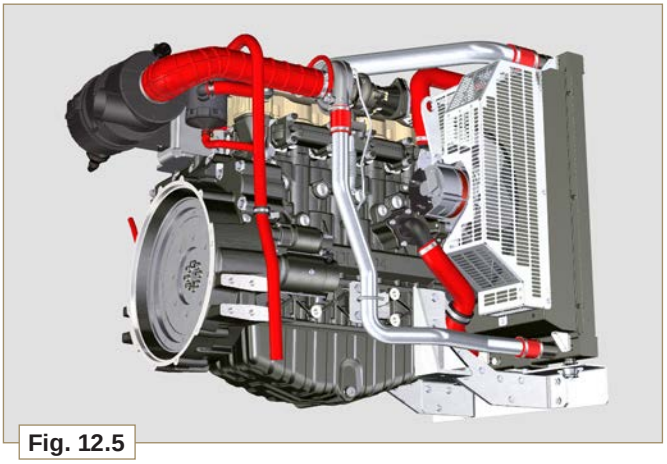


Fig. 12.5

12.5 Oil leak check

Check that there are no leakages next to area **A**.

1 - Start the engine at idle speed or without a load and check whether there are any leakages next to area **A**.

2 - It is anyhow necessary to also check the seals of all main components and their surface contact, such as:
- crankcase and gasket (side 2a PTO)
- oil sump and exhaust caps
- cylinder head and its assembled components
- rocker arm cover
- flange and gasket (side 1ª PTO)
- oil dipstick housing or rod support tube.

NOTE: Perform the checks described in **Points 1 and 2** periodically and during maintenance procedures. It is also necessary to check for leakages on the components that are not listed.

If necessary, disassemble the components that have a leakage and investigate the possible cause.
The components must be replaced otherwise they do not guarantee their sealing.

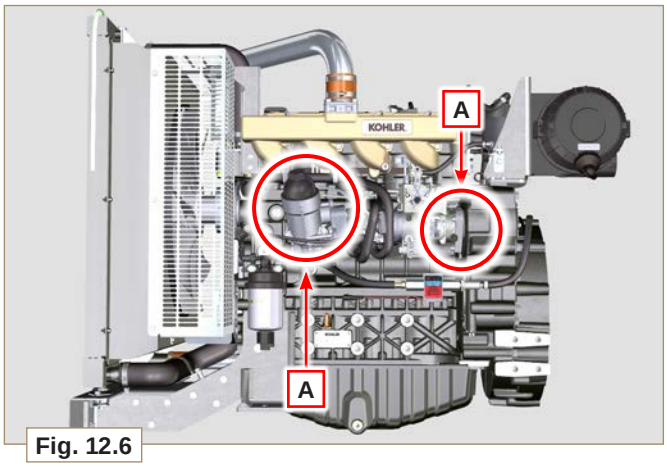


Fig. 12.6

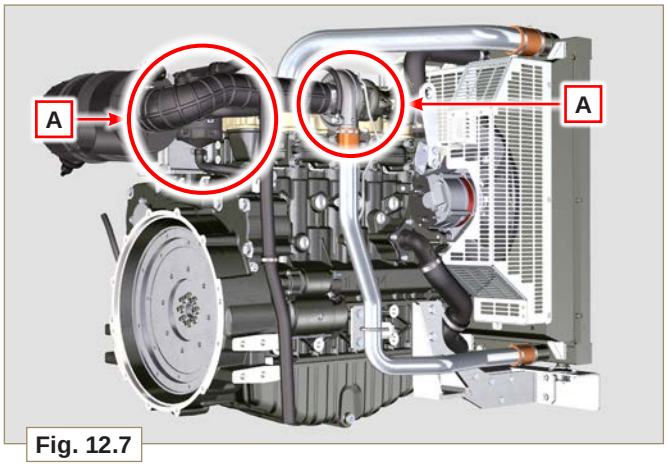


Fig. 12.7

12.6 Oil pressure check

1 - Replace the oil dipstick **A** with a thermocouple **B (Fig. 12.8).**

2 - Unscrew and remove the oil pressure switch **C** and screw on a 10 bar pressure gauge in its seat (**Fig. 12.10**).

3 - Start the engine at idle speed and without a load, check the oil pressure value according to the oil temperature (**Fig. 12.9**).

NOTE: The graph in **Fig. 12.9** illustrates the pressure line with speed of 1000 Rpm.

4 - If the pressure values are below the values indicated in **Fig. 12.9**, check to identify the cause of the problem.

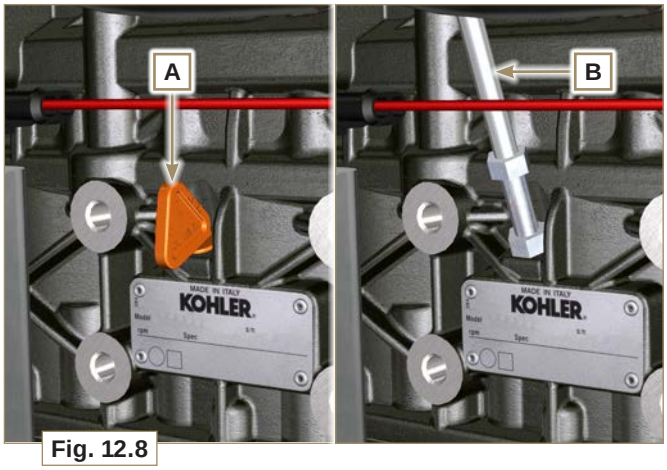


Fig. 12.8

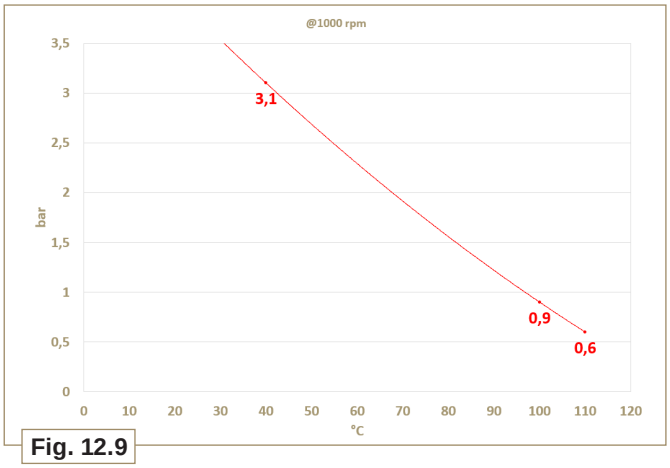


Fig. 12.9

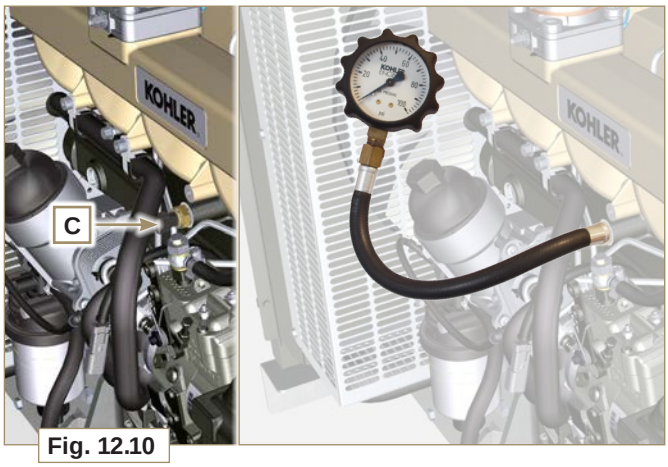


Fig. 12.10

13.1 Information regarding specific tools

For reference check the specific tools manual, cod. ED0053030770-S, to be found at:

http://iservice.lombardini.it

14.1 Possible causes and trouble shooting

IMMEDIATELY STOP THE ENGINE WHEN:

1 - Engine rpm increases and decreases suddenly without being able to control them;
2 - A sudden and unusual noise is heard;
3 - The colour of the exhaust fumes suddenly darkens or turns white;
4 - The oil pressure warning light or a Warning Lamp turns on during operation;
5 - The coolant temperature warning light turns on during operation.

Tab. 14.1 contains the possible causes of some failures, which may occur during operation.

Always perform these simple checks before removing or replacing any part.

Warning

- Search for a topic and the operations to carry out from the analytical index or chapter index found at the beginning of the manual.
- Do not carry out any checks or operations on the engine when it is running.

POSSIBLE ANOMALIES ACCORDING TO THEIR SYMPTOMS

POSSIBLE CAUSE		TROUBLES													
		Engine does not start	It starts and stops	No acceleration	Variable speed	Black smoke	White smoke	Low oil pressure	Oil level increase	Excessive oil consumption	Oil and fuel leaking out from the exhaust	Engine overheats	Inadequate performance	High noise level	The Warning Lamp switches on
FUEL CIRCUIT	Clogged fuel line	■	■	■	■		■						■		
	Clogged fuel filter	■	■	■	■		■						■		
	Air or water in the fuel system	■	■	■	■		■						■	■	
	The fuel tank cap air bleeding hole is clogged	■	■	■	■								■		
	Faulty fuel feeding pump	■													■
	No fuel	■	■												
ELECTRIC SYSTEM	Cable connection uncertain or incorrect	■													
	Faulty starting motor	■													
	Defective heater (optional)	■					■								
MAINTE-NANCE	Clogged air filter	■	■	■	■	■				■			■		
	Excessive idle operation						■			■	■				
	Incomplete run-in						■			■			■		
SETTINGS REPAIRS	Rings worn or sticking	■					■			■	■	■	■		
	Worn cylinder	■					■			■	■	■	■		
	Worn out valve guides						■			■	■	■			
	Badly sealed intake valve	■				■					■	■	■		
	Crankshaft/Connecting rod bearings worn out							■					■	■	
	Damaged cylinder head gasket	■			■		■		■	■		■	■		
	Defective timing system	■			■		■					■	■	■	

POSSIBLE CAUSE		TROUBLES													
		Engine does not start	Engine starts but stops	No acceleration	Variable speed	Black smoke	White smoke	Low oil pressure	Oil level increase	Excessive oil consumption	Oil and fuel leaking out from the exhaust	Engine overheats	Inadequate performance	High noise level	The Warning Lamp switches on
LUBRICATION CIRCUIT	Oil level too high						■			■	■	■	■	■	
	Oil level low							■				■	■		
	Dirty or blocked pressure regulating valve							■							
	Worn oil pump							■							
	Air in the oil suction pipe							■							
	Oil suction hose clogged							■							
	Oil steam exhaust pipe clogged													■	
INJECTION	Damaged electronic injectors	■		■		■	■		■		■	■	■	■	
	Damaged injection pump	■		■									■		
	Wrong injector IMA codes				■	■	■						■	■	
COOLING CIRCUIT	Insufficient coolant											■			
	Defective fan, radiator, or radiator cap											■			
	Blockage inside the radiator or the coolant ducts											■			
	Heat exchange surface of the radiator clogged											■			
	Defective thermostatic valve											■			
	Coolant leaking from the radiator, manifolds, crankcase or from the coolant pump											■			
	Defective or worn coolant pump											■			

A	**Air gap:**	Distance to respect between a fixed component and one in movement.
	Alternator:	A component that transforms mechanical energy into AC electrical energy.
	Authorised service station:	KOHLER authorised workshop.
	Authorised workshop:	Kohler authorised service centre.
	Base configuration:	Engine having components represented in Para. 1.4 - 1.5.
	BDC:	Bottom Dead Centre; a moment in which the piston is at the start of its stroke.
	Bore:	Internal diameter of the cylinder in combustion engines.
C	**Cold Start Advance:**	the device provides for advance injection modification to enable advance of the engine at low temperatures.
	Combustion:	Chemical reaction of a mixture composed of fuel and fuel (air) inside a combustion chamber.
	Crankshaft:	A component that transforms straight operation into rotary operation, and vice-versa.
E	**EC:**	European Community.
F	**Fig.:**	Figure.
	Functional units:	Component, or group of main components, able to carry out specific functions on the engine.
G	**Galvanised:**	Material that has undergone surface protection treatment.
	Grinding (valves and seats):	Cleaning operation of the valves and seats carried out with an abrasive paste (refer to an authorised service station for this type of operation).
H	**Heater:**	A device that heats the intake air by means of an electrical resistor.
	Heavy conditions:	Type of extreme condition referred to the work environment in which the engine is used (very dusty - dirty area, or in a contaminated environment due to various types of gas).
I	**Idle speed operation:**	Operation of a running engine with the vehicle stopped and on idle speed.
K	**KDI:**	Kohler Direct Injection
M	**Maintenance - periodic:**	A group of maintenance actions that have the sole objective to control and replace elements on their expiry, without modifying or improving the functions carried out by the system, neither increasing the value nor improving performance.
	MAX:	Maximum.
	Methyl ester	It is a mixture of products by means of a chemical conversion of oils and animal and/or vegetable fat, which is used to produce Biofuel.
	Min.:	Minutes.
	MIN:	Minimum.
	Model:	Model, engine identification plate, which indicates the engine's model.
N	**N/C:**	Normally Closed, referred to switches (oil-pressure switch).
	N/O:	Normally Opened, referred to switches (Coolant temperature sensor)
O	**Oil Cooler:**	Small radiator used to cool the oil.

P	**Par.:**	Paragraph.
	Paraffin:	Fatty and solid substance that may form inside the diesel.
	Pipe cleaner:	An instrument having a metal cylindrical body with bristles that jut outwards. It is similar to a brush and is used to clean areas that are not easily accessible manually (e.g. oil ducts inside an engine).
	Power operation:	Operation of the engine at high speeds.
	PTO:	Power Take Off - a point provided to take advantage of alternative operation transmission.
R	**Ref.:**	Reference.
	Rpm:	Rounds per minute.
S	**s/n:**	Serial number (engine identification name plate) indicating the engine identification series/chassis number.
	Spec.:	Specification, (engine identification name plate) indicating the engine version.
	STD:	(Standard), base configuration of a component, or a group of components.
T	**Tab.:**	Table.
	TDC:	Top Dead Centre; a moment in which the piston is at the end of its stroke.
	Thermostatic valve:	A valve that adjusts the flow of coolant liquid; it is able to operate by means of temperature variation.
	Tightening torque:	A term indicated for installation of threaded components and which is determined by means of a unit of measurement Nm.
	Torque:	Force applied to an object that rotates on an idler shaft.
	Trochoid:	Rounded toothed profile (also known as "lobes").
U	**Used oil:**	Oil altered by operation or time, which is no longer compliant for correct lubrication of the components.
W	**Warning Lamp:**	A warning light (usually red) that indicates a serious anomaly during engine operation.
	Waste-Gate valve:	A device, which is directly or automatically controlled, used to limit the pressure of exhaust gas inside the turbine.

Tab. 15.1

SYMBOLS AND UNITS OF MEASUREMENT

SYMBOL	UNIT OF MEASUREMENT	DESCRIPTION	EXAMPLE
α	degree	Rotation/inclination angle	1°
cm^2	square centimetre	Area	1 cm^2
Ø	millimetre	Circumference	Ø 1 mm
Nm	newton-metre	Torque	1 Nm
mm	millimetre	Dimension	1 mm
µm	1/1000 of a millimetre (micron)		1 µm
h	hour	Quantity	1 h
g/kWh	grammes per kilowatt per hour		1 g/kWh
kg/h	kilogramme per hour		1 kg/h
L/min.	litres per minute		1 L/min.
L/h	litres per hour		1 L/h
ppm	parts per million		1 ppm
N	newton	Force	1 N
A	Ampere	Intensity of electrical current	1 A
gr.	gramme	Weight	1 gr.
kg	kilogramme		1 kg
W	Watt	Power	1 W
kW	kiloWatt		1 kW
pa	pascal	Pressure	1 pa
KPa	Kilopascal		1 KPa
bar	barometric pressure		1 bar
mbar (1/1000 bar)	barometric pressure		1 mbar
R	Resistance	Resistance to electrical current (referred to a component)	1 Ω
Ω	ohm	Resistance of electrical current	1 Ω
Rpm	revs per minute	Rotation of an axis	1 Rpm
Ra	average roughness expressed in microns	Roughness	Ra = 1
°C	degree centigrade	Temperature	1°C
V	Volt	Electrical voltage	1 V
⬢	millimetre	Hex-head capscrew	⬢ 1 mm
cm^3	cubic centimetre	Volume	1 cm^3
L	litre		1 L

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