C13 ENT M83.10

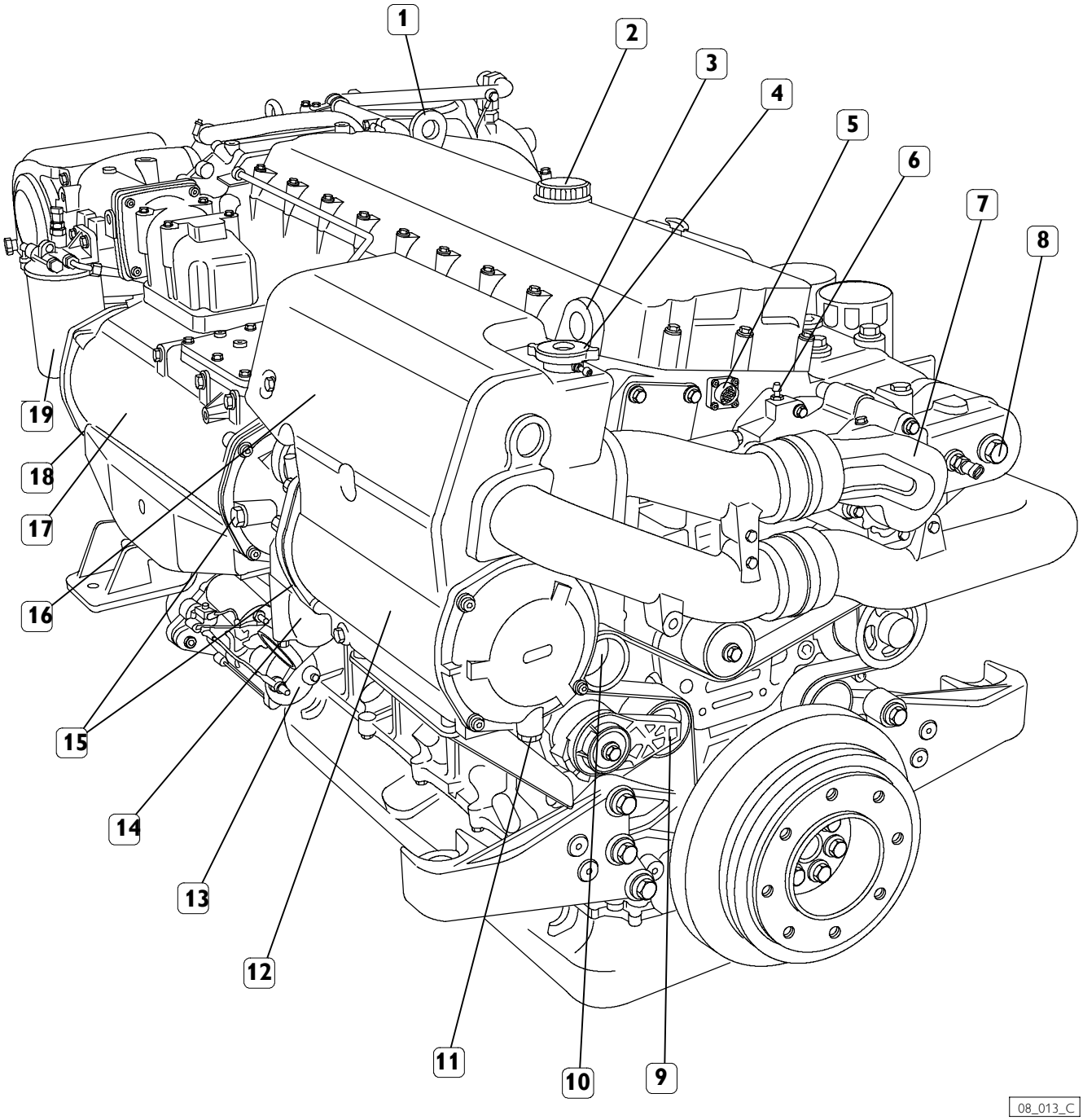
TECHNICAL AND REPAIR MANUAL

SEPTEMBER 2010 EDITION

FPT
POWERTRAIN TECHNOLOGIES

ENGINE PARTS AND COMPONENTS

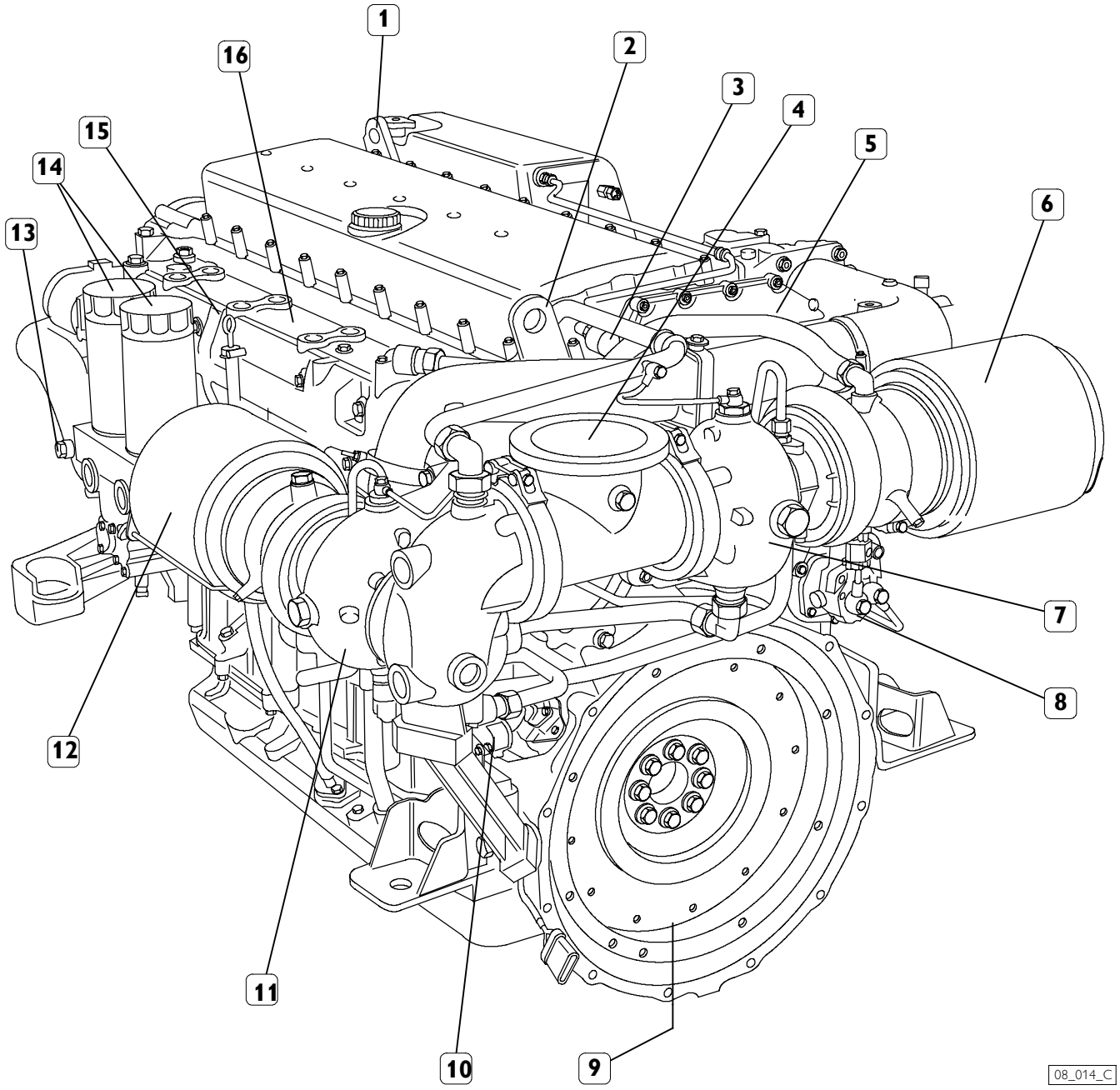
Figure 3



1. Lifting padeye - 2. Lubricating oil refill cap - 3. Lifting padeye - 4. Coolant refill cap - 5. Injector solenoid valve connector - 6. Fuel loop purge fitting - 7. Location of thermostatic valve - 8. Cap for engine coolant outlet to sanitary water heating system - 9. Auxiliary belt automatic tensioner - 10. Alternator location - 11. Sacrificial anode and cap for engine coolant discharge. - 12. Coolant-sea water tube bundle heat exchanger - 13. Electrical starter motor - 14. Sea water pump - 15. Sacrificial anode - 16. Engine coolant tank - 17. Air-sea water heat exchanger - 18. Sacrificial anode - 19. Fuel filter.

ENGINE PARTS AND COMPONENTS

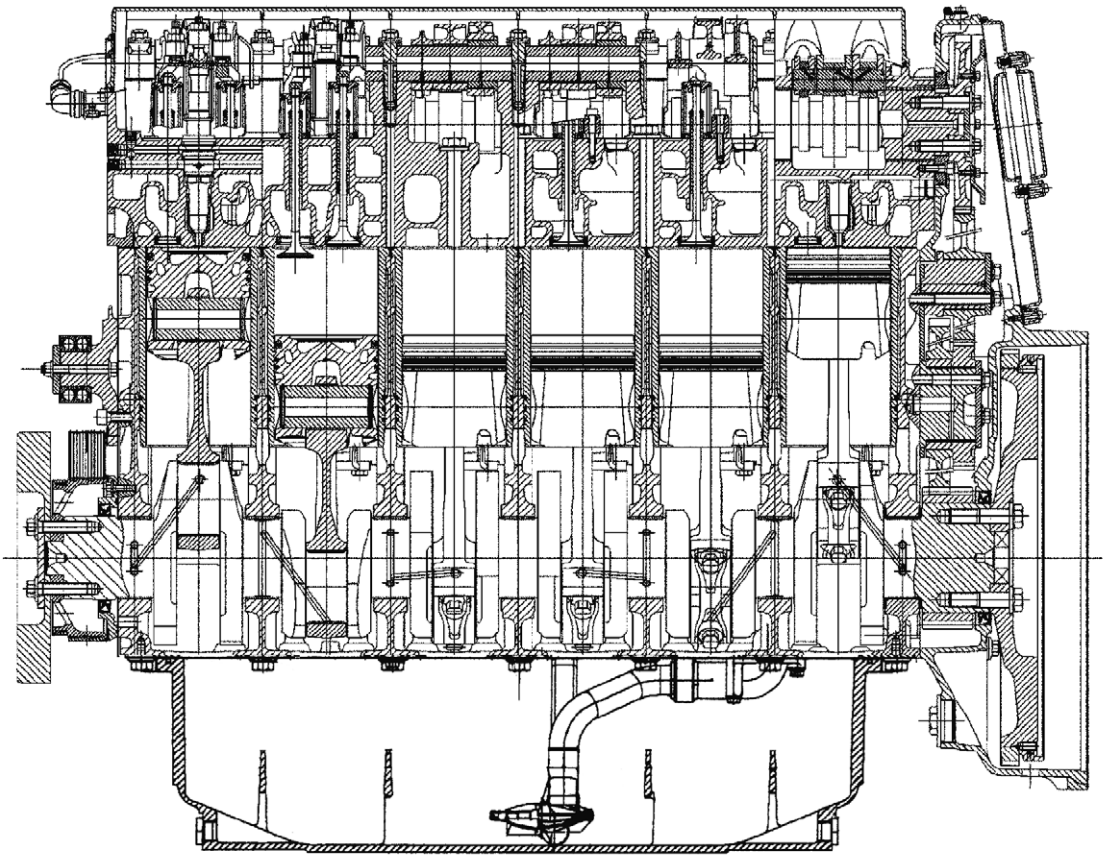
Figure 4



1. Lifting padeye - 2. Lifting padeye - 3. Oil filter clogging indicator - 4. Exhaust gas outlet flange - 5. Timing mechanism and oil vapor filter cover - 6. Intake air filter (A) - 7. Cooled turbo-charger (A) - 8. Fuel transfer pump - 9. phase inspection port - 10. Throttle position sensor potentiometer - 11. Cooled turbo-charger (B) - 12. Intake air filter (B) - 13. Cap for engine coolant discharge and recyrculation from sanitary water heating system - 14. Lubricating oil filters - 15. Lubricating oil dipstick - 16. Cooled exhaust manifold.

ENGINE ARCHITECTURE

Figure 5



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With the CURSOR series engines, FPT has reached unequalled standards in power delivery for industrial, marine, and automotive uses; CURSOR engines are the result of a continuous research process aimed at product improvement, and they inherit no elements of previous propulsion units. They adopt the most rational and effective solutions to achieve, with smaller displacement engines, power outputs that are typical of larger, heavier engines.

The architecture of these engines is characterized by six cylinders in line, four valves per cylinder and roller rocker arms with overhead cam shaft and "bonded" block.

Electronic control extended to all functions ensures reliable and durable operation, offering important benefits in terms of performance and usage.

FPT's contribution to environmental protection is amply demonstrated by the CURSOR engines' environmental performance: fumes and noise are well below current regulatory requirements and compliance with future limits was the target of the whole design effort.

The 24 valve cylinder head with its camshaft with seven supports, incorporates the intake manifold and the conduits for the cooling and lubrication fluids, as well as for fuel supply.

The overhead camshaft with roller rocker arms directly activates both the valves and the EUI (Electrical Unit Injector).

Figure 6

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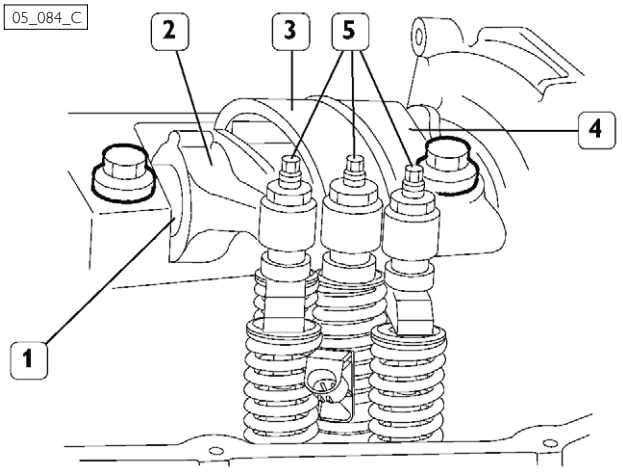
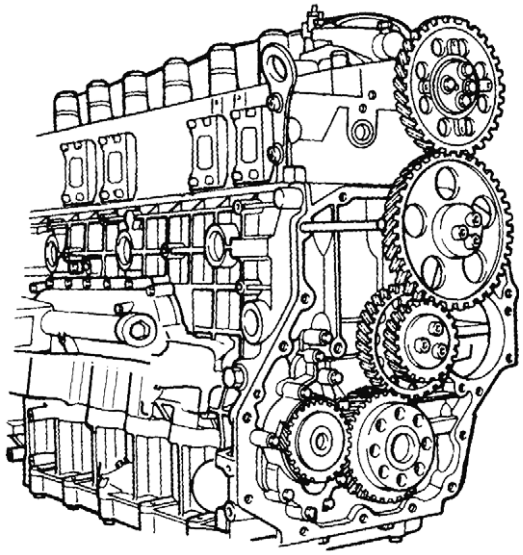


1. Rocker arm shaft - 2. Intake valve rocker arm - 3. Pump injector rocker arm - 4. Exhaust valve rocker arm - 5. Calibration screw.

Figure 7



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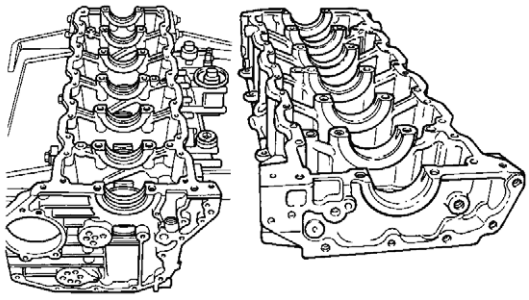
Timing control is to the rear to reduce torsional effects and it is built with helical tooth gears to contain noise.

Figure 8



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Block and sub-block constitute a rigid assembly to reduce vibration and noise and secure the drive shaft with seven shaft supports. Aluminum pistons provide effective heat dissipation.

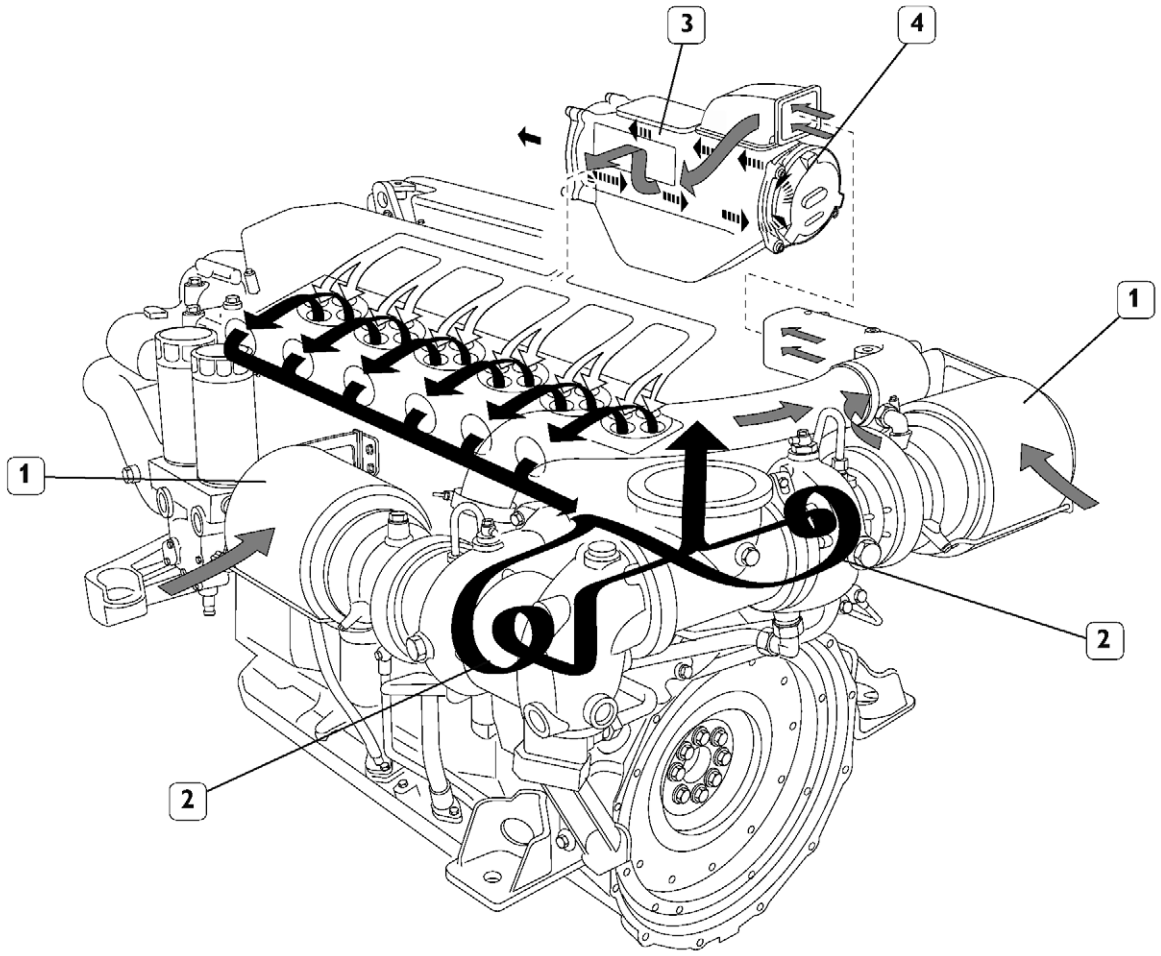
Pump injectors are mounted at the center of the combustion chamber and provide the highest possible thermodynamic efficiency thanks to an injection that is able to reach pressures that exceed 1800 bar. Electrically driven by the electronic control, they deliver fuel at a time that minimizes fuel consumption and contains gas emissions, while maximizing torque and power output.

The EDC, Electronic-Diesel-Control system, constantly monitors environmental and engine operating conditions, providing an optimized injection control to maximize performance at all times. Even when operating in critical conditions, control is optimized. This permits navigation and operation to continue in complete safety.

The electronic unit's control over the entire engine's efficiency provides information about the engine's global performance and other, specific, information for each cylinder, thereby making servicing operations easy; associated with the testing of the working condition of the injection system's electrical and electronic components, it stores information about the most significant events that occur during the engine's operation and allows maintenance personnel to anticipate the onset of faults and resolve them.

COMBUSTION AIR INTAKE AND EXHAUST SYSTEM

Figure 9



1. Air filters - 2.Turbocompressors - 3. Air/sea water heat exchanger - 4. Sea water.

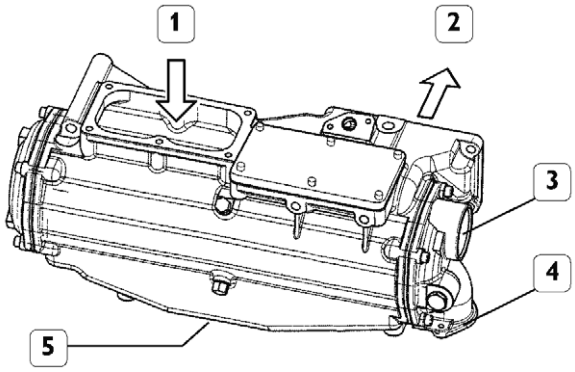
Description and Operation

Air, drawn in and compressed by the turbocompressors, flows through the heat exchanger together with sea water. The latter, by reducing temperature, allows an increase in the engine's volumetric efficiency.
The air density at the inlet of the intake manifold is measured by two sensors, for pressure and temperature, allowing the ECU of the EDC system to calculate fuel dosage relative to the actual quantity of air available for combustion.
Lubricating oil vapors (blow-by) not condensed in the separator, are sent to the engine intake by a gauged hole downstream of the air filters.

Exhaust gas expelled by the engine flows through the cooled exhaust manifold to reach the turbocompressors rotors.
Exhaust manifold and turbocompressor body are cooled by the fresh water loop. Exhaust gases flow into the exhaust terminal and, when provided, they are mixed with the sea water it carries for overboard discharge.

Air/sea water heat exchanger

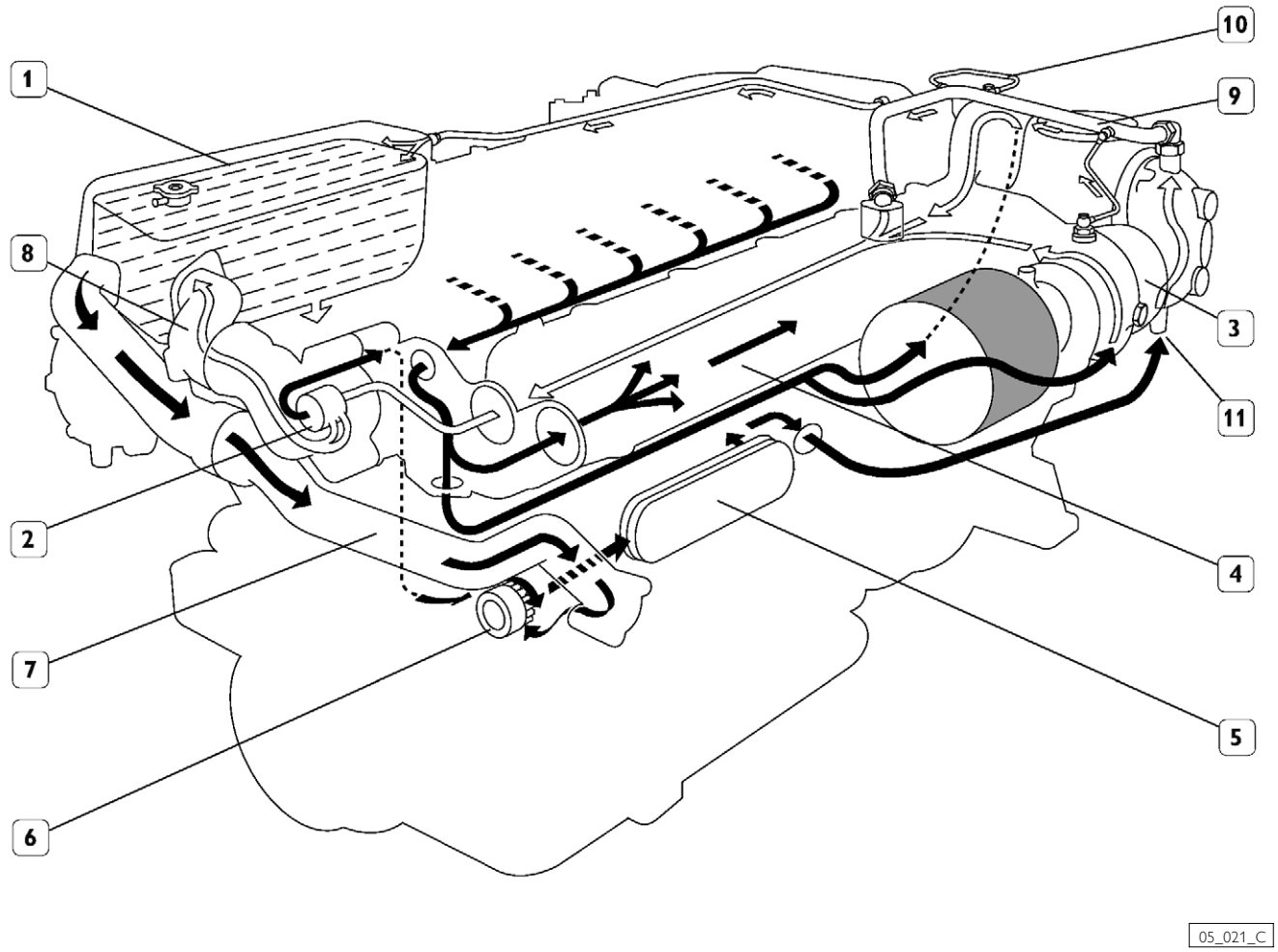
Figure 10



1. Air inlet from the turbocompressor - 2. Outlet for air cooled by the sea water and destined to the intake manifold - 3. Sea water outlet - 4. Sea water inlet - 5. Condensed water outlet.

COOLING FRESH WATER CLOSED LOOP

Figure 11



High temperature liquid Low temperature liquid

1. Coolant (fresh water) heat exchanger - 2. Thermostatic valve - 3. Side turbocompressor - 4. Exhaust manifold - 5. Engine oil/coolant heat exchanger - 6. Coolant pump - 7. Coolant intake duct from heat exchanger - 8. Coolant delivery duct to heat exchanger - 9. Coolant recirculation from turbocompressors and exhaust manifold junction - 10. Coolant recirculation from rear turbocompressor - 11. Side turbocompressor coolant inlet.

Description and operation

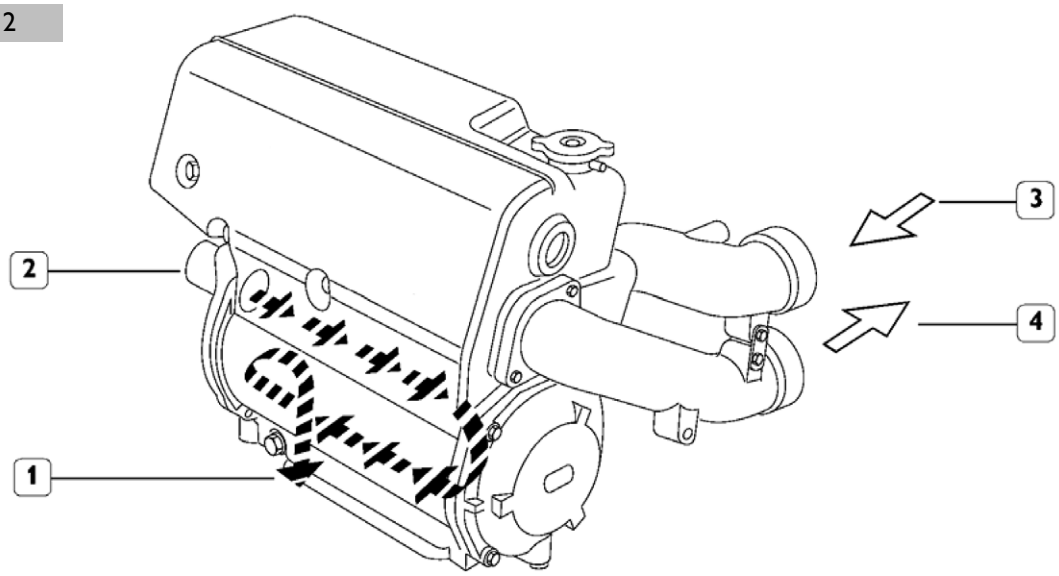
The centrifuge pump, rotated by the drive shaft with a poly-V belt, draws in the coolant coming from the fresh water/sea water heat exchanger or from the exhaust manifold cooling loop and sends it into the block, where it comes in contact with the lubricating oil heat exchanger. It then touches the heat exchange areas of the cylinders and subsequently those of the engine head, from which it exits flowing through the junction fitting that contains the temperature sensors for the instrument panel and the injection system. This junction has the purpose of bypassing the coolant from the engine head to the exhaust manifold and from the exhaust manifold to the thermostat - which routes it according to the temperature either to the water/water heat exchanger or to the recirculation pump.

From the bypass fitting the liquid is then injected into the heat exchange chamber of the exhaust manifold - through which it flows going to touch the body of the waste gate, of a portion the exhaust and of the turbo compressor. When it returns into the bypass junction it comes in contact with the wax actuator of the thermostatic valve. This will throttle flows according to temperature.

Part of the liquid will enter the tank and flow through the tube bundle heat exchanger, releasing heat to sea water, while the rest will go directly to the pump, to be recirculated.

Tube bundle water/water heat exchanger

Figure 12

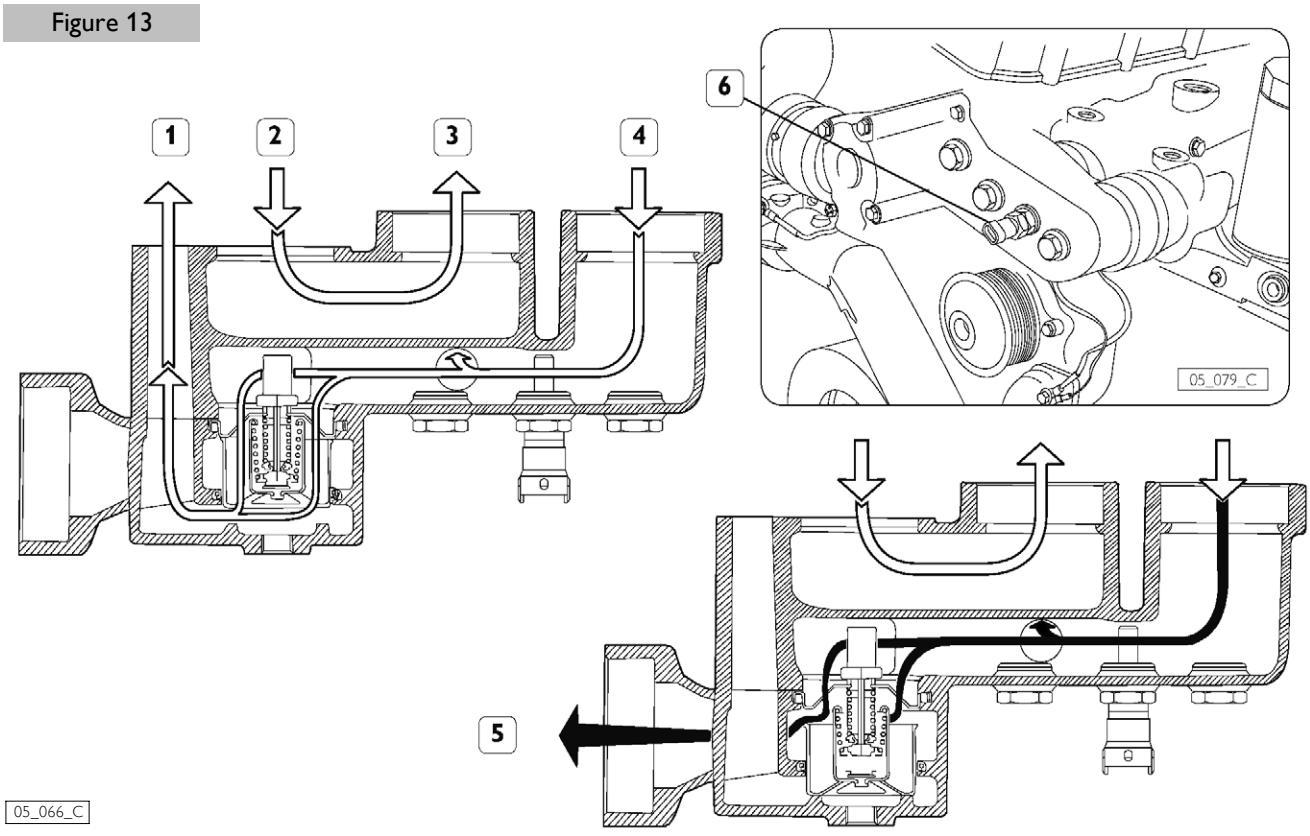


High temperature liquid ■■■■ Sea water

1. Sea water outlet to overboard discharge - 2. Sea water inlet from after cooler - 3. Coolant inlet from thermostatic valve - 4. Coolant outlet to pump.

Bypass junction for thermostatic valve

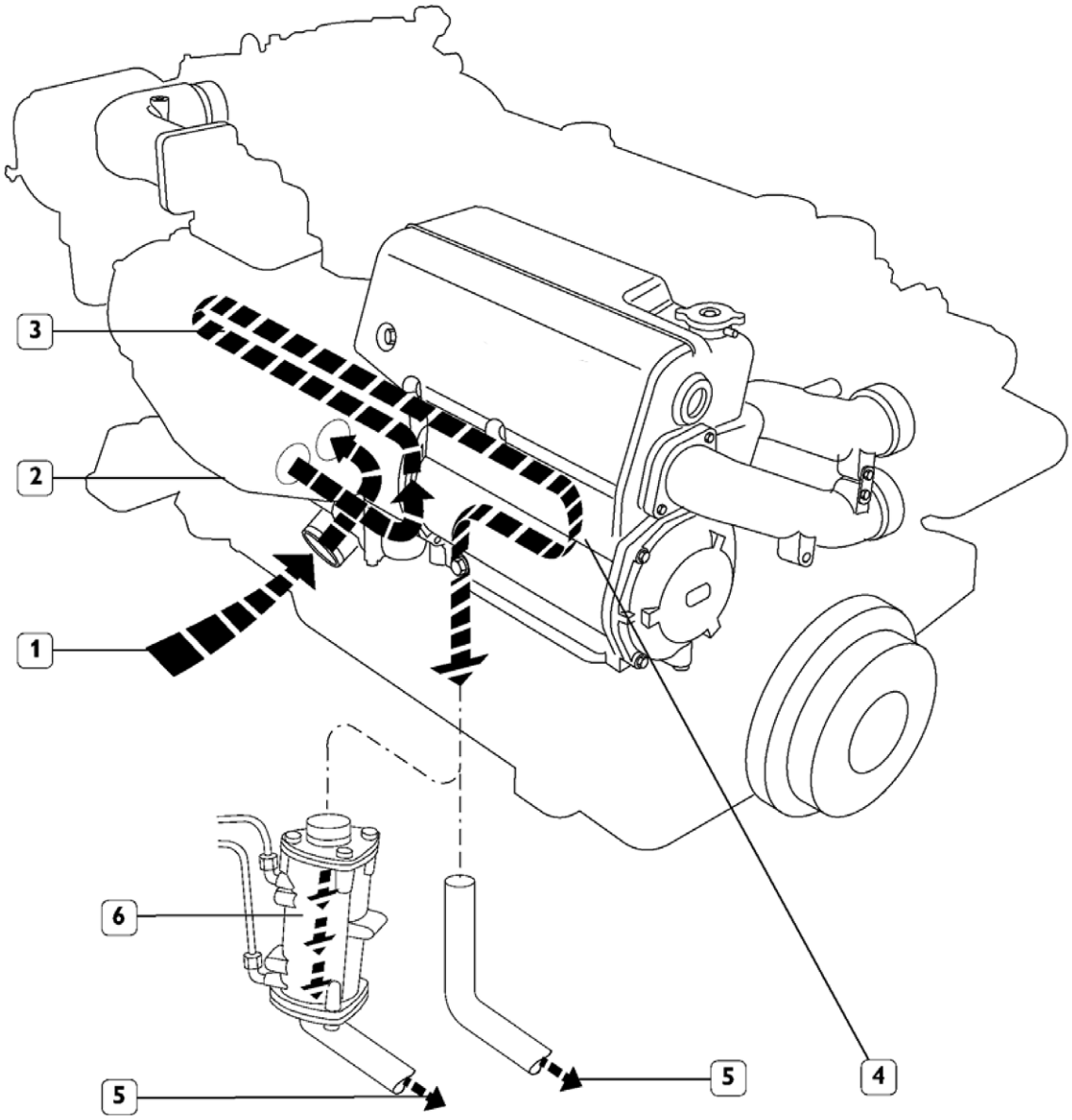
Figure 13



1. Bypass flow to engine - 2. Outflow from engine - 3. Outflow from exhaust manifold - 4. Inflow to exhaust manifold - 5. Flow to sea water heat exchanger - 6. Temperature sensor.

SEA WATER OPEN COOLING LOOP

Figure 14



■■■■ Sea water

1. Sea water suction - 2. Sea water pump - 3. Supercharger air heat exchanger - 4. Coolant (fresh water) heat exchanger - 5. Sea water outlet from heat exchangers for overboard discharge - 6. Heat exchanger for gearbox oil (on request).

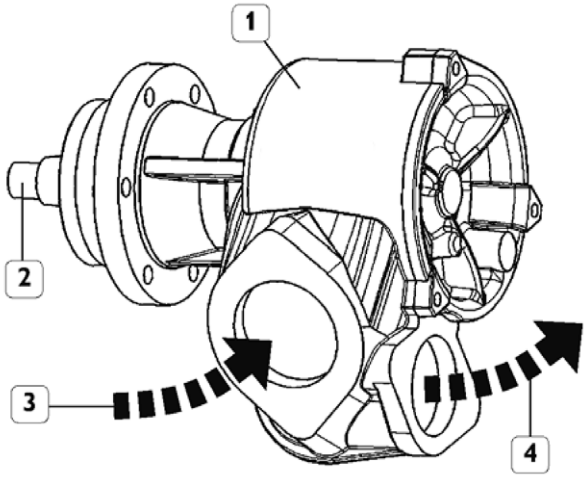
Description and operation

Sea water, drawn from under the keel and necessarily filtered, is drawn by the pump and sent to the supercharger air heat exchanger and from there to the water/water heat exchanger of the closed cooling loop; only after this will it flow through the heat exchanger for the gearbox oil, if one is provided.

The configuration of the discharge lines depends on the choice of a dry "chimney" exhaust, or a mixed one. The outlet pipe will carry the water directly to the overboard discharge or, if the water/exhaust gas mixer solution is adopted, a conduit will connect the outlet of the last heat exchanger with the mixer inflow junction pipe.

Sea water pump

Figure 15

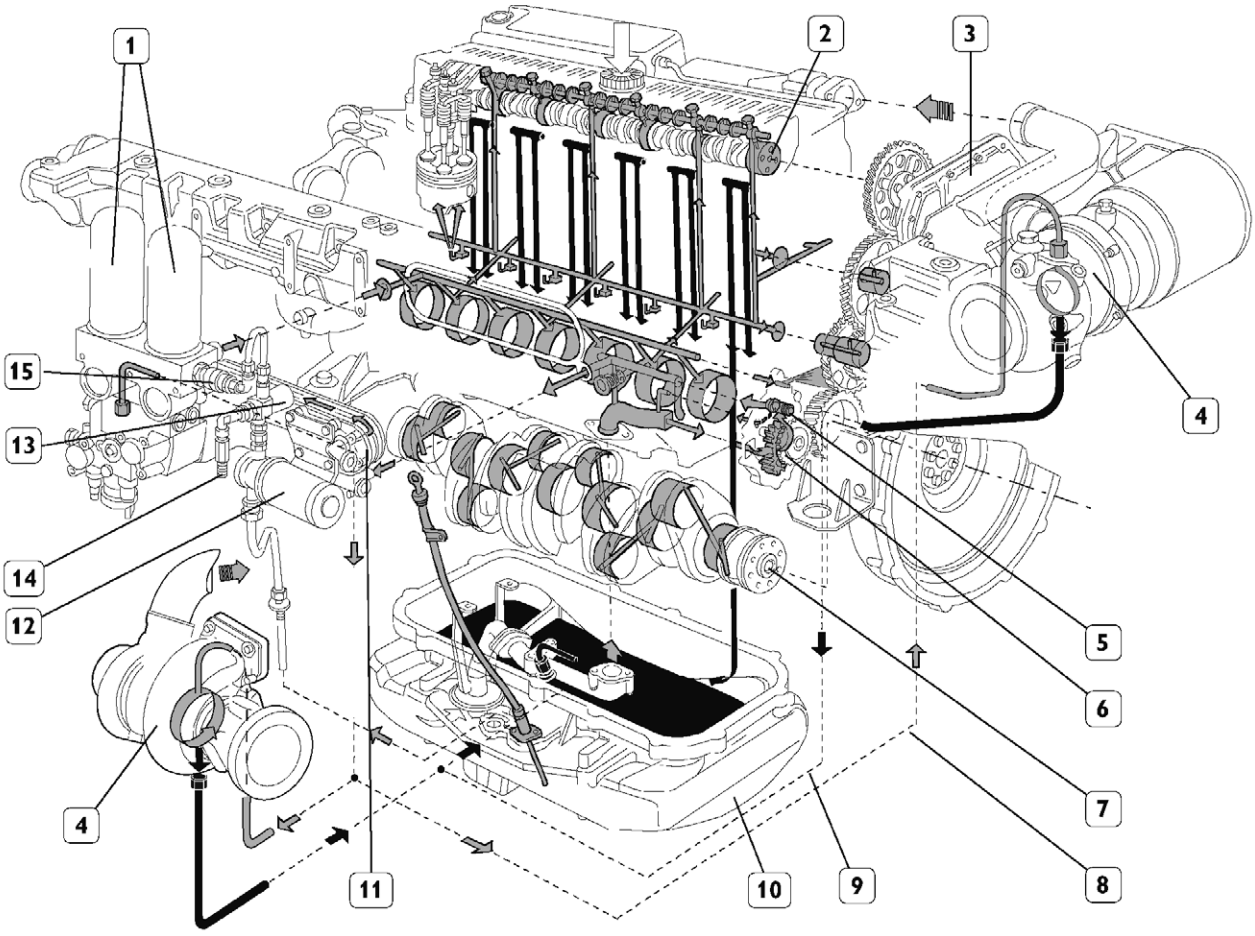


1. Pump impeller seat - 2. Driving gear shaft - 3. Sea water intake - 4. Sea water delivery.

The sea water pump, centrifugal type, is rotated by the gears keyed to the rear of the flywheel.

ENGINE OIL - LUBRICATION LOOP

Figure 16



1. Oil filters - 2. Camshaft on cylinder head - 3. Oil vapor condenser and filter (blow by) - 4. Turbocompressor - 5. Oil pump safety valve - 6. Lubrication oil pump - 7. Drive shaft - 8.Turbocompressor lubricating oil flow line - 9. Oil return flow from turbocompressor - 10. Oil sump - 11. Heat exchanger with coolant - 12. Electrical pump for pre-lubrication and oil filling/emptying (on request) - 13. Solenoid valve for switching between the pre-lubrication or oil filling/emptying functions (on request) - 14. Oil emptying junction - 15. One-way pre-lubrication valve.

Description and operation

The gear pump, rotated by the gears at the rear of the flywheel sends the lubricating oil directly to the heat exchanger which, incorporated in the block and lapped by the coolant, reduces temperature to maintain optimal lubricating capability.

The thermostatic valve that regulates oil flow is located at the inlet of the heat exchanger, opening the bypass pipe if temperature falls below calibration temperature.

From the output of the heat exchanger, the oil is sent to the filter assembly and from this back to the engine block to lubricate all anti-friction elements.

The blow-by vapor condenser, provided with filter and safety valve, is located on the upper part of the timing mechanism lid. The vapors, after returning to the liquid state, will flow from the vapor condensor into the sump. The engine is provided with the pre-lubrication system on request. This can inject enough oil into the engine's ducts to guarantee a totally safe start.

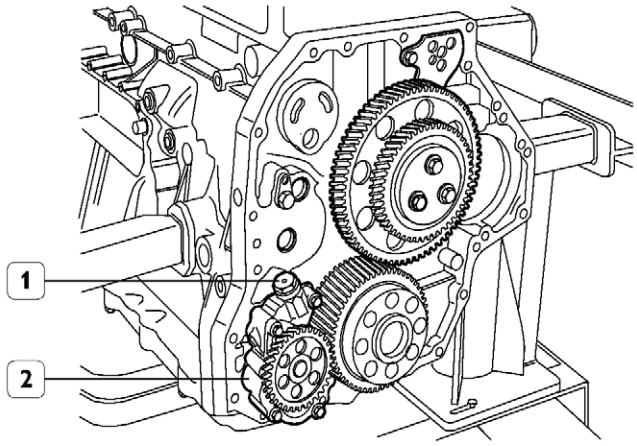
The operation of the electrical pre-lubrication pump (on request), is automatically controlled by the ECU electronic unit.

This system, with the aid of the flow-switching solenoid valve, also permits the oil sump to be emptied and filled.

Detailed descriptions of this operation are provided in Section 3.

Gear pump

Figure 17



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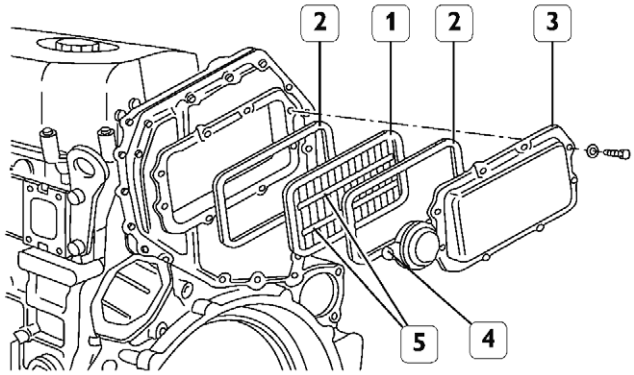
1. Safety valve - 2. Oil pump.

Oil vapor filter

Figure 18



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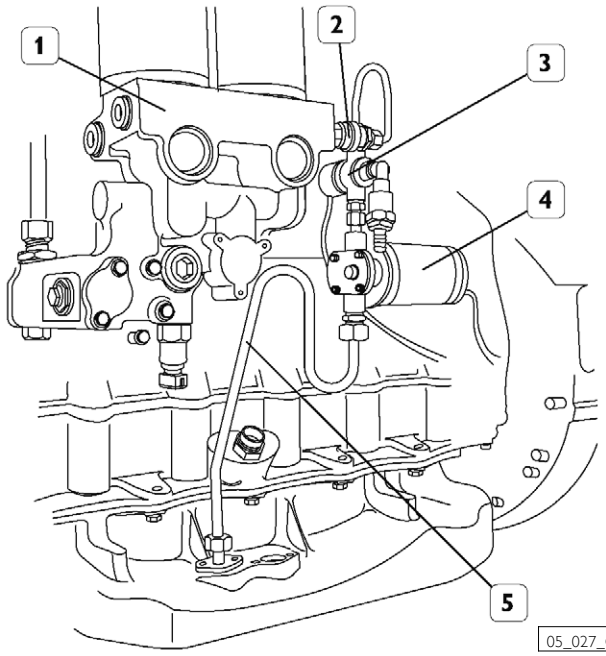
1.Oil vapour filter - 2. Gaskets- 3. Cover - 4. Exit of vapour from the motor extraction system - 5. Reinforcing bars.

The oil vapours go through the filter (1) where their liquid parts condense and flow back in the sump whilst the remaining gas exits from the connection (4) and are sucked by the motor positioned after the air filter.
The filter (1) only works in one direction. Consequently it must be assembled with the two reinforcing bars (4) on the visible side, as shown in the picture.

Pre-lubrication system (on request)

Figure 19



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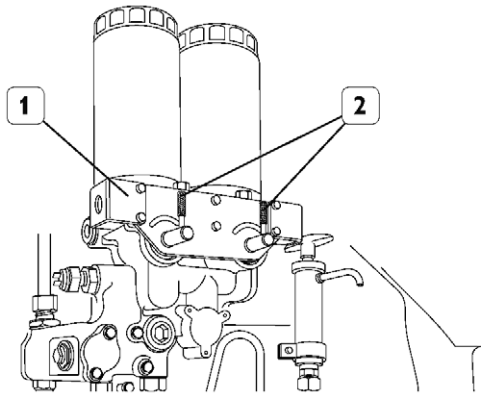
1. Oil filter support - 2. One-way valve to prevent emptying - 3. Switching solenoid valve - 4. Electrical pump - 5. Oil sump inflow and suction pipe.

Commutable filters (on request)

Figure 20



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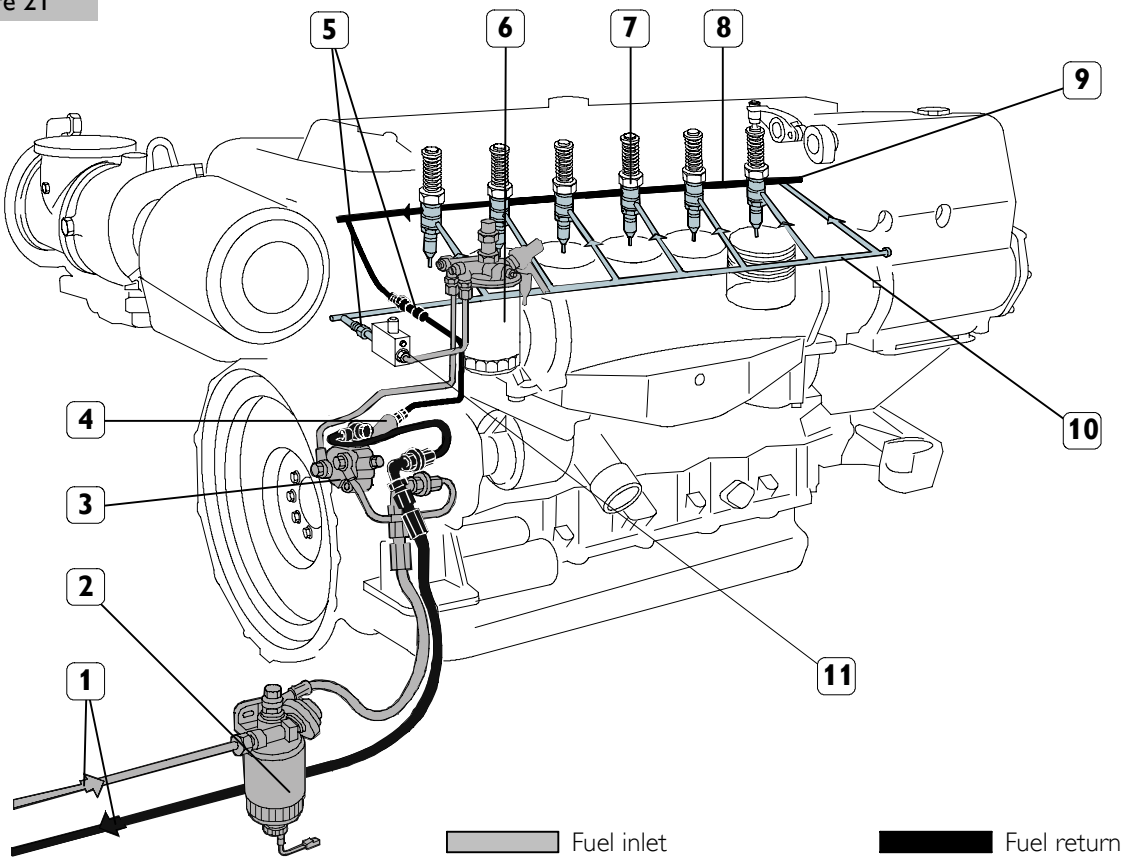
1. Commutable oil filters support -
2. Filters activation/deactivation levers.

The supports are equipped with levers and, if necessary, they enable the replacement of a filter even if the motor is rotating. If necessary, operate very carefully to avoid risks of burning. Do not exclude both the filters together for any reason.

1. FUEL LINE

Figure 21



1. Return and suction flows from the tank - 2. Pre-filter - 3. Low pressure supply pump - 4. Return loop pressurization valve - 5. Inlet and outlet fittings from cylinder head - 6. Fuel filter - 7. Injector pump - 8. Fuel return line - 9. Cylinder head channel venting point - 10. Low pression injector feeding line - 11. Pulses smoother.

For the installation, the following connections are required:

- from the tank to the pre-filter
- from the pre-filter to the pump inlet
- from the fuel discharge outlet to the tank

Pre-filter

The pre-filter with priming pump, supplied separately from the engine, must be fastened near the tank, in a relatively low point of the line to allow for easy replacement the filtering cartridge and/or the operation of the hand pump. Avoid the use of additional mesh or paper filters along the feed lines between pre-filter and engine. To avoid introducing impurities in the feeding lines inside the engine, do not place filter cartridges pre-filled with fuel in the system.

Materials Characteristics

The fuel tank and the suction and return assembly must withstand the continuous abrasion caused by a flow of fuel oil of 160 l/h at a temperature of 90°C without noticeable deformation or wear or release of material. Use of metal tanks, preferably made of iron alloys, is allowed, provided they are connected to the negative terminal of the battery to prevent the accumulation of electrostatic charges.

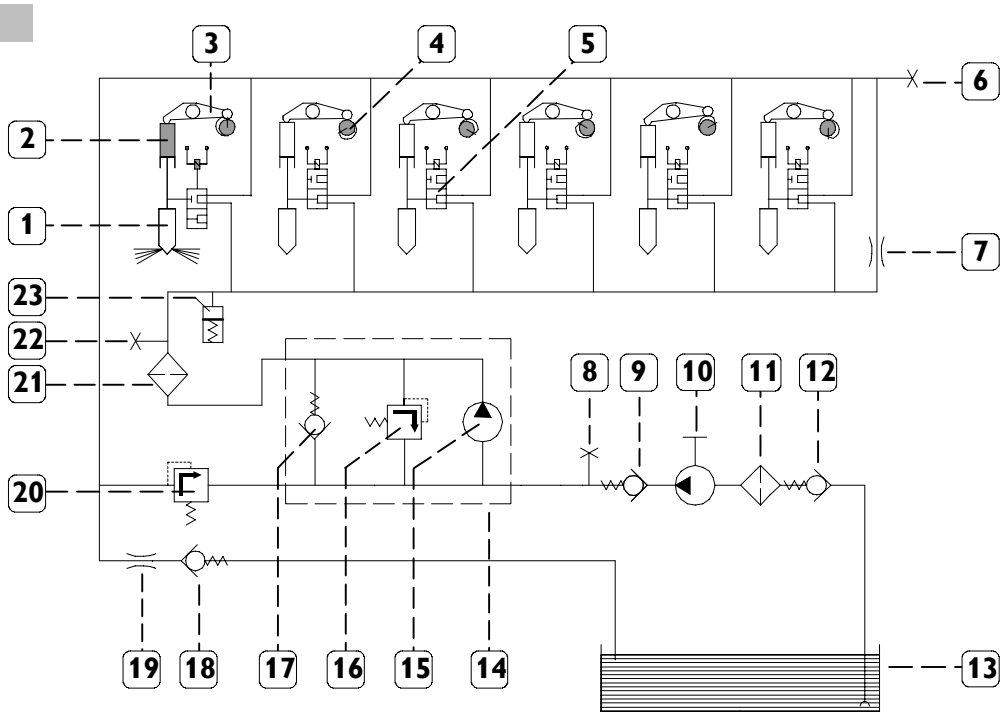
Tanks must be provided with vents to avoid exceeding an internal pressure of ± 5kPa (± 0.5 m of H_2O column); their shape and the suction assembly must be such as to assure a suction at the maximum longitudinal and transverse inclination allowed for the boat, with a residual quantity of fuel oil considered "reserve".

The suction inlet should be positioned in such a way as to avoid taking in sludge. The return flow must be in such a way as to facilitate the mixing of the returning fuel with the fuel in the tank. If the tank is lower than the filter, then the return pipe must always be submerged.

The pipes and union fittings of the fuel line must withstand a fuel oil flow rate of 160 l/h at a temperature of 90°C and a pressure of 3 bar (300 kPa) without noticeable deformation, wear or release of material. Mmetal tubes, preferably made of iron alloys, are recommended, taking care to connect each individual segment to engine ground to avoid the accumulation of electrostatic charges and inserting a vibration damper elastic joint on each segment. The pipes used must be certified according to the relevant Countries' rules or to the standards issued by classification Bodies.

Fuel supply system scheme

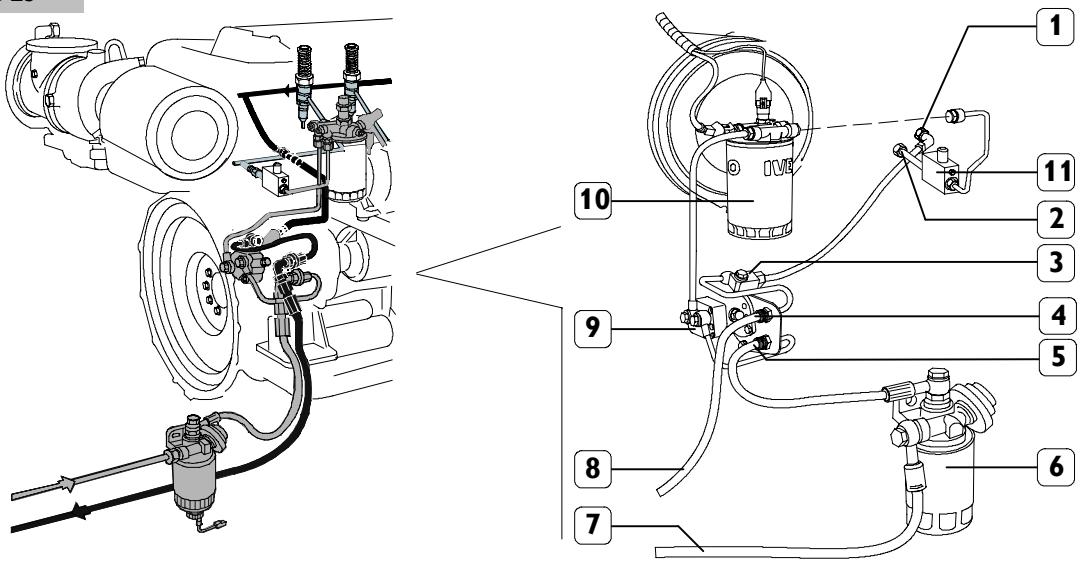
Figure 22



1. EUI injector - 2. EUI pumper - 3. Rocker arm - 4. Actuating cam - 5. EUI solenoid valve - 6. Vent fitting on cylinder head - 7. Calibrated hole - 8 Vent fitting on pre-filter - 9. One-way valve - 10. Hand pump - 11. Fuel pre-filter - 12. One-way valve - 13. Fuel tank - 14. Gear pump assembly - 15. Fuel supply gear pump - 16. Pressure limiter valve (initial opening pressure 5 bar) - 17. One-way valve - 18. One-way valve - 19.Calibrated hole - 20. Pressure regulating valve (initial opening pressure 3.5 bar) - 21. Fuel filter - 22. Vent fitting on fuel filter support.

Hydraulic connections

Figure 23



1. Outlet fitting from cylinder head - 2. Inlet fitting to cylinder head - 3. Pressure regolating valves location - 4. Outlet fitting for fuel outflow to the tank - 5. Inlet fitting from pre-filter - 6. Pre-filter - 7. Inlet pipe from the tank - 8. Outlet pipe to the tank - 9. Low pressure feed pump - 10. Fuel filter.