



A274-100 and A275-100 Engines

Design, Maintenance, and Repair

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INTRODUCTION

This Manual applies to A275 engines and its versions with electronic control of fuel supply and ignition, intended for installation into light commercial vehicles manufactured by LLC AZ GAZ.

This Manual provides information about the design, operation principle, characteristics (properties) of the engine, its components, and instructions that may be useful for evaluation of its technical condition, engine repair, transportation, storage, conservation, warranty obligations of the manufacturer, as well as the information about the engine disposal.

* * *

Climatic version of the manufactured engines is U as per GOST 15150, and the engines are designed for operation in ambient temperature conditions from minus 45 °C to plus 40 °C, average annual relative humidity up to 80% at plus 20 °C.

Engines must be operated as a part of a vehicle with air dust levels up to 0.1 g/m³ and in altitudes up to 3000 m above sea level, with corresponding change in power.

* * *

Service personnel should have special qualification.

* * *

Parameters provided in the Manual without tolerances are provided for reference only.

* * *

Regular maintenance of your engine as per this Manual and the service book will ensure its reliable operation.

* * *

JSC Ulyanovsk Motor Plant does not establish operational standards for fuel consumption.

* * *

Engine manufacturer is JSC Ulyanovsk Motor Plant (JSC UMZ), Ulyanovsk.

* * *

JSC UMZ is continuously improving the engine assemblies and components design, so they may differ from those described in this publication.

This description is valid as of July 6, 2018.

1 TECHNICAL SPECIFICATIONS

Engine type	4-stroke gasoline engine with microprocessor control of fuel supply and ignition
Number of cylinders	4
Cylinder operation order	1 - 2 - 4 - 3
Cylinder diameter, mm	96.5
Piston stroke, mm	92
Capacity, l	2.69
Compression ratio	10
Nominal power, kW (hp): as per GOST R 41.85 at crankshaft rpm, min. ⁻¹	78.5 (106.8) 4000
Maximum torque, Nm (kgf-m): as per GOST R 41.85 at crankshaft rpm, min. ⁻¹	220.5 (22.5) 2350 ± 150
Minimum idle speed, min. ⁻¹ :	800 ± 50
Increased idle speed (for reference), min. ⁻¹ :	3000
Minimum specific fuel consumption, wide-open throttle operation ("net" scope of supply), max., g/kWh (g/hp-h)	272 (200)
Burning oil consumption in % of fuel consumption (OST 37.001.642), max.	0.2
Fuel supply system	Distributed phased injection
Cooling system	Fluid, closed-loop, forced circulation
Capacity of the cooling system without the cooling radiator, l	4.92
Lubrication system	Combined, pressurized and sprayed
Oil system capacity, without oil cooler, l	4.5
Electrical equipment	Single-wire, negative terminals of the products are connected to the vehicle body. Battery nominal voltage 12 V
Ignition system	Ignition microprocessor control system with knock feedback
Clutch	Single disk, dry
Mass of the engine not filled with oil, scope of supply 1000400 (without air conditioning compressor), kg	191

Table 1 - Basic data for adjustments and control.

Oil pressure (to be controlled, not to be adjusted) at idle $800 \pm 50 \text{ min.}^{-1}$ at oil temperature $80 \text{ }^{\circ}\text{C}$, min., kPa (kgf/cm ²):	
with the oil cooler off	127 (1.3)
with the oil cooler on	78 (0.8)
Fluid temperature in the cooling system, $^{\circ}\text{C}$	80-105*
Gap between the spark plug electrodes, mm	$1.0_{-0.1}$
Working air gap of the crankshaft position sensor	$1.0_{-0.7}^{+0.8}$
Phase sensor working air gap	0.2-1.8

* Short-time, max. 10 minutes, temperature increase to $110 \text{ }^{\circ}\text{C}$ is allowed.

2 ENGINES MARKING

1.1. Engine identification number is embossed on a special platform on the left side of the cylinder block (see Figure 1).

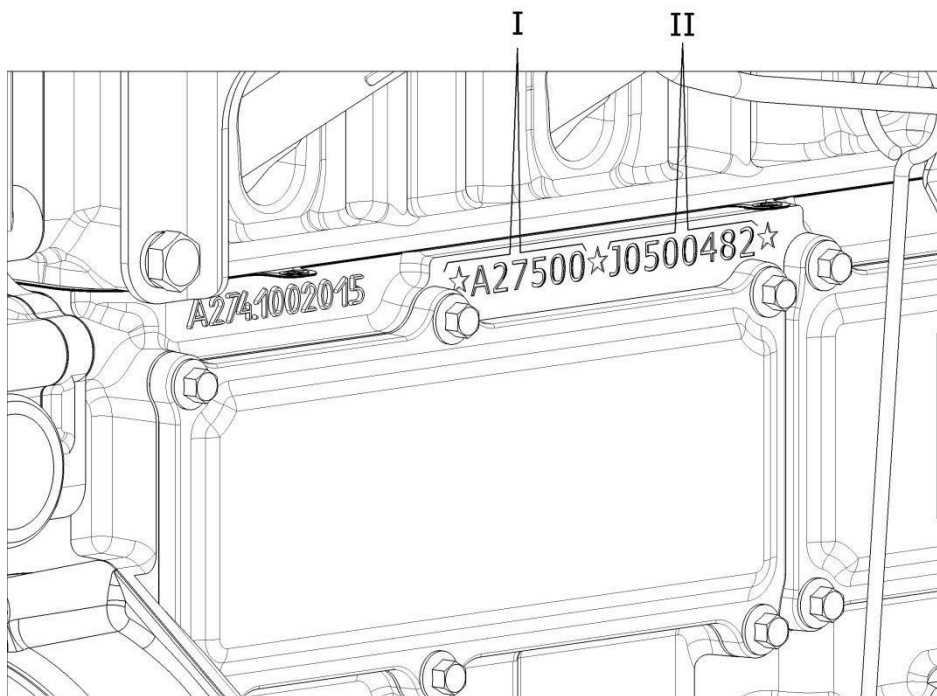


Figure 1 - Location of A275 engine identification number

Identification number consists of two parts separated by the star:

- the first part (I) is a conditional engine code adopted as a descriptive part (VDS) consisting of six characters, where the first four characters indicate the index of the base model, the fifth and sixth - the version index, or zero.
- the second part (II) is the identification part (VIS) consisting of eight characters (Latin numbers and letters) specifying the engine number, where the first character (Latin number or letter) specifies the year of the engine manufacture, the second and third characters specify the month of manufacture, and subsequent characters specify the serial number of the engine manufactured in the current month.

The following codes are adopted to specify the year of manufacture of the engine: 2018 – J; 2019 – K; 2020 – L.

Example of the engine marking A275.1000400 manufactured in May 2018:

★ A 2 7 5 0 0 ★ J 0 5 0 0 4 8 2 ★

1.2. Engine has a data sheet marked with trademark, has the technical control (QC) stamp, and the date of conservation. Data sheet has the address of the manufacturer.

1.3. Certified engines are marked with a circulation sign on the front cover of the pusher box and in the data sheet.

1.4. When packing engines into the crates, the following data are applied onto the packaging crates using indelible ink:

- manufacturer's name;
- manufacturer's trademark;
- engine model designation;
- circulation sign;
- engine technical specifications (TU);
- engine manufacturing time, date, and date of conservation;
- warning (handling) signs No. 1, 3, 11 as per with GOST 14192.

3 ENGINE DESIGN AND MAINTENANCE

3.1. Engine main assemblies

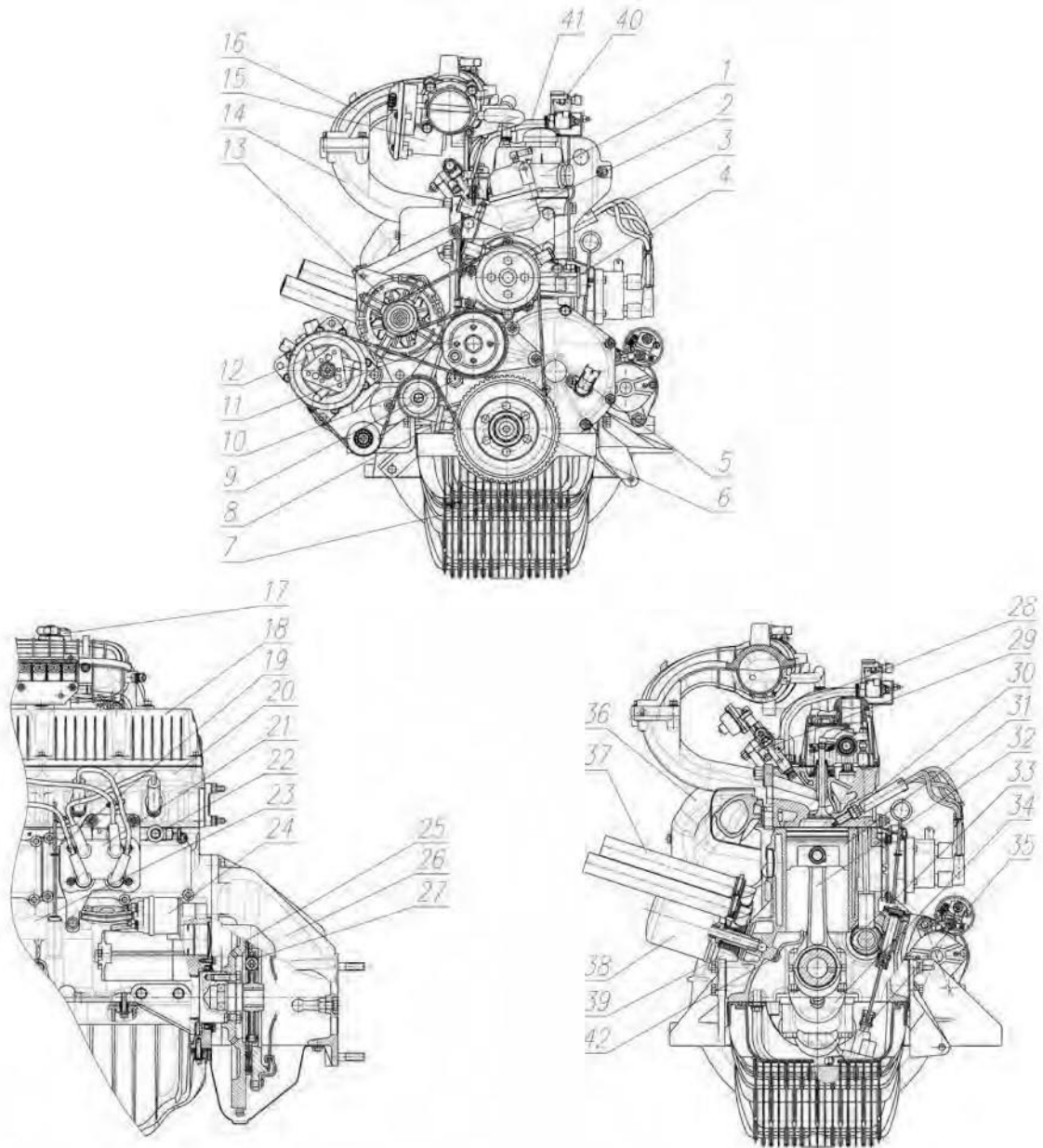


Figure 2 - Engine A275

1 - stub for coolant draw-off to radiator; 2 - thermostat housing; 3 - water pump pulley; 4 - stub for coolant inflow from radiator; 5 - phase sensor; 6 - crankshaft damper; 7 - oil case; 8 - synchronization sensor; 9 - emergency oil pressure sensor; 10 - automatic tensioner; 11 - fan coupling pulley; 12 - air conditioning compressor; 13 - alternator; 14 - input pipe; 15 - throttle intake with electric actuator; 16 - receiver; 17 - absolute pressure sensor; 18 - valve cover; 19 - oil level dip stick; 20 - cylinder head; 21 - ignition coil; 22 - knock sensor; 23 - cylinder block; 24 - starter; 25 - flywheel; 26 - clutch case; 27 - clutch; 28 - ventilation valve; 29 - injector; 30 - spark plug; 31 - piston; 32 - connecting rod; 33 - camshaft; 34 - crankshaft; 35 - oil pump; 36 - header shield; 37 - heat exchanger hose; 38 - oil filter; 39 - heat exchanger.

3.2 Housing parts

Cylinder block

Cylinder block is cast from gray cast iron. Nominal inner diameter of the machined sleeves is 96.5 mm.

For uniform cooling of the sleeves, a cavity for coolant is provided in the inter-cylinder links. At the front end of the block, there are ports for coolant inflow. On the top plate of the block, there are ports for the coolant passage to the cylinder head.

At the bottom of the cylinder block, there are 5 main supports closed by covers. Covers are made of ductile iron and machined with the cylinder block as a whole, so these are non-interchangeable.

Cylinder head

Aluminum alloy cylinder head with pressed-in seats and valve guides. MLS (Multi-Layer Steel) metal gasket is installed between the block and the head. Gasket thickness in the compressed state is 0.6 mm. Gasket is positioned on two pins diam. 8 to fix the head relative to the cylinder block.

When installing the cylinder head, tighten the head securing nuts using the torque wrench.

ATTENTION!

Cylinder head gasket is not reusable.
Tighten only when the engine is cold.

To ensure uniform and tight fit of the gasket to the head of the block and the cylinder block, tighten the nuts in the sequence shown in Figure 3, in two steps: first run - pre-tightening with less effort (tightening torque 5.0-6.5 kgf-m), second run - final tightening (tightening torque 9.0-9.8 kgf-m).

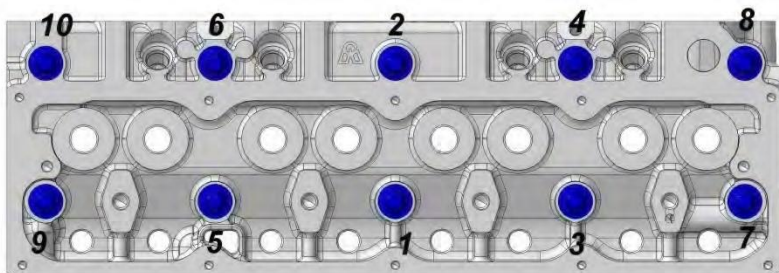


Figure 3 - Cylinder head nuts tightening sequence

3.3 Crank gear

Crankshaft is the five-bearing shaft cast from ductile iron. There are cavities in the crank pins for additional centrifugal oil cleaning. Oil from the main journals in the cavity is fed through the drilled channels. To the main journals, the oil is supplied from the channels of the cylinder block.

Front end of the crankshaft is sealed using self-clamping spring cuff (Figure 4) working on the outer surface of the hub of the crankshaft pulley.

Force acting along the axis of the crankshaft when the clutch is disengaged is taken by thrust bearings installed on the front support of the crankshaft.

Rear end of the crankshaft is also sealed using self-clamping spring cuff (Figure 5) working on the cylindrical surface of the shaft extension.

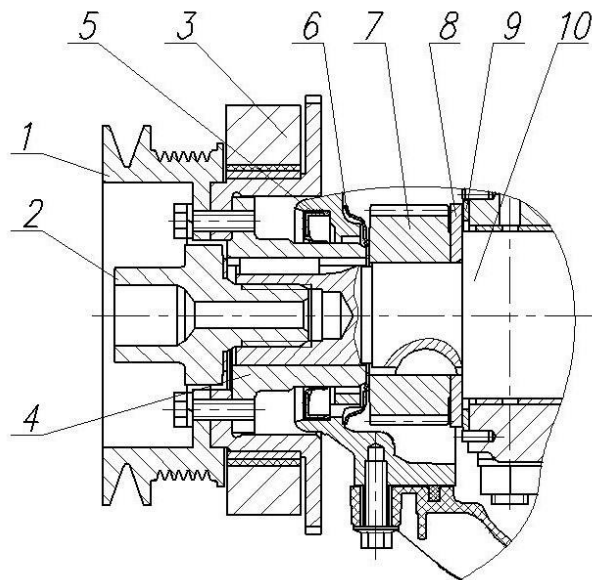


Figure 4 - Crankshaft front end sealing:

1 - accessories drive pulley; 2 - crankshaft bolt; 3 - crankshaft damper; 4 - crankshaft pulley hub; 5 - cuff; 6 - crankshaft oil deflector; 7 - crankshaft cogwheel; 8 - crankshaft thrust washer; 9 - crankshaft thrust bearing front washer; 10 - crankshaft.

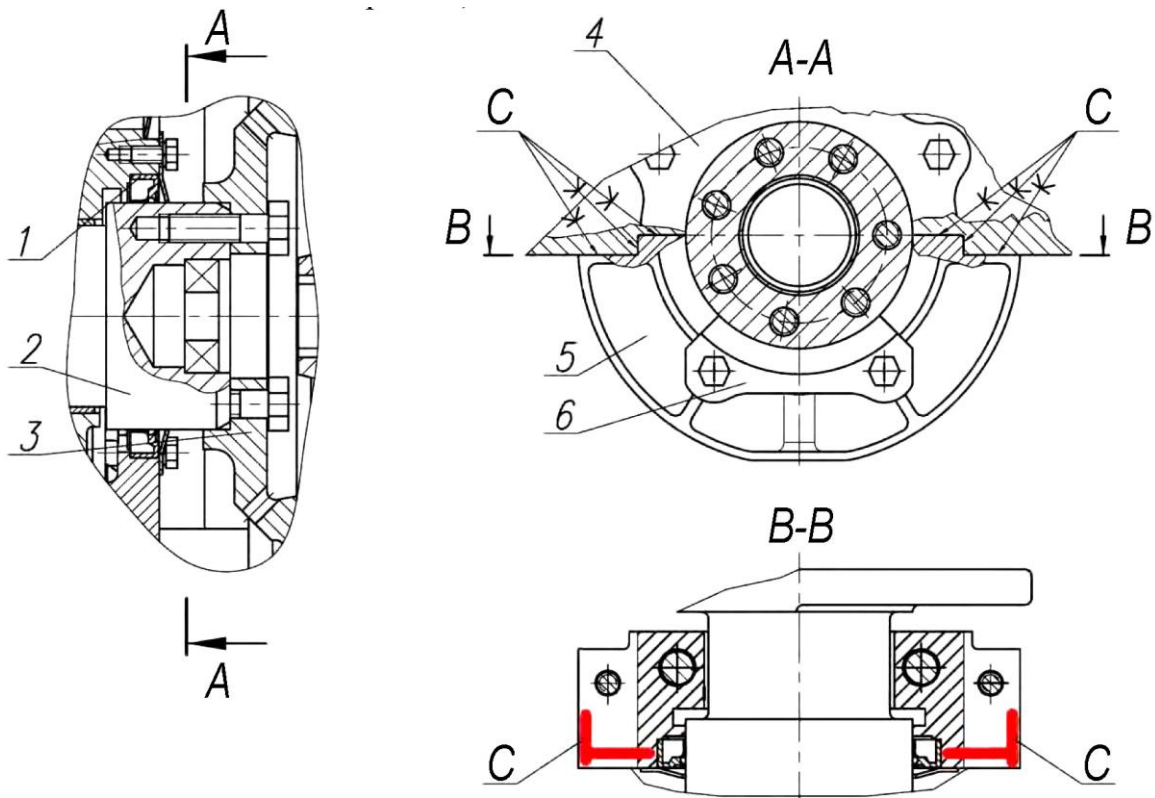


Figure 5 - Crankshaft rear end sealing:

1 - cuff; 2 - crankshaft extension; 3 - flywheel; 4 - cuff upper holder; 5 - crankshaft cuff cover; 6 - cuff lower holder. C - locations where liquid gasket needs to be applied when assembling the unit.

Inserts of the main and connecting rod bearings of the crankshaft are made of steel tape coated with antifriction aluminum alloy. Inserts of the main bearings installed into the crankshaft bearing covers, unlike the inserts in the cylinder block, do not have oil-feeding grooves.

Flywheel is made of cast-iron, with a steel toothed rim for starting the engine using the starter, attached to the crankshaft end using seven self-locking bolts. Crankshaft is balanced with flywheel and clutch as a whole.

Connecting rods are made of steel, forged, with I-shaped cross-section. Thin-walled tinned bronze sleeves are pressed into the connecting rod upper heads. To lubricate the piston pin, there is a port that matches the port in the sleeve in the upper head of the connecting rod.

Nuts of the connecting rod bolts are locked using Triboplast-9 or Germikon-9 sealant. When dismantling these connections, make sure to remove the applied sealant completely. When assembling, apply 2-3 drops of the fresh sealant onto the threaded parts of the bolt and tighten the connection.

Piston pins are floating type, hollow, made of steel.

Pistons are made of aluminum alloy. In the upper part of the piston, i. e. the head, there are three grooves for the piston rings. Piston skirt is oval in horizontal cross-section. Major axis of the oval is perpendicular to the axis of the bosses for the piston pin. In vertical cross-section, the skirt has a “barrel-shaped” profile. Surface of the skirt has a special coating.

Piston rings are installed in the count of three on each piston: two compression rings, one oil scraping ring. 1-st compression and oil scraping prefabricated ring are made of steel, the 2-nd compression ring is made of cast iron.

First compression ring is nitrided and has a barrel-shaped profile with polished working surface.

Second compression ring of the scraper type has dark phosphate coating. For orientation when mounted on the piston, on the upper surface of the ring there is a laser mark, which should be facing upwards.

Oil scraping ring consists of two nitrided rings and a two-function extender in the form of a profiled tape.

Before installation of the pistons and connecting rods assembly onto the engine, piston rings should be oriented as follows:

- locks of the first and second compression rings should be turned at an angle 180° relative to each other;
- lock of the upper disk ring of the oil scraping ring is set at an angle 90° relative to the lock of the lower compression ring. Lock of the lower disk ring must be turned at an angle 180° relative to the upper disk ring. Lock of the two-function extender of the oil scraping ring is installed at an angle 90° relative to the locks of the disk rings.

3.4 Valve train

Input and output valves are arranged vertically and linearly in the cylinder head. Valves are driven by the camshaft via pushers, pusher rods, hydraulic lifters, and rockers (Figure 6).

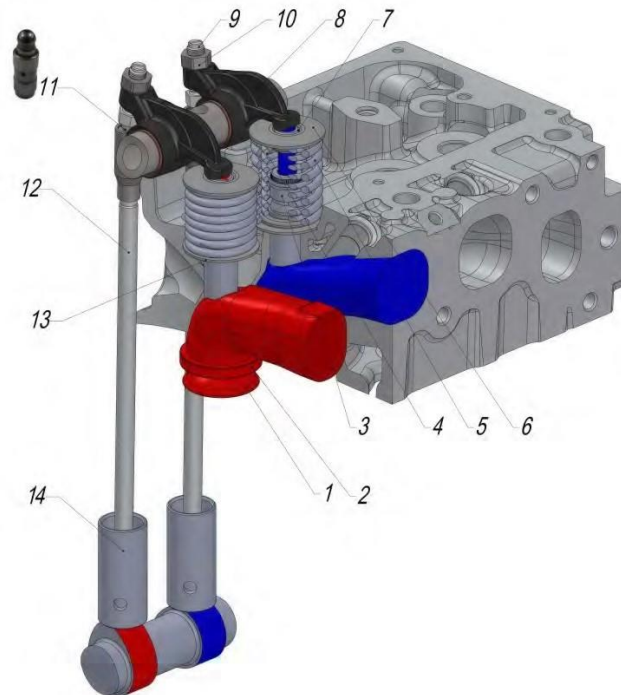


Figure 6 - Valves drive

1 - valve; 2 - valve seat; 3 - oil deflector cap; 4 and 5 - springs; 6 - springs plate; 7 - trunnion; 8 - rocker; 9 - adjustment screw; 10 - adjustment screw locknut; 11 - hydraulic lifter; 12 - rod; 13 - springs support washer, 14 - pusher.

Camshaft is made of cast iron with chilled cams to have high hardness. It has five journals and a cogwheel for oil pump drive.

Camshaft is driven by the crankshaft using a pair of cogwheels with oblique teeth. Both cogwheels have two threaded ports for dismantling.

Axial movement of the camshaft is limited by a steel thrust flange 2 (Fig. 7). Working gap 0.1-0.2 mm between the hub of the cogwheel and thrust flange is ensured by that the spacer ring 3 sandwiched between the cogwheel and the camshaft journal is thicker than the thrust flange.

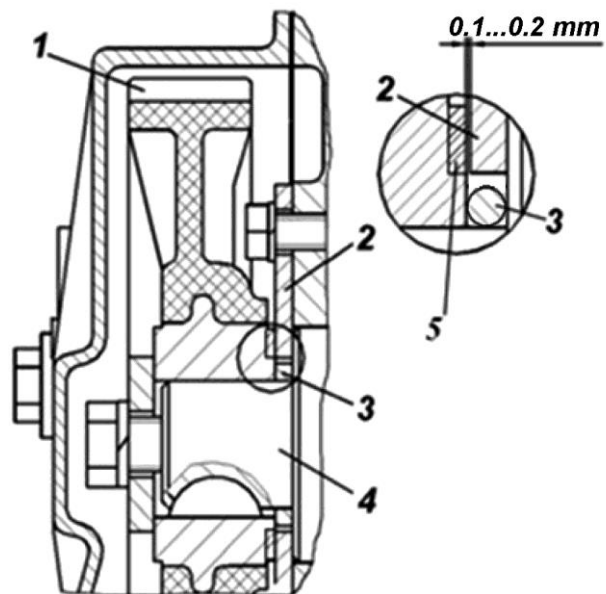


Figure 7 - Camshaft thrust flange

1 - camshaft cogwheel; 2 - camshaft thrust flange; 3 - camshaft spacer ring; 4 - camshaft; 5 - washer.

Correct timing is ensured by installation of the cogwheel using the marks (Fig. 8). “O” mark on the cogwheel of the crankshaft should be opposite to the notch at the gullet on the camshaft cogwheel. At the end of the camshaft cogwheel, there is a target. When passing by the end of the phase sensor (mounted on the cover of the cam cogwheels), the target generates an electric pulse in it to control the phased fuel supply.

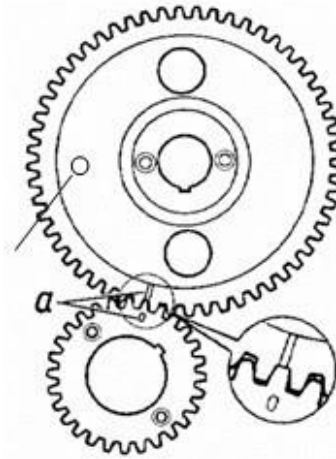


Figure 8 - Cogwheels installation using the marks

Pushers are made of steel or cast iron, with high hardness.

Hydraulic lifters (356230C, EATON, or F-46318.37, INA) are designed to automatically maintain clearance-free interfaces in the engine timing system. Installed in cylinders on pusher rods. Appearance of the hydraulic lifters is shown in Figure 9.

Pusher rods are made of duralumin rod. On one side, a steel tip is pressed in, and on the other, there is a steel cylinder for hydraulic lifters.

Rockers are made of steel, with pressed-in sleeve made of tinned bronze.

Valves: input valves are made of chrome steel, output valves are made of heat-resistant steel. Working chamfer of the output valves is surfaced using special-purpose heat-resistant alloy.

3.5 Cooling system

Cooling system is fluid type, closed-loop, with forced circulation of the coolant.

Cooling system (Figure 9) includes cooling jackets for the cylinder block and head, water pump, thermostat, fluid-oil heat exchanger (FOHE), electromagnetic coupling (EMC) that the cooling fan is mounted on. Depending on the engine version, instead of EMC, a viscous coupling assembly with a fan can be installed, which is mounted onto a support. Water pump, fan coupling is driven by V-ribbed belt from the crankshaft.

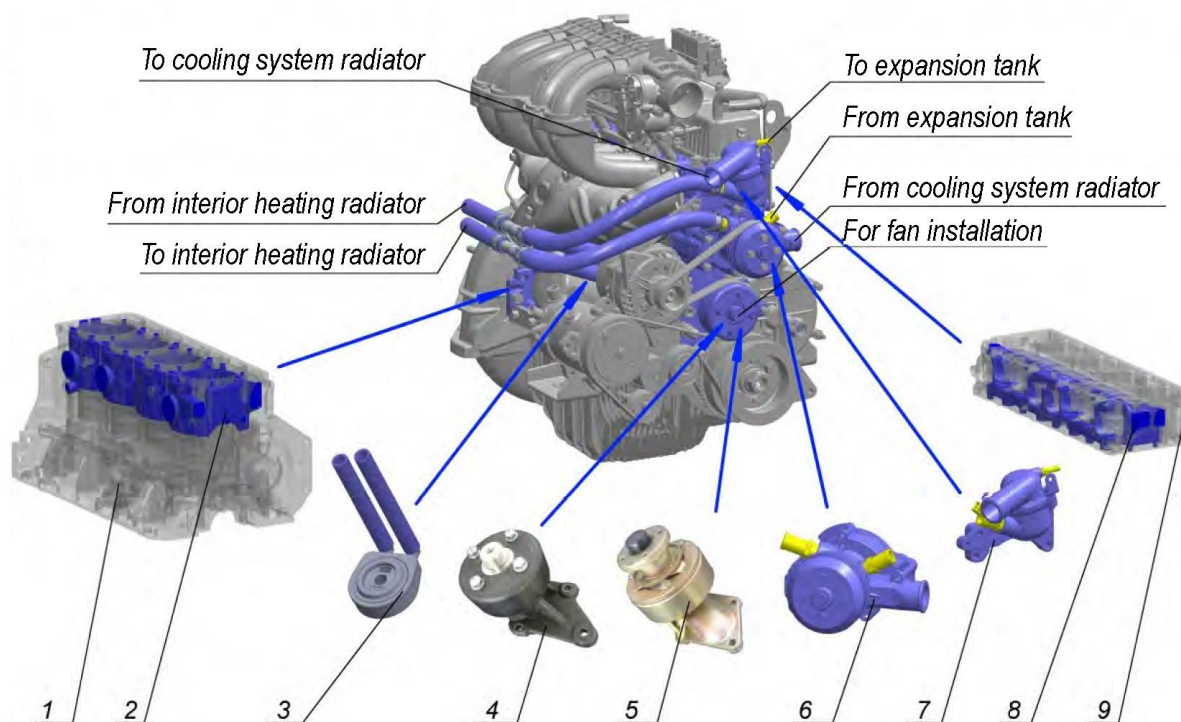


Figure 9 - Cooling system

1 - cylinder block; 2 - cylinder cooling jacket; 3 - fluid-oil heat exchanger (FOHE); 4 - fan drive viscous coupling support; 5 - fan drive electromagnetic coupling (EMC); 6 - water pump; 7 - thermostat box; 8 - cylinder head cooling jacket; 9 - cylinder head.

Coolant is pumped into the cooling jacket of the cylinder block 2 by the water pump 6, from where through the ports in the upper plate of the block and the lower plane of the cylinder head the fluid enters the cooling jacket of the head 8, and then further into the thermostat box 7 where the thermostat provides the operating temperature of the coolant in the engine. Depending on the position of the valve of the thermostat, the ratio of the fluid streams allowed to pass for cooling to the radiator and returned to the engine is changed.

Nozzles of the thermostat housing 7 and the water pump 6 provide fluid supply to the interior heating radiator. Coolant is supplied and drawn off through the same nozzles to the fluid-oil heat exchanger 3.

Fluid vapors generated in the system and the air released through the nozzle in the thermostat cover are drawn off to the expansion tank. To prevent cavitation during pump operation, its suction cavity is connected to the expansion tank using the stub.

⚠ ATTENTION!

- To prevent burns from the coolant, never remove the cap on the expansion tank while the engine is hot. Ejection of fluid from under the cap of the expansion tank can result in severe burns. Wait for the engine to cool down.
- Coolant is toxic, do not ingest the coolant, and avoid contact with skin.

During the course of operation, pour and add coolant to the cooling system in the expansion tank through the opened filler port. Use good-quality coolant. Recommended brands of the coolants and use times are provided in the vehicle user manual. Bad coolant can lead to overheating of your engine and failure.

Engine cooling system is filled by the manufacturer with high-quality coolant, which is designed for year-round use and has long service life. Coolant has low freezing point and contains a complex of anti-corrosion additives, so additional additives are not needed.

Temperature mode of the engine is also maintained by controlling the fan drive, which is turned on during the operation of the engine through electromagnetic or viscous coupling, which changes the amount of air passing through the radiator grilles. Electromagnetic coupling is switched on and off by the relay according to the commands received from the controller. Viscous coupling is switched on and off automatically depending on the temperature of incident air passing through the radiator grilles.

For normal operation, cooling system must be completely filled with fluid. Tightness of the cooling system allows the engine to operate with coolant temperature over plus 100 °C. When the temperature exceeds the permissible temperature (plus 115 °C), the high-high temperature coolant alarm is activated (red indicator on the instrument panel). When the temperature of the fluid decreases (after the engine stops), the fluid from the expansion tank under the action of the generated vacuum is returned to the confined space.

⚠ ATTENTION!

When the indicator lamp lights up, reduce the temperature, stop the engine, and eliminate the cause of overheating.

Causes of overheating can be: insufficient amount of coolant in the cooling system, bad tension of the drive belt of the coolant pump, improper use of hood covers.

Cooling system pump (Figure 10)

Centrifugal pump mounted on the front end of the cylinder block. Driven by the pulley of the engine crankshaft using the V-ribbed belt.

Pump consists of aluminum housing 3 where bearing 5 is installed. Double-row radial ball-roller bearing with double-side sealing, with a roller instead of inner ring. Retainer 4 prevents the bearing from axial displacement relative to the housing. Metal impeller 8 and hub 1 for pulley 2 installation are pressed in onto the bearing roller. Pump tightness is ensured using sleeve 9. Pump is closed using the cover 7 sealed with a paronite gasket.

Drain port 10 is provided in the pump housing for tightness control. If there is leakage through this port, repair the pump.

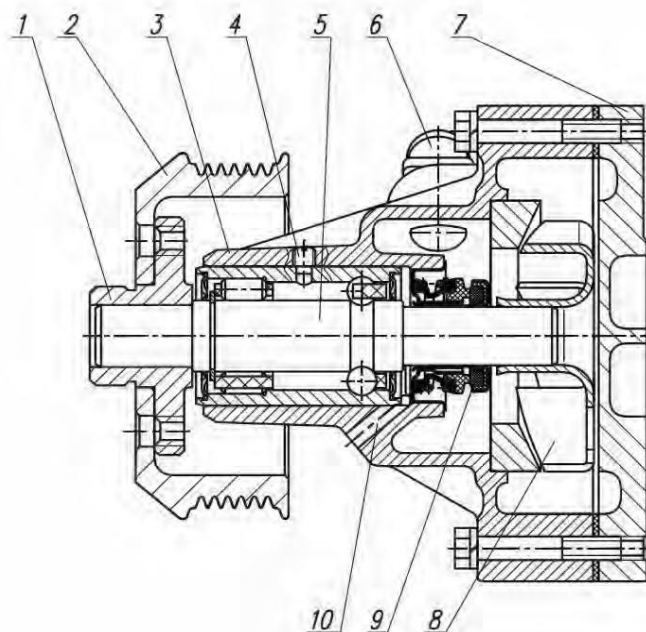


Figure 10 - Cooling system pump

1 - hub; 2 - pulley; 3 - housing; 4 - retainer; 5 - bearing; 6 - nozzle; 7 - cover; 8 - impeller; 9 - cuff; 10 - drain port.

Thermostat

Engine cooling system uses a single-valve thermostat with solid filler. Housed in a cast aluminum housing. Thermostat has the function of distributing the coolant between the small and large circuits of the engine cooling system depending on the position of the thermostat valve.

Figure 11 shows TA108-01K thermostat, a single-valve thermostat with solid filler that starts opening at 80 ± 2 °C, the stroke of the main valve at 95 ± 2 °C is min. 8.5 mm.



Figure 11 - TA108-01K thermostat

Thermostat automatically adjusts the temperature of the coolant. When the coolant temperature is below 80 °C, the thermostat valve is closed, and the fluid does not enter the radiator of the cooling system, the engine is warming up (Figure 12a). When the temperature of the fluid rises above 80 °C, the thermostat valve opens, and the coolant circulates through the radiator (Figure 12b).

Thermostat structure has drain port with air bleed valve when filling the cooling system. During the course of engine operation, pressure created in the cooling system forces the valve to rise and close the drain port, thereby preventing the leakage of fluid into the radiator, and accelerates engine warming up.

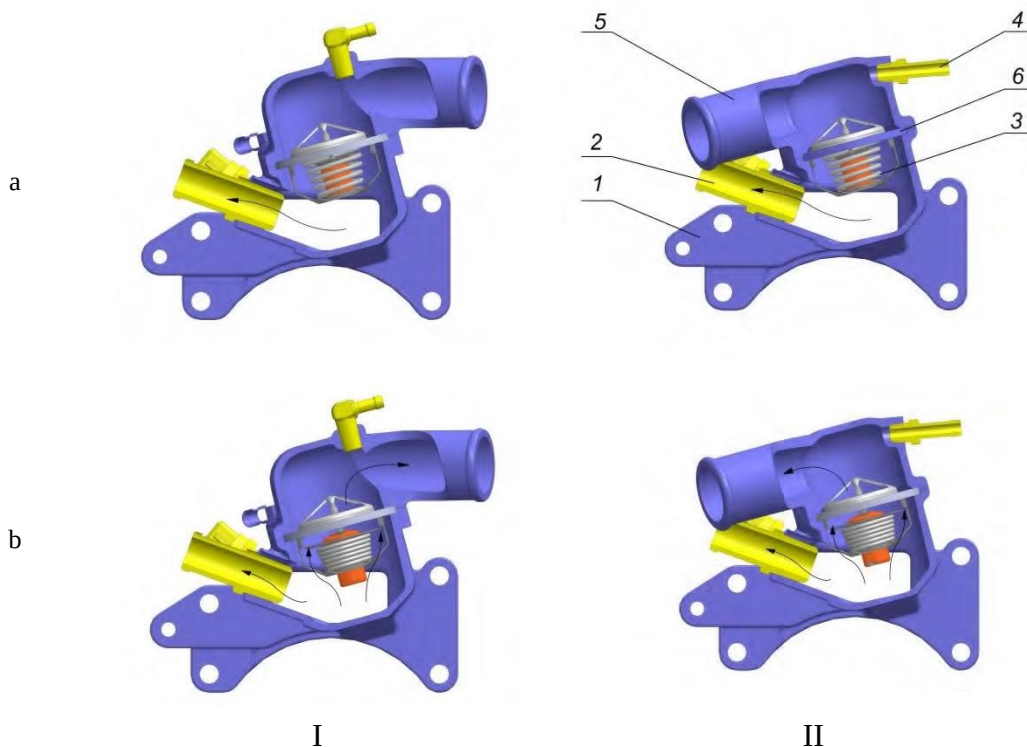


Figure 12 - Thermostat operation diagram

I - GAZelle Business; II - GAZelle NEXT; a - thermostat main valve is closed; b - thermostat main valve is open.

1 - thermostat housing; 2 - interior heating radiator nozzle; 3 - thermostat; 4 - vapor draw-off nozzle; 5 - thermostat housing stub; 6 - gasket.

Electromagnetic coupling

Design of the engine cooling system uses electromagnetic fan coupling (see Figure 13) controlled by the controller of the control system using a signal from the coolant temperature sensor.

Electromagnetic coupling design is shown in Figure 14.



Figure 13 - Electromagnetic coupling

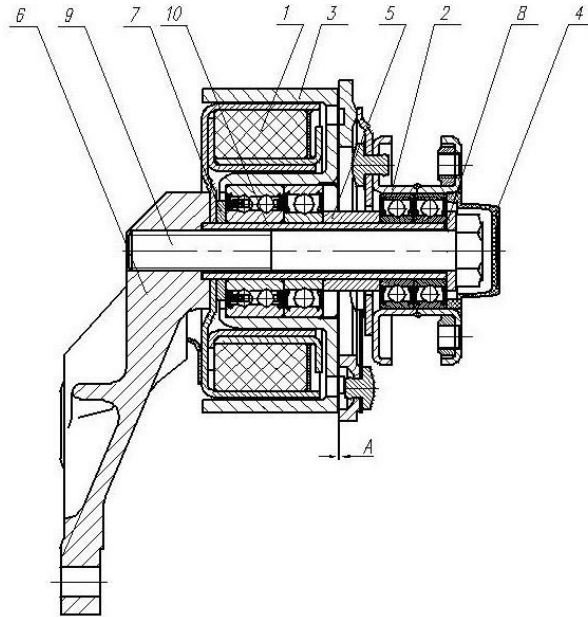


Figure 14 - Electromagnetic coupling

1 - coil with support and magnetic core; 2 - fan hub; 3 - pulley; 4 - blind plug; 5 - spacer sleeve; 6 - bracket; 7 - washer; 8 - thrust washer; 9 - axle; 10 - installation sleeve; $A = 0.4 \pm 0.1$ mm - gap between the end face of the pulley and the driven disk of the fan hub when there is no current in the coil.

Electromagnetic coupling is mounted on the front end of the engine. Its function is to control the temperature of the coolant by changing the air flow through the radiator grilles by turning the cooling system fan on/off. Coupling is controlled by the command from the engine control system controller.

After starting the engine with cold coolant, rotation of the pulley to the driven disk and the fan hub connected to it is not transmitted, because the end face of the pulley and the driven disk are separated by the gap A between them. Required gap is provided by adjustment of the position of the three petals of the driven disk limiter. In the extreme right position, driven disk is retained by three leaf springs.

After the engine warming up, and the coolant reaches plus 97 °C, coupling is triggered, and the fan installed on the hub 2 starts rotating.

When the temperature drops below plus 92 °C, EMC is turned off, hub with the fan stops rotating. When the coolant temperature rises over plus 97 °C, the process repeats.

Coupling maintenance is to check the gap A, and, if necessary, adjust it using a flat probe 0.4 mm thick by bending the three limiters of the driven disk.

Coupling requires cleaning from dust and dirt from time to time. Additional lubrication of the coupling bearings during the course of operation is not required.

Viscous coupling

For some engine designs, instead of electromagnetic coupling, a viscous coupling can be installed, which, together with the fan, is mounted on the fan support. Fan support is shown in Figure 15.

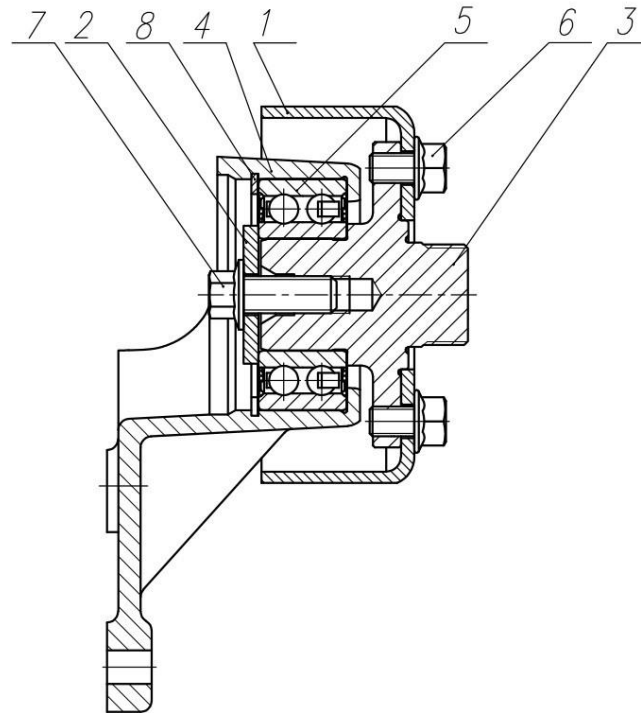


Figure 15 - Fan and viscous coupling support

1 - pulley; 2 - washer; 3 - fan drive shaft; 4 - fan support housing; 5 - double-row radial thrust ball bearing; 6 - M8 bolt; 7 - M10 bolt; 8 - thrust ring.

Fan support is a cast-iron housing 4 with pressed-in bearing 5 secured using thrust ring 8. Fan drive shaft 3 is installed into the inner ring of the bearing. Pulley 1 is mounted onto the flange of the shaft 3 using four bolts 6. Front end of the shaft has right-hand thread for viscous coupling installation with the fan.

During the course of operation, the fan support is maintenance-free.

3.6 Lubrication system

Engine lubrication system (Figure 16) is a combined system: pressure and spray. From the main oil line, oil flows through channels in the block and head to the friction surfaces.

Lubrication system includes oil pump with oil receiver and pressure relief valve (installed inside the oil pump), oil channels, oil filter, case, oil filler port, emergency oil pressure signaling device sensor 5, and fluid-oil heat exchanger. Through the oil receiver 2, the oil is sucked in by oil pump 1 and through FOHE it passes into the oil filter 4 from where it is fed into the main oil line through the drilled channel. From the oil line through the channels in the partitions of the block, oil is supplied to the crankshaft main bearings and to the camshaft supports.

Oil enters onto the crank pins through channels from the crankshaft main journals. To the axle of the rockers, oil is supplied from the rear camshaft support having annular groove that communicates through channels in the block, cylinder head, and in the fourth main strut of the rockers axle with the cavity of the rockers axle. Through the ports in the rockers axle, oil enters the sleeves of the rockers and then further, through the channels in the rockers and adjustment screws, to the upper tips of the pusher rods, and then into the hydraulic lifters.

From the fourth camshaft support, through the groove on the outer surface of the sleeve, oil is fed to lubricate the oil pump drive.

Oil flowing out of the fifth camshaft support into the block cavity between the shaft and the blind plug is drawn off into the case through transverse port in the shaft journal.

All other parts (valve - its rod and the face end, oil pump drive roller, camshaft cams) are lubricated by oil flowing from the gaps in the bearings and sprayed by moving parts of the engine.

All valves of the lubrication system during the course operation do not require any additional adjustment.

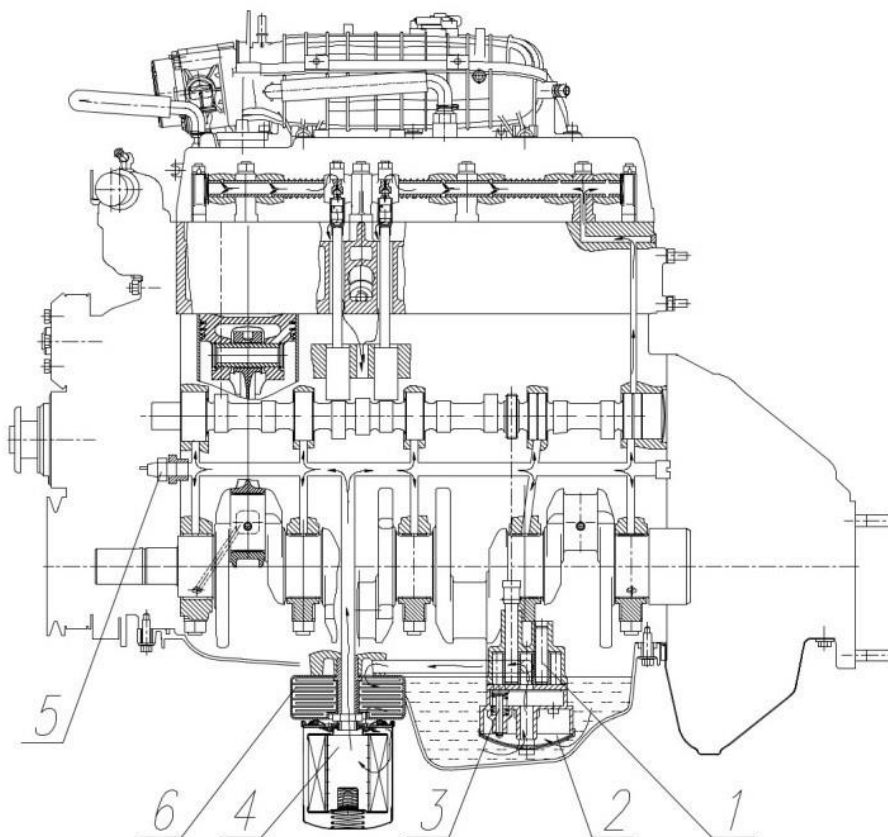


Figure 16 - Engine lubrication system

1 - oil pump with pressure relief valve; 2 - oil receiver; 3 - pressure relief valve; 4 - oil filter; 5 - oil emergency pressure signaling lamp sensor; 6 - fluid-oil heat exchanger.

Oil level in the case needs to be checked when the engine is stopped (at least 10 minutes after the engine was stopped). Your vehicle must be on flat horizontal surface. Oil level must be between the marks on the oil dip stick. If necessary (oil level below the “min” mark), add oil into the engine through the oil filler port on the valve cover and capped by the plug with rubber gasket. Too high oil level in the case - above the upper mark on the dip stick - can lead to elevated burning oil consumption, which is adverse for the performance of the piston rings and the neutralizer.

Oil pump

Oil pump (Figure 17) is the gear type pump installed inside the oil case and attached to the cylinder block using two bolts.

Drive cogwheel 4 is fixed to the roller 2 using a pin. On the upper end of the roller, there is a groove that the oil pump drive plate fits thereinto. Driven cogwheels 5 rotate freely on the axle pressed into the pump housing.

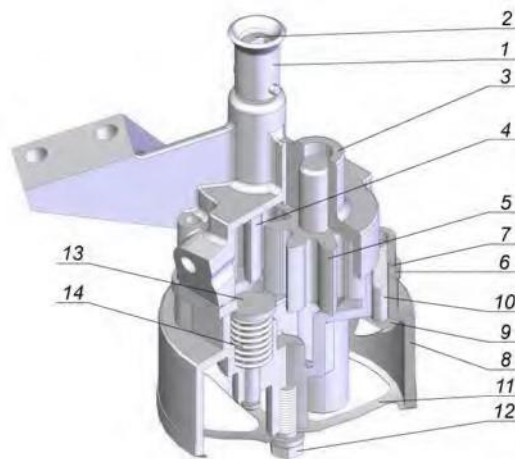


Figure 17 - Oil pump

1 - guide sleeve; 2 - roller assembly; 3 - housing; 4 - drive cogwheel; 5 - driven cogwheel; 6 - oil pump plate; 7 - gasket; 8 - oil receiver housing; 9 - retainer plate; 10 - bolt; 11 - mesh with frame; 12 - bolt; 13 - pressure relief valve; 14 - pressure relief valve spring.

Oil filter

Full-flow non-dismountable single-use oil filter. There is a bypass valve that bypasses the oil into the main line bypassing the filter element with high resistance (clogged, cold start). Bypass valve opens when the pressure difference at the input and output of the filter is 58-73 kPa (0.6-0.75 kgf/cm²).

Oil filter is mounted on the cylinder block on the right side of the engine.

To remove the filter, turn it counterclockwise. When installing a new filter on the engine, make sure that the rubber gasket is in good condition, then lubricate it with engine oil, and screw the filter manually until the gasket touches the plane of the block or FOHE, then rotate by additional 3/4 of the turn.

After installing the filter, starting and warming up the engine filled with oil to the operating temperature of the coolant, check for oil leakage around the oil filter. If leaking, tighten the filter. Stop the engine and wait for 10 minutes. Check oil level and top up if necessary.

Oil pump drive

Oil pump is driven from the camshaft using a pair of helical cogwheels: drive cogwheel 4 is positioned directly on the camshaft, driven cogwheel 3 is secured with a pin on shaft 5 that rotates in the drive housing 6. Oil pump drive plate is pivotally connected to the shaft lower end, bottom part of the plate enters the groove of the oil pump roller 1. A spiral groove is cut out in the opening of the drive housing. Oil rises up and is evenly distributed along the entire shaft length when the shaft is spinning.

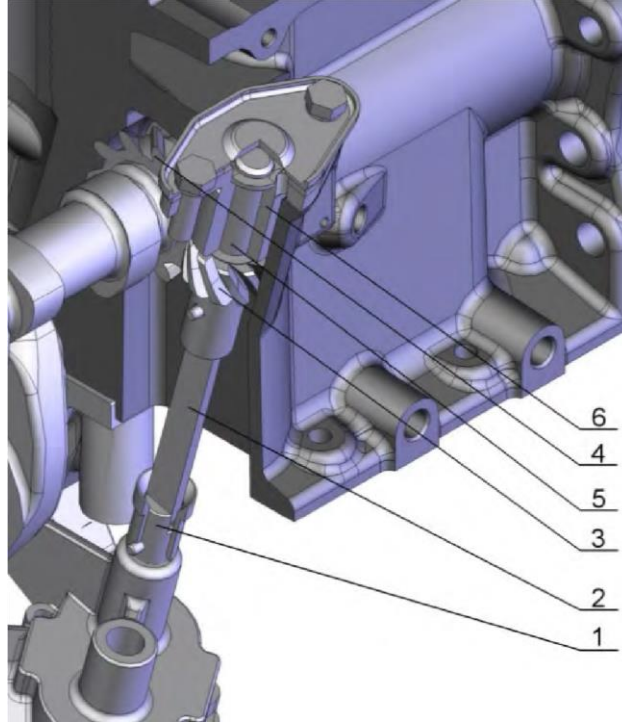


Figure 18 - Oil pump drive

1 - oil pump roller; 2 - oil pump drive plate; 3 - driven cogwheel; 4 - drive cogwheel; 5 - shaft of the drive; 6 - drive housing.

3.7 Crankcase ventilation system

Crankcase ventilation system is a closed system that functions due to vacuum in the engine intake system.

Crankcase ventilation system is shown in Fig. 20. Gases breaking through the compression rings are drawn off into the input passage using a combined manner via two branches. The system functions due to the pressure difference between the intake passage and the oil case.

Major branch ensures removal of the crankcase gases during the course of the engine operation at full load or near full load. When the engine is running at low load and in idle mode, gases from the crankcase are removed via the minor branch of ventilation. In the minor branch, a ventilation valve (PCV) is provided, which maintains the vacuum in the engine oil case at the required level.

At the same time, a device is provided in the rockers cover that separates suspended oil from the crankcase gases and returns it back to the oil case.

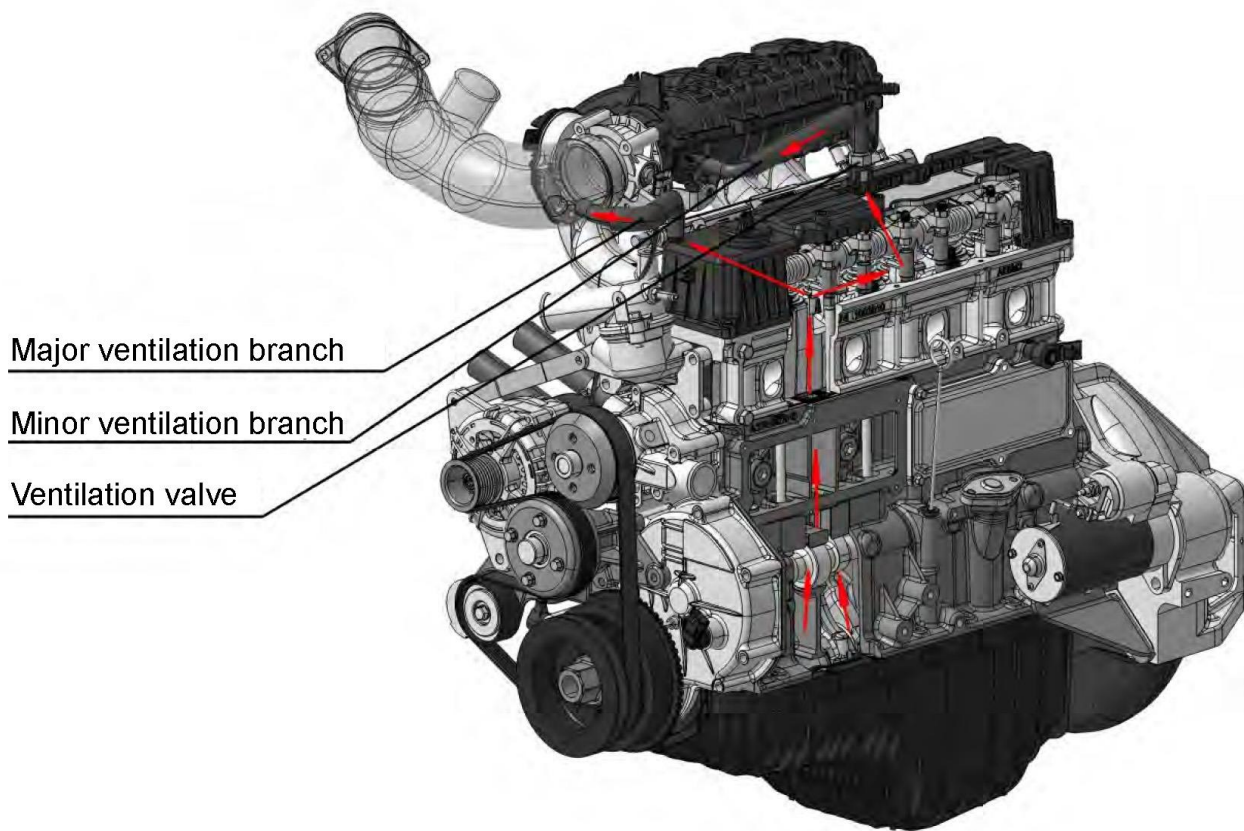


Figure 19 - Crankcase ventilation system

3.8 Clutch

Design

Clutch (ZF Sachs) is single-disk, dry, with diaphragm pressure spring.

It is mounted on flywheel 1 using aligner. It is secured using alignment bolts 7.

Clutch pressure disk consists of a housing 4, disk 3, diaphragm spring 5, and support rings 6.

Clutch housing 4 is stamped from steel.

Diaphragm spring 5 is stamped from sheet spring steel.

Clutch driven disk is an assembly unit consisting of a hub, friction inserts, and damping springs.

ATTENTION!

JSC UMZ dynamically balances the crankshaft, flywheel, and clutch assembly.

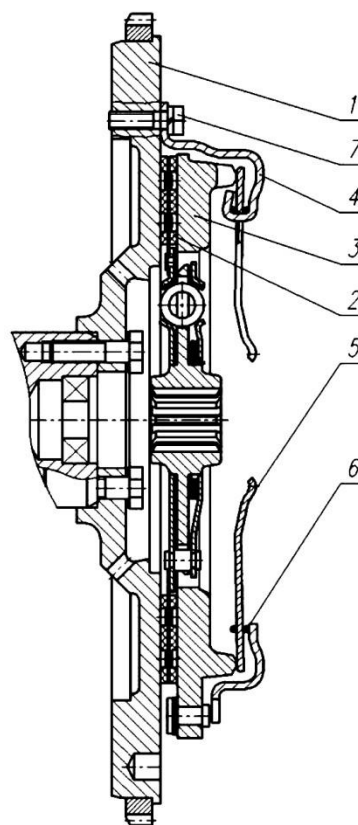


Figure 20 - Clutch

1 - flywheel; 2 - driven disk, 3 - pressure disk;
4 - clutch housing; 5 - diaphragm spring; 6 - support
ring; 7 - alignment bolt.

To check the clutch technical condition.

After removal from the engine, inspect the clutch disk carefully, pay attention to the reliability of riveted connections, make sure there are no bends, wear, cracks, nicks, and breaks on the pressure disk and driven disk, spring plates, springs, hub, housing, and other parts of the mechanism.

Pressure disk.

If there is no visible damage on the pressure disk, such as scratches, annular grooves, burns, and galling more than 0.3 mm on the working surface, wear of the ends of the petals of the diaphragm spring more than 0.3 mm, deformation of the connecting plates, gaps between them, etc. - check the position of the ends of the diaphragm spring petals and the smoothness of the disk disengagement process.

To do so, secure the pressure disk on the working surface of a new flywheel (Fig. 20) by placing three evenly spaced washers 7.8 mm thick between them. Secure the disk using 6 bolts with uniform application of the load until tightening torque 20-25 Nm (this is to prevent warping of the housing and, accordingly, increased runout of the diaphragm spring petals). Distance between the end of the flywheel and the ends of the petals should be 42 ± 1 mm. Deviation from the position in one plane of the petals is max. 0.65 mm. When moving the ends of the petals by 8.5 mm, pressure disk should move away by at least 1.4 mm.

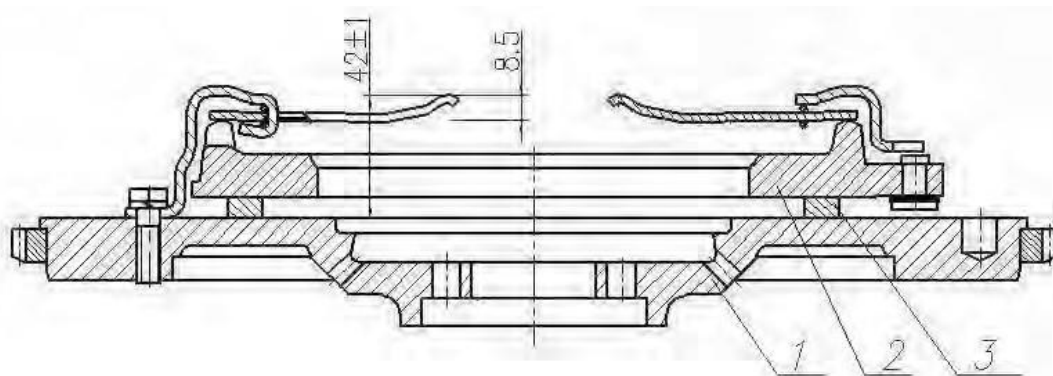


Figure 21 - Pressure disk checking

1 - flywheel; 2 - pressure disk; 3 - washer.

Driven disk.

Clear small nicks, burr, and rust on splines of the driven disk.

To control the face runout of friction surfaces (inserts), install the disk with tightening onto the splined shaft (to exclude the influence of gaps in the splines). Then, install the shaft in the centers of the device and measure the runout at the edge of the disk. Runout should be max.

1.2 mm. With greater runout, the disk needs to be replaced.

To control flatness, put the disk onto a new flywheel, and use the probe to measure the gap between the covers and the flywheel. Control on both sides of the disk.

If the sum of the deviations of the face runout and flatness exceeds 1.25 mm, then the disk needs to be replaced.

Possible clutch malfunctions

No.	Possible causes of malfunction	Solution
1	Clutch is not disengaging.	
1.1	Clutch pedal fall	
1.1.1	Malfunction in the clutch mechanism.	Replace defective parts.
1.1.2	Air in the hydraulic drive system.	Tighten the connections, bleed air from hydraulic drive system.
2	Clutch is not fully disengaging.	
2.1	Incorrect clutch adjustment.	
	Gaps in the drive are too big.	Adjust the clutch drive according to the vehicle User Manual. Contact service station to adjust the clutch drive
2.2	Clutch drive malfunction.	
2.2.1	Air in the hydraulic system.	Tighten the connections, bleed air from the system.
2.2.2	Skew or wear of the declutching fork.	Replace the fork.
2.2.3	Wear or skew of the guide sleeve of the release bearing (gearbox input shaft cover).	Face runout of the surface of the flange adjacent to gearbox should be max. 0.05 mm. Replace the worn sleeve.
2.3	Driven disk warpage	
2.3.1	Disk deformation due to overheating.	When the face runout of the surface of the disk is more than 1.2 mm, replace the disk.
2.4	Pressure disk warpage or skew	
	Deformation of the disk caused by overheating, mechanical impact.	Replace the pressure disk assembly.
2.5	Diaphragm spring petals are not in the same plane.	
	Damage during installation.	Petals can step up (or down) relative to each other by max. 0.65 mm. Bend the petals or replace the pressure disk assembly.

2.6	Diaphragm spring petals breakage	
	Incorrect clutch installation using excessive force.	Replace the pressure disk assembly.
2.7	Wear of the diaphragm spring petals in contact location with the pressure bearing	
2.7.1	Release bearing jamming.	Replace the bearings and the pressure disk assembly.
2.7.2	Engine and gearbox misalignment.	Align; replace the pressure disk assembly.
2.7.3	Release bearing guide sleeve skew (gearbox input shaft cover).	Face runout of the surface of the flange adjacent to gearbox should be max. 0.05 mm. Replace pressure disk assembly and worn gearbox input shaft cover
2.8	Uneven wear, burr on the working surfaces of the flywheel and pressure disk	
	Wear of the driven disk inserts to the limit residual thickness (rivet heads must be recessed to depth at least 0.2 mm)	Replace the driven disk.
2.9	Driven disk hub jamming on the gearbox input shaft splines.	
	There are foreign particles on the surface of the splines	Clean and lubricate the splines surface.
2.10	Driven disk hub damage (nicks)	
	Wrong installation of the gearbox using excessive force (drive disk was not aligned during installation).	In case of small nicks, treat the surfaces. If damage is significant, replace the disk.
2.11	Wear of splines on the driven disk hub (forming of conical teeth)	
2.11.1	Gearbox input shaft support bearing problem.	Replace the bearing and/or driven disk.
2.11.2	Engine and gearbox misalignment.	Eliminate the cause, replace the disk.
2.12	Bent and/or broken connecting plate of the pressure disk	
2.12.1	Damage during installation.	Replace the pressure disk assembly.
2.13	Driven disk is bent (“dish-shaped”)	
	Hub flange is bent due to improper Installation of the gearbox	Replace the driven disk.
2.14	Driven disk plates are broken on one side.	
	Gearbox skew during wrong installation.	Replace the driven disk.
2.15	Driven disk plates are broken all over	
2.15.1	Gearbox skew during wrong installation.	Replace the driven disk.
2.15.2	Gearbox input shaft bearing problem.	Install a new bearing.
2.16	Rivets loosening, friction insert tear off	
	Friction inserts excessive wear	Replace the driven disk.
2.17	Driven disk friction inserts are stuck to flywheel and/or pressure disk	
	Vehicle was not used for a long time.	Repair.
3	Clutch is not fully engaging (slipping).	
3.1	Oiled flywheel, pressure plate, friction inserts of the driven disk	
	There is oil on friction surfaces entering through worn-out engine or gearbox cuffs.	Eliminate the cause of oiling. Thoroughly wash oily surfaces with gasoline or white spirit, and wipe dry.
3.2	Incorrect clutch adjustment	
	Small or no clutch pedal free stroke.	Adjust the drive.
3.3	Pressure plate point-like overheating	
3.3.1	There is oil on friction surfaces entering through worn-out engine or gearbox cuffs.	Eliminate the cause of oiling. Thoroughly wash oily surfaces with gasoline or white spirit, and wipe dry. In case of significant damage, replace the disk.
3.3.2	Small or no clutch pedal free stroke.	Adjust the drive. In case of significant damage, replace the disk.
3.3.3	Consequence of inept driving style (mistakes when towing and shifting the gears).	Follow vehicle driving recommendations. In case of significant damage to the disk, replace the disk.

3.4	Pressure disk breakage	
	Pressure disk overheating caused by prolonged slipping due to: – oiled inserts; – inserts wear; – malfunctions of the declutching drive.	Eliminate the cause, replace the drive assembly.
3.5	Overheating and deep grooves on the surface of the pressure disk	
3.5.1	Malfunction of the declutching drive.	Repair. Replace the pressure disk assembly.
3.5.2	Wear of the drive disk inserts to limit thickness	Replace the pressure disk assembly, driven disk.
3.6	Driven disk friction inserts wear or burn	
	Malfunction of the declutching drive.	Eliminate the cause, replace the driven disk.
3.7	Friction inserts surface carbonization or delamination	
	Driven disk overheating caused by prolonged slipping due to: – oiled inserts; – malfunction of the declutching drive;	Repair. Replace the driven disk.
3.8	Galling on the pressure disk diaphragm spring petals	
3.8.1	Release bearing jamming.	Replace the bearing and pressure disk assembly.
3.8.2	Malfunction of the declutching drive (exceeding the constant pressure force of the release bearing on the diaphragm spring petals when the clutch is engaged).	Adjust the drive, replace the pressure disk assembly.
3.8.3	Misalignment of the engine and gearbox after replacing the clutch casing.	Align; replace the pressure disk assembly.
3.8.4	Release bearing guide sleeve skew (gearbox input shaft cover).	Face runout of the surface of the flange adjacent to gearbox should be max. 0.05 mm. Replace pressure disk assembly and worn cover of the input shaft.
3.9	Diaphragm spring reduced force.	
	Pressure disk overheating.	Replace the pressure disk.
4	Vehicle snatching when operating the clutch.	
4.1	Vehicle snatching when starting movement.	
4.1.1	Foreign particles, rust on the surface of the splines of the driven disk hub and gearbox input shaft.	Clean and lubricate the splines surface.
4.1.2	Oiled friction inserts.	Eliminate the cause of oiling. Thoroughly wash oily surfaces with gasoline or white spirit, and wipe dry.
4.1.3	Incorrect adjustment of engine systems.	Adjust engine systems.
4.1.4	Driven disk deformation.	When the face runout of the surface of the disk is more than 1.2 mm, replace the disk.
4.1.5	Loosening of the driven disk friction inserts, wear or cracks on the inserts.	Replace the disk.
4.1.6	Burr on the working surfaces of the flywheel or pressure disk.	Eliminate burrs or replace flywheel and pressure disk assembly.
4.2	Driven disk hub splines damage (nicks)	
	Wrong installation of the gearbox using excessive force (drive disk was not aligned during installation).	If damage is significant, replace the disk.
4.3	Diaphragm spring petals are bent	
	Petals are bent if the clutch is installed incorrectly.	Replace the pressure disk assembly. Petals can step up (or down) relative to each other by max. 0.65 mm.
4.4	Bent and/or broken connecting plate of the pressure disk	
4.4.1	Damage during transportation, installation	Replace the pressure disk assembly.
4.4.2	Consequence of inept driving style (mistakes when towing and shifting the gears).	Replace the pressure disk assembly.

5	Noise during clutch operation	
5.1	Uniform noise when the clutch is engaged or disengaged	
	Wear, damage to the clutch pressure bearing.	Replace the bearing.
5.2	Wear of driven disk hub splines	
5.2.1	Gearbox input shaft support bearing malfunction.	Replace the bearing and/or driven disk.
5.2.2	Engine and gearbox misalignment.	Align, replace the disk.
5.2.3	Release bearing guide sleeve wear or burr (gearbox input shaft cover).	Replace driven disk and worn cover of the input shaft.
5.3	Galling on the pressure disk diaphragm spring petals	
5.3.1	Release bearing jamming.	Replace the bearings and the pressure disk assembly.
5.3.2	Engine and gearbox misalignment.	Align. Replace the pressure disk assembly.
5.3.3	Release bearing guide sleeve skew (gearbox input shaft cover).	Face runout of the surface of the flange adjacent to gearbox should be max. 0.05 mm. Replace pressure disk assembly and worn cover of the input shaft.
5.4	Wear of thrust pins, destruction of the driven disk torsion vibration damper	
	Consequence of inept driving (destruction when driving in high gear at low speed and full load).	Replace the driven disk.
5.5	Torsion vibration damper spring breakage	
5.5.1	Malfunction of the declutching drive.	Repair the drive, replace the driven disk.
5.5.2	Engine and gearbox misalignment.	Align, replace the driven disk.
5.5.3	Incorrect adjustment of engine systems.	Adjust the systems, replace the driven disk.

4 ACCESSORIES AND ADDITIONAL EQUIPMENT

4.1 Starter

Starter (11.131.675, LLC Pramo-Electro) is a DC electric motor with excitation from permanent magnets, with electromagnetic relay, planetary gear, and freewheel clutch, for short-time operation with continuous operation period up to 10 s, powered by battery with capacity 55-90 Ah. At negative temperatures, duration of up to 15 s is permissible.



Figure 22 - Starter 11.131.675

ATTENTION!

- Do not propel your vehicle using the starter. This can lead to starter failure.
- In winter, do not start your cold engine by continuous starter operation, if it has not been preheated. Otherwise, the starter and the battery can be damaged.

4.2 Alternator

Alternator (5122.3771-50, LLC Pramo-Electro, or 32182.3771, LLC BATE) is a three-phase AC electric machine with built-in rectifier and limiter unit, and integrated voltage regulator designed to operate as a source of electrical power in parallel with the battery in the vehicle electrical system. On the DC side, the rated voltage is 14 V, the rectified current is at least 115/110A (Pramo-Electro/BATE).

Rectifier limiter unit provides rectification of three-phase alternating current and limits the voltage pulses in the vehicle electrical system.



Figure 23 - Alternator

Voltage regulator is designed for automatic regulation within the preset voltage range at the alternator output.

During the course of operation, control the operation of the alternator according to the indication of the battery discharge indicator in the vehicle instrument cluster.

⚠ ATTENTION!

- Do not, even for short time, connect the terminals of the regulator and alternator to each other or to the body. Otherwise, the voltage regulator will be damaged.
- Do not operate the engine with the battery disconnected.
- Do not start the engine when the positive lead of the alternator is disconnected, as this causes increased voltage on the rectifier, which is dangerous for the rectifier diodes.
- Do not troubleshoot the alternator and voltage regulator by megaohmmeter or using the lamp powered from grid with voltage more than 36 V.
- When washing the engine, do not spray water jet directly onto the alternator.

Alternator maintenance

Check the condition of the alternator brush assembly. Working surface of the contact rings should be smooth and without significant “burnout”.

- in case of contamination or significant “burnout”, wipe the contact rings using clean fabric moistened with gasoline;
- clean contact rings with fine sand paper (C 100), if dirt or “burnout” cannot be removed by wiping;
- make sure that the brushes move freely (no jamming) in the brush holder;
- replace the brush holder with voltage regulator with brush yield at least 7 mm or if brushes have significant chips;
- if the alternator is noisy, replace the bearings.

4.3 A/C compressor

Air conditioner compressor (SD5S11 or SD7H15, SANDEN) ensures the functioning of the vehicle climate system.



Figure 24 - Air conditioner SD7H15

4.4 Automatic tensioner

Automatic tensioner (4216.1029010, Litens) is designed to keep the required tension of the units drive belt. No manual adjustment required.



Figure 25 - Automatic tensioner 4216.1029010

To remove/install the accessory drive belt

Procedure:

1. Turn the tensioner (1) clockwise using the wrench S = 15 (3)
2. Lock the tensioner with a steel rod diam. 3.5-4 mm (2).
3. Remove the accessory drive belt (4).
4. Install the belt using the reverse order.

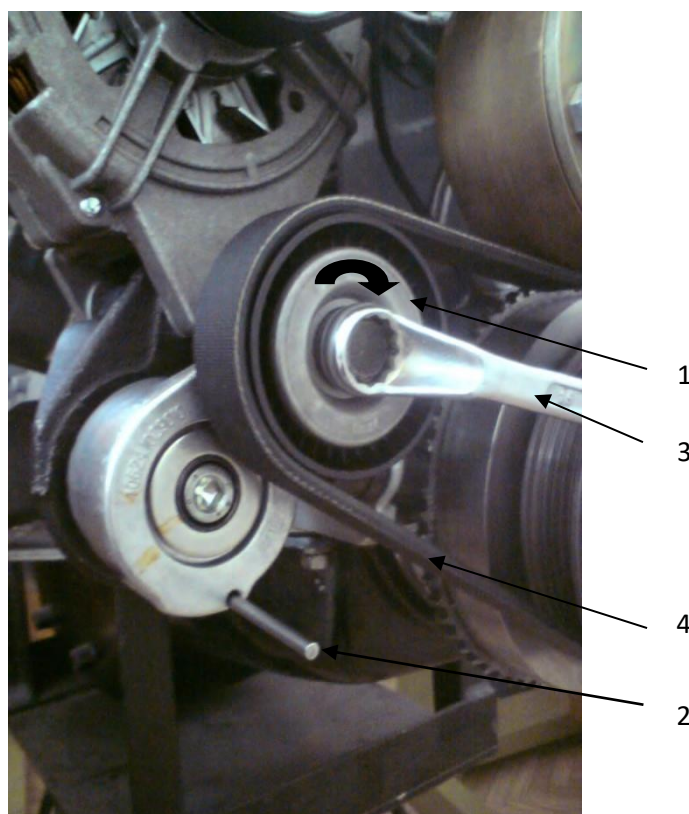


Figure 26 - Belt removal/installation

4.5 Drive belt

ATTENTION!

When checking the drive belt of the engine accessories in your vehicle, make sure that the ignition switch is in the “OFF” position.

Visually inspect the belt, pay attention to signs of abnormal wear, cuts, delamination, and loose tension. If the belt is worn, damaged, or loose, contact GAZ authorized dealer for replacement of the belt or tensioner.

5. ENGINE CONTROL SYSTEM

5.1 Vehicle Integrated Microprocessor Engine Control System (IMECS)

IMECS main functions:

- optimization of engine operation in terms of compliance of the vehicle with Euro 5 environmental standards regarding emission of harmful substances and external noise;
- ensuring operation of the engine installed on the vehicle in all modes regarding the fuel-efficient driving, starting and driving qualities of the vehicle;
- prediction and tracking the technical condition of the engine and control system elements.

IMECS components:

- controller (or electronic control unit);
- sensors
- fuel supply system actuators and assemblies;
- ignition system actuators;
- cooling system actuator mechanism;
- neutralization system devices.

Controller, sensors, actuators, assemblies, and devices of the systems are interconnected using the wire harnesses, hoses, and tubes.

During the course of operation, IMECS sensors transmit information about the current status of the engine and the driver's operation of the vehicle's controls to the controller that having processed the information by actuators and relays controls the operation of the engine by operating the throttle intake choke, changing the fuel injection duration, and ignition angle.

5.2 IMECS sensors included into the engine package.

Crankshaft position sensor is a synchronization sensor DG-6P-K (0 261 210 331, BOSCH), inductive type. Sensor is paired with a synchronization disk with 60 teeth, with the two of these teeth removed. Tooth notch is the phase mark of the position of the engine crankshaft: Beginning of the 20-th tooth of the disk corresponds to the TDC of the first or fourth engine cylinder (teeth are counted after two removed teeth along in the direction of the crankshaft rotation). Sensor is used by IMECS for synchronizing the control over actuators with the engine timing mechanism. Sensor is installed in front of the engine, on the left side, on the flange of the camshaft cogwheels cover. The gap between the end face of the sensor and the teeth of the synchronization disk should be within 0.3-1.8 mm.



Figure 28 - Crankshaft position sensor

Camshaft position sensor is a phase sensor PG 3.8 (0 232 103 097, BOSCH), an integral sensor based on the Hall effect (magnetoresistive effect) with built-in amplifier and signal conditioner. Sensor is paired with a marker pin installed on the hub of the camshaft cogwheel. The moment of matching of the middle of the marker pin with the camshaft position sensor corresponds to the coincidence of the middle of the first tooth of the synchronization disk with the crankshaft position sensor. Sensor is used in determination of the TDC (top dead center) phase of the first cylinder, i. e. it allows to determine the beginning of the next engine rotation cycle. Sensor is installed in front of the engine, on the right side, on the camshaft cogwheels cover. Nominal gap between the end face of the sensor and the marker pin must be within 0.2-1.8 mm.



Figure 29 - Camshaft position sensor PG 3.8

Coolant temperature sensor TF-W (0 280 130 093, BOSCH) is the resistive type sensor used in monitoring the thermal condition of the engine. Sensor is installed in the thermostat housing. According to the information received from the sensor, the controller corrects the fuel supply and the ignition timing, and also sends signals to the relay, which turns the electromagnetic coupling of the cooling fan on and off and controls the red warning lights for “high-high coolant temperature” and “STOP” on the instrument panel.



Figure 30 - Coolant temperature sensor

Absolute pressure sensor (110308-0239010, LLC Mika-Motor) is structurally combined with air temperature sensor. It measures the pressure in the receiver, which varies depending on the load, and simultaneously determines the temperature of the air entering the engine. Sensor is mounted on the receiver, on the top side.



Figure 31 - Absolute pressure sensor

Oil emergency pressure sensor (6022.3829-03, LLC PO PZ Electromekkhizmereniye), contact type, installed in the engine oil line. Sensor signal is used by the controller to control the red warning light for emergency oil pressure, and “STOP” signal, and the red warning light for critical engine failure. Contacts are closed when the pressure is 0.4-0.8 kgf/cm² (0.04-0.08 MPa).



Figure 32 - Emergency oil pressure sensor

Knock sensor KS-4-S (0 261 231 176, BOSCH) is the piezoelectric type sensor used in determination of detonation in the engine cylinders, and allows the controller to adjust the ignition timing. Sensor is mounted on a special-purpose nut that secures the head of the block, on the left side, between the second and third cylinders.



Figure 33 - Knock sensor KS-4-S

5.3 Fuel supply system

Actuators and assemblies of the fuel supply systems in all operation modes provide the engine with the supply of fuel and air in the amount necessary for optimal operation.

Electromagnetic gasoline injectors - MULTEC 3.5 (28316657, Delphi) are designed for dosing and fine atomization of the fuel. Injectors are high-precision hydraulic valves actuated by quick-acting electromagnet. Amount of injected fuel depends on the duration (width) of the current pulse, which is determined automatically by the controller for each engine operation mode. Injectors are installed on the rail and attached to it using special-purpose plates. Tightness of the joints at the connection points between the injectors and the cylinder head and the rail is ensured by silicone rings.



Figure 34 - Delphi injector

Fuel pressure fluctuation damper (A2C58067310, Continental) is a special-purpose device designed to damp pressure fluctuations in the fuel rail of the engine and ensure stable pressure in the rail during engine operation.



Figure 35 - Continental fuel pressure fluctuation damper

Fuel module (4216.1104010-20, LLC Fuel Systems) serves to deliver, supply, and distribute the fuel to the engine cylinders and ensure its stable operation in all modes. Module includes a damper, injectors, and a diagnostic nozzle.

Diagnostic nozzle is for controlling the pressure in the fuel supply system using special-purpose equipment and to bleed the air from the system that can accumulate in case of emergency (when the fuel tank is emptied completely, excessive increase in fuel temperature in the system, etc.). Diagnostic nozzle has external thread 7/16"-20 UNF-2ACTH 37.101.1001-72, and is capped from the outside.



Figure 36 - Fuel module 4216.1104010-20

Throttle intake with electric drive (28316394, Delphi) by moving the throttle valve controls the amount of air entering the engine intake system in all possible modes of engine operation (including idling). Using the throttle intake and accelerator drive pedal module, the function of the remote control over the throttle valve (“electronic accelerator”) is implemented. The following is integrated into the throttle intake: electric motor, throttle choke, gear, throttle choke position sensor, and electrical connector for connecting the mating part from the low-voltage harness of the electronic engine control system. Throttle intake functioning in the IMECS system allows to minimize emissions of harmful substances, and optimize the fuel consumption.



Figure 37 - Delphi throttle intake

Intake module is a receiver, receiving pipes, and throttle intake as a single unit. This device, due to the use of resonant oscillations of the air column (in each inlet stub pipe between the receiver and the inlet valve), has the effect of recharging the cylinders with air and thereby increases the engine power.

Throttle device is attached to the receiver from the front end. Through a special-purpose nozzle, a minor branch of the crankcase ventilation is connected to the receiver. Receiver has a nozzle for connecting the vacuum brake booster and adsorber purge valve. Absolute pressure sensor with integrated air temperature sensor is installed on top of the receiver.

For normal engine operation, all joints of the inlet pipe flanges with the receiver and the throttle intake, installation points of the nozzles and the hoses connected to them, as well as the locations to install the nozzles into the head, must be tight (with no air leakage).

5.4 Ignition system

Ignition system is a non-contact system with low-voltage distribution of control pulses along the corresponding channels of the dual ignition coil. Actuators of the ignition system are used for generating the high voltage that is needed to ignite the combustible mixture and transfer it through the cylinders.

Dual ignition coil (54.3705, FGUP PO Sever) provides high voltage simultaneously to the plugs of two cylinders, whose pistons are near the top dead center. At the same time, in one of the cylinders of each pair there will be the end of the compression stroke, and in the other - exhaust stroke. Mixture will ignite in the cylinder where the compression stroke is performed. For correct connection of the high-voltage wire harness, the ignition coil housing is marked with the corresponding engine cylinders.



Figure 38 - Dual ignition coil 54.3705

Spark plugs (ELR9QC10, Yuratech). Length of the threaded screw-in part is 26.5 mm, with interference suppression resistor, gap between the electrodes is 1.0-0.1 mm.



Figure 39 - Spark plug ELR9QC10

⚠ ATTENTION!

- When dismantling spark plugs, use only special-purpose wrench. Faulty tools can damage the spark plugs.
- For replacement, use only the recommended type of the spark plugs.
- Tighten the spark plug with torque 14.70-19.61 N•m (1,5-2,0 kgf•m).

Have the spark plugs replaced at service stations of the authorized GAZ dealer with replacement intervals according to the service book.

High-voltage wire harness (4216.3707080-24, JSC Tesla Blatna) with resistance distributed along the length and silicone tips. Wires are marked according to the cylinder to be connected. Resistance of the wires, depending on the length, should be within the range 2.7-9.9 kOhm.



Figure 40 - High voltage wire harness
4216.3707080-24

⚠ ATTENTION!

- Do not touch or attempt to dismantle the ignition wires while the engine is running!
- Operations with live ignition system is hazardous for your life!
- After turning off the engine, allow it to cool down, and only after that proceed to work.
- Repair operations must be performed by qualified personnel.



Right



Wrong

Figure 41 - Installing of the harness onto the engine

5.5 Measures for safe IMECS operation

1. Before starting the engine, make sure that the battery is connected securely.
2. When the engine is running, do not disconnected the battery from the vehicle grid.
3. Dismantle and install the elements of the IMECS system only after disconnecting the negative wire of the battery.
4. In case of charging from an external source, the battery must be disconnected from the vehicle electrical system.
5. Water is not allowed on the IMECS connectors.

⚠ ATTENTION!

IMECS should be diagnosed by a specialist with appropriate level of training.

6 SAFETY

ATTENTION!

Do not start operation, repair, and maintenance if not familiar with this Manual. Accident can occur if described procedures and safety requirements are not respected.

6.1. General requirements

1. Do not modify the design and structure of the engine and the wiring. Otherwise, this may disrupt the safe operation of the vehicle.
2. Do not warm up the engine in a closed room that does not have good ventilation, so as to avoid carbon monoxide poisoning.
3. During the course of maintenance and repair, use appropriate personal protective equipment (overall, safety goggles, ear muffs, etc.).
4. Do not wear loose clothing when servicing and adjusting the engine.
5. Engine should only be operated using the fuel recommended by this Manual in the “Operating materials” section.
6. Do not run the engine without oil and/or coolant.
7. If there is noise and knocks in a running engine, find out the cause of their occurrence. Do not operate the vehicle until repaired.
8. Do not operate the vehicle without the thermostat in the cooling system.
9. During the course of maintenance and repair, if there are no special requirements, follow these instructions:
 - use only recommended tools and equipment in good order;
 - stop the engine;
 - activate parking brake;
 - do not work with the engine when the engine is running or right after the engine is stopped;
 - do not service (repair or replacement) the units with the engine running or right after the engine is stopped (overpressure 4 kgf/cm² is maintained in the fuel supply system).
10. In the running engine, the coolant is hot and pressurized. If instantly depressurized, the coolant turns into vapor. Any contact with hot coolant or vapor can cause severe burns. Therefore, do not repair or service the cooling system when the engine is hot.

When working with non-freezing fluid of the engine cooling system, follow these rules:

 - avoid any operations that can lead to ingestion of the fluid or vapor;
 - do not wait until the fluid on the skin dries out. Wash it off right away using warm water and soap;
 - do not spill fluid in the engine compartment of your vehicle or in the room. Wash contaminated location with water, and ventilate the room;
 - dry contaminated clothes outdoors before washing.

6.2 Fire safety

Cause of engine fire under certain conditions may be the ingress of oil or fuel onto hot surfaces, or faulty wiring. Fire can lead to personal injury, or even death. To avoid fire in the engine compartment, follow these requirements:

1. Make sure that there are no gas leaks from the fuel lines and hoses.
2. Tighten all threaded connections using tightening torques recommended in this Manual. Oil leak can cause fire.
3. During the course of repair and maintenance, keep fuels and lubricants in a safe place.
4. Avoid getting oily cloth and other flammable materials onto the engine.
5. Make sure that the manifold shield is secure. It limits the heat flow from the exhaust manifold to the fuel line.

6. Check wiring to make sure that the insulation is in good condition and there are no loose connections.
7. During the course of maintenance, inspection, or repair, use low-voltage lighting max. 36 V.

**ATTENTION!**

Do not use open flame to heat the engine oil case at low ambient temperatures.

Oil case is made of plastic!

Do not smoke:

- when filling fuel and oil;
- during engine maintenance or repair.

Always have a fire extinguisher ready.

7 ENGINE MAINTENANCE

Maintenance intervals

Frequency and types of maintenance for A275 engine are listed in Table 2 and correspond to the frequency and types of maintenance of the GAZelle family vehicles specified in the User Manuals for these vehicles.

Table 2

Types of maintenance	Intervals (vehicle mileage, km)	
	Business	NEXT
1. Daily maintenance (DM)	-	-
2. First maintenance (M-1)	15000	20000
3. Second maintenance (M-2)	30000	40000

Maintenance tasks are listed in the service book supplied with the vehicle.

7.1 Timing mechanism maintenance

Hydraulic lifters (356230C, EATON, or F-46318.37, SL) provide a gap-free kinematic connection of the parts in the timing mechanism throughout the entire service life of the engine. Maintenance of the mechanism is the periodic control on the running engine that there are no distinctive knocks in the timing mechanism.



Figure 42 - Hydraulic lifter (appearance)

After cold-starting, knocks of the valves hydraulic lifters may occur, which should disappear as the engine warms up to the working temperature of the coolant, plus 80-90 °C. If knocking is persistent after 30+ minutes after reaching the specified temperature, check the hydraulic lifters as follows.

Knocking that occurs when cold-starting, repeated attempts to start the engine (with several unsuccessful starting attempts), starting the engine after a long downtime, and disappearing subsequently with engine warming is not a malfunction of the hydraulic lifter. In this case, the reason of knocking is the ingress of air into the high-pressure chamber of the hydraulic lifter, which leads to loss of its rigidity, and the valve actuator operates with knocking.

To remove air, it is recommended that when the engine is idling, do the following:

1. Start and warm up the engine to the working temperature of the coolant.
2. Set the increased speed of 2000-2200 rpm by opening the throttle for 3-4 minutes, listen how the engine runs at idling rpm 800 ± 50 rpm for 15-30 seconds, knocking should disappear.
3. If knocking is still there, repeat the cycle. This cycle can be repeated up to 5 times.
4. If knocking is persistent, run the engine for 15 minutes at 2200-2500 rpm, and then listen how the engine runs at idle rpm.

Knocking should disappear. Otherwise, the valve train needs to be adjusted. To do so:

1. Remove the valve cover.
2. Install the piston of the first cylinder to top dead center (TDC) in compression stroke using the mark on the crankshaft pulley.
3. Loosen the locknut and unscrew the adjustment screw until there is a gap on 1, 2, 4, 6 valves.
4. For each of these valves, smoothly turn the adjustment screw clockwise to choose the gap.
5. Turn the adjustment screw clockwise 1.5 turns (which corresponds to the pusher stroke 1.5 mm), and tighten the lock nut.
6. Install the piston of the 4-th cylinder to TDC in compression stroke using the mark on the crankshaft pulley.
7. Loosen the locknut and unscrew the adjustment screw until there is a gap on 3, 5, 7, 8 valves.
8. For each of the remaining valves, smoothly turn the adjustment screw clockwise to choose the gap.

9. Turn the adjustment screw clockwise 1.5 turns (1.5 mm), and tighten the lock nut.
10. Install the valve cover back.
11. Start the engine.

If knocking is still there after valve train adjustment, the following is required:

1. Use a stethoscope (or other sound-amplifying device) to locate the source of the knocking.
2. Remove the valve cover.
3. By turning the crankshaft, install the piston of the first cylinder in TDC in the compression stroke, and check the hydraulic lifters on the 1, 2, 4, and 6 valves by applying force to the adjustment screw along its motion axis.

Elastic behavior in case of short-time application of the force about 10 N (1 kgf) indicates the presence of air in the high-pressure chamber of the lifter.

Gap between the working face of the hydraulic lifter and the cam when a load of about 20-30 N (2-3 kgf) is applied for 10-15 sec., and disappearing after removing the load, indicates a leak in the hydraulic lifter check valve, and/or plunger pair wear.

Gap between the nib of the rocker and the valve indicates jamming of the hydraulic lifter.

Replace hydraulic lifters having the above symptoms.

4. By turning the crankshaft, install the piston of the 4-th cylinder in TDC in the compression stroke, and check the hydraulic lifters on the 3, 5, 7, and 8 valves by applying force to the adjustment screw along its motion axis. Replace faulty hydraulic lifters.
5. If there are none of the above signs, dismantle the rockers axle, remove all hydraulic lifters from the rods. Check the appearance of the hydraulic lifters and the sphere of the adjustment screw for big scratches, cracks, signs of wear, foreign particles, dirt, and galling at the end of the hydraulic lifter. Replace defective parts.
6. Check for oil supply to hydraulic lifters.

7.2 Cooling system maintenance

Periodically check the fluid level in the expansion tank, according to the vehicle User Manual.

When the level of coolant in the expansion tank abruptly decreases within a short period of time or (and) after short mileage intervals (up to 500 km), check the tightness of the cooling system, identify and eliminate the leak, add coolant (the same coolant that is already in the expansion tank).

ATTENTION!

If you have to add coolant often, contact your authorized GAZ dealer service station to have your engine cooling system inspected.

Every three years or every 60000 km (whichever comes first), cooling system needs to be flushed, and the coolant needs to be replaced.

ATTENTION!

- Have your engine cooling system repaired only at the authorized GAZ dealer service station.
- Improper maintenance of the cooling system can reduce the efficiency of the heater and overheat the engine.

7.3 Lubrication system maintenance

ATTENTION!

Operating the engine with insufficient oil can cause engine failure. Warranty provided by the manufacturer does not cover this type of engine damage.

Check the oil level in the engine case daily before starting. Oil level must be between the two marks on the oil dip stick. Amount of oil added to the engine case between bottom mark and top mark is 1.2 liters. After stopping the warm engine, check the oil level after at least 10 minutes. If the oil level is below the lower mark, remove the oil filler cap on the valve cover and add the engine oil recommended in this Manual. Don't exceed the upper level mark.

Change the oil at each TO-1, and replace the oil filter as well.

Drain the used oil from the case when the engine is hot. In this case, the oil drains quickly and completely.

⚠ ATTENTION!

- Do not drain used engine oil onto the ground, into canals, rivers, etc. It is recommended to have the oil changed in authorized GAZ dealer service station.
- Be careful, so as not to get burned with hot oil.
- Avoid contact of exhausted oil with your skin. If exhausted oil gets on your skin, immediately wash the contaminated areas with soap, or remove the contamination using a hand cleaner with plenty of water.
- Store exhausted engine oil in labeled containers, out of the reach of children!
- Dispose the exhausted oil according to applicable regulations.

Before installing, clean the oil case drain plug and the plug port. Replace rubber O-ring, if necessary. Use a wrench to tighten the plug securely. Do not tighten the drain plug beyond the specified torque. Drain plug tightening torque:

19.6-24.5 N·m (2.0-2.5 kgf·m)

It is recommended to flush the engine lubrication system after two oil changes. To do so, drain the exhausted oil from the crankcase when the engine is hot, add special-purpose washing oil 3-5 mm higher than the lower mark on the oil dip stick, and let the engine run for 10 minutes. Then, drain the washing oil, replace the oil filter, and add fresh oil. It is permissible to mix residual washing oil after draining with fresh oil. If there is no washing oil, you can flush the system using clean engine oil.

During the course of the vehicle operation, control the operation of the emergency oil pressure sensor, which is triggered by pressure 39-78 kPa (0.4-0.8 kgf/cm²).

⚠ ATTENTION!

If there is a malfunction in the lubrication system (triggered low-low oil pressure warning light or “Attention” indicator of the engine control system on the instrument panel), stop the engine immediately, and troubleshoot.

- Time of the vehicle operation with active alarm signals is recorded in the control unit’s memory. Untimely service in the service station is the reason to cancel the warranty service.

7.4 Ventilation system maintenance

During the course of operation, depressurization of the engine case ventilation system and engine operation with the oil filler port open are not allowed. This leads to increased entrainment of oil with crankcase gases. Maintenance of the ventilation system includes inspection and cleaning, if necessary, from clogging of the ventilation system channels and the vacuum valve.

One of the reasons for excessive pressure in the crankcase may be “coking” of the ventilation system channels. To bring the functioning of the system back to normal, clean the rubber hoses and the ventilation valve from oil deposits.

Another reason for pressure in the crankcase, provided that the ventilation system is in good condition, may be the excessive breakthrough of gases in the crankcase due to significant wear of the cylinder-piston group.

⚠ ATTENTION!

Depressurization of the crankcase ventilation system is unacceptable, because this leads to increased emissions of toxic substances into the atmosphere.

7.5 Possible engine malfunctions and solutions

Table 3 - Possible engine malfunctions and solutions

No.	Possible causes of malfunction	Solution
1	Engine is not starting.	
1.1	Gasoline supply system problem.	
1.1.1	No fuel in the tank	Add fuel into the tank
1.1.2	Electric gasoline pump (EGP) in the submersible fuel module is not functional.	Check the contact in the power supply circuit of the EGP main relay. If necessary, clean the contacts, crimp the terminals, replace the blown fuse.
1.1.3	Fuel fine filter is clogged.	Replaceable fuel fine filter.
1.1.4	Frozen water in the fuel line.	Warm the fuel line at room temperature, remove water by purging with compressed air.
1.1.5	Fuel line is clogged.	Purge the fuel line with compressed air.
1.1.6	Air in the fuel line.	Remove air through the diagnostic nozzle.
1.1.7	Fuel line leakage	Repair
1.1.8	Malfunction of the fuel pressure regulator (fuel pressure should be 4 kg/cm)	Replace pressure regulator
1.2	Ignition system malfunction.	
1.2.1	Defective ignition coil	Replace ignition coil.
1.2.2	No contact in the electrical circuit of the ignition coil, control unit.	Check the connectors. After each testing operation of the connector, test-run the engine.
1.2.3	Gap between the spark plug electrodes is not normal.	Adjust the gap by bending the side electrode. To check, use round probe (gap $1.0_{-0.1}$ mm).
1.2.4	Defective spark plugs.	Replace spark plugs.
1.2.5	Controller malfunction.	If the primary winding of the coil is not connected to the controller, make sure using a multimeter that there is no break of the wire from the ignition coil to the controller strip. If the circuit is open, repair the circuit. If the circuit is ok, then there is a controller problem.
1.2.6	Tear or short-circuit in the crankshaft position sensor (CPS), tear in the sensor coil, tear of the connecting cable of the sensor at the place of termination in the sensor, cable damage by rotating parts.	With the controller disconnected from the wiring harness, check for tear between the terminals J2 and J3 of the harness connector. Resistance should be 1050 ± 105 Ohm. If there is a tear, disconnect the harness from the sensor and measure the resistance between contacts 1 and 2 of the sensor. If it is equal to 1050 ± 105 Ohm, then the problem is with the wires. Replace wiring harness. If error code P0335 persists, install a test sensor and verify that there is no error code. Replace the sensor. Start the engine. Connect Askan-10 diagnostic tester to the diagnostic connector, make sure that there is no malfunction.
1.2.7	Increased interference caused by faulty ignition system.	Replace the high-voltage wire harness, each of the wires must have a distributed anti-interference resistance ($1.8-9.2$ k Ω depending on the length). Check spark plug gaps ($1.0_{-0.1}$ mm).
1.2.8	Loss of contact at the junction of CPS with the harness, tear or short-circuit of the CPS wires in the harness.	Inspect the harness wires, harness connectors and sensor, make sure the connectors are securely connected. Check the sensor installation (mounting reliability) and the gap between the sensor and the synchronization disk, which should be within 0.3-1.8 mm.
1.3	Engine does not work when cranked by starter	
1.3.1	Faulty power supply and starter control circuits	Repair the electric equipment wiring harness
	Battery is low or faulty.	Charge or replace the battery
	Starter is defective	Replace the starter

2	Engine operation is unstable at minimum rpm of the crankshaft in idle mode.	
2.1	Fuel line, fuel filters are clogged. There is water in the fuel.	Clean the gasoline intake mesh, replace the filter. If bad gasoline is suspected, use other gasoline.
2.2	Strong carbon deposits on the electrodes of the spark plugs and the insulator of the central electrode. Ingress of carbon particles into the gap between the electrodes.	Clean the spark plugs. Make sure that they are working and that the markings comply with the requirements of this A2755 engine repair and operation manual. Identify and eliminate the cause of increased carbon formation in the combustion chamber (replace spark plugs, if necessary).
2.3	Defective sensors of the engine control system, controller, injectors, or their electric circuits.	If there is a malfunction in electronic components and electrical circuits, the malfunction indicator of the IMECS system lights up on the vehicle instrument panel. Using the diagnostic equipment, identify diagnostic codes, and troubleshoot. Use the ohmmeter to test the CPS circuit resistance (1050 ± 105 Ohm). Visually, the sensor should have no mechanical damage. Check the gap between the sensor and the synchronization disk (0.3-1.8 mm). Check the operation of injectors, electrical circuits, and sensors. If necessary, replace the faulty controller, sensors, wires, injectors. Wash the contaminated injectors on a special-purpose bench.
2.4	Low compression in the cylinders (less than 10 kgf/cm ²): leakage of the input and output valves, piston rings wear, sticking, or breakdown.	Warm up the engine to operating temperature 80-90 °C. Turn off the ignition. Remove spark plugs. Disconnect the injector and ignition coil connectors. Turn on the ignition. Press the accelerator pedal all the way to open the throttle. One by one insert the compression tester into the spark plug ports, rotate the crankshaft using the starter. Repeat the measurement after pouring 10-15 cm ³ of the engine oil into the cylinders through the spark plug ports. In cylinders where the compression has increased by more than 2 kgf/cm ² , rings may be severely worn, broken or stuck. If compression has not increased, valve wear or leakage is possible. Lap the valves to the seats, grind the seats if necessary. Repair the cylinder-piston group (CPG).
2.5	Camshaft is incorrectly installed.	Install the camshaft according to the marks.
2.6	Bad contact at the junction of the throttle intake and the harness.	Turn off the ignition, inspect the harness wires, harness connectors, and the sensor, make sure the connectors are securely connected.
2.7	Defective throttle intake.	See Operating Manual 4216-114801II "Throttle intake 42161148010".
2.8	Air inflow through the input gas line gaskets (input pipes, receiver)	Replace gaskets. Check the flatness of the input and output gas lines on the calibration plate; if non-flatness is more than 0.2 mm, mill the gas pipeline plane
3	Engine operation is unstable.	
3.1	Water in the fuel tank.	Drain the sediment from fuel tank.
3.2	Interruptions or failure of one or more cylinders.	Determine the number of the failed cylinder by turning off the engine cylinders one by one, by removing the connector from the injectors or using the Askan-10 diagnostic tester. Interruptions or failure of the cylinder may be caused by malfunction of the spark plug, lack of contact in the injector connector, injector malfunction, and breakdown of the spark plug tip. To repair, replace the defective parts.
3.3	Malfunction in low voltage wiring harness.	Check the reliability of the connectors of the low-voltage wiring harness with ignition coil and with the controller. Make sure that there is no damage to the insulation of the wires, breaks, and short circuit of the wires in the low-voltage harness to the mass.
3.4	Bad contact of the negative terminal of the battery with the ground bus or the ground bus with the vehicle body.	Repair the contact.

3.5	Ignition coil failure	Using known good low-voltage harness (for test procedure, see clause 3.3), disconnect the low-voltage wires from the ignition coil, connect the wires to the probe to check the ignition coil, “rotate” the engine using the starter, and using a probe determine if the controller connects the primary winding of the coil to the mass. If the primary winding of the coil is connected to the mass, but there are no high voltage pulses in the secondary circuit, replace the ignition coil.
3.6	Controller malfunction.	If the primary winding of the coil does not connect to the controller, use a multimeter to check for tear of the wire from the ignition coil to the controller unit. If open circuit is identified, rectify the problem. If the circuit is not open, then the controller is faulty.
4	Engine exhaust toxicity is above normal.	
4.1	Camshaft is incorrectly installed.	Install the camshaft according to the marks.
4.2	Faulty controller.	Check the controller. If faulty, replace the controller.
4.3	Injectors are leaking (excess) or spraying nozzles are contaminated.	Replace the injectors
4.4	Loss of contact or coolant temperature sensor malfunction.	Check the connector, replace the sensor.
4.5	Leakage of valves, wear of valve oil deflector caps.	Lap the valves, replace the caps.
4.6	Neutralizer is “poisoned”.	Replace the catalytic neutralizer.
5	Engine does not reach full power	
5.1	Camshaft is incorrectly installed.	Install the camshaft according to the marks.
5.2	Increased resistance of the exhaust system of the vehicle due to the “sintering” of the ceramic substrate of the neutralizer.	Replace the catalytic neutralizer.
5.3	Air filter is dirty.	Replace the filter element.
5.4	There is water in the fine fuel filter.	Remove water from the fine fuel filter.
5.5	Cylinder-piston group wear.	Repair the engine.
5.6	Throttle does not open fully.	Have your engine diagnosed in dedicated service station, replace if necessary
5.9	Submersible fuel module does not create the required pressure in the system.	Check the pressure using the manometer at the output of the submersible fuel module (4.0 kgf/cm ²), make sure that the strainer of the gasoline receiver is clean. Replace the submersible fuel module that does not pressurize the system.
5.10	Fuel lines and/or fuel filters are clogged, hoses are pinched, tubes are deformed.	Clean the gasoline receiver strainer, replace filters, bad tubes, eliminate hoses kinking.
5.11	Injectors or their circuits are defective	When the injectors coils or their circuits are faulty, the IMECS diagnostic indicator lights up. Using the diagnostic codes, determine the fault. Using the ohmmeter, test injectors windings and their circuits to make sure there is no open circuit or short circuit. Replace defective injectors to ensure good contact in electrical circuits.
5.12	Gap between the spark plug electrodes is not normal.	Adjust the gap by bending the side electrode. To check, use round probe (gap 1.0 _{-0.1} mm).
5.13	Burnout of insulation in high voltage wires.	Use the ohmmeter to check, and also check visually (black cracks, melted insulation). Replace the faulty wiring harness.
5.14	Low compression in the cylinders (when rotated by starter with the spark plugs removed, pressure measured by the compression tester) should not be lower than 10.0 kg/cm ² .	1. Loose fit of valves to seats. Lap the valves to seats. 2. Burning of output valves chamfers. Grind or replace the valves, with further lapping. 3. Maximum wear, breakage, or burning of the piston rings. Replace the piston rings. First, clean the grooves in the pistons
5.15	Damaged cylinder head gasket.	Replace the gasket

5.16	Wear of the cylinders bearing inserts and piston skirts to max. values (maximum installation gap between sleeve and a piston skirt 0.2 mm)	Repair cylinder-piston group
5.17	Absolute pressure sensor is defective	Replace the sensor
6	Increased idle rpm.	
6.1	Faulty accelerator drive.	Replace the accelerator pedal module.
6.3	Throttle intake or its electric circuit is faulty.	Replace the throttle intake
6.4	Injectors are leaking (excess) or spraying nozzles are contaminated.	Replace the injectors
6.5	Coolant temperature sensor is faulty	Replace the sensor
6.6	Air inflow in the intake system, crankcase ventilation system, or brake vacuum booster	Eliminate air leaks
7	Engine is overheating	
7.1	Thermostat is defective (the main valve is not fully opening).	Replace the thermostat.
7.2	Radiator is clogged.	Flush the engine cooling system.
7.3	Coolant pump is faulty (low performance).	Replace the pump.
7.4	Insufficient amount of fluid in the cooling system.	Fluid level must not be lower than the “min” mark on the expansion tank. Eliminate fluid leaks (replace faulty hoses, tighten the mounting clamps), add coolant.
7.5	There is scale in the cooling system	Flush the cooling system with descaler. Do not use hard water in the cooling system. Dilute concentrated antifreeze with distilled water only.
7.6	Electromagnetic coupling of the cooling fan drive is not engaging.	With the ignition off, apply 12 V voltage from the battery to the contact of the electromagnetic coupling of the fan drive. If you can hear a characteristic click, and the fan stops rotating freely, then the electromagnetic coupling is in good condition. Otherwise, replace the coupling. Check the integrity of the electrical circuits (using the ohmmeter), the condition of the electromagnetic relay, coolant temperature sensor, and the fuse in the engine compartment. Restore electrical circuits integrity, replace defective elements. Rectify the cause of the fuse blowing. Replace the fuse.
8	Engine is not warming up to operating temperature for a long time.	
	Faulty thermostat.	Start cold engine. When the thermostat is faulty, the coolant immediately circulates in a major circuit, the temperature of the parts of the cooling system increases gradually and has the same value
9	Increased fuel consumption.	
9.1	Air filter is dirty.	Replace the filter element.
9.2	Fuel line is leaking.	Eliminate the leakage.
9.3	High pressure in the fuel line due to malfunction of the pressure regulator in the submersible fuel module.	Using the manometer, check the pressure in the fuel rail, which should be no more than 4 kgf/cm ² at idle and at medium rpm. Replace defective regulator.
9.5	Injectors leakage (overflow).	Check the injectors. Replace defective ones.
9.6	IMECS faulty components.	To check the control unit, replace it with another one that is fault-free, or check using Askan-10 diagnostic tester. Also, check the sensors and their circuits. Repair electrical circuits contacts. Replace the defective system components.
9.7	Increased wear of CPG, wear or damage to valves, seats, pistons rings sticking or breakage.	Repair your engine.
9.8	Air inflow in the intake system, crankcase ventilation system, or brake vacuum booster	Eliminate air leaks

9.9	Fuel absolute pressure sensor is defective	Replace the sensor
9.10	Engine timing adjustment is incorrect	Have the gaps adjusted in the service station
10	Increased oil consumption rates (more than 100 g per 100 km).	
10.1	Increased wear of CPG, wear or damage to valves, seats, pistons rings sticking or breakage.	Repair your engine.
10.2	Oil leaks through cuffs, seals, and gaskets, oil filler cap is not tightly fit.	Inspect the engine visually, and eliminate identified oil leaks.
10.3	Too much oil in the engine case (above the "max" mark).	Check the oil level in the engine case. Drain excessive oil
10.4	Low-quality oil	Use high-quality oil instead.
10.5	Clogged air filter element.	Replace the filter element.
10.6	Crankcase ventilation system fault leading to crankcase gas pressure and release of oil through the stuffing box seals.	Measure the vacuum in the engine case (there should be no pressure). Wash the ventilation ducts and ventilation valve.
10.7	Valves oil deflector caps are damaged.	Replace oil deflector caps.
10.8	Caverns in the ports for valve sleeve in the cylinder head.	Check for leaks in the valve sleeve - cylinder head interface. Mill the port for repair size sleeve, or replace the cylinder head.
10.9	Increased gap in valve sleeve - valve rod interface.	Replace guide sleeves and valves.
10.10	Low quality, bad running-in, or increased wear of compression and oil scraping rings.	To check the running-in of the ring and the surface of the cylinder, place the ring in the working area of the cylinder and orient the ring to the greatest fit to the surface of the cylinder. The ring should have at least 90% (324°) contact with the surface of the cylinder with mandatory fit in 15° section on each side of the lock.
10.11	Oil entrainment into the engine cooling system because the gasket is leaking.	Check the condition of the gaskets, replace, if necessary.
10.12	Wear of the end faces of the grooves for piston rings in the pistons.	Check the lateral gap between the rings and the wall of the piston grooves. To check, use the probe around the circumference of the piston in several points. Lateral gap should be within 0.04-0.08 mm. Compression grooves 0.04-0.08. Oil scraping groove 0.07-0.16
10.13	Increased breakthrough of gases into oil case due to breakage or sticking of the piston rings in the grooves, and max. wear of cylinder sleeves and pistons	Repair the piston-cylinder group.
11	Reduced oil pressure (emergency oil pressure warning light is activated).	
11.1	Faulty emergency oil pressure sensor.	Check the pressure using portable pressure gauge installed instead of the sensor. Pressure should be at least 343 kPa (3.5 kgf/cm ²) at 2000 min. ⁻¹ crankshaft rpm and 127 kPa (1.3 kgf/cm ²) at 800 min. ⁻¹ . If inconsistent, replace the sensor.
11.2	Low oil level in oil case	Measure the oil level. Top up the oil.
11.3	Faulty oil pump drive.	Remove and inspect the drive. Repair or replace, as necessary.
11.4	Worn cogwheels and oil pump plates.	Replace worn cogwheels and plate.
11.5	Increased gaps in the crankshaft and connecting rod assembly and timing mechanisms	Replace inserts of the crankshaft bearing, and install camshaft repair sleeves.
11.6	Oil with unsuitable viscosity.	Change the oil.
11.7	Clogged oil receiver mesh.	Clean the mesh.
11.8	Dilution of oil with gasoline due to leaking solenoid valve.	Replace the defective injector.
11.9	There is a small foreign object in the pressure relief valve of the oil pump.	Clean the valve.

11.10	Leaking connection of the oil pump discharge tube.	Eliminate the leakage.
11.11	Oil filter is defective	Replace the filter
12	Extraneous noise and knocks in the engine.	
12.1	Valve train is not adjusted, hydraulic lifter is faulty.	Adjust the valve train, replace the hydraulic lifter (see cl. 3.4.1 p. 12)
12.2	Increased gaps between the piston pin and the holes for them in the piston bosses and in the connecting rod upper heads.	Replace the connecting rod and piston group.
12.3	Increased gaps in main and connecting rod bearings.	Replace inserts. In case of significant wear of the crankshaft journals, grind them to the repair size.
12.4	Increased axial displacement of the camshaft due to wear on the end face of the camshaft cogwheel hub.	Replace the worn camshaft cogwheel.
12.5	Increased gap in the timing cogwheels, loosening the camshaft toothed rim on the hub.	Replace the worn camshaft cogwheel.
12.6	Broken valve spring.	Replace the spring
12.7	Increased axial displacement of the crankshaft due to wear of the front washer of the thrust bearing.	Replace the front thrust and rear washers, and press in the new pins.
12.8	Gaps between the cylinders and pistons are above the permissible limit (knock is heard only when the engine is cold)	Repair the CPG
12.9	Sinking of the valves trunnions in the sleeve of the plate.	Replace the trunnions
12.10	Burr on the working surface of the piston skirt	Replace the piston. In case of damage to the sleeve, repair the CPG
12.11	Turning of the sleeve in the connecting rod upper head	Replace the connecting rod
12.12	Excessive wear on the end face of the valve pusher	Replace the pusher
13	High engine vibration.	
13.1	Interruptions or failure of one or more cylinders.	Determine the number of the failed cylinder by turning off the engine cylinders one by one, by removing the connector from the injectors or using the Askan-10 diagnostic tester. Interruptions or failure of the cylinder may be caused by malfunction of the spark plug, lack of contact in the injector connector, injector malfunction; breakdown of the spark plug tip. To repair, replace the defective parts.
13.2	When replacing the pressure disk, the crankshaft became out of balance.	Balance the crankshaft with the flywheel and clutch assembly.
13.3	Lost elasticity or collapsed engine insulators.	Replace the insulators.
14	Knocking in the front side of the engine and in the area of the timing cogwheels cover.	
14.1	Defective front bearing of the alternator.	Remove the accessory drive belt, start the engine, and listen. If there is no knocking, then the defect is related to malfunction of the accessories. Otherwise, the camshaft cogwheel drive is the problem. Check ease of rotation of the alternator shaft. Replace the defective bearing.
14.2	Water pump bearing is noisy.	Check ease of rotation of the shaft, make sure there is no play. Repair.
14.3	Crankshaft hub bolt or crankshaft damper bolts are not tightened properly.	Check by swaying the crankshaft damper in the direction of travel and against travel to make sure there is no play.
14.4	Fan bearing noise	Replace the fan support

15	Too much gas breakthrough to the engine case.	
15.1	Worn, burned, or broken piston rings	Replace the piston rings. First, clean the grooves in the piston.
15.2	Burnout of piston groove links.	Replace the pistons.
15.3	Wear or burr on cylinder sleeves.	Repair the sleeves. Replace the cylinder-piston group.
16	Low compression in cylinders	
16.1	Burning of the output valve chamfer. Valves are leaking.	Polish the chamfer of the valve, or replace the valve, lap, check for leaks.
16.2	Wear, loss of elasticity, breakage, and gumming of the piston rings.	Replace the piston rings, clean grooves in the piston from soot.
16.3	Cylinder wear, scratches, and burrs.	Repair the cylinder block, or replace it.
17	Ingress of fluid from the cooling system into the oil case.	
17.1	Cylinder head gasket is destroyed.	Replace the cylinder head gasket
17.2	Deformation or cracks in the cylinder head.	Replace the cylinder head.
17.3	Nicks or scratches on the lower plane of the cylinder head.	Replace the cylinder head
18	Emission of gas into the cooling system (into the expansion tank).	
18.1	Cylinder head gasket is destroyed.	Replace the cylinder head gasket
18.2	Cylinder head deformation.	Set the cylinder head on a flat horizontal surface. Use the probe to determine the deformation. The cylinder head flatness tolerance is 0.05 mm over the entire length. Replace the head.
18.3	Crack or cavern in the combustion chamber of the cylinder head.	Replace the cylinder head
18.4	Crack or cavern in the cylinders of the block.	Replace the cylinder block.
19	Engine detonates at partial loads and full power	
19.1	Bad gasoline (low octane rating, water in the fuel, fractional composition does not comply with standards)	Change fuel in tank
19.2	Defect of the knock sensor wires shielding	Repair the sensor circuit, check the connection of the shield to the mass
19.3	Knock sensor is faulty	Replace the knock sensor
19.4	Faulty controller	Replace the controller

7.6 Electrical equipment malfunctions

Table 4 - Electrical equipment malfunctions

No.	Possible causes of malfunction	Solution
1	Starter malfunctions.	
1.1	When the starter is turned on, starting relay is not working (no characteristic click).	
1.1.1	Battery is low or faulty.	Check the battery status. If necessary, charge or replace the battery. When turning the key in the ignition switch to the “ignition and starter is on” position, use a multimeter or a test lamp to check for voltage between the starter housing and the terminals of the starting relay, to which the vehicle wire harness terminals are connected.
1.1.2	Loosening or oxidizing of the battery cable tips.	Clean, tighten the cable tips, and grease with petroleum jelly.
1.1.3	Loosening of the relay terminal coil connections.	Tighten the mounting screws or solder the leads of the coil windings.
1.1.4	Coil windings tear.	Replace the relay.
1.1.5	Malfunction of the starter activation relay or electrical circuits.	Repair.
1.1.6	Failure of the ignition switch or starter activation relay terminal group.	Replace the terminal group of the ignition switch or starter activation relay.
1.2	When the starter is turned on, repeated clicks of the starting relay and impacts of the drive cogwheel against the engine flywheel can be heard.	
1.2.1	No reliable contact in the starter power supply circuit, including connection from the negative terminal of the battery and the mass.	Repair the connections with the battery.
1.2.2	Battery is discharged or faulty.	Charge or replace the battery.
1.2.3	Tear in the seal-in coil of the starting relay.	Replace the starting relay.
1.3	When the starter is turned on, a rattle of the drive cogwheel is heard, which does not engage with the engine flywheel.	
1.3.1	Nicks on the teeth of the flywheel rim.	Rectify the nicks, or replace the flywheel rim.
1.3.2	Nicks on cogwheel teeth.	Replace the drive.
1.3.3	Starter installed in skewed position.	Tighten screw connections, replace broken and/or worn parts, or the starter assembly.
1.4	When the starter is turned on, the starting relay is activated, but the starter does not crank the engine or makes it rotate very slowly.	
1.4.1	Battery is discharged or faulty.	Charge or replace the battery.
1.4.2	No good contact in the starter power supply circuit or between the negative terminal of the battery and the mass.	Repair the connections with the battery.
1.4.3	Starter armature touches the poles.	Repair or replace the starter.
1.4.4	Bad contact between the brushes and the collector.	Clean the contaminated collector using 80-100 grit sand paper, and blow with compressed air. In case of large burning or large galling, grind or clean the collector using the sand paper. After grinding, the runout of the collector relative to the extreme journals of the armature shaft should not exceed 0.05 mm. Use the dynamometer to check the spring force acting on the brushes.
1.5	After starting the engine, the starter drive disengages and the armature continues to rotate.	
	Starting relay contacts are welded	Turn off the ignition, turn off the battery. Turn the contact bolts of the starting relay by 180°, and turn the contact plate with the other side, or clean it using sand paper.
1.6	When the starter is turned on, the drive is not engaging.	
	Slipping of the roller type freewheel clutch.	Replace the drive.

1.7	After starting the engine, the starter armature is jammed.	
	Starter armature overspeeding.	Repair or replace the starter.
1.8	Cogwheel does not disengage from the flywheel.	
1.8.1	Drive lever jammed.	Remove the starter and inspect after disassembly. Check the operation of the ignition switch using the ohmmeter or visually, by removing its contact part. Replace defective starter parts.
1.8.2	Coupling jamming on splines of the armature shaft or core of the traction relay.	
1.8.3	Loose or broken freewheel coupling spring or starting relay	Replace defective starter parts.
2	Alternator malfunctions.	
2.1	When the engine operates within the range 2000-4000 min.⁻¹, the voltage in the vehicle is below 12 V.	
2.1.1	Defective voltage regulator, brush assembly, or excitation winding	Check the components, and replace, if necessary.
2.1.2	Jammed brushes in the brush holder channels.	Clean the brushes and brush holders from dirt and dust. Eliminate the jamming of brushes. Replace the brushes, if worn out.
2.1.3	Burning, oxidation, or wear of rotor contact rings.	Clean or grind the contact rings.
2.1.4	Voltage drop in the circuit from alternator to the instrument cluster.	Check wiring, and repair.
2.1.5	Rectifier unit diodes are damaged.	Replace diodes or rectifier unit.
2.1.6	Tear or short-circuit between convolutions in the stator or rotor windings.	Replace
2.2	When the engine operates within the range 2000-4000 min.⁻¹, the voltage in the vehicle is above 12 V.	
	Voltage regulator problem.	Check the regulator.
2.3	Increased noise during alternator operation.	
2.3.1	Rotor touches the stator poles.	Check the runout of the rotor shaft, bearing wear, rotor and/or stator damage, and seats.
2.3.2	Loose screws of the alternator covers.	Replace defective parts or the alternator assembly. Tighten the screws.
2.3.3	Damage, wear of bearings of the alternator ("high-pitch noise"), wear of the bearing seat in the alternator cover.	Replace the bearings, cover, or the alternator assembly.
2.3.4	Short circuit in the stator winding, short-circuiting it to the mass (high-pitch noise).	Replace the stator or alternator assembly.
2.3.5	Short circuit in one of the diodes.	Replace the diode or rectifier unit of the alternator.
2.4	Fast wear of brushes and contact rings.	
2.4.1	Contact rings runout.	Grind and sand the contact rings.
2.4.2	Oily contact rings.	Wipe the contact rings and brushes using a piece of fabric soaked in gasoline.
3	Ignition coil malfunctions.	
3.1	Engine is not starting or unstable, Askan-10 tester displays the following errors: "open ignition coil 1" (code P0351), "open ignition coil 2" (code P0352), "low vehicle voltage" (code P0562), "short circuit of coil 1 to 12 V bus" (code P2301), "short circuit of coil 2 to 12 V bus" (code P2304), "exceeding toxicity threshold with misfire" (code P0300), "misfire in the cylinder" (codes P0301, P0302, P0303, P0304)	
	Malfunction in low voltage wiring harness.	Check the connections of low-voltage sockets with ignition coil, make sure there is no damage to the insulation of wires, wire breakage and short circuit to mass, check the reliability of connection between the terminal of the wiring harness and the controller.
3.2	Engine is unstable, Askan-10 tester displays the error "high voltage level in vehicle network" (code P0563)	

	Defective alternator or relay-controller. Bad contact of the negative terminal of the battery with the ground bus or the ground bus with the vehicle body.	With the engine running and high crankshaft rpm, measure the voltage on the battery terminals. It must be no higher than 14.7 V, otherwise the alternator or relay-voltage regulator is faulty. In this case, further operation of the control system may lead to controller failure. If there are no problems, proceed to the next step.
4	Faulty high-voltage wires.	
4.1	In idle mode, engine is unstable or stable, but when the throttle is suddenly opened, it starts to operate intermittently, Askan-10 tester displays the following errors: “exceeding the toxicity threshold with misfire” (code P0300), “misfire in the cylinder” (codes P0301, P0302, P0303, P0304)	
	High-voltage wires and (or) spark plugs tips problem.	Replace the high-voltage wires one by one with known good ones. If the engine runs without demonstrating any malfunction, the replacement is reasonable. If, after replacing all the wires with the known good ones, the defect is still persistent, then the replacement is unreasonable. Identify and eliminate the malfunction that is not related to the high-voltage wires of the ignition system.
5	Spark plugs malfunctions.	
5.1	In idle mode, engine is unstable or stable, but when the throttle is suddenly opened, it starts to operate intermittently, Askan-10 tester displays the following errors: “exceeding the toxicity threshold with misfire” (code P0300), “misfire in the cylinder” (codes P0301, P0302, P0303, P0304)	
	Faulty spark plug.	Unscrew the spark plugs one at a time and inspect them. If necessary, adjust the spark gap, which should be within 1.0-0.1 mm. Make sure that the thermal cone of the spark plug is dry and clean. If the defect is not rectified, replace the spark plug with a known good one, and repeat the operation mode where the malfunction was detected. If the engine runs without demonstrating any malfunction, the spark plug replacement is reasonable.
6.1	With the ignition on, without starting the engine, the warning light of the emergency oil pressure is not lighting up.	
6.1.1	Tear of the wire in the harness.	Close the wire of the emergency pressure sensor to mass. If the lamp did not light up, the wiring harness or indicator lamp is faulty.
6.1.2	Sensor malfunction (sensor contacts are always open).	Close the wire of the emergency pressure sensor to mass. If lamp lights up, the sensor is defective. Replace the sensor.
6.2	After engine starting and warming up, emergency oil pressure lamp lights up.	
6.2.1	Short circuit in the wire harness to mass.	Disconnect the wire from the emergency pressure sensor. If the lamp is still on, the wire harness is faulty.
6.2.2	Sensor malfunction (sensor contacts are always closed).	Disconnect the wire from the emergency pressure sensor. If the control lamp goes out, the sensor is faulty. Replace the sensor.
6	Faulty emergency oil pressure sensor.	
6.1	With the ignition on, without starting the engine, emergency oil pressure lamp is not lighting up.	
6.1.1	Tear of the wire in the harness.	Close the wire of the emergency pressure sensor to mass. If the lamp did not light up, the wiring harness or indicator lamp is faulty.
6.1.2	Sensor malfunction (sensor contacts are always open).	Close the wire of the emergency pressure sensor to mass. If lamp lights up, the sensor is defective. Replace the sensor.
6.2	After engine starting and warming up, emergency oil pressure lamp lights up.	
6.2.1	Short circuit in the wire harness to mass.	Disconnect the wire from the emergency pressure sensor. If the lamp is still on, the wire harness is faulty.
6.2.2	Sensor malfunction (sensor contacts are always closed).	Disconnect the wire from the emergency pressure sensor. If the control lamp goes out, the sensor is faulty. Replace the sensor.

7	Faulty crankshaft position sensor (CPS).	
7.1	Engine is not starting up or unstable. Askan-10 diagnostic tester displays the following error codes: “open circuit” (code P0335) or “synchronization error” (code P0336).	
7.1.1	Loss of contact at the junction of the sensor with the harness, tear or short-circuit of the wires in the harness.	Inspect the harness wires, harness connectors and sensor, make sure the connectors are securely connected. Make sure the sensor is installed correctly (proper installation).
7.1.2	“Flickering” short-circuit between the wires (34) YDB and (15) WB.	With the controller and sensor disconnected from the wiring harness, check for short between the wires (34) YDB and (15) WB by measuring the resistance between contacts 1 and 2 in the socket of the connector of the wiring harness (see diagram in cl. 1.2.6).
7.1.3	“Flickering” short circuit of wires (34) YDB or (15) WB to shield.	With the controller and sensor disconnected from the wire harness, check for break of the wire (E15) by measuring the resistance between pin 3 and the engine mass. With the controller and sensor disconnected from the wiring harness, check for short circuit between the wire (34) YDB and the shield by measuring the resistance between pins 1 and 3 in the socket of the connector of the wiring harness. Check for short circuit between the wire (15) WB and the shield by measuring the resistance between pins 2 and 3 in the socket of the connector of the wire harness (diagram in cl. 2.6).
7.1.4	Increased interference caused by faulty ignition system	Replace high-voltage wires and tips of the ignition system, check the spark plug gaps (1.0-0.1 mm). High-voltage wires with distributed anti-interference resistance (1.8 - 9.2 kOhm) should be used.
7.1.5	Tear or short-circuit of the sensor wires, tear in the sensor coil, tear of the connecting cable of the sensor at the place of termination in the sensor, cable damage by rotating parts.	With the controller disconnected from the wiring harness, check for tear between terminals J3 and J2 of the harness connector. Resistance should be 1050 ± 105 Ohm. If there is a tear, disconnect the harness from the sensor and measure the resistance between contacts 1 and 2 of the sensor. If it is equal to 1050 ± 105 Ohm, then the problem is with the wires 34, 15. Replace wiring harness. If error code P0336 persists, install a test sensor and verify that there is no error code (code P0336). Replace the sensor.
8	Faulty knock sensor (KS).	
8.1	When the engine is idling at 3000+ rpm, diagnostic tester displays the malfunction “low signal from knock sensor” (code P0327).	
8.1.1	Loss of contact at the junction of the sensor with the harness, tear or short-circuit of the wires in the harness.	Inspect the harness wires, harness connectors and sensor, make sure the connectors are securely connected. Make sure the sensor is installed correctly (proper installation). Check for open circuit or short circuit in the wires. Remove the terminal from the controller, disconnect the terminal from the knock sensor. Make sure there is no open or short circuit in the wiring harness between pin E3 of the controller terminal and pin 2 of the sensor terminal. Make sure there is no open or short circuit in the wiring harness between pin D3 of the controller terminal and pin 1 of the sensor terminal. With the controller and the sensor disconnected from the wiring harness, make sure there is no short circuit of the wires (20) RDB and (19) GW on the shield by measuring the resistance between the pin 1 of the sensor block and the engine mass, between the pin 2 of the sensor terminal and the engine mass, respectively. Make sure the sensor is installed correctly (proper installation).
8.1.2	Knock sensor is defective (piezoelectric contacts problem).	Install a test sensor and make sure that there is no error code (code P0327). Replace the sensor.

9	Faulty phase sensor (PS).	
9.1	Engine starts, diagnostic tester identifies the PS malfunction - “low signal level” (code P0342), “high signal level” (code P0343)	
9.1.1	Bad contact at the junction of the sensor to the harness.	Inspect the harness wires, harness connectors and sensor, make sure the connectors are securely connected. Make sure the sensor is installed correctly (proper installation).
9.1.2	Short circuit of the wire (79) OW to “mass”.	Turn on the ignition. Disconnect the controller and the sensor from the wiring harness. Check for short circuit in the harness between the wire (79) OW and the “mass”.
9.1.3	Tear of the (45) RY wire.	With the controller and sensor disconnected from the wiring harness, check for open circuit in the wire (45) RY by measuring the resistance between pin 45 in the controller socket and pin 3 in the sensor connector socket.
9.1.4	Short circuit in wiring harness between the wire (45) RY and the wire (79) OW.	With the controller and the sensor disconnected from the wiring harness, check for short circuit between the wire (45) RY and the wire (79) OW by measuring the resistance between pins 3 and 2 in the socket of the sensor connector.
9.1.5	Tear of the (61) DB wire	Check for (61) DB wire breakage by measuring the resistance between pin 1 of the sensor socket and the engine “mass”.
9.1.6	Tear or short circuit of the sensor wires, failure of the sensor electronic circuit.	With the sensor disconnected, check for short circuit or open circuit in the sensor between pins 2 and 1 by measuring the resistance between them. If short circuit or breakage is confirmed, replace the sensor.
10	Malfunction of the absolute pressure sensor with integrated air temperature sensor (AP&TS).	
10.1	Engine is not starting. Askan-10 diagnostic tester identifies the temperature sensor malfunction: “low signal level” (code P0112), “high signal level” (code P0113), or absolute pressure sensor malfunction: “low signal level” (code P0107), “high signal level” (code P0108), “incorrect signal (P0105)”.	
10.1.1	Short circuit of wires (40) WP, (56) V, (32) R to wire (63) B in the IMECS harness.	Disconnect the controller and AP&TS from the IMECS harness. Check for short circuit between the wires (40) WP, (56) V, (32) R and the wire (63) B (pins 1, 2, 3, and 4 of the sensor connector socket).
10.1.2	Short circuit of wires (40) WP, (56) V, (32) R to “mass” in the IMECS harness.	With the controller and AP&TS disconnected, check for short circuit of the wires (40) WP, (56) V, (32) R to “mass” (pins 2, 3, 4 of the sensor socket).
10.1.3	Tear of wires (40) WP, (56) V, (32) R, (63) B in the IMECS harness.	Disconnect the controller and AP&TS from the IMECS harness. Check for breakage of the wires (40) WP, (56) V, (32) R, (63) B by checking the continuity of the circuit: pins H2, F4, C4, H1 in the controller socket - pins 1, 2, 3, 4 in the AP&TS connector socket.
10.1.4	Short circuit or tear inside AP&TS.	Install the test sensor, turn on the ignition, and if no error codes are identified, replace the AP&TS.
11	Throttle choke position sensor malfunctions.	
	Engine is operating with limited power (rpm). Diagnostic tester identifies the malfunctions: “low signal level” (code P0122 or P0222) or “high signal level” (code P0123 or P0223), “sensors correlation error” (code P2135), “position controller error” (code P2112 or P2113), “spring failure” (code P1632 or P1633), “adaptation procedure problem” (P0134), “closed position adaptation problem” (P1635), “de-energized position adaptation problem” (P1636)	
	Faulty throttle choke electric drive.	See operating manual “Throttle intake 4216-1148010IE”
12	Faulty coolant temperature sensor (CTS).	
12.1	Engine is not starting. Diagnostic tester identifies the malfunctions: “signal beyond acceptable range” (code P0116), “low signal level” (code P0117) or “high signal level” (code P0118)	
12.1.1	Loss of contact at the junction of the sensor with the harness, tear or short-circuit of the wires in the harness.	Inspect the harness wires, harness connectors and sensor, make sure the connectors are securely connected.

12.1.2	Short circuit in CTS circuit.	Start the engine. If the fault persists, disconnect the controller and CTS from the harness. Check for short circuit between the wire (39) WDB and the wire (84) DB (pins 1 and 2 in the connector socket). With the controller and sensor disconnected, check for short circuit of the wire (39) WDB to “mass” (pin 1 in the socket of the connector and pin 39 in the controller terminal). If there is no short circuit between the wires (39) WDB and (84) DB, the wire (39) WDB and the “mass”, then the sensor is faulty. Replace the sensor.
12.1.3	CTS circuit break.	Inspect the harness wires, harness connectors and sensor, make sure the connectors are securely connected. Start the engine. If the malfunction persists, disconnect the controller and the temperature sensor from the harness and check for open circuit in the wire (39) WDB by checking the circuit continuity: pin B4 in the controller socket - pin 1 in the sensor connector socket. With the controller and sensor disconnected, check for open circuit in the wire (84) DB by checking the circuit continuity: pin D1 in the connector terminal of the controller - pin 2 in the connector terminal of the sensor. If there is no discontinuity of the wire (39) WDB and (84) DB, then the sensor is faulty. Replace the sensor. Connect the controller to the wiring harness, turn on the ignition. With the temperature sensor disconnected, check the voltage on pins 1 and 2 in the socket of the sensor connector. If voltage exceeds 5 V, then there is a short circuit of wire (39) WDB to the +12 V bus. Defective harness. Replace the harness. Note: if the engine is started with this malfunction, Askan-10 tester will show the temperature setpoint set by the controller from 0 °C to 80 °C depending on the time the engine has been running after starting.
12.1.4	Internal sensor connections are defective.	Connect the “+” of the multimeter to pin 1 of the sensor. Measure the resistance between pin 1 and 2 of the sensor. With the sensor temperature 18-22 °C, the resistance should be about 2.2-2.6 kOhm. Measure the resistance between pin 1 and the sensor housing, between pin 2 and the sensor housing. Make sure there is no short circuit. If the measured values differ from the specified ones, replace the sensor.

8 ENGINE REPAIR

8.1 Tools and accessories for engine repair and maintenance

⚠ ATTENTION!

Good and high-quality tooling guarantees safety during repair operations.

Universal tools.

- 1 Set of socket wrenches with interchangeable heads with size from 10 to 17 mm.
- 2 Spark plug wrench, 16 mm.
- 3 36 mm wrench for crankshaft bolt.
- 4 Hinged tommy bar with long handle.
- 5 Set of box and open-end wrenches. Size range from 10 to 17 mm.
- 6 Set of allen wrenches. Size range from 6 to 10 mm.
- 7 Torque wrench.
- 8 Set of flat and Phillips screwdrivers.
- 9 Steel and copper hammers.
- 10 Vise.

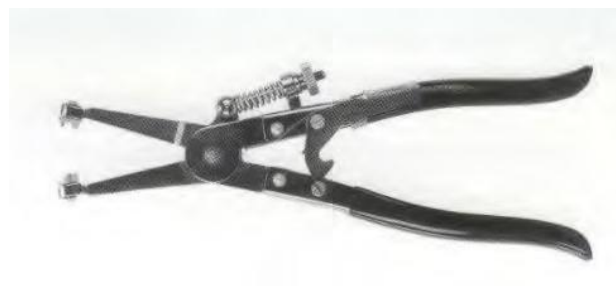
Table 5 - Special tools

Designation	Name
71-1978	Tool for removing and pressing-in the hub of the crankshaft pulley and timing cogwheels
71-1769	Tool for pressing out the input shaft bearing of the gearbox from the crankshaft, impeller of the cooling system pump, and the hub of the fan pulley
73-2641	Valves remover tool
55-1265	Aligner (mandrel) for timing cogwheels cover alignment
55-1187	Aligner (mandrel) for driven disk alignment when installing the clutch
4190-5258	Tool for compressing the piston rings and installation of the piston into the cylinder

To install and remove the spring clamps, use the dedicated manually operated tongs (Figure 43): type 1 - for small nominal diameters and type 2 (with integrated protective lever for fixing the position of the tongs) - for all nominal diameters.



Type 1



Type 2

Figure 43 - FBS manual tongs

⚠ ATTENTION!

Do not use pliers, wire cutters, or other improper tools for removal and installation of spring clamps, as it may cause injury.

8.2 Engine disassembly

It is recommended to dismantle and assemble the engine on special-purposes benches and using special tools and accessories.

Before work, clean wash the outer surfaces of the engine and its accessories. Keep parts clean and safe.

Table 6 - Engine disassembly sequence

	
E1. Unscrew oil drain plug and drain oil from engine. Allen wrench 8	E2. Remove the oil level dip stick.
	
E3. Remove ventilation hoses. FBS tongs See cl. 8.1 p. 54	
	
E4. Unscrew throttle intake bolts. Remove throttle intake. Wrench S10	E5. Unscrew absolute pressure sensor screws. Remove the sensor. Flat screwdriver



E6. Remove receiver bracket bolts.
Wrench S12, S13



E7. Unscrew 5 screws of the receiver, remove the receiver with gaskets.
Wrench S13



E8. Remove 10 bolts of the rockers cover, remove the cover with the gasket.
Wrench S8



E9. Remove high-voltage cable harness tips from spark plugs.



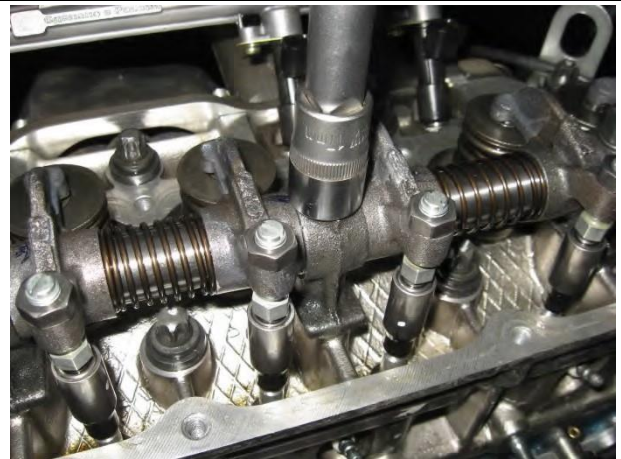
E10. Unscrew spark plugs from cylinder head.
Spark plug wrench S16



E11. Remove the nuts and bolt of the ignition coil bracket. Remove bracket with coil.
Wrench S12



E12. Remove bracket bolts.
Remove the bracket.
Wrench S14



E13. Unscrew 4 nuts of the rockers axle.
Wrench S17



E14. Unscrew 2 nuts of the extreme struts of the rockers axle.
Wrench S13



E15. Remove rockers axle.



E16. Remove 8 pusher rods with hydraulic lifters.



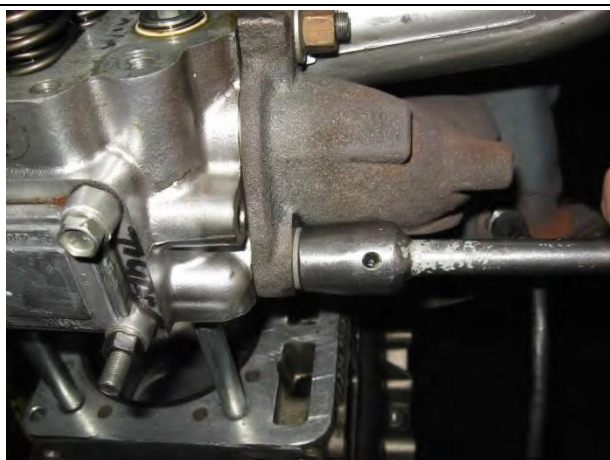
E17. Unscrew nuts of the fuel module.
Wrench S13



E18. Remove the fuel module.



E19. Unscrew the shield bolts.
Remove the shield.
Wrench S = 12



E20. Unscrew the nuts of the exhaust manifold and remove it (wrench S = 17). Unscrew the nuts of the intake pipe and remove it (wrench S = 17)



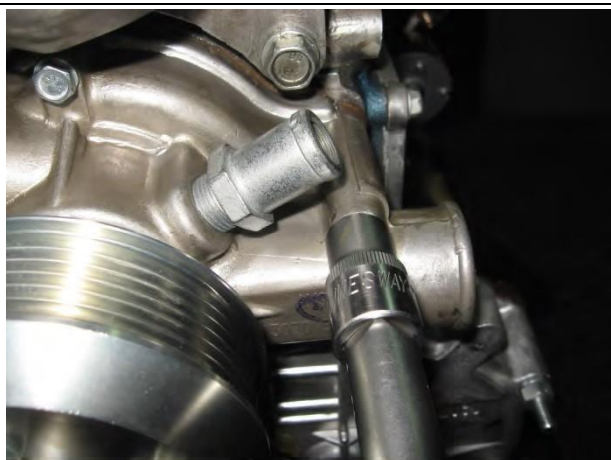
E21. Arm the automatic tensioner by turning it using the wrench clockwise (wrench S = 15) and fix it with diam. 3.5-4 mm pin.
Wrench S15
See 4.4 p. 29



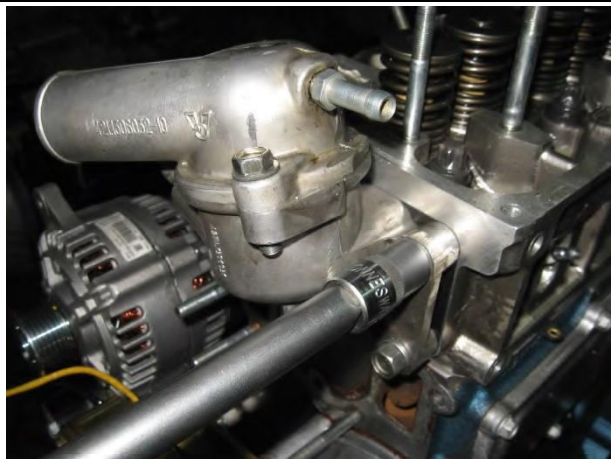
E22. Remove the belt



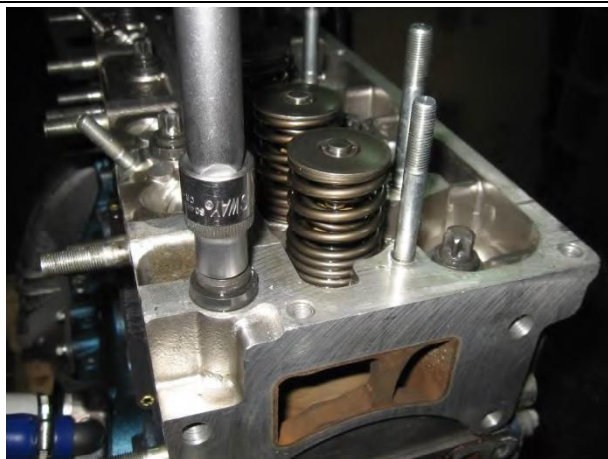
E23. Unscrew the bolt of the bracket of the alternator plate, disconnect the installation plate of the alternator from the thermostat housing.
Wrench S12, S13



E24. Unscrew the connection of the water pump housing, and remove it with the gasket. Wrench S13



E25. Unscrew the thermostat housing connection and remove it with the gasket. Wrench S14



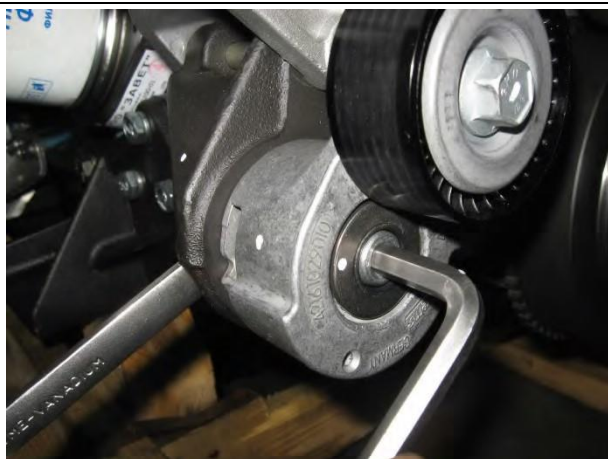
E26. Unscrew 10 nuts of the cylinder head and remove the cylinder head with the gasket.
Torx wrench E14



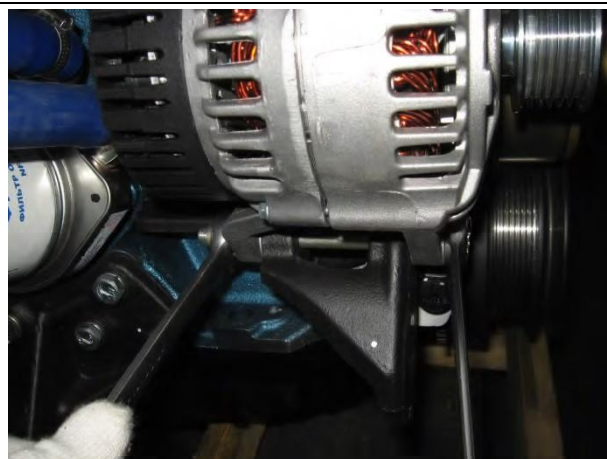
E27. Unscrew the knock sensor mounting bolt, remove the sensor.
Wrench S13



E28. Unscrew 6 bolts of the pusher box cover and remove it with the gasket. Remove the second cover.
Wrench S10



E29. Unscrew the nut and remove automatic tensioner.
Wrench S17



E30. Unscrew the alternator nut, pull out the bolt and remove the alternator.
Wrench S17



E31. Unscrew oil filter.
See cl. 3.6 p. 18



E32. Unscrew the nozzle and remove the FOHE.
Wrench 27



E33. Unscrew oil cooler nozzle.
Wrench S24



E34. Unscrew the connection of the accessories bracket and remove the bracket.
Wrench S19



E35. Remove the screw and remove phase sensor.
Flat screwdriver



E36. Remove the screw and remove the synchronization sensor.
Flat screwdriver.



E37. Unscrew starter nuts, remove starter.
Wrench S19



E38. Unscrew 4 bolts of the clutch case, remove the clutch case.
Wrench S12



E39. Remove 20 bolts of the oil case and remove the oil case with the gasket.
Wrench S13



E40. Remove bolts and nuts of the oil pump, remove the pump.
Wrench S12, S13





E41. Remove the crankshaft bolt with washer from the front end of the crankshaft.
Wrench S = 36



E42. Unscrew 6 bolts connecting the damper to the hub, remove the damper and the accessories drive pulley.
Wrench S12



E43. Unscrew nuts of the electromagnetic coupling to remove it.
Wrench S13



E44. Unscrew the emergency oil pressure sensor.
Wrench S24



E45. Unscrew 2 bolts of the oil pump drive. Remove the oil pump drive.
Wrench S13



E46. Remove the hub from the crankshaft.
Remover tool 71-1978



E47. Unscrew the nuts and remove the camshaft cover.
Wrench S13



E48. Remove the key from the crankshaft. Flat screwdriver.



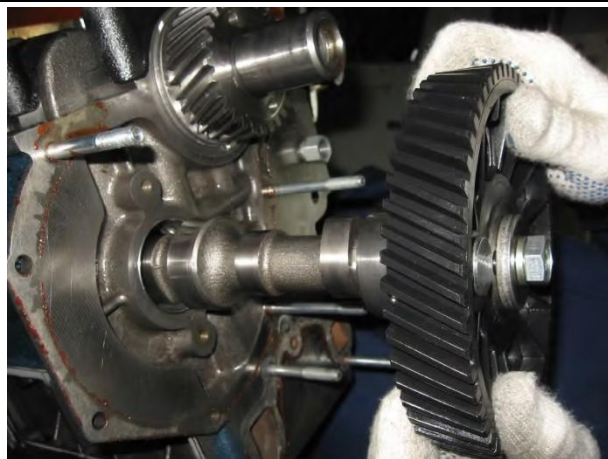
E49. Remove the oil deflector washer from the crankshaft.



E50. Remove 2 bolts of the camshaft thrust flange.
Wrench S12



E51. Remove the camshaft after recessing the pushers.





E52. Remove the pushers from the guide sockets.
For proper assembly of the disassembled engine, each pusher must be marked with the number of the corresponding socket in the block.



E53. Unscrew the nuts of the crankshaft connecting rod caps.
 Box wrench S14



E54. Remove 4 connecting rod caps with inserts from the blots. When removing the covers, knock on the sides of the covers with copper hammer.
Connecting rod covers are not interchangeable and must be numbered accordingly.



E55. Remove pistons with connecting rods assembly out of the block, dismantle the inserts. Fit the connecting rod covers onto the corresponding connecting rod bolts.



E56. Remove timing cogwheel from the crankshaft.
 Remover tool 71-1978



E57. Remove the crankshaft thrust washers



E58. Unscrew 10 nuts of the main bearings.
Wrench S19
Main bearings covers are not interchangeable and must be numbered accordingly



E59. Remove 2 bolts of the main bearing cover. Remove the cover.
Wrench S13



E60. Remove 5 main bearing covers together with the inserts, mark 2-nd and 3-rd cover. When removing the covers, knock on the sides of the covers with copper hammer. Take out the crankshaft.



E61. Remove the inserts from the main bearing seats.



E62. Unscrew the bolts of the power steering bracket and the engine insulator bracket, remove the brackets.
When this operation is accomplished, the block is empty.
Engine disassembling process is completed.



8.4 Dismantling of individual engine components

Thermostat housing disassembly

1. Unscrew nuts of the thermostat housing cover. Wrench S13
2. Take out the thermostat.

Cylinder head disassembly:

1. Unscrew all studs (using the stud runner)



Figure 45 - Studs unscrewing

2. Unscrew 2 bolts, 2 nuts, and remove the water jacket cover with gasket. Wrench S13, wrench S12.



Figure 46 - Unscrewing the water jacket cover fasteners

3. Remove the valve cotters, remove the springs, and remove the valves. Place the parts on the table in the appropriate order (**remover tool 73-2641**)



Figure 47 - Valve cotters removal

8.5 Repair of engine parts

To troubleshoot the parts of the disassembled engine, first clean them from dirt, oil, carbon deposits, and tar.

Clean the parts mechanically using solvents (kerosene, gasoline) and chemically.

Chemical cleaning from carbon deposits is to soak the parts in a bath with a washing solution heated to 80-95 °C for 2-3 hours. Recommended detergent compositions are provided in Table 9.

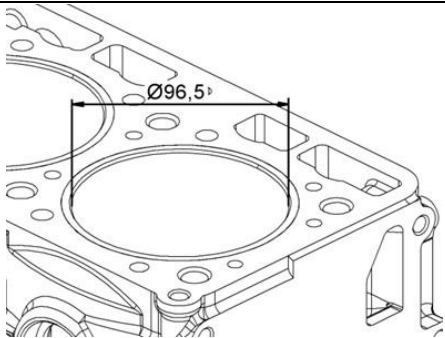
Table 7 - Recommended detergent formulations.

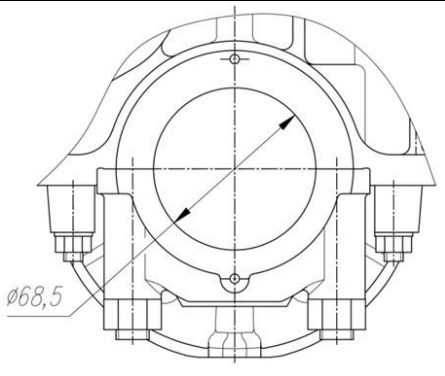
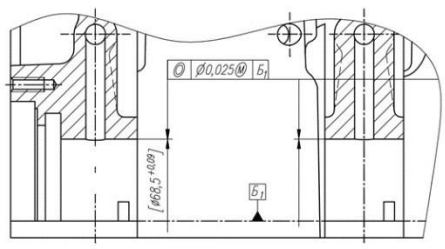
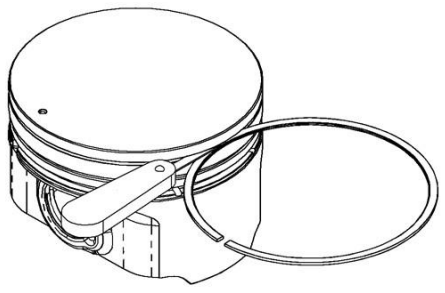
Component	Aluminum parts	Steel and cast iron parts
	Concentration, g/l of water	
Soda ash (Na_2CO_3)	18.5	33
Caustic soda (NaOH)	-	25
Laundry soap	10	3.5
Liquid glass (Na_2SiO_3)	8.5	1.5

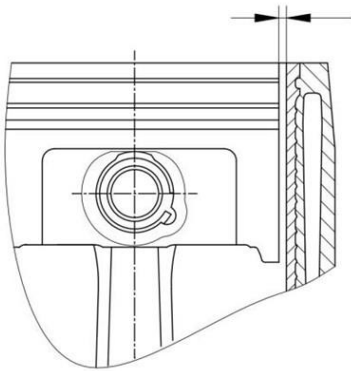
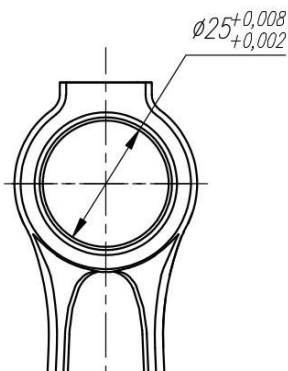
ATTENTION!

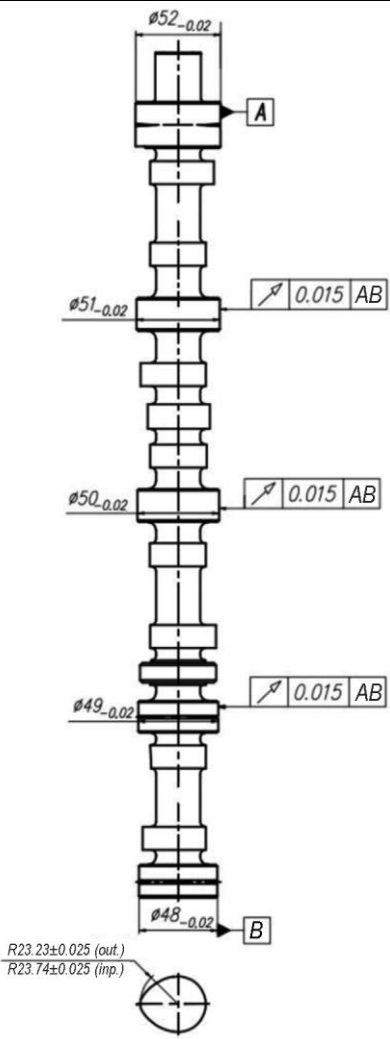
Do not wash aluminum alloy parts in a solution containing alkali (NaOH).
The room for washing must be equipped with exhaust ventilation.

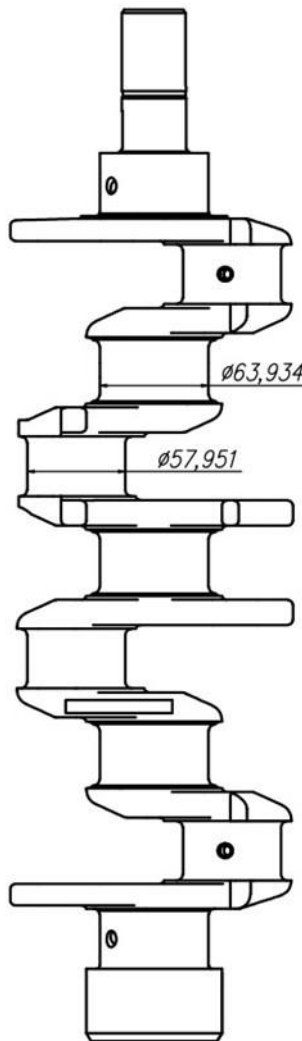
Table 8 - Inspection points, limit sizes, and defects elimination methods

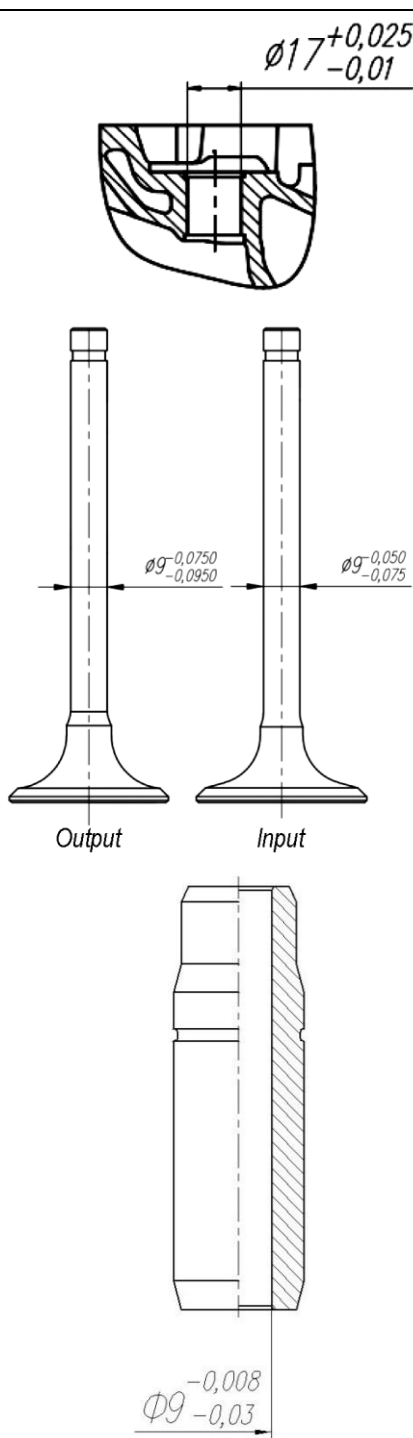
Defect	Solutions	Control point
1. Cylinder block		
1.1 Holes on the cylinder walls, cracks on the upper plane of the block, in the area of the water jacket and on the ribs supporting the main bearings, holes on the water jacket and crankcase.	Reject.	-
1.2 Wear of the cylinder to diameters above 0.1 mm	Reject.	
1.3 Increase in non-circularity and non-cylindricity of cylinder sleeves up to 0.08-0.1 mm.	Reject.	
1.4 Damage to threaded ports in the form of nicks or thread breakage of less than two convolutions.	Repair. Run the thread through tap (thread former) with nominal size.	
1.5 Wear or stripping of the threads on threaded ports more than two convolutions.	Repair. – Tap the thread with oversized repair size. – Install threaded screw inserts. Then, tap a thread with nominal size in them, or install threaded spiral inserts.	

1.6 Wear of the diameters of the supports for the main bearing journals is more than $68.5 + 0.019$ mm.	Reject. Measure the diameters of the supports for the main bearing journals on the cylinder block assembled with the corresponding main bearing covers.	
1.7 Misalignment of the supports for the crankshaft relative to the axis of the crankshaft is more than 0.15 mm.	Reject the cylinder block.	
1.8 Wear of the camshaft supports in the block is more than 0.75 mm.	Remove camshaft sleeves. – Press the camshaft sleeves into the block. – Bore the sleeves reducing the diameter of each subsequent sleeve starting from diam. 52 mm, by 1 mm. $\text{Ø } 52 + 0.065/+0.040$ $\text{Ø } 51 + 0.065/+0.040$ $\text{Ø } 50 + 0.065/+0.040$ $\text{Ø } 49 + 0.065/+0.040$ $\text{Ø } 48 + 0.065/+0.040$	
2. Piston		
2.1. Mechanical damage (cracks, chips, burr on the surface of the skirt)	Reject the piston	
2.1. Piston diameter wear less than 96.35 mm.	Repair. Replace the pistons	
2.2. Groove width wear – for upper compression ring, more than 1.35 mm. – for lower compression ring, more than 1.65 mm – for oil scraping ring, more than 3.14 mm	Reject the piston.	
2.3. Height gap between the groove and the compression rings is more than 0.08 mm.	Reject the piston. Measure in several points using the probe	

3. Cylinder sleeve - piston.		
3.1. Gap between the piston and the cylinder is more than 0.30 mm. Measure in two mutually perpendicular directions (along the axis of the crankshaft and perpendicular to it) and in two zones (at distance 8-10 mm and 60-65 mm from the upper plane of the block). Use the biggest size for decision. Measure the piston at the distance 5-10 mm from the bottom of the skirt in a plane perpendicular to the axis of the piston pin.	Repair. Match the piston to the cylinder, while maintaining the gap 0.030 to 0.054 mm between the cylinder and the piston.	
4. Connecting rod		
4.1. Wear of the connecting rod piston head diameter more than 25.045 mm.	Repair. Replace the connecting rod piston head sleeve with the repair sleeve, press into the connecting rod. Bore to nominal size.	
5. Camshaft		
5.1. Cracks on the camshaft.	Reject.	
5.2. Burr and deep caverns on the surface of the support journals and cams.	Reject.	
5.3. Wear of camshaft cams by more than 0.5 mm in height.	Replace the camshaft with a new one.	
5.4. Camshaft bend.	Shaft is installed in the centers. Use the indicator to check on the backs of the input and output cams of the second and third cylinders. If runout exceeds 0.03 mm, replace the shaft.	

5.5. Wear on the support journals. Gap in connection with the block socket is more than 0.15.	Grind the journals to reduce their size by max. 0.75, while maintaining the gaps. Install repair sleeves, see cl. 1.8.	 Technical drawing of a crankshaft showing dimensions and surface finish requirements. The drawing includes the following details: - Top journal diameter: $\phi 52_{-0.02}$ - Second journal diameter: $\phi 51_{-0.02}$ - Third journal diameter: $\phi 50_{-0.02}$ - Fourth journal diameter: $\phi 49_{-0.02}$ - Fifth journal diameter: $\phi 48_{-0.02}$ - Surface finish requirements for the journals: $R23.23 \pm 0.025$ (out.) and $R23.74 \pm 0.025$ (imp.) - Surface finish requirements for the connecting rod journals: 0.015 AB - Labels A and B indicate specific areas of interest.
6. Crankshaft		
6.1. Cracks.	Reject.	Chamfers and openings of the front and rear ends of the crankshaft are not suitable for installation on a grinding machine.
6.2. Damage to the thread or thread stripping in the ports max. two thread convolutions.	Repair. Run the thread through tap (thread former) to nominal size.	
6.3. Thread wear or stripping in the ports max. two thread convolutions.	In the ports for flywheel mounting bolts - Reject . In the ports for plugs, in the ports for ratchet: Repair by tapping the repair thread.	
6.4. Wear of main journals diameter less than 63.934 mm.	Repair. Grind the main journals to fit for one of the repair sizes: first repair - $\phi 63.75_{-0.013}$ mm; second repair - $\phi 63.50_{-0.013}$ mm; third repair - $\phi 63.25_{-0.013}$ mm; fourth repair - $\phi 63.00_{-0.013}$ mm; fifth repair - $\phi 62.75_{-0.013}$ mm; sixth repair - $\phi 62.50_{-0.013}$ mm. After repair, use appropriate repair inserts	
6.5. Wear of connecting rod journals diameter less than 57.951 mm.	Repair.	

	Grind the connecting rod journals to fit for one of the repair sizes: first repair - Ø 57.75 _{-0.013} mm; second repair - Ø 57.50 _{-0.013} mm; third repair - Ø 57.25 _{-0.013} mm; fourth repair - Ø 57.00 _{-0.013} mm; fifth repair - Ø 56.75 _{-0.013} mm; sixth repair - Ø 56.50 _{-0.013} mm. After repair, use appropriate repair inserts	
6.6. Runout of the main journals more than 0.05 mm.	Reject.	
After repair operations, wash the crankshaft. To do so, unscrew the dirt trap plugs, wash the cavities and oil channels using metal brush and a detergent (see cl. 8.5 page 68). Then rinse the cavity with kerosene and dry. Tighten the plugs with Triboplast-9, Fiksator-9, or Germikon-9 anaerobic sealant applied onto the threads, with torque 3.8-4.2 kgf/m. Clean the crankshaft cavities every time the engine is disassembled.		

7. Cylinder head, valve train		
7.1. Breaches, burnouts, and cracks on the walls of the combustion chamber, and destruction of links between the sockets.	Reject the cylinder block head	
7.2. Thread wear or stripping more than two convolutions.	Repair. – Tap the thread with oversized repair size. – Install threaded screw inserts, then tap a thread with nominal size in them.	
7.3. Non-flatness of the surface of the cylinder head adjacent to the cylinder block	Repair. Up to 0.2 mm - grind, required size is 0.03/100 mm. More than 0.2 mm - replace the cylinder head.	
7.4. Loosening of valve sleeve in the cylinder head.	Replace the cylinder block head	
7.5. Gap in the valve-sleeve connection is more than 0.25 mm.	Repair. – Replace the valve and the sleeve. – Grind the chamfers of the seats, align them by the port in the sleeve, keep the dimensions provided in the figure, ensure the chamfer concentricity on the valve seat with the port in the sleeve within 0.025 mm.	
7.6. Warpage of the valve disc and burnout of the valve and valve seat.	Repair. – Grind the seat. – Replace the valve with a new one.	
7.7. Wear of the valve rod diameter Output - less than 8.905 mm Input - less than 8.925 mm.	Replace the valve	
7.8. Wear of the guide sleeves ports diameter more than 9.022 mm	Repair. – Press out the guide sleeves. – Press in new repair sleeves into the cylinder head Expand sleeves holes to nominal size.	

8.6 Assembling individual engine components

8.6.1 Oil pump assembling



Figure 48 - Oil pump components

1. Before assembling, purge the parts to be assembled with compressed air and lubricate the cogwheel axle with motor oil.
2. Insert the oil pump roller with cogwheel (2) and cogwheel (3) into the oil pump housing (1), make sure the cogwheels are rotating freely by turning the roller.
3. Screw in two process pins into the threaded ports in the oil pump housing.
4. Insert a spring with a pressure relief valve (5) into the port of the oil pump cover (4).
5. Set gasket 451M-1011065 (6), oil pump plate (7), gasket 451M-1011065 (6), oil pump cover preassembled with the spring and the pressure relief valve, two lock plates (8) onto the pins one by one.
6. Start 2 bolts of the oil pump drive.
7. Unscrew two process pins and screw in the bolts instead of them.
8. Tighten the bolts of the oil pump cover, make sure the cogwheels rotate freely by turning the roller. If necessary, install an additional gasket 451M-1011065-10 between the housing (1) and the plate (7).
9. Press in the sleeve (9) onto drive roller.
10. Put the mesh with the housing (10), washer, and secure them using the bolt with tightening torque 1.2-1.8 kgf*m (torque wrench).

8.6.2 Piston and connecting rod assembly

1. To fit the pistons to the cylinder block, we use the marks on the block (inside the pusher box) and on the piston that look like the letters "A", "B", "C". The size of the cylinder-piston group increases from "A" to "C".
2. Assemble the piston with connecting rod. Take the piston, insert the connecting rod into it, so that the "FRONT" marks on the piston and connecting rod are on the one side. Then, insert the piston pin, which should move freely in the ports of the piston and connecting rod by hand.

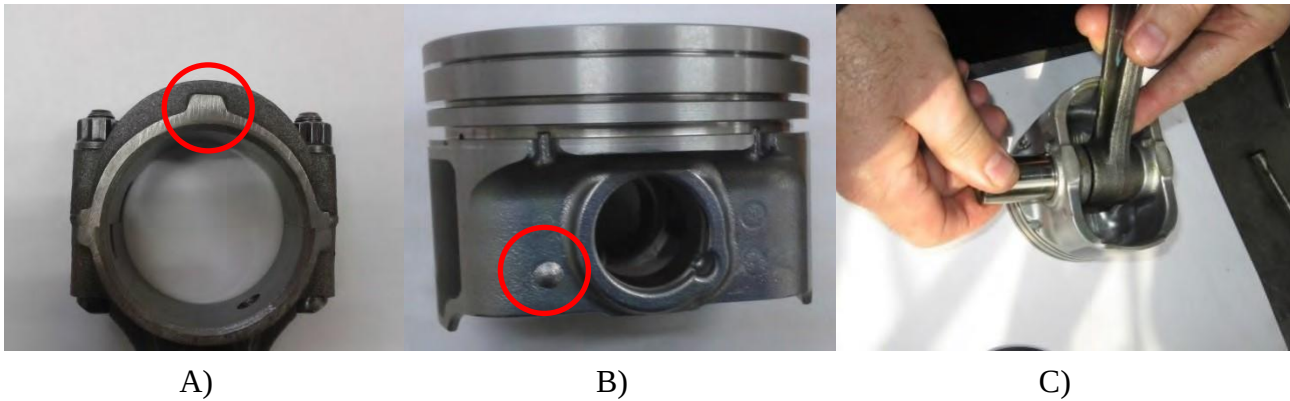


Figure 49 - Assembling the connecting rod and the piston

A) - mark “FRONT” on the connecting rod; B) - mark “FRONT” on the piston; C) - assembly.

3. Install retaining rings.



Figure 50 - Retaining rings installation

4. Install piston rings using the mandrel (aligner) or manually. Position the rings with the mark facing up. To prevent the crankcase gases from breaking through and the pressure in the crankcase to rise, it is recommended that the gap in the lock of each ring be spaced 180° apart
5. Assemble the remaining pistons with connecting rods using the same procedure.
6. After preassembling of the entire piston group, weigh using the reference balance. Weight difference should be max. 8 grams.



Figure 60 - Piston rings installation

8.6.3 Rockers axle assembling

1. Take the rocker of the valve and screw in the adjustment screw into it all the way, so that its working sphere is oriented towards the sleeve for the rocker axle.
2. Screw the nut onto the adjustment screw
3. Attach the following onto the rocker axle:
 - a) spring washer
 - b) rocker with screw and nut
 - c) fourth rocker axle strut

- d) rocker with screw and nut
- e) spacer spring
- f) rocker with screw and nut
- g) rockers axle strut
- h) rocker with screw and nut
- i) spacer spring
- 4. Compress the springs
- 5. One by one add the following
 - a) rocker with screw and nut
 - b) rockers axle strut
 - c) rocker with screw and nut
 - d) spring washer
 - e) rockers axle strut
- 6. Insert a cotter pin into the port of the rocker axle, and bend the cotter pin ends
- 7. Turn the rocker axle, and one by on add
 - a) spring washer
 - b) first rockers axle strut
- 8. In the rockers axle port
- 9. Insert the cotter pin and bend the cotter pin ends

8.6.4 Assembling the heat exchanger with hoses

1. Install the hoses onto the heat exchanger nozzles
2. Set the hose clamp onto the hose.
3. Tighten the clamp bolts (flat screwdriver)



Figure 61 - FOHE assembling with hoses

8.6.5 Camshaft assembling.

1. Take the spacer ring and put it on the extension of the camshaft with the chamfer oriented to the first support
2. Press in the key into the groove of the camshaft extension (use the hammer)
3. Take the thrust flange, apply some oil, and put on the camshaft extension
4. Install the cogwheel onto the camshaft extension.
After the cogwheel has been installed, the thrust flange should turn freely.
5. Preassemble the bolt with washers, start and screw it using the wrench in 2 stages, first - all the way, second - tighten it using the torque wrench with torque 4.0-5.6 kgf•m

8.6.5 Crankshaft with flywheel and clutch preassembling.



- add 3.5 g of Mobil Polyrex EM DIN 51825-2004 into the gearbox input shaft front end bearing
- press it into the socket of the crankshaft flange all the way to protective washer towards the flywheel.
- apply CIATIM 201 grease onto $\varnothing 80$ flange of the crankshaft;
- set the crankshaft cuff onto the crankshaft flange;
- set the flywheel onto the rear end of the crankshaft;
- set the washer of the flywheel bolts;
- secure the flywheel to the crankshaft using the bolts. Tighten the flywheel bolts in two stages: first - screw in all the way (wrench S17), second - tighten using the torque wrench with torque 8.9 kgf•m (calibrated wrench 8545-4005/9);
- set the driven disk onto the aligner and install it, so that the protrusion on the disk is oriented to the clutch basket (aligner);
- install the pressure disk and secure it using the bolts and washers in 2 stages: first - screw in all the way, second - tighten using the torque wrench with torque 2.3 kgf•m (calibrated wrench 8545-4005/1).

If during the course of assembling the crankshaft, flywheel, or pressure disk is replaced, then balancing is required (see cl. “Balancing”).

Thrust bearing installation:

- set the rear washer of the thrust bearing onto the first main journal of the crankshaft assembly with the aluminum side oriented to the shaft cheek (oil slots oriented to the crankshaft);
- install the front thrust washer with steel surface oriented to the block;
- set the steel thrust washer onto the front end of the crankshaft with chamfer oriented to the block, and press in the key into the groove of the crankshaft.



8.7 Engine assembling

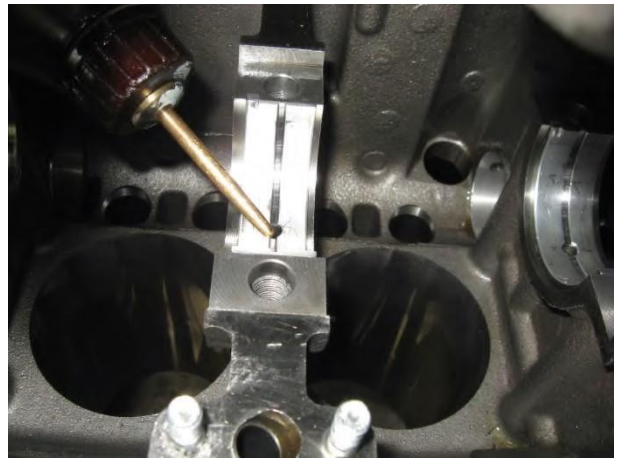
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When assembling the engine, do not reuse the gaskets and cuffs.

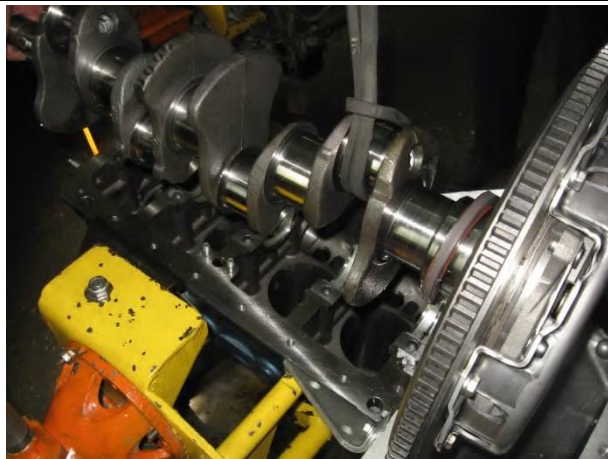


E1. Wipe the main bearings inserts with technical fabric, and put them into the bed of the block and the covers of the main bearings.

Beds in the block must be clean.



E2. Apply oil onto the bearings inserts (motor oil for engine lubrication)



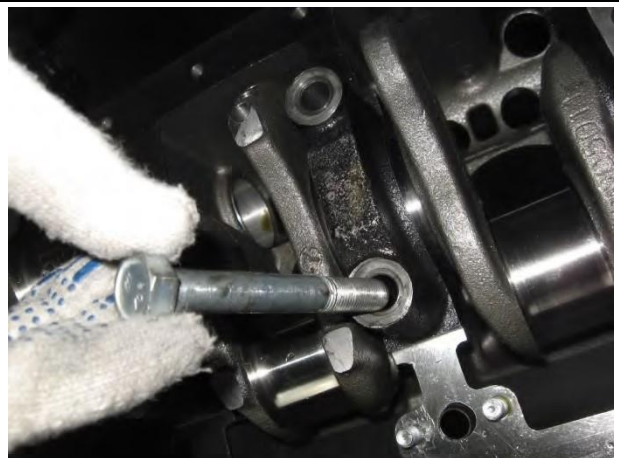
E3. Lay the crankshaft into the main bearings beds. Lubricate the crankshaft main journals.



E4. Install the main bearings covers using the correct order, align the crankshaft thrust washers with the grooves and pins on the cover and block.



E5. Apply Loctite 5900 sealant onto the connecting plane of the crankshaft cuff cover.
See p. 10 Fig. 5



E6. Set the bolts into the ports of the main covers.



E7. Tighten the main cover bolts in two stages.

First - all the way. Second - tighten using the torque wrench with torque 12.5-13.6 kgf*m.

Wrench S19

Make sure that the crankshaft is rotating freely by turning it using the tool by at least 180°, so that the first and fourth connecting rods are in the BDC



E8. Lubricate the valve pushers with oil and fit them to the guide ports. Selected pusher must move freely and turn in the guide port by hand (motor oil for engine lubrication)



E9. Lubricate the camshaft support journal (motor oil for engine lubrication). Install the preassembled camshaft into the port in the block.



E10. Align the mark on the crankshaft gear with the notch on the camshaft cogwheel.

See p. 13 Fig. 8



E11. Install the camshaft thrust flange, so that its ports match the ports in the block, and secure with bolts and washers.

Wrench S = 12

Make sure that the camshaft rotates freely by hand



E14. On the front end of the crankshaft, set the oil deflector washer, place the gasket and timing cogwheel cover onto the studs. Apply Anakrol-500 sealant glue onto both sides of the gasket. Attach the aligner to the front end of the crankshaft and secure the camshaft cover using bolts, nuts, and washers.

Aligner 55-1265

Wrench S = 13



E15. Install the crankshaft hub.

71 -1978 Tool for removing and pressing-in the hub of the crankshaft pulley and timing cogwheels.

E16. Install the key

Hammer



E17. Preassemble the crankshaft bolt with washer. Before installing the crankshaft bolt, apply Loctite-262 anaerobic sealant glue onto 2-3 thread convolutions in the form of a closed ring. It is allowed to apply the sealant onto the thread in the form of two longitudinal strips 2-3 mm wide along the entire length of the thread.

E18 Tighten the crankshaft bolt.

Wrench S = 36



E19. Set the camshaft cogwheels cover bolts. Tighten bolts and nuts.
Wrench *S* = 13



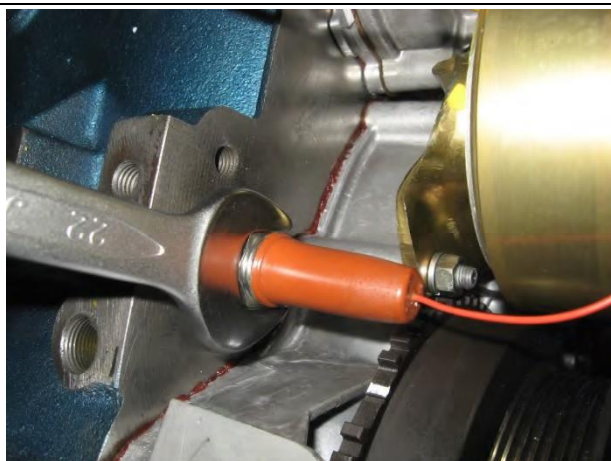
E20. Install the electromagnetic coupling
Wrench *S* = 13



E21. Install the accessories drive pulley onto the crankshaft hub, and tighten using bolts with washers.
Wrench *S*13



E22. Install the phase sensor.
Flat screwdriver.



E23.
Wrench *S*22



C24. Install the crankshaft position sensor.
Flat screwdriver



E25. Install the connecting rod inserts into the connecting rods, and lubricate them with oil.

Surfaces must be clean, without mechanical impurities.



E26. Install the connecting rod inserts into the connecting rod covers, lubricate them with oil.

Surfaces must be clean, without mechanical impurities.



E27. Install the 1-st and 4-th connecting rod journals of the crankshaft in the bottom dead center. Wipe the working surfaces of the sleeves using technical fabric. Lubricate cylinder sleeves working surfaces and piston rings. Wipe the crankshaft journals using technical fabric. Insert the preassembled pistons into the cylinders corresponding to the group, so that the mark on the piston bottom faces the front plane of the engine.

Aligner 4190-4111



E28. Install the corresponding connecting rod covers onto the connecting rod bolts (groove on the connecting rod cover and the marking on the connecting rod on one side) and apply Triboplast 9 or Germikon 8 sealant onto threaded part of the bolts with the nuts on them



E29. Screw the connecting rod covers in 2 stages: first - all the way, second - tighten using the torque wrench with torque 6.8-7.5 kg·m
Wrench $S = 15$



E30. Set the aligner for oil pump installation.



E31. Take the oil pump. Make sure that the oil pump roller spins freely. Install the discharge pipe with the gasket onto the oil pump housing, and secure using the bolts with washers. Put the gasket on the studs for securing the discharge pipe to the block, set the tube preassembled with the oil pump onto the studs. Install the oil pump, so that the drive extension enters the groove of the roller, and secure it using the bolts and washers. Secure the discharge pipe to the block using the nuts and washers.
Wrench $S = 12$ and $S = 13$



E32. Install the oil pump drive in the corresponding port in the cylinder block. Before doing so, apply Anakrol-500 sealant glue on both sides of the gasket. Tighten using bolts with washers.
Avoid getting glue into the engine



E33. Install the pusher box cover together with the gasket, and secure using the bolts with washers. Tighten the bolts with torque 0.8-1.0 kgf·m.
Wrench $S = 10$



E34. Install the oil case with the gasket. Tighten the oil case mounting bolts to 1.0-1.2 kgf•m
Wrench S = 13



E35. Install the clutch case (lower part) and secure it using the bolts with washers
Wrench S = 12



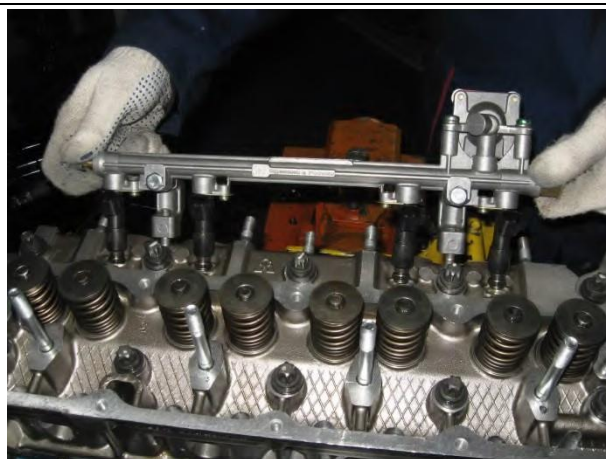
E36. Set cylinder head gasket onto the cylinder head studs.
Pay attention to the alignment of the oil channel in the cylinder block with the port in the gasket.



E37. Take the preassembled cylinder head and install it onto the studs.



E38. Set the bracket for engine lifting onto the fifth bolt on the right side of the engine. Tighten the cylinder head mounting bolts in two stages: first - all the way, second - tighten using torque wrench with torque 9.0-9.8 kgf•m.
For tightening procedure, see cl. 3.2 p. 9.



E39. Install the injector rail onto the studs, and secure using the nuts.
Wrench S13



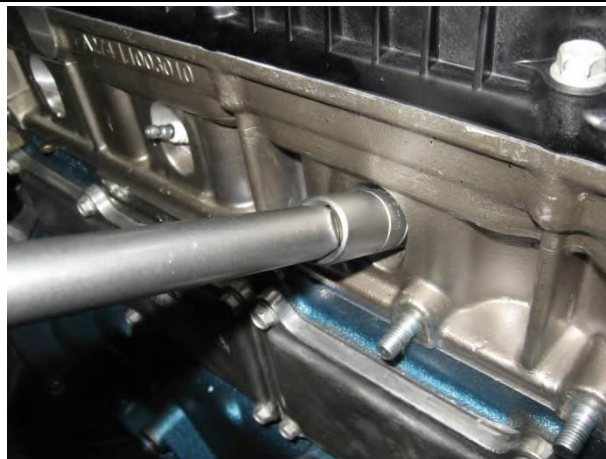
E40. Install the pusher rods with hydraulic lifters into the cylinder head ports.



E41. Install the rockers axle assembly onto the studs. Spherical part of each adjustment screw should be aligned with the sphere of the corresponding hydraulic lifter. Tighten the rockers axle nuts in two stages: first - all the way, second - tighten using the torque wrench with torque 3.5-4.0 kgf•m
Wrench S17
 Tighten 2 nuts of the extreme struts of the rocker axle using the torque 1.6-2.0 kgf•m
Wrench S13
 Adjust the valve train, see cl. 7.1 p. 38



E42. Lubricate the rockers axle with motor oil, install the rockers cover with the gasket onto the engine. Screw the bolts in: first - all the way, second - tighten using the torque wrench with torque 0.8-1.0 kgf•m
Wrench S = 10



E43. Take the spark plugs, start screwing them into the ports in the windows of the cylinder head. Screw the spark plugs: first - all the way, second - tighten using the torque wrench with torque 1.5-2.5 kgf•m
Wrench S = 16



E44. Install the ignition coil with bracket. Connect the wires of the high-voltage harness to the outputs of the ignition coils, and the tips to the spark plugs according to the marking.

Wrench $S = 12$



E45. Insert the oil dip stick into the corresponding port.



E46. Install the thermostat housing with the gasket onto the studs. Tighten the nuts to torque 2.4-3.0 kgf·m
Wrench $S 13$



E47. Install water pump with gasket lubricated on both sides with Anakrol-500 sealant glue. Install the bracket onto the lower stud. Install the alternator plate onto the thermostat housing stud, and tighten using the nut and washer. Tighten the water pump using nuts and washers.
Wrench $S = 13$

Avoid getting glue into the engine



E48. Install the starter onto the studs, and tighten using the nuts and washers.

Wrench $S = 19$



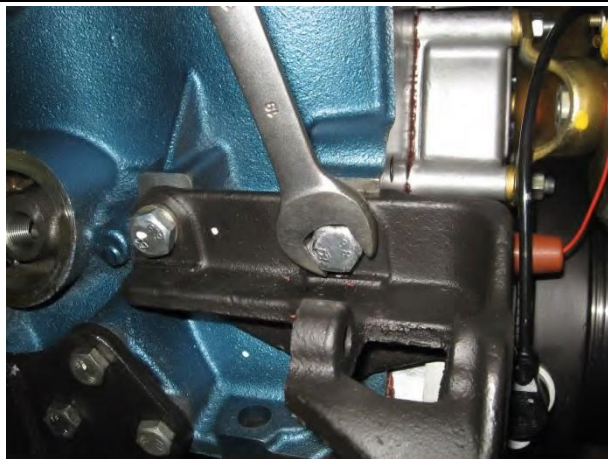
E49. Install the front bracket onto the cylinder head, and secure using the bolts with washers.

Wrench $S = 13$



E50. Tighten the power steering pump mounting bracket using the bolts.

Wrench $S = 17$

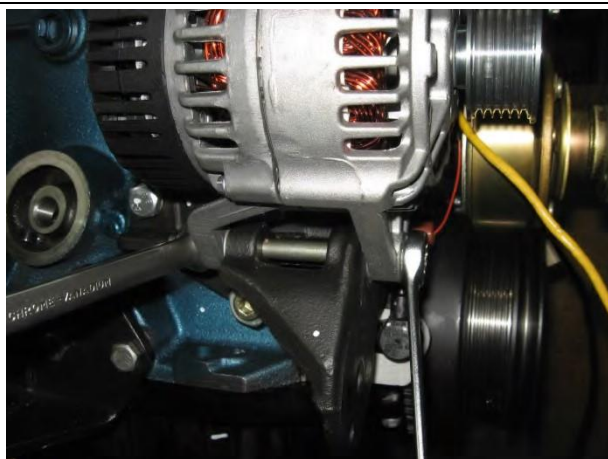


E51. Install the accessories bracket by pressing the bracket projection to the front end of the block. Secure the bracket using the bolts.

Wrench $S = 19$



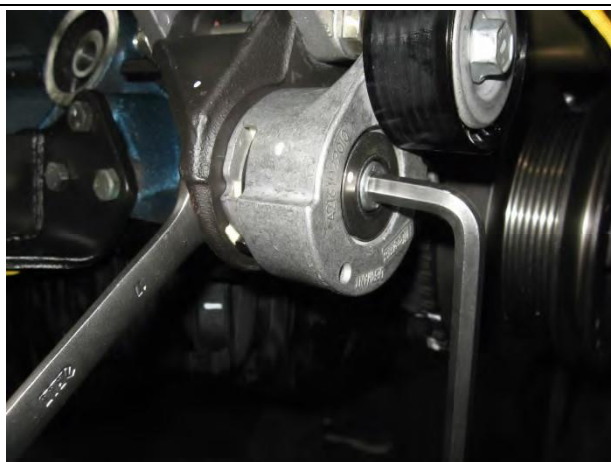
E52. Install oil radiator valve nozzle. Before doing so, apply Avtogermesil sealant onto the thread. Tighten the nozzle with torque 11.0-12.0 kgf·m



E53. Install the alternator

Wrench $S = 12$





E54. Install automatic tensioner

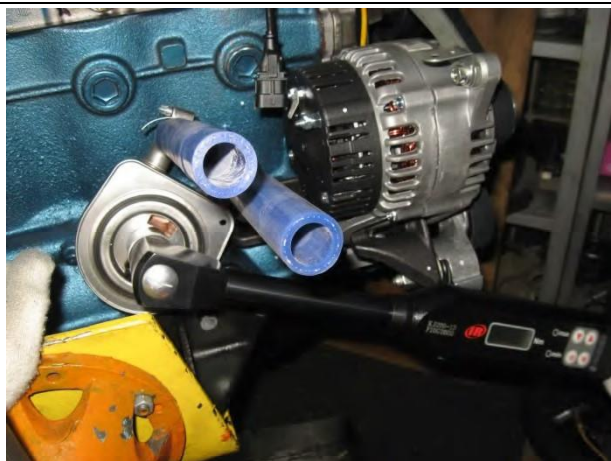
Wrench $S = 17$

Allen wrench $S = 8$



E55. Install the accessory drive belt as follows:

- Set the belt on the pulleys;
- Tension the tensioner using a wrench;
- Pull out the pin;
- Release the tensioner.



E56. Install heat exchanger with hoses onto engine, tighten the nozzle

Wrench 27



E57. Install the oil filter using the torque 2.0-2.5 kgf·m.

This torque is comparable with screwing the filter in all the way by hand, and additional $\frac{3}{4}$ turn.



E58. Screw the engine insulator bracket bolts.

Apply Triboplast 9 or Germikon 9 sealant onto 3 lower bolts

Wrench $S = 17$



E59. Install the knock sensor by placing the bracket at angle 45° in the rear-top direction.

Wrench $S = 12$



E60. Install the gasket onto the studs.



E61. Install the input pipe onto the studs and tighten using the nuts and washers.
Wrench S17



E62. Install the exhaust manifold onto the studs. Tighten using nuts and washers.
Wrench S = 17



E63. Install the preassembled receiver onto the input pipe. Tighten using the bolts.
Wrench S13



E64. Screw the receiver bracket bolts.
Wrench S = 13



E65. Install the throttle intake with terminal bracket.
Wrench S13



E66. Install the terminal into the holder.



E67. Install the absolute pressure sensor.
Flat screwdriver



E68. Secure the manifold shield using the bolts.
Wrench S = 13



E69. Install ventilation hoses and secure with hose clamps.
FBS tongs

Engine is now assembled and ready for breaking in on the test bench.

8.8 Engine break-in after repair

Durability of the repaired and adjusted engine depends to a large extent on its breaking-in and the operating mode of your vehicle during the first 2000 km.

Breaking-in of a newly repaired engine is carried out in accordance with the “Operation Manual” of the vehicle. It is recommended to break in the engine on the bench in the following mode:

1. Cold break in with crankshaft rpm 1200-1500 min.⁻¹ for 15 minutes.
2. Hot break in:

1000 min. ⁻¹	1 hour
1500 min. ⁻¹	1 hour
2000 min. ⁻¹	30 min.
2500 min. ⁻¹	15 min.

Keep the oil pressure in the engine lubrication system at least 2.5 kgf/cm², and the temperature at the engine input at least plus 50 °C.

Water temperature exiting from the engine should be plus 70-85 °C, and at input - at least 50 °C. Then, check the engine at rpm up to 3000 min.⁻¹.

If there is no test bench for engine break-in, then after installing the engine on the vehicle and refueling it with coolant and oil, hot break in for 30-40 minutes. To do so:

1. Let it idle for 10-15 minutes. Control the oil pressure and coolant temperature according to the standard indicators on the vehicle dashboard;
2. After the time expiration, switch the engine to 1800-2000 min.⁻¹. Oil pressure in this mode after warming up the engine (coolant temperature 70-80 °C) should be at least 300 kPa (3 kgf/cm²). Run the engine with this frequency for 10-15 minutes;
3. Increase the rpm to 2500-3000 min.⁻¹, keep this operation mode for 10-15 min. During break-in, check the engine for noise.

8.9 Engine noise check

Use stethoscope on a warm engine at different crankshaft rpm values.

Start listening from timing mechanism at low and medium rpm: valves at 750-1000 min.⁻¹, pushers at 1000-1500 min.⁻¹, timing cogwheels at 1000-2000 min.⁻¹.

Valves knocking is clearly audible from the head side, above the valves, knocking of pushers and camshaft journals - from the side of the camshaft, at the level of the camshaft axis; knocking of timing cogwheels - from the side of the cover. Listen to the crank gear (pistons and main bearings) with abrupt change in engine rpm within the range 750-2500 min.⁻¹.

Knocking of bearings is most clearly heard on the crankcase walls on the right side at the level of the camshaft, knocking of pistons and piston pins - on the walls of the cooling jacket opposite the respective cylinders.

Knocking of the main bearings is dull, and knocking of the connecting rod bearings and piston pins is sharper and more vibrant. Knocking of pistons are sharp, rattling. They can be heard in all engine operating modes.

Knocking of pistons, piston pins, main and connecting rod bearings, valves, and pushers on cold engine are the signs of engine malfunction.

Too loud knocking of valves and pushers, merging into the general engine noise with increasing crankshaft rpm, or the periodic knocking of valves appearing and disappearing with sharp change in the rpm of the crankshaft, as well as a minor knocking of pistons on cold engine are not the signs of engine malfunction. Slight high-pitch noise from timing cogwheels and oil pump cogwheels is permissible.

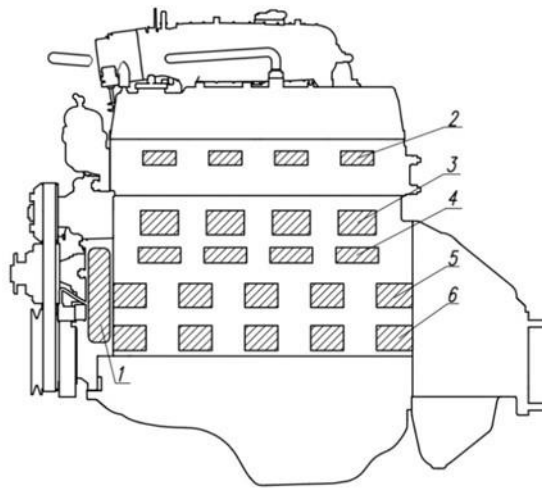


Figure 62 - Engine listening areas

1 - timing cogwheels; 2 - valves; 3- piston pins; 4, 5-pushers, valve rods, camshaft bearings; 6 - crankshaft main bearings.

8.10 Engine parts balancing

Ulyanovsk Motor Plant balances the following separately:

- clutch driven disc
- clutch basket assembly
- flywheel with rim assembly
- crankshaft

After assembling the crankshaft, the entire assembly is balanced.

Crankshaft assembly balancing

1. Install the crankshaft assembly onto the balancing machine. Balance the crankshaft dynamically.
2. Maximum allowable imbalance $35 \text{ g}\cdot\text{cm}^2$. When balancing, drill $\varnothing 12$ hole in the flywheel at $R 158 \pm 0.5$. Distance between the centers of the holes is 14 mm min. Hole depth 12 mm max.
3. Balance only if there is initial imbalance max $100 \text{ g}\cdot\text{cm}^2$.



Figure 63 - Balancing

4. With larger value, dismantle and re-check the balance of the components.

When repairing the engine and replacing the parts (crankshaft, flywheel, or clutch), entire assembly needs to be balanced.

Damper balancing

1. Balance the damper by drilling $\varnothing 11$ mm to $\varnothing 142$ with depth max. 10 mm, keeping the distance between the holes at least 3 mm.
2. Permissible imbalance max. $8 \text{ g}\cdot\text{cm}^2$



Figure 64 - Damper balancing

9 STORAGE

9.1 Storage

- 1 Engines supplied for installation into the vehicles should be installed no later than three months from the date of shipment from the manufacturer.
- 2 Engines supplied for installation into the vehicles must be conserved in accordance with the applicable instructions of the manufacturer and ensure safety for 3 months from the conservation date. Keep these engines in warehouses in closed unheated rooms or under canopy. Do not store acids and alkalis in the same rooms or under canopy. When installed on a vehicle, the engine must not require disassembly for removal of protective greases.
- 3 Engines supplied as spare parts, when stored in warehouses, must be packed in crates (it is allowed, depending on the terms of the contract, to deliver engines without packaging them in crates) and subjected to complete (external and internal) conservation sufficient to ensure safety for one year. Instructions for de-conservation should be attached.
- 4 Stands and crates must ensure reliable securing of the engine, protection from damage during transportation, and ensure the possibility of mechanized loading and unloading of the engines.
- 5 Documents accompanying the engine must be enclosed in a waterproof bag and placed inside the crate or attached to the engine.

9.2 Conservation

Conservation ensures safety of engines and protects against corrosion for a period of:

- 3 months – assembling plant,
- 1 year – domestic market,
- 2 years – export,

provided that the engines are stored in warehouses and in closed non-heated rooms, or under canopy. Do not store acids and alkalis in the same rooms or under canopy.

Engines should be conserved and packed in a room with a temperature not lower than 15 °C and relative humidity not higher than 70%. Sudden fluctuations in temperature and humidity are not permissible. Humidity increase up to 80% is permissible during the time when the temperature difference in the room does not exceed 5 °C.

Conservation oils and additives used must comply with the following parameters, as provided in Table 9.

Table 9

Parameters	LUKOIL Standard SAE 10W-30 STO 00044434-002-2005	K-17 GOST 10877
1. Water content	traces	absent
2. Kinematic viscosity at 100 °C, cSt at 100 °C, mm ² /s	6.5-12.5	15.5-21.0
3. Flash point determined in open cup, °C, min.	200	-
4. Mechanical impurities, %, max.	0.05	0.07
5. Free organic acids, %, max.	-	0.4
6. Alkaline number, mg KOH per 1 g of additive, min.	1.2	-

Conservation of engines for storage period up to 3 months.

Conservation of the internal surfaces of the engine is combined with testing the engine with LUKOIL Standard SAE 10W-30 motor oil.

Conservation of engines for storage period up to 12 months.

1. Conservation of the internal surfaces of the engine is combined with testing the engine with LUKOIL Standard SAE 10W-30 motor oil.
2. Conservation of surfaces of the cylinder inserts of the engine is carried out according to the following method:

- remove spark plugs;
 - pour 20 g of conservation oil K-17 GOST 10877 heated to 40° through each spark plug port into each cylinder.
 - after filling the oil, turn the crankshaft manually by 3-5 turns;
 - install spark plugs.
3. Ports of the stubs and nozzles of the thermostat, water pump, carburetor, heater nozzle, fuel pump nozzle, vacuum regulator nozzle, adsorber nozzle, vacuum brake booster nozzle, throttle nozzle (if there is no transport plug) are plugged with adhesive plaster.
 4. Starter, alternator, coolant, and air temperature sensors, synchronization sensors, phase sensors, knock sensors, ignition coils, fuel lines, carburetor microswitch pins, bolts and nuts that do not have paintwork and other protective coatings are lubricated with a mixture for preparation of plaster adhesive solution.

Engine conservation for storage period 2-5 years.

1. Conservation of the internal surfaces of the engine is carried out by pouring into the crankcase above the level of the upper mark of the oil dip stick (“P” or “max”) by 100 mm of conservation oil K-17 GOST 10877 heated to 40°.
2. Conservation of surfaces of the cylinder inserts of the engine is carried out according to the following method:
 - remove spark plugs;
 - pour 20 g of conservation oil K-17 GOST 10877 heated to 40° through each spark plug port into each;
 - after filling the oil, turn the crankshaft manually by 3-5 turns;
 - drain the oil from the crankcase;
 - install spark plugs after lubricating the metal parts of the spark plugs with K-17 GOST 10877 conservation oil heated to 40°.
3. Ports of the stubs and nozzles of the thermostat, water pump, carburetor, heater nozzle, fuel pump nozzle, vacuum regulator nozzle, adsorber nozzle, vacuum brake booster nozzle, throttle nozzle (if there is no transport plug) are plugged with adhesive plaster.
4. Starter, alternator, coolant, and air temperature sensors, synchronization sensors, phase sensors, knock sensors, ignition coils, fuel lines, carburetor microswitch pins, bolts and nuts that do not have paintwork and other protective coatings are lubricated with a mixture for preparation of plaster adhesive solution.
5. External metal parts of the engine that do not have paintwork are coated with a mixture for adhesive plaster preparation.
6. External painted surfaces of the engine do not need additional conservation.
7. If conservation oil gets onto rubber products and other non-metallic products, remove the oil using a cotton fabric.
8. After internal and external conservation, the engine manufacturing date is specified in the engine data sheet, and the quality service specialist signs it. Date of the engine manufacture is the date of the initial conservation of the engine. From this date, the conservation period is counted depending on the delivery conditions.

9.3 Safety requirements

- room where conservation is carried out must be provided with supply and exhaust ventilation;
- conservation can be carried out by employees who have undergone special training and familiar with the methods of work;
- persons engaged in conservation areas should use personal protective equipment in accordance with GOST 12.4.011;
- in a room in a highly-visible location there should be a first-aid kit with medicines for first aid in case of accidents;
- waste of conservation products must be removed in lockable boxes.

- conservation area should be equipped with fire safety equipment in accordance with the requirements of GOST 12.4.009.
- site must have health and safety instructions, and a briefings log according to the established form.

It is recommended that the conserved engine be stored in a clean, ventilated room with relative humidity 40-70%, and air temperature min. +5 °C.

9.4 Conserved engine maintenance

Engine maintenance is carried out once every two months. Do the following:

- thoroughly examine the engine from outside;
- screw out the spark plugs and turn the crankshaft by 15 turns. Once a year, before turning the crankshaft, pour 30-50 g of oil into the engine cylinders;
- clean the affected areas from corrosion, clean and paint them;
- check the condition of all electrical appliances;
- eliminate faults detected during inspection.

9.5 Deconservation

1. Remove conservation grease from the parts. To do so, wash them with kerosene or unleaded gasoline. Carefully remove grease from parts that may come in contact with rubber parts or painted surfaces. Wash spark plugs thoroughly in unleaded gasoline.
2. Do daily maintenance of the engine.

9.6 Transportation

1. Engines can be transported by all means of transport ensuring the protection of engines and packaging from mechanical damage and environment. Type of transport and packaging are specified in the supply contract.
2. Groups of conditions for transportation and storage of engines according to GOST 15150 - 5 and 2, respectively.
3. Mass of engines packed in containers (four engines) for transportation is max. 1000 kg, one engine packed in crate - max. 250 kg.
4. Dimensions of the cargo unit for the packed engine is 2220 x 1220 x 1010 mm, packed in a crate - 1050 x 690 x 950 mm.

9.7 Disposal

Engine is disposed of in accordance with the regulations, rules, and methods applicable at the disposal site.

9.8 Factory warranties and claim management procedure

The warranty periods for the engines depending on the purpose of delivery are provided in the data sheet.

During the warranty period, JSC Ulyanovsk Motor Plant guarantees the free-of-charge elimination of defects arising from its fault and not specified by the seller.

Procedure for making claims, the addresses of warranty service stations and the addresses of the locations that replace (ship) components that early fail under operating conditions due to the fault of the manufacturer are specified in the vehicle manual and service book.

If there are no companies that provide warranty service in your region area, contact either the organization that sold the vehicle or the engine, or send a written message about the identified deficiencies to: 432006, Ulyanovsk, Locomotivnaya Str., 17.

Warranty obligations become null and void if defects result from:

- consumer's failure to comply with the requirements set forth in this Manual and the service book;

- damage to the vehicle, including damage resulting from traffic accident with no fault of the manufacturer;
- disassembling or repairing engine components and assemblies by yourself;
- modification or making changes to the design or configuration of the engine without the consent of JSC Ulyanovsk Motor Plant;
- replacement of the standard components and assemblies by the consumer with other ones that are not envisaged in the regulatory and technical documentation of JSC Ulyanovsk Motor Plant;
- use of engine in sport cars;
- damage caused due to fording with depth more than 300 mm, or other cases when water gets into engine parts and components.

Address the claims regarding to incomplete scope of supply of mechanical damage to the vehicle or engine seller.

During the warranty period, engine maintenance provided for by the service book is carried out at the expense of the owner.

APPENDICES

Appendix 1

Operational materials

Recommended motor oils

Table 4 - Motor oils temperature range depending on the viscosity class

Ambient temperature	Viscosity classes according to STO AAI 003 and SAE
from minus 30 to plus 20 °C	0W-30
from minus 30 to plus 25 °C	0W-40
from minus 25 to plus 20 °C	5W-30
from minus 25 to plus 35 °C	5W-40
from minus 20 to plus 30 °C	10W-30
from minus 20 to plus 35 °C	10W-40
from minus 15 to plus 35 °C	15W-30
from minus 15 to plus 45 °C	15W-40
from minus 10 to plus 45 °C	20W-40; 20W-50
from minus 5 to plus 45 °C	SAE 30
from 0 to plus 45 °C	SAE 40

Performance of the motor oils according to STO AAI 003 (API) classification should be at least SN

Recommended oils for use are Lukoil GENESIS ARMORTECH (STO 79345251-075-2015). Long-term factory tests have been carried out using Lukoil GENESIS ARMORTECH oil.

To ensure reliable operation of hydraulic lifters, it is not recommended to use mineral oils.

Coolants

Cool Stream Standard 40, Cool Stream Standard 65 TU 2422-00213331543, SINTEC Antifreeze-40, SINTEC Antifreeze-65 TU 2422-04751140047-2004; Antifreeze FELIX CARBOX TU 2422-068-36732629-2006; NIAGARA GREEN 40, NIAGARA GREEN 65 TU 2422-002-63263522-2011.

Fuel

Fuel - unleaded automobile gasoline Regular-92 grades as per GOST R 51105, Premium Euro-95 and Super Euro-98 as per GOST R 51866

Liquefied fuel gas PBA GOST R 52087 (A2755)

Rolling bearings

No.	Name	Designation	Manufacturer	Qty
1	Ball roller, water pump	4216.1307027 (R1769)	Kinex	1
2	Guide end of gearbox input shaft, (in crankshaft socket)	6203-C-Z-C3	FAG	1
		6203-Z/C3	SKF	1
3	Fan support bearing	3206-BD-2HRS-TVH-L207	FAG	1

Cuffs and glands

No.	Name	Designation	Manufacturer	Qty
1	Front cuff of the crankshaft	4216-1005034MKB	Rezinotekhnika (RF)	1
2	Rear cuff of the crankshaft	2108-1005160MKB	Rezinotekhnika (RF)	1
3	Water pump gland	SP/1341	Umbra (Italy)	1
4	Oil deflector cap of the input and output valve	4021.1007026	RF	8

Appendix 2

Tightening torques for vehicle engine threaded connections

No.	Part (assembly unit) name or designation	Part (assembly unit) purpose	Tightening torque, N·m (kgf·m)
1	2	3	5
1	Bolt M10-6gx35	engine front insulator to block connection	39.22-54.92 (4.0-5.6)
2	Bolt M10-6gx40	power steering pump bracket to block connection	39.22-54.92 (4.0-5.6)
3	Bolt M6-6gx12	gland cuff holder connection	6.86-8.82 (0.7-0.9)
4	Bolt M8	crankshaft cuff cover connection	11.76-17.65 (1.2-1.8)
5	Nut M8x1-6H	timing cogwheels cover connection	11.76-17.65 (1.2-1.8)
6	Bolt M12x1.5	crankshaft bearings covers connection	107.87-117.67 (11-12)
7	Bolt M10-6gx35	clutch case connection, upper part	43.15-54.92 (4.4-5.6)
8	Bolt M12-6gx35	clutch case connection, upper part	49.03-60.80 (5.0-6.2)
9	Plug KG 3/8"	oil channel plug	25-48 (2.55-4.90)
10	Bolt M8x70	timing cogwheels cover connection	11.76-17.65 (1.2-1.8)
11	Nut M8	timing cogwheels cover connection	11.76-17.65 (1.2-1.8)
12	Plug KG 1/2"	coolant drain ports	25-56 (2.55-5.71)
13	Nut M8x1-6H	head water jacket cover connections	15.69-19.61 (1.6-2.0)
14	Bolt M8-6gx22	head water jacket cover connection	15.69-19.61 (1.6-2.0)
15	Bolt M12x1.25	cylinder head connection	88.25-96.04 (9.0-9.8)
16	Bolt M10-6gx25	bracket connection	23.53-35.30 (2.4-3.6)
17	Nut Sp M10x1	connecting rod cover bolt connection	66.64-73.54 (6.8-7.5)
18	Bolt M10x1.25	flywheel self-locking bolt	78.45-88.26 (8.0-9.0)
19	Plug Sn M22x1.5	crankshaft oil cavities plug	37.26-41.18 (3.8-4.2)
20	Bolt M8-6gx30	damper to crankshaft hub connection	17.65-24.51 (1.8-2.5)
21	Bolt M24x2	crankshaft bolt (ratchet)	156.9-176.51 (16.0-18.0)
22	Bolt M8-6gx20	camshaft flange connection	15.69-17.65 (1.6-1.8)
23	Bolt M12x1.25-6gx30	cogwheel to camshaft connection	43.15-54.92 (4.4-5.6)
24	Nut M9x1	valve pusher adjustment screw locking	11.76-17.65 (1.2-1.8)

25	Nut M8x1	rockers axle and struts assembly connection	15.69-19.61 (1.6-2.0)
26	Bolt M6x30 (flange)	rockers cover connection	7.74-9-80 (0.8-1.0)
27	Nut M10x1	rockers axle and struts assembly connection	34.34-39.22 (3.5-4.0)
28	Bolt M8	receiver to intake pipe connection	14.70-19.61 (1.5-2.0)
29	Nut M10x1	input pipe and manifold to cylinder head connection:	34.30-39.22 (3.5-4.0)
30	Bolt M8-6gx12	receiver bracket connection	14.70-19.61 (1.5-2.0)
31	Bolt M6x10	manifold shield connection	8.82-9-80 (0.9-1.0)
32	Bolt M8x1.25	oil case connection	14.70-19.61 (1.5-2.0)
33	Plug M14x1.5	oil case drain port, special	19.61-24.51 (2.0-2.5)
34	Bolt M8-6gx30	oil pump to block connection	11.76-17.65 (1.2-1.8)
35	Nut M8x1-6H	oil pump discharge tube connection	11.76-17.65 (1.2-1.8)
36	Bolt M6-6gx35	retainer plate to oil pump connection	6.86-8.82 (0.7-0.9)
37	Bolt M8-6gx16	oil receiver mesh connection	11.76-17.65 (1.2-1.8)
38	Oil filter NF-1004-02	oil filter	19.61-24.51* (2.0-2.5)
39	Transitional nozzle	oil filter connection	78.45-88.25 (8.0-9.0)
40	FOM and TZM nozzle	oil filter to heat exchanger connection	29.42-39.22 (3.0-4.0)
41	Plug K 1/4"	oil drain ports in cylinder block	25.0-40.0 (2.55-4.10)
42	Plug KG 3/8" (steel**)	oil radiator valve port (transport)	25-48 (2.55-4.90)
43	Nozzle (M18x1.5)	oil radiator valve	107.8-117.6 (11.0-12.0)
44	Nozzle (K 3/8 ")	transitional for oil pressure sensor	25-48 (2.55-4.90)
45	Sensor (K 1/4")	emergency oil pressure	25.0-40.0 (2.55-4.10)
46	Bolt M6x20	pusher box cover connection	7.74-9-80 (0.8-1.0)
47	Nut M8x1	oil pump drive cover connection	11.76-17.65 (1.2-1.8)
48	Nut M8x1-6H	fuel module connection	17.65-21.57 (1.8-2.2)
49	Bolt M8-6gx30	thermostat cover connection (and wire bracket)	10.78-14.70 (1.1-1.5)
50	Angular nozzle (K 1/8")	connecting hose	7.9-21.57 (0.81-2.20)
51	Nut M10x1	thermostat housing connection	23.53-29.42 (2.4-3.0)

52	Bolt M10-6gx40	thermostat housing connection	23.53-29.42 (2.4-3.0)
53	Straight nozzle (K 1/2")	heater connection	25.0-58.83 (2.55-6.00)
54	Bolt M6-6gx40	water pump connection	3.92-7.84 (0.4-0.8)
55	Nut M8x1	water pump connection	11.76-15.69 (1.2-1.6)
56	Bolt M8x80	water pump connection	11.76-15.69 (1.2-1.6)
57	Straight nozzle (K 1/8")	vapor output, hose to throttle	7.9-21.57 (0.81-2.20)
58	Bolt M8-6gx16	water pump pulley connection	15.69-17.65 (1.6-1.8)
59	Nut M8x1-6H	electromagnetic coupling connection	13.73-17.65 (1.4-1.8)
60	Bolt M10-6gx35	clutch case connection, upper part	43.15-60.80 (4.4-6.2)
61	Bolt M10x1x29	ball joint connection	23.53-35.30 (2.4-3.6)
62	Bolt M8-6gx16	clutch case connection, upper part	10.78-24.51 (1.1-2.5)
63	Bolt M6-6gx12	clutch case seal holder connection	6.86-8.82 (0.7-0.9)
64	Bolt M10-6gx30	booster to block connection	27.45-35.30 (2.8-3.6)
65	Bolt M8-6gx22	booster to clutch case connection	17.65-24.51 (1.8-2.5)
66	Bolt M8x30	pressure disk housing connection	19.61-29.42 (2.0-3.0)
67	Nut M8x1	alternator installation plate to block connection	11.76-17.65 (1.2-1.8)
68	Bolt M8x22	pressure bracket to alternator plate connection	17.65-24.51 (1.8-2.5)
69	Nut M12x1.25-6H	alternator brackets connection	43.15-60.80 (4.4-6.2)
70	Bolt M10x40	alternator connection using first nut	7.74-9.80 (0.8-1.0)
71	Nut M10	alternator bolts	39.22-54.92 (4.0-5.6)
72	Bolt M12x40	accessories bracket connection	73.54-83.35 (7.5-8.5)
73	Nut M12x1.25-6H	accessories bracket connection	73.54-83.35 (7.5-8.5)
74	Bolt M6-6gx25	ignition coils to bracket connection	7.74-8.82 (0.8-0.9)
75	Bolt M8-6gx16	ignition coils bracket connection	11.76-15.69 (1.2-1.6)
76		spark plug	14.70-19.61 (1.5-2.0)
77	Nut M12x1.25-6H	starter connection	43.15-60.80 (4.4-6.2)
78	0 280 130 093	coolant temperature sensor	16-18 (1.63-1.83)

79	Bolt M8x25	knock sensor connection	15-25 (1.53-2.55)
80	Bolt M6x55	throttle connection	7.74-11.76 (0.8-1.2)
81	Screw M6-6gx14	phase sensor connection	7.5-8.5 (0.76-0.86)
82	Screw M4x25 or M4x22	absolute pressure sensor connection	2.94-3.92 (0.3-0.4)
83		oxygen sensor	40.0-60.0 (4.1-6.1)
84	Bolt M8-6gx12	bracket holder connection	17.65-24.51 (1.8-2.5)
85	Nut M8-6H	bracket holder connection	17.65-24.51 (1.8-2.5)
86	Screw M6-6gx14	synchronization sensor connection	6-10 (0.61-1.02)
87	Nut	heat exchanger connection	29.42-39.22 (3-4)
88	Nut M6-6H	gas injectors rail connection	4.41-5.88 (0.45-0.6)

* Note: this torque is comparable with screwing the filter in all the way by hand, and additional $\frac{3}{4}$ turn

** Note: screw the plug made of polymeric materials all the way and tighten using the torque max. 3.9 (0.4) N•m (kgf•m)