

Open Joint Stock Company

MINSK MOTOR PLANT

DIESEL ENGINES

**D-245S3A M, D-245.2S3A M, D-245.5 S3A M,
D-245.43 S3A M**

OPERATION MANUAL

MINSK, 2010

Table of Content

1. DESCRIPTION AND OPERATION	5
1.1 Description and Operation of the Diesel Engine	5
1.1.1 Diesel function	5
1.1.2 Technical characteristics	2
1.1.3 Diesel Engine Components	2
1.1.4 Operation and Description	2
1.1.5 Diesel Engine Marking	3
1.1.6 Packing	3
1.2 Description and operation of diesel engine components, its mechanisms, systems and devices	3
1.2.1 General information.....	4
1.2.2 Description and work.....	5
3.2. <i>Cylinder Heads</i>	5
3.4. Valve Mechanism	6
1.2.3 <i>Marking sealing of diesel engine components</i>	8
2. PROPER USE	8
2.1 Operating Constraints	8
2.2 Preparation for Use	8
2.2.1 Safety Precautions during the Engine Preparation	8
2.2.2 Depreservation of the Diesel Engine, Assembly Units and Parts	9
2.2.3 Additional Completing the Diesel Engine Set	9
2.2.4 Cooling system filling	10
2.2.5 Filling with fuel and oil	10
2.2.6 Diesel engine operation control elements and inspection tools	10
2.3 Diesel Engine Operation	10
2.3.1 Service staff operating procedure during fulfillment of the diesel engine operation tasks	10
2.3.2 Starting the Engine	11
2.3.3 Stopping the engine	12
2.3.4 Run-in	12
2.3.5 Engine operating and service in cold weather	12
2.3.6 Troubleshooting	13
2.3.7 Safety requirements at the diesel engine proper use	16
2.4 Operation in extreme conditions	16
3 TECHNICAL MAINTENANCE	16
3.1 Technical maintenance of diesel engine	16
3.1.1 General instructions	17
3.1.2 Safety measures	19
3.1.3 Technical maintenance procedure.....	20
3.1.4 Check of diesel engine workability.....	22
3.1.5 Preservation (represervation) when placed for storage.....	23
3.1.6 Preparation of engine for operation when removed from storage	25
3.2 Technical maintenance of engine and its parts	26
3.2.1 Maintenance of cooling system.....	26
3.2.2 Maintenance of lubrication system.....	26
3.2.3 Check of oil level in the engine crankcase.....	27
3.2.4 Replacement of oil in the engine crankcase	28
3.2.5 Replacement of oil filter.....	28
3.2.6 Drain of sediment form coarse fuel filter	29
3.2.7 Washing of coarse fuel filter	30
3.2.8 Drain of sediment from fine fuel filter	30
3.2.9 Replacement of fine fuel filter	31
3.2.10 Filling the fuel system.....	32
3.2.11 Maintenance of air cleaner.....	32
3.2.13 Washing of the engine breather.....	34
3.2.14 Check of cylinder head bolt tightening	34
3.2.15 Check of clearance between valves and rockers	34
3.2.16 Maintenance of high-pressure fuel pump.....	36
3.2.18 <i>Check of injectors for pressure at the beginning of injection and quality of fuel atomization</i>	40
3.2.19 Alternator maintenance	41
3.2.20 Check of belts tension.....	42

3.2.21 Check of starter state.....	43
3.2.22 Maintenance of turbocharger	43
3.2.23 Maintenance of compressor.....	44
4 RUNNING MAINTENANCE.....	44
4.1 General instructions on engine assembly and disassembly.....	44
4.1.1 General instructions	44
4.1.2 Safety measures	45
4.2 Running repair of components.....	46
4.2.1 Main instructions on piston rings replacement.....	47
4.2.2 Main instructions on valve grinding.....	48
5. STORAGE.....	50
6. TRANSPORTATION.....	50
7. RECYCLING.....	51
ANNEX A (REFERENTIAL).....	52
CHIMMOTOLOGY LIST.....	52
ANNEX B (REFERENTIAL).....	56
QUANTITY SHEET OF SPARE PARTS, TOOLS AND ACCESSORIES (SPARE PARTS, INSTRUMENT).....	56
ANNEX C (REFERENTIAL).....	57
SIZE GROUPS OF CYLINDERS AND PISTONS	57
ANNEX D (REFERENTIAL).....	58
ENGINE ADJUSTING PARAMETERS.....	58
ANNEX E (REFERENTIAL).....	58
ADJUSTING PARAMETERS OF FUEL PUMP PP4M10U1I 3793 WHEN CHECKED ON THE STAND.	58
ANNEX E (REFERENTIAL).....	59
ANNEX E (REFERENTIAL).....	60
ANNEX F	61
IDENTIFICATION OF ENGINE AND TURBOCHARGER FAULTS.....	61
ANNEX G (REFERENTIAL).....	2
SCHEME OF ENGINE STRAPPING	2

The present operation manual is designed for operators, drivers and agricultural tractors motormen, combine harvesters and agricultural machinery equipped with diesel engines D-245 S3A M, D-245.2S3A M, D-245.5 S3A M, D-245.43 S3A M, and for maintenance centers and repair workshops staff competent to provide repair and maintenance of the abovementioned diesel engines.

The present manual provides brief technical description, maintenance and service rules of diesel engines.

Operation and maintenance of diesel engines is allowed by persons specially trained and familiar with the present manual only.


Routine repair operations for diesel engines and its components can be carried out by machine men knowing design and operating principles of diesel engines, and having general technical skills according to training program for machinemen of the 3rd or 4th grade.


Diesel engine is designed for continuous service without need of major repairs provided that equipment operating procedures, storage, and timely maintenance requirements set forth in this manual are complied with.

Diesel engine exhaust gas contains hazardous substances (nitrous oxides, carbon monoxides, hydrocarbons, solid particles). Diesel engines design is based on technical solutions which enable reduction of emission impact on human's health and environment

Premises where the diesel engine is operated shall have combined extract-and-input ventilation, and diesel engine exhaust system shall be equipped with independent offtake ensuring positive offtake of exhaust gases from muffler to the outside of the room.

Due to the continuous improvement some alterations in diesel engine design can be made which are not specified in this operation manual.

 **!** *In case of non compliance with rules and procedures of operation, maintenance, transportation and storage specified herein, crippling of plant seals, and use of expandable materials (petroleum, oil and lubricants, parts and assembly units) of other manufacturers which are not provided with design documentation of RUE "MMP" during the maintenance and routine repair, and introduction of changes of engine design, guarantee ceases to be effective.*

 **!** *In the event when maintenance of failed diesel engine parts during a period of guarantee for engine or its components is carried out by the owner or the third party without involvement of plant's technical specialists or an authorized dialer center, guarantee for engine or its components ceases to be effective.*

1. DESCRIPTION AND OPERATION

1.1 Description and Operation of the Diesel Engine

1.1.1 Diesel function

Function, range of use and operation conditions of the diesel engines are shown in Table 1.

Table 1.

Description	Diesel engine			
	D-245S3A M	D-245.2S3A M	D-245.5S3A M	D-245.43S3A M
Purpose	For installation to fodder chopper and tractors of drawbar category 1.4.			
Range of use	Places with infinitely large air exchange			
Climatic service conditions	Macroclimatic areas with moderate climate. Air temperature rate during operation at temperature from + 40° C to - 45° C. Macroclimatic areas either with dry or damp tropical climate. Air temperature rate during operation at temperature from + 50° C to - 10°C.			

1.1.2 Technical characteristics**1.1.2.1 Characteristics and operating parameters of diesel engines.**

Table2

Description	Units of measurement	Diesel engine			
		D-245S3A M	D-245.2S3A M	D-245.5S3A M	D-245.43 S3A M
		Value			
Diesel engine type		Four-cycle, turbo-charging and supercharging cooler			
Carburetion method		Voluminous carburetion			
Number and arrangement of cylinders	Items	4			
Cylinders arrangement		In four rows, vertical			
Cylinder displacement	l	4,75			
Firing order		1-3-4-2			
Crankshaft rotation direction in accordance with GOST 22836-77 (viewed from fan side)	mm	To the right (Clockwise)			
		110			
Piston stroke	mm	125			
Compression ratio (rated)		17			
Operating engine incline angles: - lengthway - crossover	degrees	20			
		20			
Operating Horse Power	kW (Hp)	77 (103)	86 (115)	66,7 (89)	58,7 (78)
Rated RPM	min ⁻¹	2200		1800	
Fuel consumption at rated HP	g/kW·h	235		220	
Torque peak at the moment of complete diesel set for determination of nominal power	N·m	440	501	464	411
Rotating frequency at torque peak, not less than	min ⁻¹	1600		1400	

Diesel engine weight without petroleum, oil and lubricants and liquid coolant in a complete set according to the GOST 18509 for determination of nominal rating power.	kg	430	450	430
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1.1.2.2 Testing parameters of the diesel engines

Table 3

Description of parameters	Units of measurement	Diesel engine			
		D-245S3A M	D-245.2S3A M	D-245.5S3A M	D-245.43S3A M
		Value ± confidence interval (permissible variation)			
Rated Horse Power	kW	81,0±2,0	90,0±2,0	70,0±2,0	62,0±3,0
Rated RPM	min ⁻¹	2200 ⁺⁴⁰ ₋₂₅		1800 ⁺⁴⁰ ₋₂₅	
Fuel consumption at rated HP	g/kW·h	225±11		210±11	
Min. constant idling rpm	min ⁻¹	800±50			
Max. idling rpm, not less than	min ⁻¹	2420			2070
Oil pressure in main lubrication gallery: - at rated RPM - at min. RPM	MPa	0,25...0,0,35			
		0,08			

Note: Parameters are achieved after operating time equal to 60^{-5} hours with backpressure of 150 KPa in exit channel 200 m from turbine flange while engine brake is shut down, and with fuel temperature at the inlet of fuel-handling system ranging from 38°C to 43°C reference atmospheric conditions according to the rules № 24(03)/Revision 2 of UN's Economic Commission for Europe:

- atmosphere pressure – 100 KPa;
- vapour pressure – 1 KPa;
- air temperature – 25°C.

Parameters shall be calculated by the formulae set forth in GOST 18509-88.

1.1.2.3 Measurement instrumentation for definition of testing parameters

Table 4

Measurable parameter	Units of measurement	Measurement instrumentation	Fundamental absolute accuracy limits of measurement instruments	Note
Torque moment	Nm	Strain-gauge-type force measurement system and dynamometer force measurement system – acc. to GOST 15077-78	$\pm 0,005$ micron max	For rated power calculation
RPM	min^{-1}	Electronic tachometer of pipe-electrical welding machine acc. to TU25-04.3663-78, GOST18303-72	$\pm 0,005n$ noy, but not more than 10 min^{-1}	
Oil pressure in lubricating system	MPa	Pressure gauge, vacuum pressure gauge acc. to GOST 2405-80, GOST 11161-84, pressure and depression transducer acc. to GOST 22520-85	$\pm 0,02$	
Hourly fuel consumption	kg/h	Nonstandard measurement instrumentation	$\pm 0,01G_T$	For specific fuel consumption

1.1.3 Diesel Engine Components

Diesel engine is composed of parts, assembly units, assembly sets.

1.1.3.1 Composition of main assembly units for diesel engine D-245S3A M

Table 5

Description of assembly units and assembly sets
Cylinder block
Installation of cylinder set intake channel
Installation of breather pipe
Installation of clutch
Fuel transfer pump drive
Installation of turbocompressor
Installation of oil crankcase
Installation of fuel equipment
Turbocompressor oil pipeline
Installation of Exhaust Gases Recirculation System
Thermostat housing
Installation of water pump
Installation of fan
Installation of oil pump
Installation of compressor
Installation of electric generator
Installation of heating plug
Installation of starter
Installation of leading foot
Installation of gear wheel pump
Set of spare parts and accessories

Register of spare parts tools and accessories for diesel engines – Annex B of this manual (Table B.1).

1.1.3.2 Main features in the diesel engines modifications composition

Table 6

Description of a unit, part	Diesel engine			
	D-245S3A M	D-245.2S3A M	D-245.5S3A M	D-245.43 S3A M
	Description of a unit, part and (or) its characteristic			
Turbo-compressor	C15-505 or C14-198-01 of firm CZ («Turbo»), Czechia		C14-101-01 of firm CZ («Turbo»), Czechia	
Recirculation valve	7.22946.25.0 of firm «Pierburg»			
Compressor	Single-cylinder, air cooling, interruptible A29.05.000 BZA or A29.01.000 BZA			
Gear wheel pump	Of NSH 10-3L or NSH 14-3L type			
High-pressure fuel pump	PP4M10U1i-3794 «MERCER»	PP4M10U1i-3793 «MERCER»	PP4M10U1i-3795 «MERCER»	PP4M10U1i-3796 «MERCER»
Nozzle	VA70P360-2996 with spray bar DOP140P528- 3826			
Coarse fuel filter	Coarse fuel filter (fuel strainer)			
Secondary fine fuel filter	FT020-1117010 or T6101 (indecomposable type)			
Air filter	* Combined: monocyclone (preliminary stage of air cleaning) and air cleaner with paper filter cartridge			
Oil filter	FM009-1012005 or M5101 (indecomposable type)			
Fan and its drive	Axial type with a drive through a clutch with automatic cutoff			

Table 6 continued				
Description of a unit, part	Diesel engine			
	D-245S3A M	D-245.2S3A M	D-245.5S3A M	D-245.43 S3A M
	Description of a unit, part and (or) its characteristic			
Clutch	Frictional, double-disk or single-disk, dry, spring-loaded clutch			
Electric generator	Alternate current, rated voltage of 14 V or 28 V			
Starter	Rated voltage 12 V or 24 V			
Starting aid	Diesel engines are supplied with pin heating plug, rated voltage of 11 V or 23 V and provided with openings for heat input and output during connection of starting preheater.			

Note: *- shall be determined by a customer.

Outside appearance of diesel engine D-245S3A M is shown on Figure 1.

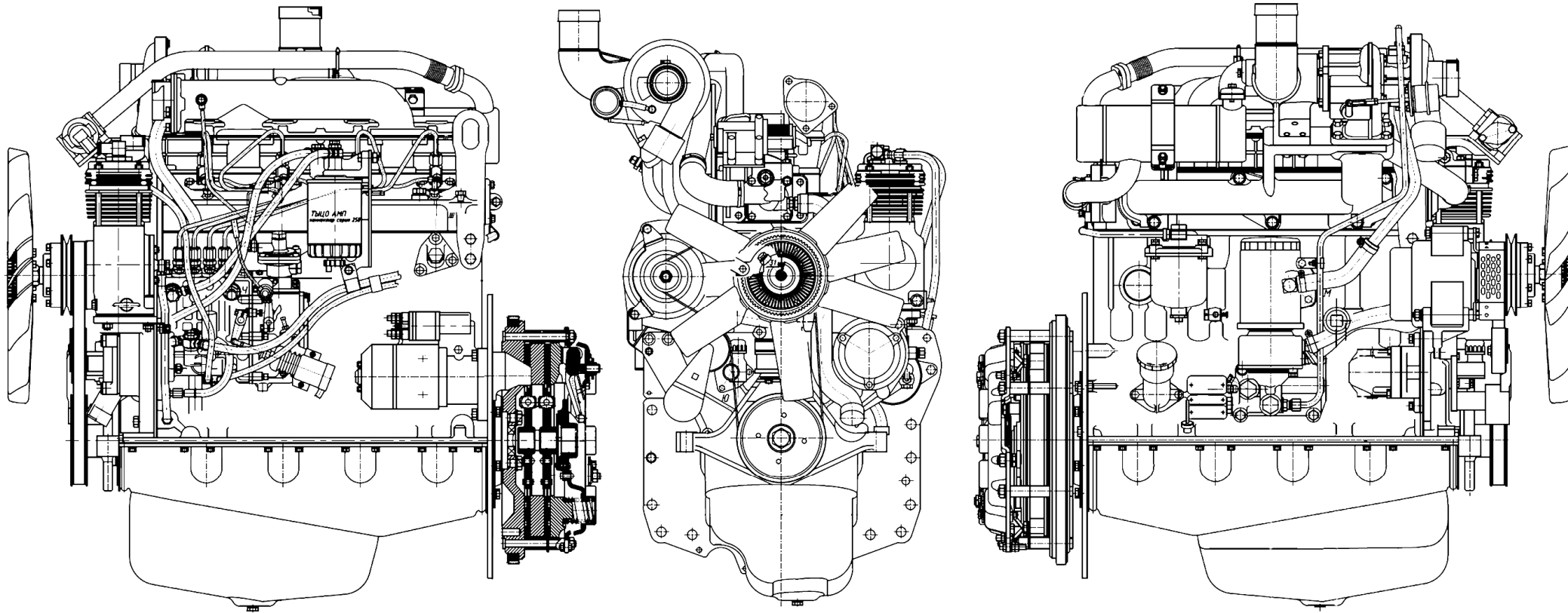


Figure 1 – The Diesel Engine D-245S3A M

1.1.4 Operation and Description

1.1.4.1 General information

The diesel engine D-245S3A M and modifications of it, is four-cycle reciprocating four cylinder engine with in-line vertical configuration of cylinders, and with direct injection of diesel fuel and direct injection diesel fuel and ignition due to compression.

Main assembly units of the diesel engine are the following: a cylinder block, a cylinders head, piston, connecting rod, a crankshaft, and a flywheel.

In order to ensure high technical and economic indicators of diesel, turbocharging with aftercooling is used in an engine intake system.

Use of turbocompressor with charging pressure control in charging system make it possible to have improved accelerating capacity, achieved due to increased torque value at low rotating frequency rate of crank shaft.

Diesels are equipped with fuel pump of Motorpal, Czechia with electronic modular switch of exhaust gas recirculation valve of MERCER system. Exhaust gas recirculation controlled by MERCER system provides for decrease in operating procedure temperature and therefore ensures exhaust gases composition corresponding to ecological requirements of level Tier-3A.

In order to ensure positive start-up in low environmental temperature conditions heating plugs are installed in a cylinders head, and liquid and oil heat exchanger installed in the diesel engines allows the fastest attaining of effective oil temperature in the engine lubricating system, and to maintain it at the required level during operation process.

1.1.4.2 Diesel engine operating principles and interworking of its components

Diesel engine operating principle, as well as of any combustion engine, appears in transformation of thermal energy of fuel combustible in working cylinder into mechanical energy.

At piston down stroke an air charge enters cylinder through an open intake valve at the moment of intake stroke. During the operating point of the diesel engine an air charge comprises recirculated exhaust gases, whereas the volume of recirculated gases makes from 5% to 20% depending on the engine operation speed mode and position of recirculation valve controlled with MERCER system. After closure of intake valve and piston up stroke high compression of air charge happens. When this happens, air charge temperature rises sharply. At the end of compression stroke fuel is injected into a cylinder through a nozzle. During injection the fuel is sprayed, mixed with hot air in cylinder and evaporated, forming air-and-fuel mixture.

Flaming of the mixture during the diesel engine operation is effected due to high compression of air up to mixture self-ignition temperature. Fuel injection in order to avoid preignition starts at the end of compression stroke.

Air-and-fuel mixture burning out is followed by enlargement and cleanout of cylinders from residues of combustion through exhaust valve.

Conforming opening and closure of intake and exhaust valves is controlled by valve timing gear.

The diesel engine is started by means of functioning of rotation of crankshaft by electric starting motor via flywheel installed on a crankshaft flange.

Driving of water pump in cooling system is performed via belt drive from a pulley wheel, installed on a nose of crankshaft to a pulley wheel, installed on the water pump shaft.

Driving of gear wheel pump is carried out by gear drive of trip valve gear.

Drive of compressor A 29.05.000 BZA, A29.01.000 BZA is carried out by gear drive of trip valve gear.

During the operation the diesel engine provides for automatic power control to maintain constant speed of rotation, by means of speed controller installed on high-pressure fuel pump.

1.1.4.3 Tools and Accessories

For the purpose of scheduled maintenance on verification and adjustment of clearance between rocker striker and valve end, carried out during maintenance and repair, SPTA for engine are supplied with a tool according to the List of Table B.1 Annex B.

1.1.5 Diesel Engine Marking

Nameplate of each diesel engine contains the following information:

- name of the manufacturer and its trade mark;
- model (modification) of the diesel engine;
- serial manufacturing number of the diesel engine;
- label “Made in Belarus”.

Cylinder block contains a serial manufacturing number identical to the serial manufacturing number specified on the nameplate. The diesel engine with its type having been officially approved according to the Rules of UN's Economic Commission for Europe has marks of official type approval.

The diesel engine for which Certificates of Conformance of the Republic of Belarus or of CIS-countries has been issued, are marked with correspondence signs of National Conformity Approval System of countries issuing the certificate.

Marks of official type approval are placed near the nameplate, and mark of compliance is on the nameplate.

Transport marking of the diesel engine shall be made according to GOST 14192.

Marking method ensures its persistence during transportation, storage and operation of the diesel engine.

1.1.6 Packing

If transportation of the diesel engine is carried out in closed wagons, containers or cars, the diesel engines shall be placed on support frames according to drawings of the diesel engines manufacturing works.

If transportation of the diesel engine is carried out open (automobile or railway transport), the diesel engines shall be packed in plastic bags and wooden boxes according to manufacturing documentation, if transportation is carried out in containers – in plastic bags only.

1.2 Description and operation of diesel engine components, its mechanisms, systems and devices

1.2.1 General information

The diesel engine is complex aggregate containing a range of independent mechanisms, systems and devices. The diesel engine structure is shown in Table 7.

Table 7

Diesel Engine Structure		Description of units and parts from which mechanisms, systems and devices are made	
Case		Cylinders block and suspension	
Mechanisms	Valve Timing Gear	Cylinder head. Valve and valve push rods	
		Cylinder head cover, exhaust channel (collecting channel)	
		Distribution mechanism	
	Crank-and-Rod Mechanism	Pistons and piston rods. Crankshaft and flywheel.	
Systems	Lubricating System	Breather	
		Oil crankcase	
		Oil pump receiver and oil pump	
		Oil filter with liquid-and-oil with heat exchanger	
		Turbocompressor oil pipeline	
	Feed System	Combustible equipment and fuel pipelines	
		Coarse fuel filter	
		Secondary fine fuel filter	
		Air cleaner и air delivery channel	
	Exhaust Gases Recirculation System	Integrated modular switch, electromagnetic recirculating valve	
	Cooling system	Water pump	
		Thermostatic regulator	
		Fan	
	Devices	Supercharging Device	Turbocompressor
		Exhaust Gases Recirculation Device	Exhaust gases recirculation system coolant, valve, tubes
Starting Device		Starter	
		Heating plugs	
Drives		Electrical Equipment Drive	Electric generator
		Accessory Drive	Compressor
			Gear wheel pump
	Clutch		

1.2.2 Description and work

1.2.2.1 Cylinder Block

Block of cylinders is the main engine case and is designed as a special rigid cast-iron alloy mono-block.

Four removable sleeves made of special cast-iron, are fixed in block bores.

Sleeves are installed into the block of cylinders in two centering leads – in the upper and bottom lead. In the upper lead the sleeve is fixed by collar, in the lower lead it is sealed by two rubber rings in cylinder block grooves.

According to inner diameter sleeves are classified into three size groups: big (B), medium (M) and little (L). Group marking is made on lead-in chamfer of sleeve. Sleeve sizes are listed in Table B.1 (Annex B). Sleeves of one size group shall be installed on a diesel engine.

The coolant circulates in the space between cylinder block sidewalls and the sleeves.

Head walls and cross walls of the cylinder block have special lugs for crankshaft supports. The lugs are covered by caps and together with them form saddles for main bearings. The saddles are bored in assembly with the caps, therefore it is not allowed to interchange them.

Cylinder block has a main oil channel supplying oil via a number of cross channels to main bearings of the crankshaft, and then to camshaft bearings.

Diesel engine cylinder block is design with three camshaft bearings.

Piston cooling injectors are mounted into the upper part of the second and fourth supports of the crankcase.

On the outside surfaces of cylinder blocks processed joint faces for fastening of oil filter, water pump, coarse fuel filter, secondary fine fuel filter, switch panel and rear web.

3.2. Cylinder Heads

Cylinder heads are made of a special cast iron alloy which contain intake and exhaust channels closed with valves. Intake channels are designed with screwed profile. Every head contains inner passages for coolant circulation ensuring dissipation of heat.

Cylinder heads have inserted valve seats made of heat- and wear-resistant alloy. On the top of cylinder head there are columns, rocker arm shaft, rocker arms, head covers and intake collector and cover cap, covering valve mechanism. On the left side of the head (from the side of fuel pump) four nozzles and four heating plugs are installed, and on the right side of the head exhaust collector is installed. To seal the joint between cylinder heads and cylinder block there is a gasket made of asbestos-free sheet amoured perforated sheet iron. Cylinder sleeve boring and oil passage are back-lined by sheet iron. When mounted at the works cylinder gasket inlets are additionally back-lined fluoroplastic rings.

1.2.2.3. Crank Mechanism

The main parts of the crank mechanism are the crankshaft, pistons, piston rings, piston pins, main and connecting rod bearings and flywheel

Crankshaft is made of steel. It has five main bearing journals and four rod journals.

Axial force of the crankshaft is taken by four semi-rings made of ferro-aluminum alloy, that are fixed in cylinder block and main bearing cap bores. To reduce inertial force influence on the main bearings, counterweight is installed on the first, fourth, and fifth crankshaft cheek. At the front and at the back the crankshaft is sealed by collars. Valve timing drive gear (crankshaft gear), oil pump driving gear, water pump and alternator driving pulley are installed on the front end of the crankshaft.

Crankshaft can be produced and mounted to the diesel engine in two production sizes (nominal values). The crankshaft with its rod bearing journal and main bearing journal mounted according to the size of the second nominal value, has additional marking on the first cheek (Table B.2, Annex B).

Piston is made of aluminum alloy. Piston top has compression chamber. Compression chamber is displaced from the piston centerline. Piston has three grooves, two of them are provided with the corresponding piston rings, and the third one provided with oil-control ring. Special patch is added under the groove of the upper piston ring. Gudgeon pin boss has bores for piston pin. Sizes of the pistons are listed in Table B.1 (Annex B).

Piston rings are made of cast iron. Upper piston ring is made of high-grade cast iron, and is shaped as isosceles trapeze in section. The second piston ring is cone-shaped. At butting end near the lock the piston rings have marking "TOP". Box-type oil-control ring with spring-mounted conservator tank.

Piston Pin is hollow, made of chromium-nickel steel alloy. It is retained in the piston by two snap rings.

Connecting rod is made of steel alloy, of double-T section. A bushing is pressed in the small end of the connecting rod. Lubricating oil is supplied to the piston pin-bushing clearance via the hole drilled in the small end of the connecting rod and hushing.

Housing for liner in saddle in connecting-rod big end is bored in assembly with the caps, and therefore the caps should not be interchanged during re-assembly. Connecting rods and caps have the same identification numbers stamped on the surfaces. Besides connecting rods have marks identifying weight groups according to weights of the connecting-rod small and big ends. Marks identifying weight groups shall be stamped on the butting end of the connecting-rod small end. Connecting rods of the same weight group shall be installed on the diesel engine.

Liners of the Main and Connecting Rod Bearings of the crankshaft are made of bimetallic strip. Regarding inner diameter the bearings can be of two sizes in correspondence with crankshaft journals. During the repair process four repair sizes of the liners are designed also.

Flywheel is made of cast iron and bolted to the crankshaft flange. The steel gear ring is pressed onto the flywheel.

3.4. Valve Mechanism

Valve Mechanism includes camshaft, intake and exhaust valves, as well as the following accessories for their installation and drive: cam followers (pushers), push rods, rocker arms, rocker shafts, adjusting screws and nuts, plates, valve keepers, valve springs, brackets and rocker arm shafts.

Camshaft is supported by three journals and is connected with a crankshaft via timing gears. Three sleeves pressed in unit borings are the bearings of the camshaft. Front sleeve (on the fan side) is made of aluminum alloy, has thrust land preventing camshaft from axial displacement, the rest of sleeves are made of cast iron.

Cam Followers (Pushers) are made of steel and have spherical bottoms of large radius (750 mm) built-up with chill cast iron. Camshaft lobes are designed with a small inclination to provide pushers rotation.

Push Rods are made of steel bars. Spherical part, that goes inside the cam follower, and rod cup are hardened.

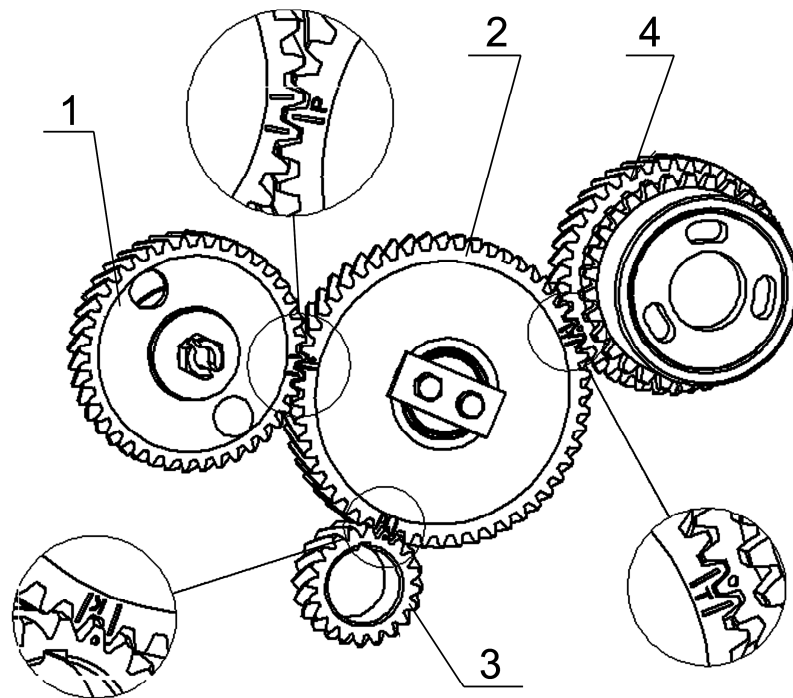
Valve Rocker Arms are made of steel, swing on the rocker shaft, which is supported by the brackets. The outer brackets are of enhanced firmness. The axle is hollow and contains eight radial holes to supply lubrication oil to the rocker arms. Rocker arms displacement along the axle is limited by spacer springs.

Intake and Exhaust Valves are made of heat-resistance steel; they travel in guide bushings pressed in cylinder heads. Each valve is closed by means of two springs: outer spring and inner spring. The springs are fixed by plates and valve keepers.

Seal Collars are fixed on guide bushings do not let oil leak into engine cylinders through clearances between valve stems and guide bushings.

Valve Timing Gears are mounted in the crankcase formed by power distributor that is attached to the crankcase with bolts, and by distribution cap.

Conformal operation of fuel injection pump and valve timing gear is achieved by installation of front gears according to the marks as shown in Fig. 2.



1 - camshaft gear; 2 - idler gear; 3 – crankshaft gear; 4 – reducing gear drive of fuel injection pump assembly (FIPA).

Figure 2 - Front Gears Installation Diagram.

1.2.2.5 Lubricating System

The lubricating system of the engine (Fig. 3) is a combined type: some components receive pressure lubrication, others are splash lubricated.

The crankshaft main bearing and camshaft bearings, camshaft drive gear bushing, crankshaft rod bearer compressor, valve (rocker arms) operating mechanism, shaft support bearing are lubricated under pressure via oil pump. The sleeves, pistons, piston pins, rods, cam followers (pushers), valve lifting cam, fuel pump drive are splash lubricated.

The oil pump is a gear type, single-section, mounted to the first main bearing cap by bolts. The oil pump is driven by the crankshaft via the spur gear.

Oil pump 9 takes oil from the oil pan 1 via oil receiver 8 picks and supplies it through cylinder block channels and oil filter body channels to liquid and oil heat exchanger 10, and then to full-flow oil filter 12 where it is to be cleaned from impurity, wear debris and oil breakdown product as a result of heating and combustion.

Oil cleaned in the oil filter, proceeds to the diesel engine oil gallery.

Bypass valves are positioned in:

- liquid and oil heat exchanger housing 11 (operating pressure value is $0.15^{+0.05}$ MPa);
- oil filter 13 (operating pressure value is $0.15^{\pm 0.02}$ MPa).

If the the operator starts the engine when the oil is cold, the filter element resistance exceeds 0.15...0.2MPa, than the bypass valve is opened and the oil is goes to oil filter passing by liquid and oil heat exchanger. If the filter element resistance exceeds 0.13...0.17MPa, than the bypass valve of the oil filter is opened, and the oil is passing by oil filter and proceeds to the oil gallery.

There is a safety valve 14 in the filter body. It keeps the oil pressure in the main oil gallery at the same level of 0.25...0,35 MPa. In case, oil pressure exceeds this level, the safety valve opens and excess oil is drained to engine crankcase.

In case paper filter element is highly clogged, when the filter element resistance exceeds 0.13 – 0.17 MPa, the bypass valve is opened too. As a result oil is passing by oil filter and proceeds to the oil gallery.

It is expressly prohibited to back off plugs of the pressure reducing valve.

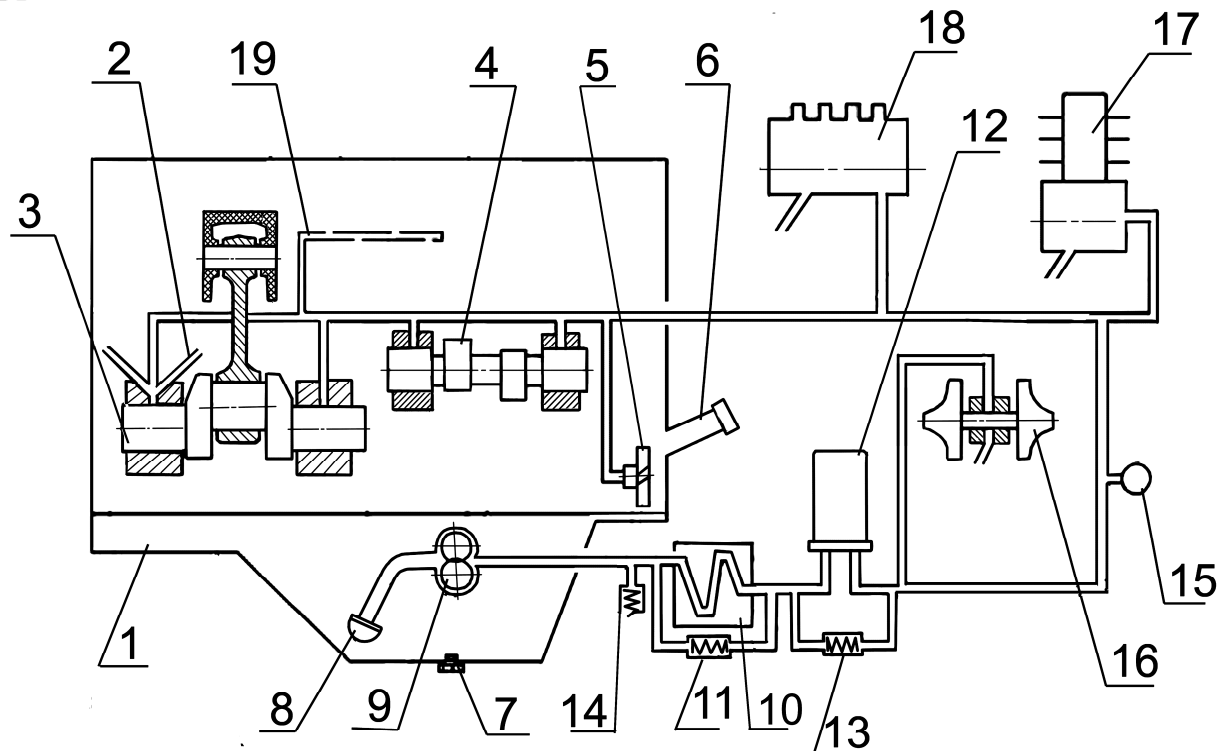
From main gallery oil is passing through cylinder block channels to all main bearings of the crankcase and camshaft journals. From the main bearings the oil goes through the crankcase channels to all connecting rod bearings. From the first main bearing oil proceeds through special channels to idler gear bushings, to oil pump drive gear, and to fuel pump also.

Valve mechanism parts are lubricated by oil supplied from the rear camshaft bearing via channels in cylinder block and heads, through the bores in the IVth bracket of rocker arms inside the rocker arms shafts and then through the opening to the rocker arm bushing, and then to adjusting screw and push rod.

Oil supplied to air compressor proceeds via oil-conducting pipes connected to heat exchanger. Oil in compressor is drained to engine crankcase.

Oil supplied to bearing assembly of the turbo-compressor flows by pipe connected

at the output of oil filter body. From the turbo-compressor bearing assembly the oil is supplied to oil crankcase.



1 – oil crankcase; 2 – piston cooling jets; 3 – crankshaft 4 – camshaft; 5 – idler gear; 6 – oil filler; 7 – oil crankcase plug; 8 – oil receiver; 9 – oil pump; 10 – liquid and oil heat exchanger (LOHE); 11 – bypass valve; 12 – oil filter; 13 – bypass valve; 14 – blow-off valve; 15 – pressure sensor; 16 – turbo-compressor; 17 – compressor; 18 – fuel injection pump; 19 – rocker arm shaft oil passage.

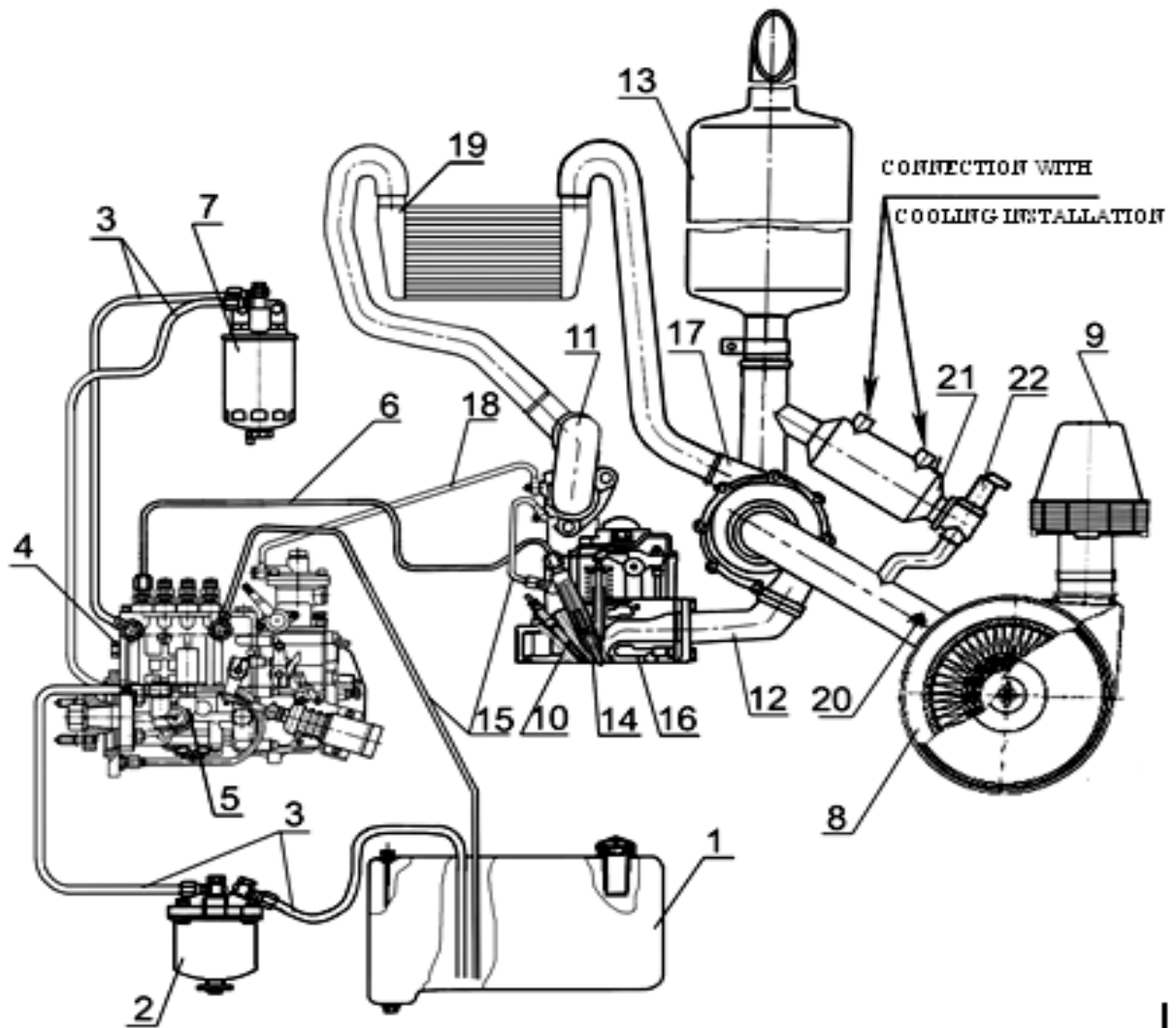
Figure 3 – The Diesel Engine with Liquid and Oil Heat Exchanger and Indecomposable Oil Filter with Paper Element Lubrication System Schematic.

1.2.2.6 Fuel Feed System

Engine Fuel System (Fig. 4) of the diesel engine according to the list of equipment of single order comprises fuel pump, injectors, low and high pressure pipes, intake and exhaust manifolds, turbo-compressor, coarse fuel filter, fine fuel filter, recirculating exhaust gases cooler, coarse air filter (monocyclone)*, air cleaner*, fuel tank*, charge air cooler*, and muffler.

In fuel feed system diagram, the diesel engine starting aid - the heating plug - at the low ambient temperature is shown.

* - shall be determined by a customer.



1 – fuel tank; 2 – coarse fuel filter; 3- low pressure pipes; 4 – fuel injection pump; 5 – fuel-feed pump; 6 – high pressure pipes; 7 – fine fuel filter; 8 – air cleaner; 9 – monocyclone; 10 – heating plug; 11 – intake manifold; 12 – exhaust manifold; 13 – muffler; 14 – injector; 15 – remaining fuel return line; 16 – cylinder head; 17 – turbocompressor; 18 – pneumatic corrector pipe; 19 – charge air cooler; 20 – air cleaner dirtiness indicator pipe; 21 – recirculating exhaust gases cooler; 22 – recirculating valve.

Figure 4 – Fuel Feed System Diagram.

1.2.2.6.1 Fuel Injection Pump

For fuel feed the diesel engine is equipped with the fuel injection pump PP4M10Uli by Motorpal, specified in Table 6 and shown in Figure 5.

The fuel injection pump assembly (FIPA) makes a single unit of four injection units placed in one housing, and having camshaft drive plunger piston and spool-type metering cyclic fuel feeding.

FIPA is designed for pressurized feeding of fuel charges into cylinder combustion chambers at a given time.

The fuel pump is driven by crankshaft via timing gears.

Relative position of fuel transfer pump drive gear and drive mechanism semi-

coupling is locked by drawing up the nuts, fixed in half-coupling stud-bolts. Nut torque value ranges from 35 to 50Nm.

The fuel injection pump assembly (FIPA) makes a single unit together with all-speed governor and piston type fuel feed pump.

FIPA has an engine start RPM automatic fuel corrector (starting solenoid 23, connection diagram – Fig. 5a), smoke supercharge pneumatic corrector 20.

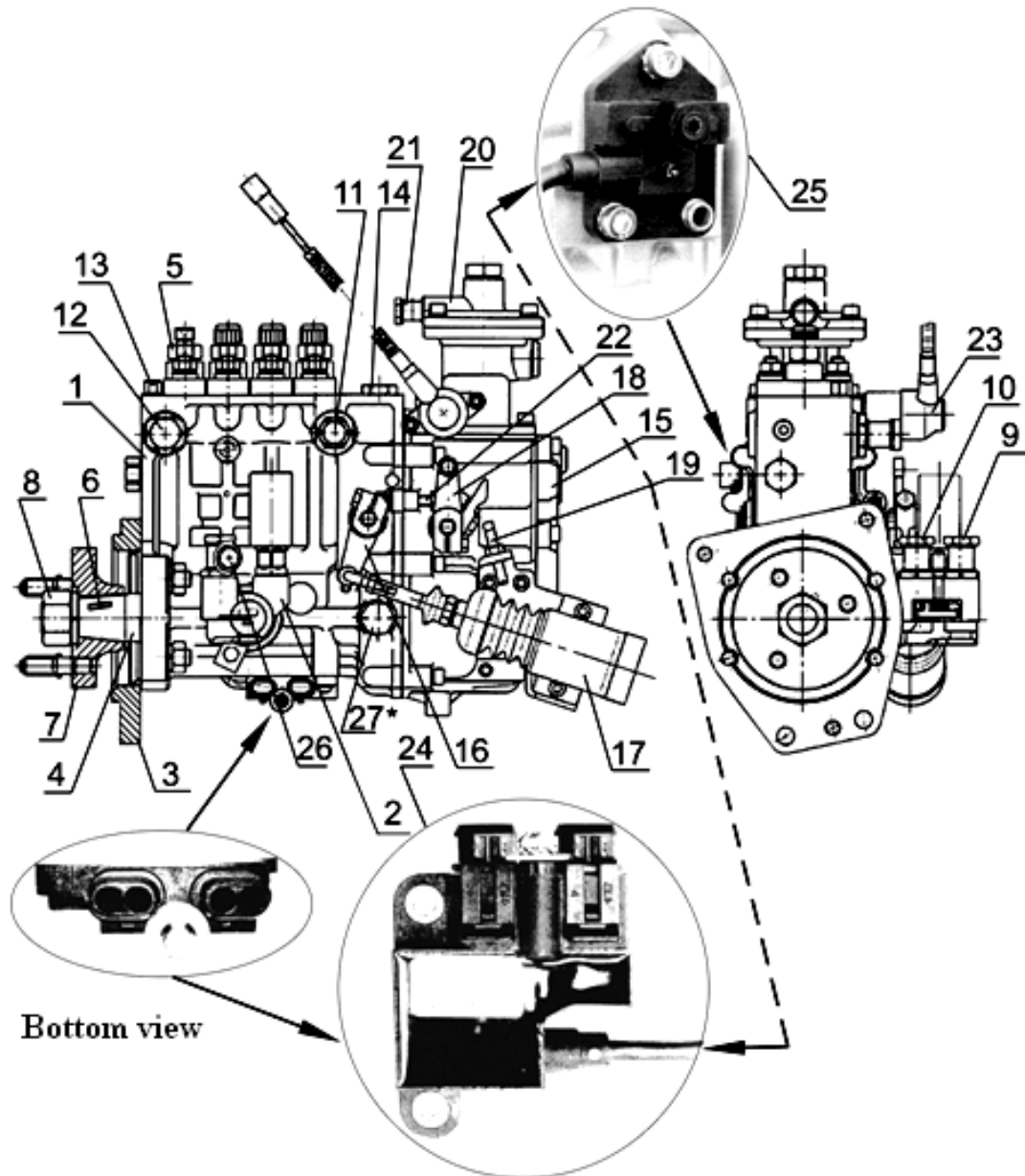
Use of starting solenoid actuating only at diesel engine start up, prevent from entry to starting fuel delivery mode during operation if operating control is incorrectly operated, excluding the possibility of unauthorized volume of content of harmful substances in exhaust gases.

The fuel injection pump is equipped with 24; 25 exhaust gases recirculation valve regulator MERCER (connection diagram – Fig. 5c) and shutdown solenoid 17 (connection diagram – Fig.5b).

The fuel priming pump is installed in high-pressure pump case and is driven by camshaft gear.

Fuel pump parts are lubricated by flowing oil via engine lubricating system. Oil drained is transferred from the pump case to the diesel engine crankcase. A reinstalled pump shall be filled with oil in the amount of 250 cm³.

Oil shall be primed through filler 14 (Figure 5).



1 – fuel injection pump; 2 – fuel feed pump; 3 – flange; 4 – camshaft; 5 – individual injection pump; 6 – armature key; 7 – drive semi-coupling; 8 – semi-coupling retaining nut; 9 – Fuel supply pipe connection bolt; 10 – Fuel drain pipe connection bolt for fuel drain from fuel feed pump to fine fuel filter (FF); 11 – bypass valve; 12 – Bolt of pipe for fuel supply from FF; 13 – air-vent plug; 14 – oilfiller plug; 15 - regulator housing; 16 – shutdown lever; 17 – \varnothing shutdown solenoid; 18 – operating lever; 19 – minimum RPM regulating bolt; 20 – supercharge pneumatic corrector; 22 – maximum RPM regulating bolt; 23 – starting solenoid; 24 – rotation velocity sensor/integrated switch of recirculation valve solenoid; 25 – rack position sensor of fuel injection pump assembly/integrated switch of recirculation valve solenoid; 26 – Oil supply pipe connection bolt; 27*– camshaft position regulator of fuel injection pump assembly.

* - available as agreed.

Figure 5 – Fuel Injection Pump

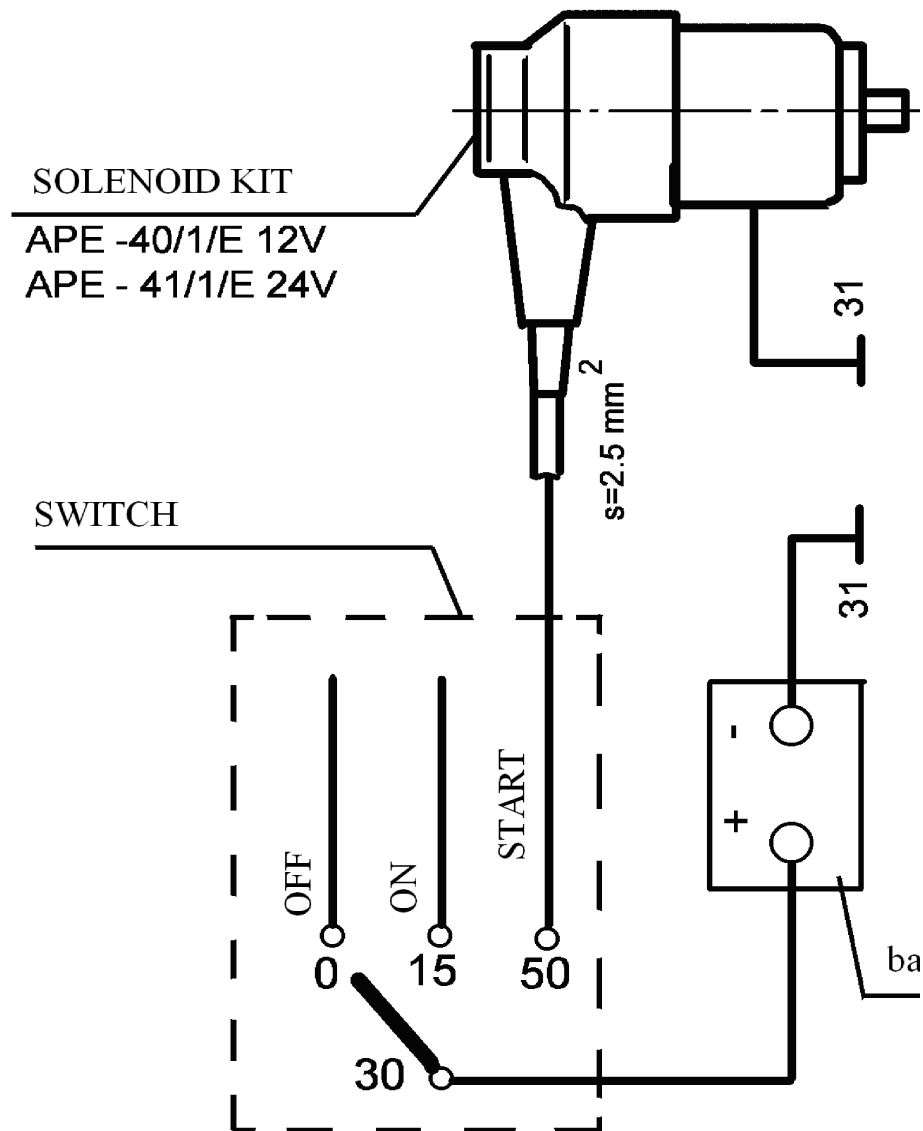


Figure 5a - Starting Solenoid Connection Diagram

Switch position

OFF – Diesel engine is stopped;

ON - Power supply diagram is linked up

START - Diesel engine start-up, electric current in solenoid coil:

1) max. 16A for 400 milliseconds – battery 12V;

max. 10A for ~ 350...450 millisecond - battery 24V:

2) max. 0.4A in the course of the diesel engine start-up time - battery 12V;

max. 0.3A in the course of the diesel engine start-up time - battery 24V.

Starting solenoid has specific protective current electronic circuit protection (~ 0.4A – battery 12V; ~ 0.3A – battery 24V), therefore a number of tries to start the diesel engine and their duration is unlimited.

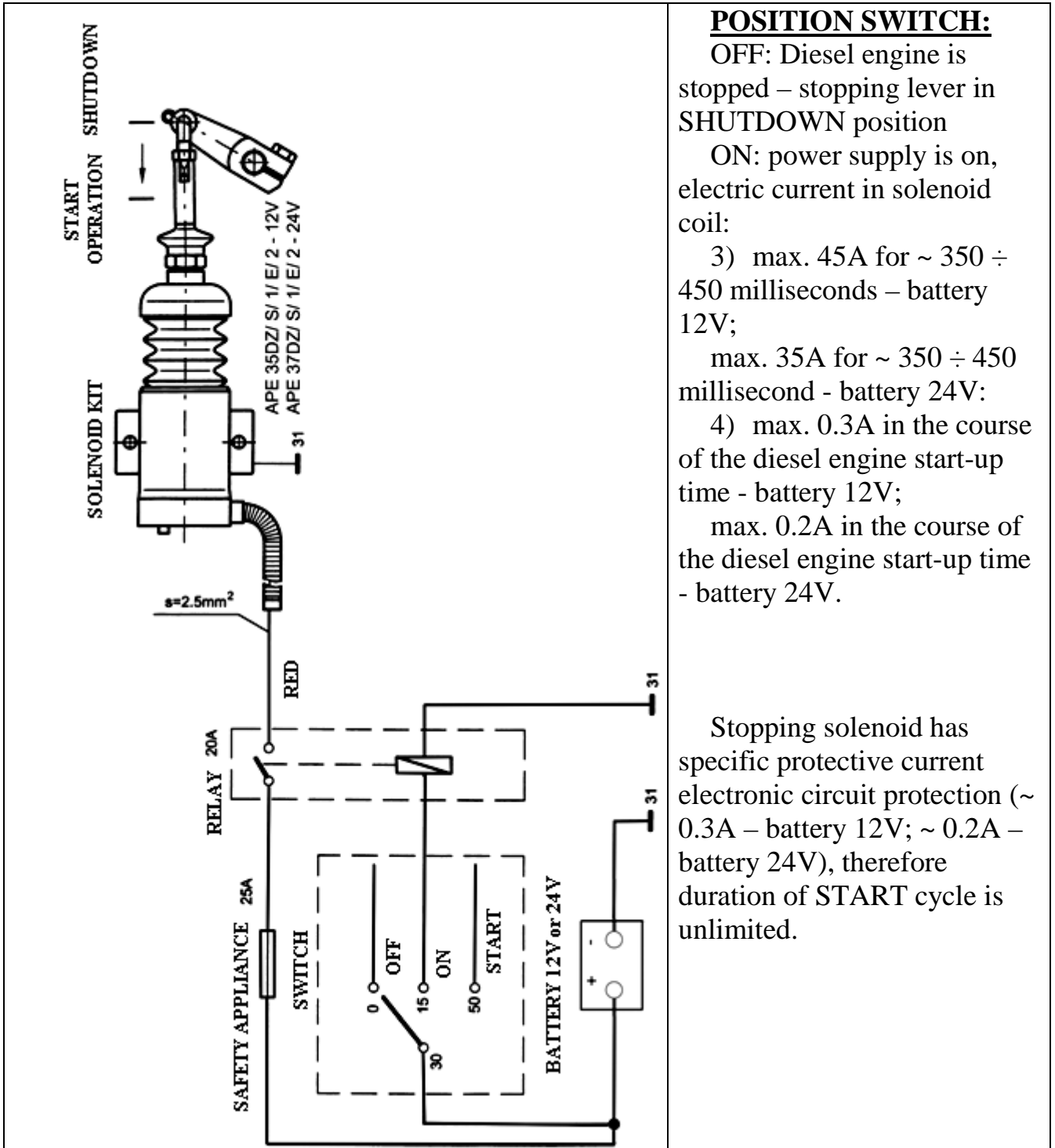


Figure 5b - Stopping Solenoid Connection Diagram

INTEGRATED MODULAR SWITCH APE 750 ELECTROMAGNETIC RECIRCULATION VALVE P/N 7.22946.25.0

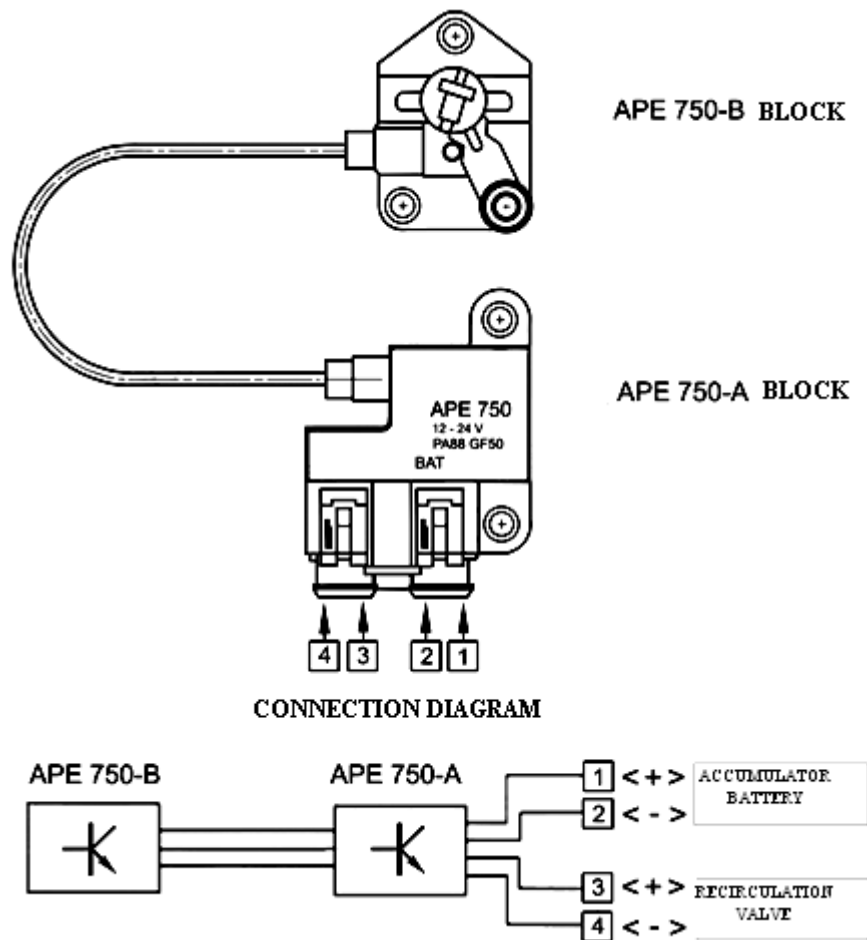


Figure 5c – Integrated Modular Switch APE 750 Connection Diagram

1.2.2.6.2 Fuel Injector

Fuel Injector is designed for fuel injection into diesel engine cylinder. It ensures required spraying of the fuel and its spreading inside the combustion chamber.

The diesel engines are equipped with VA70P360-2996 model fuel injectors with spray DOP140P528-3826 with axial fuel delivery, and with detachable clamping flange. Pressure at which fuel spraying occurs is $28^{+1.2}$ MPa.

1.2.2.6.3 Coarse Fuel Filter

The coarse fuel filter is designed for preliminary fuel cleaning by removing water and coarse contaminants. It comprises the housing, deflector with net, diffuser, cup with the damper.

Residue from the filter is drained through the opening at the bottom of the cup that is closed by the plug.

1.2.2.6.4 Fine Fuel Filter

The fine fuel filter (Figure 16) is for final fuel cleaning, and it is indecomposable.

The fuel passes through the paper filter element, and in that way foreign particles

are removed. In the bottom part of the filter housing there is a fuel-draining outlet with a drain plug.

There is a bleeding plug 6 (Figure 16) on the filter cover for bleeding air from the fuel system.

1.2.2.6.5. Air Duct

Air duct comprises an air cleaner and turbo-compressor junction pipes connecting the air cleaner with turbo-compressor, charge air cooler and intake manifold (Figure 4).

Dry-type air cleaner with paper filter element made of special high-porous cardboard, is designed for cleaning of the air drawn in cylinder.

There are three stages of air cleaning. The first stage is a monocyclic process, the second and the third stages are main and paper filter elements.

The air cleaned of dust in the air cleaner under reduced pressure created by means of the turbo-compressor, and then it is transferred to fluid end of the compressor, and is delivered under pressure through charge air cooler to cylinders.

For filter elements clogging level control and timely service of the air cleaner the engine is equipped with a special clogging level control indicator. The air cleaner and clogging level control indicator is supposed to be installed by a client.

The higher the air cleaner clogging the higher the pressure reduction in the intake pipeline, and when pressure comes up to 6.5 KPa the signaling device responds. After the signaling device has responded you should make air cleaner maintenance services.

1.2.2.6.8 Diesel Engine Gas Exchange

Gas exchange diagram is shown in Figure 6.

For air-fuel mixing in cylinders the air charge scheme structure is equipped with exhaust recirculation gases device.

Exhaust gas recirculation device for account of 5 to 20 % of exhaust gases blow-off into an inlet channel ensures combustion temperature lowering reducing NOx emission.

The device is driven by supply of a part of exhaust gases from outlet to inlet manifold via recirculation gases cooler as a result of unforced difference between exhaust gases pressure level in front of turbine and charge air pressure, and it depends on recirculation valve position (opened/closed).

Recirculation valve is controlled by MERCER System installed on the fuel injection pump.

MERCER System comprises integral modular switch APE 750 and active devices for signal generation rate of rotation frequency of camshaft of fuel injection pump and cyclic supply metering control rod position.

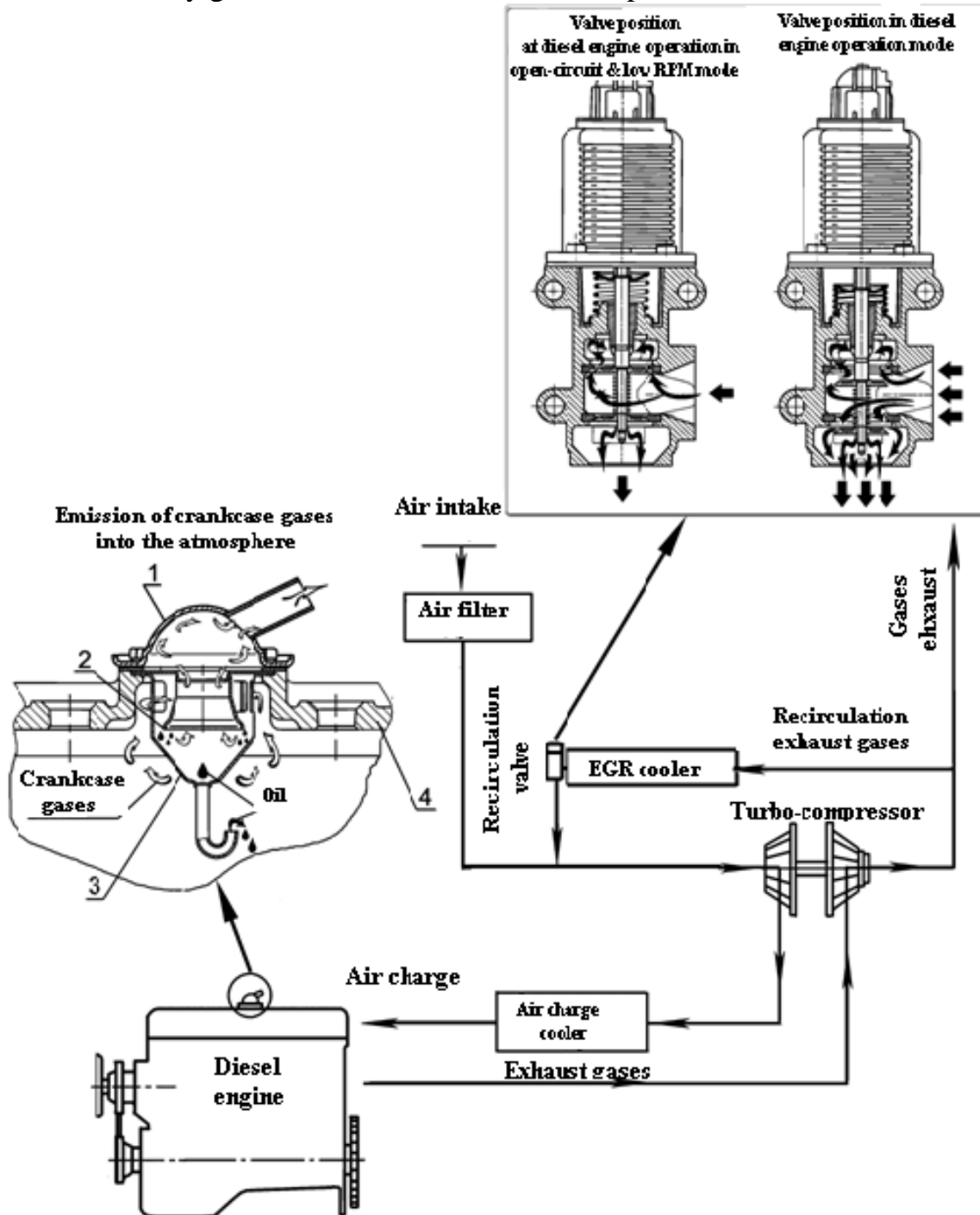
Exhaust gas recirculation cooler work on heat-exchange principle, included in the engine cooling system.

Breather is designed for exclusion of: excessive pressure in lubricating system, created by exhaust gases infiltrating to oil crankcase through gas joints of cylinder and piston group, and by export of oil to the atmosphere.

In the realized gas exchange scheme crankcase blow-by gases via channels in cylinder block and head enters the pocket created by cylinder head cover and cover

cap. Breather body 1 (Figure 6) is mounted onto cover cap 4 of the cylinder head.

Under the influence of pressure difference in atmosphere and in the pocket cylinder head cover, the crankcase blow-by gases pass through slot gaps of the cap 6 in the breather body 1. Penetrating into the pocket crankcase blow-by gases expand and collide with oil deflector 2 whereupon they lose energy and are cooled, as a result a considerable proportion of crankcase blow-by gases oil fog falls out as oil. Oil-free crankcase blow-by gases is delivered into the atmosphere.



1 – breather body; 2 – oil deflector; 3 – cup; 4 – cover cap

Figure 6 – Diesel Engine Gas Exchange Scheme

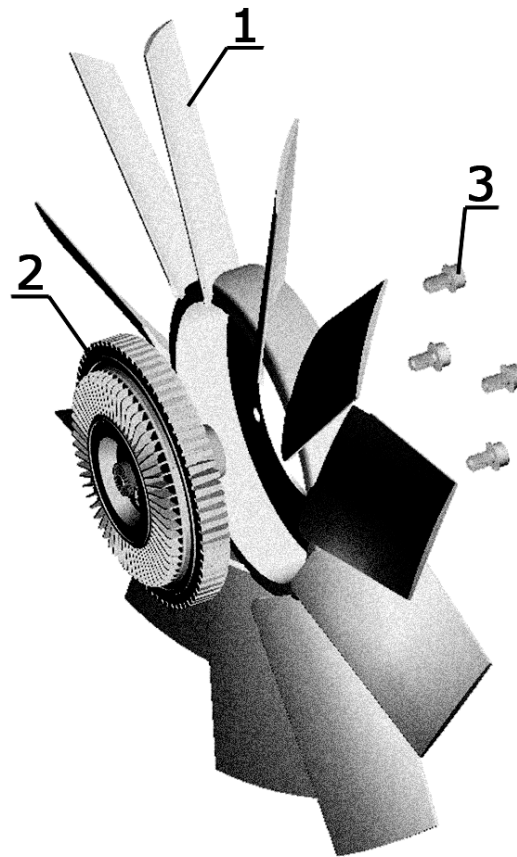
1.2.2.7 Cooling System

Cooling system (Figure 8) is a closed type, with the forced circulation of the cooling liquid, centrifugal pump assisted. The cooling system of a tractor, agricultural machine ensures that the temperature of liquid coming out of the diesel engine is below 100°C and oil is below 115°C while surrounding air temperature is 40°C.

The water pump is driven by crankshaft pulley via a "V"-belt. Lubricant "Litol-24" is supplied to bushing chamber during assembly. When the diesel engine is operated it does not need lubrication.

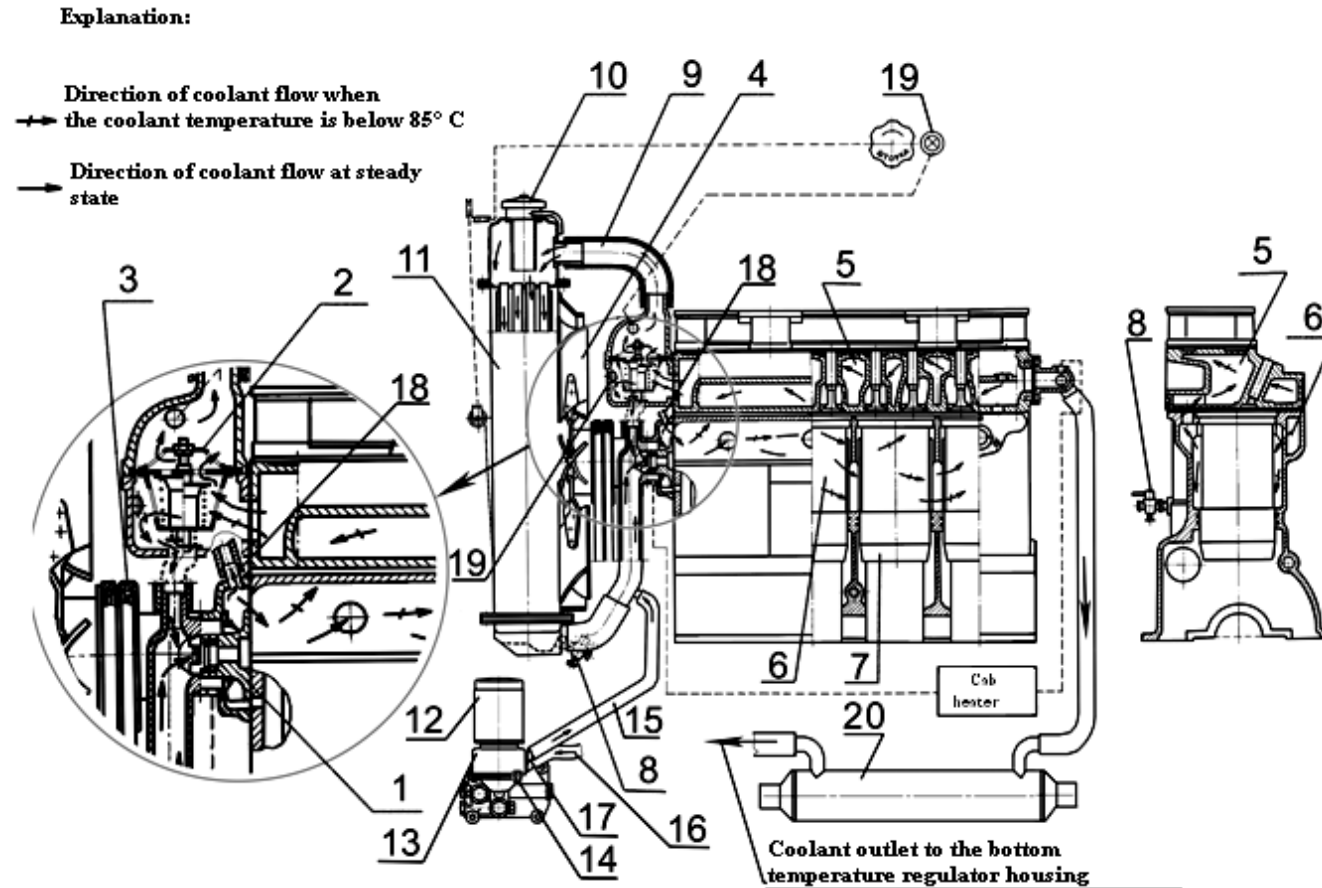
The coolant temperature shall be maintained in the range of 85°C to 95°C. In order to gear up the diesel engine warming-up after start-up, and for automatic regulation of temperature conditions at various loads and surrounding temperatures a thermostatic regulator is used with primary valve start temperature.

The fan with viscous coupling of fan shutdown shall be mounted on water pump axle (Figure 7).



1– fan; 2 – viscous coupling; 3 – bolt.

Figure 7 – Fan with Viscous Coupling of Fan Shutdown Installation

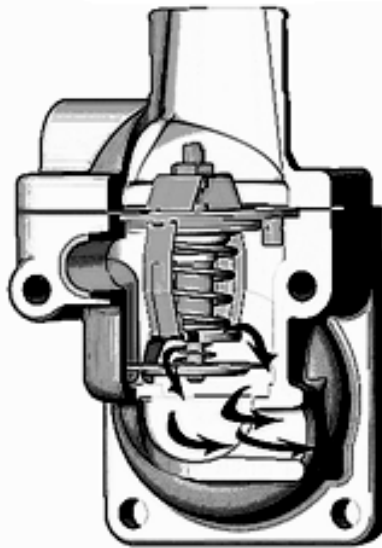


1- water pump; 2 - thermostatic regulator; 3 - strap water pump drive belt; 4 - fan; 5 - cylinder head cooling jacket; 6 - cylinder block cooling jacket; 7 - cylinder block sleeve; 8 - small cocks for coolant drain; 9 - junction pipe; 10 - filler plug; 11 - heat radiator; 12 - oil filter; 13 - oil and liquid heat exchanger; 14 - coolant drain plug; 15 - coolant drain pipe into oil and liquid heat exchanger; 16 - coolant supply pipe into oil and liquid heat exchanger; 17 - coolant temperature sensor for fuel supply system CRS; 18 - coolant supply pipe into oil and liquid heat exchanger; 19 - emergency coolant temperature indicating light; 20 - recirculation exhaust gases cooler.

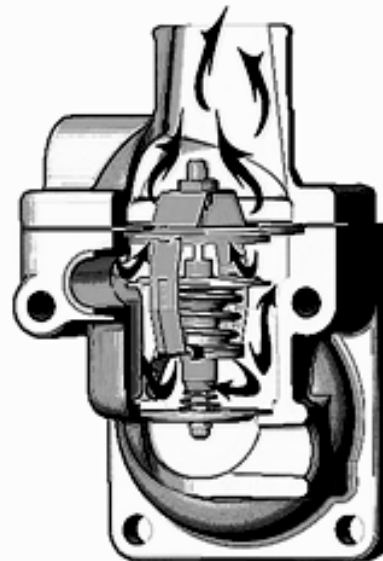
Figure 8 – Cooling System Scheme

Thermostatic regulator valves position at:

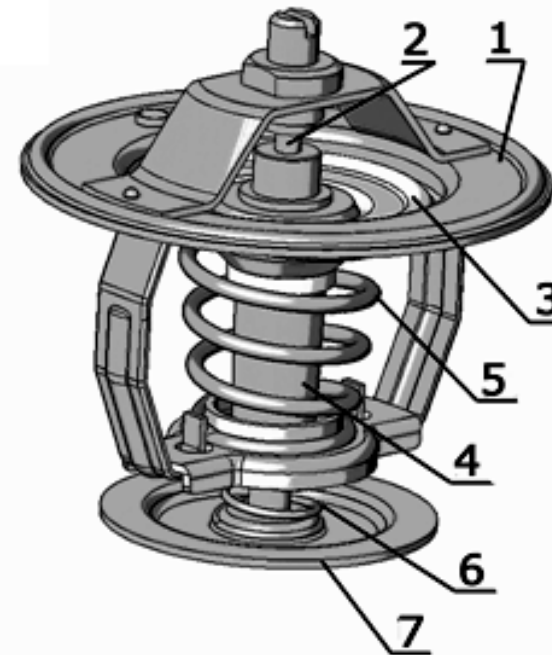
a) warming-up (the coolant temperature is below 85° C)



b) nominal conditions (the coolant temperature is over 85° C)



Thermostatic regulator



1- thermostat housing; 2 - piston; 3 – primary valve; 4 – primary thermal-load carrying member; 5 – valve spring; 6 – by-pass valve spring; 7 – by-pass valve.

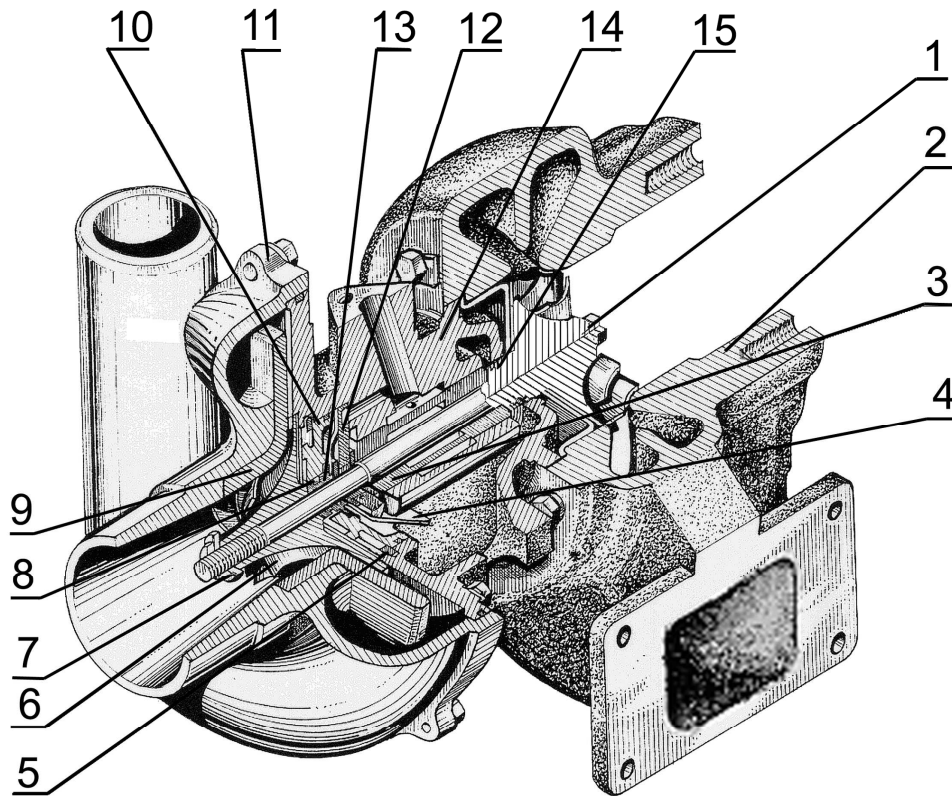
Figure 9– Thermostatic Regulator

1.2.2.8 Charging mechanism

1.2.2.8.1 Turbo-compressor

The diesel engines D-245.5S3A M, D-245.43S3A M are equipped with turbo-compressor for air supercharge into cylinders, it uses exhausts energy.

The turbo-compressor supply under pressure the exhaust gases from diesel engines cylinders to cochlear turbine channels through exhaust manifold. As a result of gas expansion, turbine wheel is rotated together with the shaft and compressor wheel, which intake air and deliver it to cylinders under pressure.



1 - turbine wheel with shaft; 2 - turbine housing; 3 – single bushing; 4 – oil deflector; 5 - eccentric ring; 6 - compressor ring; 7 - special nut; 8, 15 – O-ring; 9 - diffuser; 10 - cover; 11 - compressor housing; 12 – axial bearing; 13 – spacing sleeve; 14 - intermediate housing (bearing body).

Figure 10 – Adjustment-Free Turbo-Compressor

Turbo-charger according to Figure 10 consists of centrifugal one-step compressor with cantilevered design of wheels position against the supports, and radial centrifugal turbine.

Rotary rotations per minute, supply and pressure of delivery air depend on the diesel engine operation modes.

Turbine housing 2 of turbo-compressor is made of aluminium alloy, and its air-gas channel comprises compressor housing and wheel. Compressor and turbine housing are fixed to bearings bodies 14, made of high-grade cast iron.

Turbine wheel 1 is made of heat-resisting alloy and is welded to rotor shaft.

Compressor wheel 6 is made of aluminium alloy and is fixed on the shaft by special

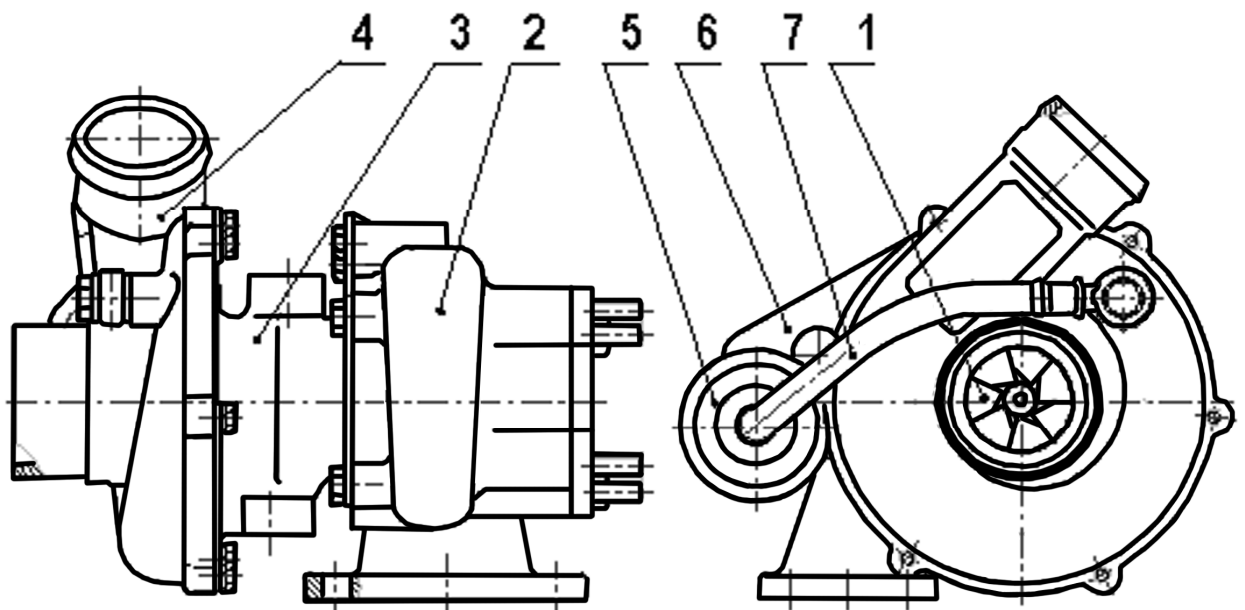
nut.

Rotor shaft is rotated in radial bearing in the form of nonrotating floating single bushing 3. The single bushing is fixed in the bearing body by means of locking mechanism. Rotor axial movement is taken by axial bearing 12.

Turbo-compressor bearings are lubricated and cooled by oil delivered through pipeline from full-flow oil filter. Optionally centrifugal oil filtration is carried out both in radial and axial bearing. The oil is drained from the turbo-compressor into the crankcase through oil return pipe.

On the side of the compressor and turbine there are spring O-rings 8 and 15, fixed in rotor grooves used as gas-oil seals. On the side of the compressor there is oil deflector, and on the side of turbine there is a screen to improve efficiency.

The diesel engines D-245S3A M, D-245.2S3A M are equipped with adjustable turbo-compressor.



1 - rotor; 2 - turbine housing; 3 – bearing body; 4 - compressor housing; 5 - actuating device; 6 - actuating device mounting bracket; 7 – air duct.

Figure 10a – Adjustable Turbo-Compressor.

Supercharge adjustment is carried out by bypass of a part of exhaust gases past turbine wheel when the charge pressure lever exceeds the set value.

Structurally turbo-compressor according to Figure 10a consists of the following units: rotor 1, turbine housing 2, bearing body 3, compressor housing 4, actuating device 5, actuating device mounting bracket 6, air duct 7.

Rotor comprises shaft welded to turbine wheel and compressor wheel, oil seal spacing sleeve, two washers, a nut and two O-rings. Rotor is rotated in radial bearing placed in the bearing body. Rotor axial movement is taken by axial bearing.

Adjustable turbo-compressor turbine housing has a built-in by-pass valve. By-pass valve lever is connected via adjustable rod with actuating device, connected with compressor output via air duct. Regulating device is adjusted for the set pressure by means of regulation of the rod length.

Change of length of the rod of turbo-compressor actuating device is not allowed during the operation.

Turbo-compressor bearings are lubricated and cooled by oil delivered through pipeline from the diesel engine lubricating system. The oil is drained from the turbo-compressor into the crankcase.

Disassembly and repair of turbo-compressor is not allowed during the operation, and shall be carried out in a special repair workshop.

1.2.2.9 Starting Device

The starting device consists of electric starter with rated voltage of 24V or 12V. Starter constitutes D.C. motor, mixed excitation with electromagnetic relay and drive gear.

To start the engine in cold weather, the tractor (machine) has to be equipped with heating plug with rated voltage of 23V or 11V, and there are holes in the intake manifold for coolant intake and drain from prestart warming-up system installed on a vehicle by a client.

In wiring arrangement of a tractor, and of an agricultural machine, starter blockage shall be carried out after diesel engine start up that is automatic starter disengagement at camshaft rpm from 900 min^{-1} up to 1000 min^{-1} , and inability of its engagement during the diesel engine operation.

1.2.2.10 Electric Generator and Its Drive

The diesel engine use generators being the source of electric power in wiring arrangements.

The generators have outputs for connection to circuits: “+” (“B”) – of load and accumulator battery; “D” - starter blocking relay; “~” (“W”) – tachometer.

The generator is used for battery recharging, and for dc power supply to power consumers, mounted on a tractor or an agricultural machine.

The generator is driven by "V"-belt via crankcase pulley.

1.2.2.11 Compressor and Its Drive

Diesel engines installed on tractors or vehicles are equipped with piston single-stage compressor for trailer air pressure brake driving and tires inflation (Table 6).

The compressor is installed break-down cover flange and is driven by the gear of compressor drive and fuel pump admission gear. Purified air is supplied to compressor cylinder from the engine intake channel.

The compressor shall be shut down during farm operations involving no air power.

The compressor is cooled by air.

Oil for lubrication of the compressor parts and units is delivered from the engine lubricating system. The oil is drained from the compressor into the crankcase.

1.2.2.12 Gear Wheel Pump and Its Drive

For supporting of tractor hydraulically operation system a gear wheel pump NSH 10-3L or NSH 14-3L is mounted on the engine.

The pump is rotated by engine timing gears.

1.2.2.13 Clutch Coupling

Clutch coupling is designed for torque transfer from camshaft to transmission line, and for short-term disconnection of the diesel engine from the transmission line during the engine operation to ensure faultless gear change and smooth starting.

The diesel engines are equipped with spring-loaded clutch coupling, friction single-drive or double-disk.

1.2.3 Marking sealing of diesel engine components

Marking of diesel engine components manufactured in MMZ and received on cooperation, is carried out according to the current construction documentation of the plant.

Marking of purchased components, is carried out according to construction documentation of delivery plants.

Position of regulating elements (bolts) of fuel injection pump, affecting the engine technical data parameters, shall be fixed by means of wire and seal with brand marked during fixation. This excludes possibility unauthorized adjustment of fuel pump.

Points of sealing are determined by construction documentation of the plant producing fuel injection pumps.

2. PROPER USE

2.1 Operating Constraints

To ensure safe and effective operation of the engine, to prevent accidents when operating and servicing the engine, it is important to follow the below-stated requirements:

- before operating a new diesel engine make run-in test according to the paragraph 2.3.4;

- in the beginning of the shift before starting the engine check oil level in the crankshaft and cooling liquid in the heat radiator;

- after starting the engine prior to load switching on let the engine to work for 2 or 3 minutes at minimum idle speed raising it gradually up to 1600 min^{-1} and not more.

Overall load of the cold engine is not allowed;

- it is not recommended to operate the engine for more than 15 min. at min. idling rpm, because the discharge of the compressor cascade of turbo-compressor that occurs during the operation can result in oil breaking out through the sealing and release of the oil into the intake manifold;

- when operating the engine notice control devices indications;

– diesel engine operation at oil pressure below 0.1MPa in the mail oil gallery is not allowed;

- remember of timely service in accordance with Chapter 3.1 of the present manual;

- check assembly units mounting occasionally, fasten them if necessary;

- use only fuel and oil types specified in the present manual depending on the season;

- keep the engine clean, check for fuel, oil and cooling liquid leaks, avoid crude air suction into cylinders.

2.2 Preparation for Use

2.2.1 Safety Precautions during the Engine Preparation

The engine preparation can be carried out only by tractors operators, drivers and motormen, having received special training and having been issued the qualification certificate, and having taken safety and fire protection training.

Get down to work only after careful study of the diesel engine mechanism and operation regulations.

During loading and unloading operations sling ropes fastening shall be carried out by eye-bolt on the engine (diesel engine fastening scheme according to the Annex H).

During depreservation of the engine comply with the safety requirements and hygienic

regulations during reagents, used rags and oiled paper handling.

Do not remove the safety guards from the engine required according to the engine design.

When inspecting diesel use portable lamp with voltage not exceeding 24V.

Tools and accessories for diesel engine preparation shall be in good order, answer the purpose and ensure safe execution of the work.

Working place where engine preparation is carried out can be equipped with fire-fighting equipment.

2.2.2 Depreservation of the Diesel Engine, Assembly Units and Parts

Engines supplied to the client are preserved for storage time of 6 months or 1 year. The preservation term shall be specified in the diesel engine license. The list of depreservation steps is shown in Table 8.

Table 8

№	List of Depreservation Steps	Preservation Term	
		1 year	6 months
	Diesel Engine Depreservation		
1	Remove the engine cover	+	-
2	Clear the unpainted outside preserved surfaces corrosion-preventing oil using diesel fuel.	+	+
3	Remove plugs or polyethylene overwrap, covering the outside vents of the exhaust manifold, intake manifold, thermostat housing, water pump pipe, turbo-compressor and breather. Remove plug out of the hydraulic pump opening of type NSH.	+	+
4	Drain the oil residue through the case drain hole.	+	-
5	Drain the corrosion-preventing solution residue from the system through drain cock.	+	-
6	Prepare the engine for start. Fill the crankcase with clean oil.	+	-
7	Bleed the fuel supply system with hand-priming pump, deairing the fine filter and fuel pump head (see. paragraph. 3.2.10).	+	-
	<i>Depreservation of Assembly Units and Parts</i>		
8	Depreservation of the assembly units supplied with the diesel engine shall be carried out by way of wiping by rags wetted with white spirit (GOST 3134-78), followed by wiping clean.	+	+
9	Depreservation of the parts supplied with the diesel engine shall be carried out in cleaning solution with use of jet method or dipping method followed by thermal drying: - cleaning solution temperature ranges from 60°C to 80°C; - drying temperature ranges from 70°C to 80°C.	+	+

2.2.3 Additional Completing the Diesel Engine Set

When installed on the vehicle the diesel engine shall be completed with fuel feeding lines and fuel drain lines, fuel tank, water radiator, charge air cooler, electric accessory and checking instrument, dirtiness indicator, monocycle and air cleaner.

The engine mechanism is provided with spaces for input and output of heat transfer medium from preheating system that shall be installed on a vehicle and shall be used for the engine preheating for starting it up at the ambient temperature below – 20°C.

2.2.4 Cooling system filling

Fill cooling system tank by way of filling the heat radiator with cooling liquid (liquid brand and volume of filling is specified in Table of Annex A).

Do not start the diesel engine with empty cooling system.

Do not use water in cooling system to avoid scale formation.

2.2.5 Filling with fuel and oil

Fill the fuel tank with the diesel fuel, oil crankcase and fuel pump - with engine oil. Fuel and oil brands shall be used according to temperature range of ambient air during diesel engine operation. Recommended brands of the diesel fuel and oil are specified in the Table of Annex A.

Use of other fuel and oil brands can result in premature engine failure, in non-compliance with ecological index, and in hard start in cold weather.

Use diesel fuel that is clean, free of mechanical impurities, oil and water.

Use lubricating agents that are clean, free of mechanical impurities and water.

2.2.6 Diesel engine operation control elements and inspection tools

The diesel engine is remotely controlled from the operator or driver seat. Mounting of control tools and elements is carried out by the end user during the engine installation on a tractor.

Camshaft rpm is changed by means of the lever or foot pedal connected to regulating device operating lever of the fuel pump.

Switching of heating plug and starter at the diesel engine start up is effected by three-position ignition switch placed on the tractor gauge board. When the key in ignition switch is placed in position I, the heating plug, shutdown solenoid starting winding, shutdown solenoid holding winding, starting solenoid, and MERCER System electrical circuit is engaged; and when the key in ignition switch is in position II - the starter electrical circuit is engaged.

Oil pressure indicator in the lubricating system and pressure warning switch indicator shall be installed in the full-flow oil filter body.

Coolant temperature gage and coolant temperature warning switch indicator shall be installed in the cylinder heads and thermostatic regulator cover correspondingly.

Air cleaner plugging level is controlled by means of air cleaner plugging signaling inductor designed for indicator lamp lightning when the air cleaner plugging overrides the standard.

Air cleaner plugging signaling inductor is installed in the intake channel on the air cleaner exit branch.

Camshaft rpm is controlled by means of tachometer. The signal is received by the tachometer from the electric generator alternate current terminal.

Diesel control elements are at the gauge board.

2.3 Diesel Engine Operation

2.3.1 Service staff operating procedure during fulfillment of the diesel engine operation tasks

Before starting the engine complete the following steps:

- check oil level in the engine crankcase;

- check cooling liquid level in the cooling system;
- check weather the fuel tank valve;
- fill the diesel engine fuel system with fuel according to the procedure prescribed in paragraph 3.2.10.

Fuel is drained in a tank.

2.3.2 Starting the Engine

Put the transmission gear shift lever in neutral.

Switch the accumulator battery switch on.

Engage the heating plug control unit by way of turning the ignition key in position I; by doing so you start heating plugs warming up, disengage the starting and holding winding of shutdown solenoid, and the solenoid drives the shutdown lever into position “Opened” (starting winding of shutdown solenoid is disengaged by a built-in restraining device in two seconds); power supply voltage of MERCER System is supplied.

Period of warming-up depends on the engine temperature, or can be fixed depending on the type of the used heating plug control unit. When the engine is switched on, an indicator at the gauge board flashes signing on the end of the heating plugs warming-up. The indicator is switched off in response to a command of control unit after complete warming-up of the heating plugs.

After the indicator has switched off, disengage the clutch of the tractor, engage the starting solenoid (engage the starting solenoid ensures injector control bar position which corresponds to **the greatest** fuel supply), turn and hold the ignition key in the position II and start the engine. During starting duty the plugs remain engaged.

Having started the engine turn the ignition key from the position II into position I. The starter is switched off. After the starter has switched off during the engine operation, the heating plugs remain engaged for 180-240 seconds.

Engage the clutch in a smooth manner.

Warm up the diesel engine to achieve the stable operation at camshaft, rpm equal to 1000-1300 min⁻¹ (within 2-3 min), then let the engine operate at increased rpm scaling the value up to 1600 min⁻¹ until the cooling liquid temperature amounts up to 40° C.

Ensure further warming-up of cooling liquid up to 70°C during the tractor or agricultural machine movement in creeper gear.

Use of the diesel engine with full power is allowed only when the cooling liquid temperature achieves 70°C.

If the engine is warm, or if it is summer, the engine start can be carried out without prior engagement of the heating plugs, by turning the ignition key into position II skipping the position I.

Time of continuous starter operation should not exceed 15 sec. Should the engine not start, repeat the operations as described after 30 - 40 sec. Should the engine not start after 3 tries, find the cause of the problem and eliminate it.

In order to facilitate the start at cold weather (when the temperature is below - 20°C, perform the following steps:

- disengage all drives of the tractor or agricultural machine make-up systems (Power take-off shaft (PTO shaft), hydraulic systems pump, compressor);
- bleed the fuel-handling system by manual priming pump to de-air it and to create the pressure in the fuel pump head;
- warm up the diesel engine with use of starting preheater for cooling liquid;

- start up the engine as described above.

At cold start the exhaust smokes white for a while which is not a trouble because the diesel is operated with overcooling.

Do not warm up the draw-in air before the air-cleaner by direct flame.

Do not start the engine by towing the tractor or agricultural machine.

2.3.3 Stopping the engine

Before you stop the engine after operating under a high load, run the engine for 3-5 min. first at middle, then at min. idle rpm. That will allow the cooling liquid and oil temperature to cool and stabilize gradually. Failure to meet these requirements will result in compressor failure.

To shutdown the engine move the ignition key in zero position. After the engine has been stopped, switch off the accumulator battery switch.

2.3.4 Run-in

Before operating the engine, it must be given a run-in to obtain the wearing-in of the diesel engine ribbing matters.

Operating the engine at full load without run-in is not allowed.

Run-in shall be carried out by operating organization only.

After starting the engine, make sure it works properly and begin run-in.

The engine must be given 5min. run-in at idling with the gradually increasing rpm to 1600 min^{-1} . and then with full load during 30 hours.

Run-in of the engine mounted at a tractor, agricultural machine is to be done while operating at reduced load range, gradually increasing the load.

After run-in follow the below-stated requirements:

- check the cylinder bolts tightness, tighten them if necessary;
- check the clearance between valves and rocker arms;
- clean the oil filter;
- change oil in the engine crankcase;
- drain the coarse and fine fuel filters;
- check and tighten if necessary outer tread parts.

2.3.5 Engine operating and service in cold weather

The diesel engine operation becomes more complicated at cold weather. To ensure continuous engine operating under cold temperature up to $+5^{\circ} \text{C}$ and less make cold weather preparations, combining regular and seasonal service.

If the engine is equipped with ether type starting aids, get it ready for operation.

The engine compartment of the tractor shall be equipped with cold weather heating jacket, and the diesel engine - with starting aids (pre-heater) if necessary. Fill the cooling system with the cooling liquid according to Table A (Annex A), check the accumulator batteries operation state, recharge them if necessary (accumulator batteries shall be fully charged).

If during warm seasons a special non-freezing coolant was used, make sure it is frost-resistant and, if needed, introduce the required changes in accordance with the expected temperature.

When entering in winter operation mode use winter oil and fuel grades according to Chimnotology List (Annex A).

In case, water is used as a coolant (emergency operation exploitation), be sure to drain it through plug 9 (Figure 13), when the tractor (machine) is parked for a long

period.

2.3.6 Troubleshooting

Troubles, possible causes		Probable remedy
1. The engine can not be started		
1.1	Air in the fuel delivery system	Bleed fuel system by manual priming pump. Eliminate air inflow in the fuel pump.
1.2	Failure of fuel pump	Repair or replace the fuel pump
1.3	Fuel filters clogged	Rinse the coarse fuel filter and replace filter elements of the fine fuel filter
2. Engine runs but loses power under load		
2.1	Fuel pump lever does not go to the end	Adjust fuel pump control rods
2.2	Dirty filter element of the fine fuel filter	Clean and/or replace filters
2.3	Failure of the injectors	Repair and adjust or replace injectors
2.4	Wrong fuel pump calibration	Have the fuel pump calibrated
2.5	Dirty air cleaner	Clean oil bath air cleaner
2.6	Failure of the fuel pump	Repair or replace fuel pump
2.7	Low supercharge pressure	Send turbocharger for a qualified repair
2.8	Air-tightness is impaired	Find the cause of depressurization and eliminate it
3. The Diesel Engine Demonstrate Smoke at All Operating Modes		
<i>3.1 The exhaust manifold smoke is black</i>		
3.1.1	Insufficient air supply	Make the maintenance servicing of the air cleaner
3.1.2	Injector nozzle needle sticking	Find the faulty injector, clean or replace the nozzle and adjust the injector
3.1.3	Failure of the fuel pump	Send fuel pump for a qualified repair
<i>3.2 The exhaust manifold smoke is white</i>		
3.2.1	Engine is overcooled	Warm up the engine, keep coolant temperature to 70-95° C.
3.2.2	Water in the fuel	Change the fuel
3.2.3	No valve and rocker arms clearance	Adjust valve and rocker arms clearance
3.2.4	Wrong angle of fuel injection lead	Set the recommended angle of fuel injection lead
<i>3.3 The exhaust manifold smoke is blue</i>		
3.3.1	Oil in combustion chamber due to sleeve and piston parts wearing	Replace the worn-out parts.
3.3.2	Excessive oil in crankcase	Drain excessive oil, check the level with the dipstick.
4. The Diesel Engine is overheated		

4.1	Insufficient quantity of coolant in the cooling system	Add coolant and check the level
4.2	Dirt on the outside of the radiator	Clean the radiator
4.3	Thermostat valve does not open fully	Replace thermostat
4.4	Fan belt loosening	Replace the belt
4.5	Oiling of fan drive belt and pulley wheel	Take the driving belt off, remove oil from belt and pulley
5. Low pressure of the warmed up engine		
5.1	Faulty pressure-gauge	Replace the pressure-gauge, after check of oil pressure with the gauge package
5.2	Oil lines air-tightness is violated	Find the cause and eliminate it
5.3	Failure of the oil pump	Find the cause and eliminate it
5.4	Oil level is too low	Add oil, check the level with the dipstick
5.5	Safety valve sticking in the oil filter	Wash the valve and adjust pressure in lubricating system
5.6	Extreme wearing of the junctions crankshaft pivot-bearings	Eliminate the trouble
6. The Diesel Engine Overspeeds		
Immediately stop the engine by way of fuel supply shutting down. Dismount the fuel pump from the diesel engine and send it for a qualified repair.		
7. Turbo-compressor – See Annex F		
8. Starter		
<i>8.1 When engaged the crankshaft either does not turn or turns slowly</i>		
8.1.1	Accumulator battery connections corroded or loose	Clean the ends or tighten the terminals
8.1.2	Accumulator batteries are discharged	Charge or replace
8.1.3	Dirty collector and brushes	Clean collector and brushes
8.1.4	Collector and brushes poor connection	Dismount the starter from the engine, clean the collector, eliminate the troubles or replace faulty parts, if they are worn
8.1.5	Starter relay contact bolts and contact plate surface are burned	Clean the points of contact, or place the contact bolts into cover seats, rotating about an axes by 180°, and place the contact plate by the underside.
	Failure of the starter drive	Replace starter drive
<i>8.2 After the engine is started, the starter is still on</i>		
8.2.1	The contact plate or the contact points in starter control wiring relay is welded to the starter relay contact bolts	Stop the engine, switch off the batteries and clean the terminals
<i>8.3 Starter armature rotates at high speed but do not crank the diesel engine crankshaft</i>		
8.3.1	Flywheel rim drive gear breakage	Replace the flywheel rim
8.3.2	The starter drive fails	Replace the starter drive
<i>8.4 The starter relay runs harshly (switches the starter on and then switches it off at once)</i>		

8.4.1	Abrupture of the relay holding winding	Replace the relay
8.4.2	The accumulator battery is discharged	Charge or replace
<i>8.5 Driver pinion is not regularly engaged with the flywheel crown in normal conditions of the relay operation</i>		
8.5.1	Front wear and tear of the backed-off part the flywheel gear rim	Back-off the flywheel rim gears or replace the rim of the flywheel.
8.5.2	Sticking of the driver pinion on armature shaft due to the lack of law quality of lubricator	Clear the drive from the old lubricating agent and coat with the lubricant CIATIM-201/203/221
8.5.3	Front wear and tear of the backed-off part the flywheel gear teeth	Back-off the teeth or replace the drive
9. Electric Generator		
<i>9.1 Ampere-meter (voltmeter) shows no voltage after start and during the engine operation</i>		
9.1.1	"+"-terminal is broken or faults to the generator housing	Remove rectifier, solder and insulate the faulty point. Isolate the insulation fault point. <i>(Repair in special workshop)</i>
9.1.2	Excitation coil circuit opening	re-assemble generator, solder and insulate the fault place, and in case it is impossible, replace the coil. <i>(Repair in special workshop)</i>
9.1.3	One of the stator phase faults to the generator housing	Replace stator <i>(Repair in special workshop)</i>
9.1.4	Short circuit of power rectifier outputs or diode of direct and indirect polarity breakdown	Replace the rectifier <i>(Repair in special workshop)</i>
9.1.5	Voltage adjuster failure	Replace voltage adjuster <i>(Repair in special workshop)</i>
9.1.6	Collector and brushes poor connection, brushes hanging and wear	Clean the collector, eliminate hanging or replace the brushes
<i>9.2 No full power output from electric generator</i>		
9.2.1	Voltage regulator connecting wires are broken	Solder and insulate the fault point <i>(Repair in special workshop)</i>
9.2.2	One of the stator phase is broken	Replace stator <i>(Repair in special workshop)</i>
9.2.3	Turn-to-turn fault of the stator coil	Replace the stator
9.2.4	Turn-to-turn fault of the excitation coil	Replace the coil
	A diod of the power rectifier failure	Replace the rectifier <i>(Repair in special workshop)</i>
<i>9.3 Accumulator battery is recharged regularly</i>		
9.3.1	Voltage adjuster failure	Replace voltage adjuster <i>(Repair in special workshop)</i>
9.3.2	faults to the voltage adjuster output “SH” housing	Isolate the fault point <i>(Repair in special workshop)</i>

<i>9.4 Electric generator noise</i>		
9.4.1	Driving belt slippage	Replace the belt

2.3.7 Safety requirements at the diesel engine proper use

To ensure safe and effective operation of the engine, to prevent accidents when operating and servicing the engine, it is important to comply with the following requirements:

- before operating the engine read this manual completely and make sure you are familiar with the controls, maintenance information and safety rules;
- do not operate the tractor if the diesel engine is out of order;
- never start the engine in a sealed building with poor ventilation;
- **technical service and troubleshooting are to be done only when the engine is shutdown;**
- to avoid face and hands burns, loosen radiator plug carefully, use gloves or rags;
- do engine assembling. and disassembling with the help of rope fastened by eye-bolts of the engine (the diesel engine fastening scheme according to Annex G);
- **do not use open flame to warm up fuel lines and oil pan of the engine in cold weather;**
- when operating the engine, no inflammables should be near exhaust manifold, turbo-compressor and muffler;
- use fuel and grease to fill up fuel and lubricate in accordance with safety requirements;
- do not warm up the intake air before the air-cleaner by open flame;
- do not start the engine without the cooling liquid in cooling system;
- after the engine has been stopped, switch off the accumulator battery disconnect switch.

Rooms where the engine is operated or a tractor is used as a power drive, shall be equipped with the combined extract-and-input ventilation, and the diesel engine intake system shall have independent offtake ensuring positive exhaust gases discharge from the muffler to the outside the room.

2.4 Operation in extreme conditions

In the event of emergency stop the engine by means of fuel shutoff.

In case of fuel inflammation, use sand, cover the flame with canvas, sackcloth or any dense texture. Use carbon dioxide extinguisher. **Do not use water.**

If the camshaft prm increases excessively during the engine no-load operation (“the engine overspeeds”), stop the engine by turning the ignition key in zero position.

If for any reasons the described actions did not result in the engine immediate shutdown, cut off the air cleaner intake pipe by a flat object (a plate, a book and etc.,)

To avoid severe injured do not close the air cleaner intake pipe with hands.

Any actions on engine uncontrolled operation stoppage shall be carried out in an expeditious manner to prevent the diesel engine from failure.

3 Technical maintenance

3.1 Technical maintenance of diesel engine

3.1.1 General instructions

Technical maintenance is carried out to keep the engine in working order during its operation.

Non-compliance with the approved maintenance periodicity and low quality of maintenance of diesel engine significantly reduce its life cycle, result in increase of the number of engine failures, decrease of its power and ecological indicators, increase of operation costs.

Running diesel engine without regular technical maintenance is forbidden.

Deviation from the approved periodicity of technical maintenance is permitted within the range of $\pm 10\%$.

Marks concerning carrying out regular technical maintenance (excluding STM) shall be included into a tractor/agricultural machine service book.

During technical maintenance when preparing for long-term storage and during technical maintenance TM-3, a technical diagnostics of the engine is carried out, where necessity of engine repair is defined as well as the kind of repair – current or capital.

All troubles, identified during carrying out technical maintenance, shall be eliminated. Maintenance operations, associated with disassembly of its assembly units, shall be conducted in indoor area to keep dust and dirt away from getting into body cavities of engine assembly units.

3.1.1.1 Kinds and periodicity of technical maintenance

Kinds and periodicity of technical maintenance are given in table 10.

Table 10

Type of technical maintenance	Diesel operation	
	Yearly	Seasonal
	Periodicity or hours	
1 Technical maintenance when preparing for running-in	Before operating a new engine or an engine after capital repair.	
2 Technical maintenance on finishing running-in	It is carried out in accordance with instructions of clause 2.2.2 – 2.2.5	
	Before operating a new engine or an engine after capital repair.	
3 Shift-time technical maintenance (STM)	It is carried out in accordance with instructions of clause 2.3.4	
	8-10	
4 First technical maintenance (TM-1)	125	
5 Second technical maintenance (TM-2)	500	
6 Third technical maintenance (TM-3)	1000	
7 Seasonal technical maintenance when passing to autumn-winter (TM-AW) or spring-summer (TM-SS) operation periods	-	Conducted simultaneously with regular technical maintenance (TM-1, TM-2, TM-3)
8 Technical maintenance by short-time storage (from 10 days to 1 month)	It is carried out in accordance with clause 3.1.5.1 and unit 5	
9 Technical maintenance when preparing for long-term storage	It is carried out in accordance with clause 3.1.5.2 and unit 5	
10 Technical maintenance by long-term storage	It is conducted in accordance with instructions of clause 3.1.5.2 and unit 5	
	5	
11 Technical maintenance before beginning of operation season (TM-O)	-	It is conducted in accordance with clause 3.1.1.1

Cycle of technical maintenance (exclusive of STM, TM-AW and TM-SS) when operating a tractor, harvester, machine will be the following: **TM-1** “ **2TM-1** “ TM-1 “ **TM-2** “ TM-1 “ 2TM-1 “ TM-1 “ **TM-3** “ TM-1 ” 2TM-1 “ TM-1 “ TM-2 “ TM-1 “ 2TM-1 “ TM-1 “ **2TM-3**.

3.1.1.1.1 Technical maintenance of engines before beginning of harvester operation season (TM-O)

Remove engine from storage following clause 3.1.6.2

Mount removed units and parts, stocked during storage.

Check all connections of air purifier and inlet pipe for tightness.

3.1.1.2 Requirements for composition and proficiency of attending personnel

Table 11

Type of technical maintenance	Composition and proficiency of attending personnel
STM TM-1; 2TM-1; TM-2; SS; AW	Operator, driver of a tractor, equipped with diesel engine Mechanic of 3 – 4 skill-category, who passed general technical training under the program of mechanics teaching, possessing knowledge on organization and general operation principle of diesel engines Д-245S3A M and their modifications; operator driver of a tractor, equipped with the engine
TM-3; 2TM-3	Motorman of 4-5 skill-category or set-up man and mechanic of 3-4 skill-category, who passed general technical training under the program of mechanics teaching, possessing knowledge on organization and general operation principle of diesel engines Д-245S3A M and their modifications, or operator, driver of a tractor, equipped with engine

3.1.1.3 Requirements for diesel engine placed on technical maintenance

Diesel engine, subjected to technical maintenance, shall be exposed to technical examination to identify places of fuel and oil leakage, which are difficult to find after washing.

After technical examination, diesel engine in assembly with the machine, where it is fitted, is exposed to cleaning and washing.

Quality of washing influences greatly on operational safety and lifetime of engine units. Non-complete cleaning of parts can shorten engine service life by 20-30% and more.

To carry out certain adjustment works, conducted by technical maintenance, it is necessary to warm up diesel engine to required temperature mode in accordance with the instructions of the this manual.

Technical maintenance shall be conducted after examination and tightening of loosened attachments, detected during examination.

After technical maintenance is finished, diesel engine assembled with the machine is sent to storage area or to get filled with fuel for continuation of the conducted works.

List of main and duplicate POLs is presented in table A.1 (Annex A).

3.1.2 Safety measures

To ensure safe work and to forestall casualties during technical maintenance of diesel engine observe the following rules:

- washing operations can be carried out by a person only after he has got theoretical and practical instructions;
- work with washing equipment unearthed and electric motor of a pump with neutral wire unearthed is not permitted;
- washing outside equipped washing places, which ensure ecological safety, is not permitted;
- do not start the engine in a closed room with poor ventilation;
- technical maintenance and elimination of faults shall be conducted with the engine stopped;
- to prevent burns on face and hands, radiator filler cap on a hot engine shall be opened using a glove or cloth;
- fixtures used at work shall be in operating conditions;
- tools shall be in good order and correct in size;
- for inspection use portable lights with voltage not higher than 12V;
- fuel is drained outside fuel system (by bleeding) to a container only;
- oil and preservative mixtures shall be drained to containers only;
- prevent POLs from spilling at working place;
- when conducting technical maintenance ensure that working place is fitted with fire-extinguishing means;

3.1.3 Technical maintenance procedure

3.1.3.1 Scope of work when conducting approved kinds of technical maintenance

Table 12

Name of work	Kind of technical maintenance							
	STM	TM-1	2TM-1	TM-2	TM-3	2TM-3	SS	AW
1 Check oil level in engine crankcase	+	+	+	+	+	+		
2 Check coolant level in cooling system	+	+	+	+	+	+		
3 Drain sediment outside coarse fuel filter		+	+	+	+	+		
4 Replace oil filter			+	+	+	+		
5 Replace oil in engine crank case			+	+	+	+		
6 Drain sediment outside fine fuel filter			+	+	+	+		
7 Carry out maintenance of air cleaner				+	+	+		
8 Check all connections of air cleaner and inlet pipeline for tightness				+	+	+		

3.1.4 Check of diesel engine workability

Engine workability is checked by means of conducting technical testing.

Engine testing is conducted when putting engine for long-time storage, when conducting TM-3, after planned overhaul period and when checking quality of the repair conducted.

Companies which carry out TM-3 shall have equipment for life cycle technical tests or use a mobile test unit.

Before carrying out engine testing operations it is necessary to perform the following preparatory works: inspect the engine, clean it out, wash it and ask operator about its functioning.

When there is information about signs of units and parts wear limits (destruction of crankcase bearings, identified by knocks during operation; failures or serious defects of cylinder block), diesel is sent to capital repair.

Testing a number of units, components and systems is conducted according to composite indexes of technical state (power, oil pressure, coolant temperature, specific fuel consumption, volume of gases getting inside the crankcase), in accordance with which state of pistons, piston rings, cylinder liners, crank mechanism can be evaluated.

Before testing the engine it is required to check attachment of units, high pressure fuel pump, injectors and fuel injection advance angle (make adjustments if necessary), carry out air cleaner maintenance (clean), replace fine fuel filter, check turbocharger, check and adjust tension of drive belts, valves of timing gear, check and if necessary restore oil level in cases of engine, fuel pump and pony motor reduction gear, level of coolant in radiator, check availability of fuel in the tank.

After the abovementioned work has been done and recognized failures have been eliminated testing is started.

Controlled engine parameters are presented in clause 1.1.2.2, table 3.

Measurement tools for defining controlled parameters are presented in clause 1.1.2.3, table 4.

After the guarantee period for engine operation has expired it is admitted to define power by non-stop method. The non-stop method allows to define power and fuel efficiency according to effective fuel consumption, herewith it is not required to take the engine off the tractor.

By non-stop method of testing, fuel flowmeter of КИ-8955 or КИ-8940 type shall be connected to low-pressure fuel supply system and a load simulator shall be mounted on inlet pipe of air intake of КИ-5653 type.

Piezometer shall be connected to inlet pipe of air supply system.

The engine is started and warmed up to normal thermal condition, and in set modes fuel consumption and, basing on it, engine power are defined.

If necessary, to evaluate technical condition of units and parts (bearing assemblies, belt drives, shafts), which don't have composite indexes, technical state is defined by measurement of dimensionals (clearances, plays) or by checking, inspection.

All faults, detected during technical testing, shall be eliminated by means of conducting current or capital repair.

3.1.5 Preservation (represevation) when placed for storage

Depending on the kind of delivery, specified in an agreement or a contract, diesel engines, supplied to the customer, are preserved for a period of 6 months or for one year. Specific period of preservation is given in the engine passport.

When the engine is stored for a longer period than the preservation period given in the passport, it shall be exposed to represevation.

Represevation after six months' storage period shall be made for 1 year of storage.

Represevation for six months' storage period is not permitted.

When put for short storage period (10 days – 1 month) diesel engine in a tractor or vehicle assembly is preserved in accordance with clause 3.1.5.1.

When put for long storage period (1 month and more) diesel engine in a tractor or vehicle assembly is preserved, or exposed to represevation when the storage period is more than 6 months, in accordance with clause 3.1.5.2.

It must be noticed that after the engine has been started, its inner cavities, cooling system and fuel supply get depreseved.

3.1.5.1 Preservation of engine when putting for short-period storage

In conditions of ambient temperature and temperature of engine parts not exceeding 60°C drain oil out of heated engine crankcase to a suitable container.

Mount and screw oil drain tube assembly in oil sump.

Fill oil sump with oil to the relevant level in accordance with Chimmotology list (Annex A).

Fill fuel tank with recommended type of fuel (Annex A).

Let the engine work for 2 minutes at 1200 min⁻¹ of frequency.

Do not drain oil out of lubrication system and fuel out of supply system after the engine has been stopped.

Check air cleaner and carry out its maintenance, if necessary.

If frosts are expected during the storage period, check coolant for conformity with respective freezing resistance and if necessary replace it. If required, add coolant up to the guide mark of the expansion tank.

Clean the engine outside (except for electrical parts) with fuel and compressed air.

Cover air cleaner inlet pipe, muffler outlet pipe and engine breather with polyethylene film GOST 10354-82 and fasten with twine IIIJI 4,0 (0,25) H1 “6” GOST17308-88;

3.1.5.2 Preservation (represervation) of engine when putting for long-period storage

Drain coolant from cooling system and wash with clean soft water under pressure.

Fill cooling system with preservative solution (thickened aqueous solution of chromates) having the following composition (g/l):

- glycerine GOST 6823-77 - 800;
- potassium bichromate GOST 4220-75 - 30...50;
- calcined soda GOST 5100-85 - 6...10;
- drink water GOST 2874-82 - 140...165

(To prepare solution, salt should be preliminary dissolved in warm water and after cooled down it is added to preservative solution).

Start the engine and let it work until it reaches a temperature of 60...80 °C.

Drain motor oil from engine oil sump into a suitable container when the ambient temperature and the temperature of engine parts doesn't exceed 60°C.

Remove and recycle oil filter. Fix oil drain plug and screw it up in oil sump.

Mount a new oil filter.

Fill flushing-preservative oil Belakor AH-T ТУ РБ (technical requirements of the Republic of Belarus) 03535026.291-97 or motor oil recommended for the engine (Annex A) with 15...25% of additive AKOP-1 GOST 15171-78 in the oil sump to the relevant level. (Add additive AKOP-1 to the motor oil by stages (along with rapid mixing to get homogenous mass). Homogeneity of mixture is defined as absence of black and dark brown blotchiness in the flow of mixture leaking out of agitator.

Before using oil Belakor AH-T shall be thoroughly mixed. Oil Belakor AH-T is not warmed up. In winter time when the oil gets thick it is allowed to warm it up to 80°C.)

Drain fuel from the fuel tank.

Fuel system preservation (fuel pipelines, fuel filters, injectors, fuel pump) is carried out with a preservation mixture of diesel fuel in conformity with GOST 305-82 with 5...10% of AKOP-1 additive.

Add additive AKOP-1 to diesel fuel by stages (along with rapid mixing to get homogeneous mass). Homogeneity of mixture is defined as absence of black and dark brown blotchiness in the flow of mixture leaking out of agitator.

Drain fuel from coarse fuel filter. Connect pipe coming from the container with a preservative mixture to the fuel delivery point on the fuel coarse filter.

Replace fine fuel filter, recycle the removed filter.

Fill fuel system in conformity with instructions in clause 3.2.10.

Crank the engine without fuel supply by means of triple starter engagement with 1-2 min. switching interval. Duration of each engagement is 15 sec.

Remove monocyclone of air cleaner (if available) and put a cap on a suction hole of air cleaner and turbocharger. Set fuel supply lever to the position of max. supply and crank the engine with a starter for 15 sec. to deliver the preservation mixture to engine cylinders.

Detach a pipe from the coarse fuel filter.

Drain preservative oil from the oil filter.

Drain preservative mixture from fine and coarse fuel filters.

Drain preservative mixture from the cooling system through drain cock.

Remove the cap from the hole of air cleaner pipe and mount the monocyclone, remove the cap from the suction hole of turbocharger and mount a temporary cover.

Drain preservative mixture from the cooling system.

Drain preservative oil from the oil sump, mount and tighten the oil drain plug.

Remove, serve and store the accumulator battery in conformity with instructions of Tractor, machine operations manual.

Clean the engine outside (except for electrical parts) with fuel and compressed air.

Detach compressor air-delivery pipe and add 4-6 grams of preservative oil to the compressor cylinder. Mount air delivery pipe. Engage the compressor (for single-cylinder compressor).

Cover air cleaner inlet pipe, muffler outlet pipe and engine breather with polyethylene film GOST 10354-82 and fasten with twine IIIJI 4,0 (0,25) H1 “6” GOST 17308-88.

Protect the engine with weatherproof canvas, positioned so that to provide for air circulation.

The engine at storage shall be periodically checked. If there are any signs of rust or corrosion, proper measures shall be taken to prevent damage of engine parts.

For engines prepared for preservation repeatedly, which are stored unassembled on a tractor, machine, the following shall be done additionally:

Clean with a napkin and apply oil Belakor AH-T or operation preservative oil to flywheel mounting face (by absence of coupling clutch), mounting faces of hydraulic pumps of HIII type, splines of clutch pressure plate, flange connector of turbocharger outlet hole (for engines without outlet pipe, tube).

Outer holes of exhaust manifold, of intake manifold, of thermostat housing, of pipes of water pump and turbocharger, of engine breather shall be covered with polyethylene film GOST 10354-82 and fastened with twine IIIJI 4,0 (0,25) H1 “6” GOST 17308-88.

Starter and monocyclone of air cleaner shall be covered with bags made of polyethylene film and pasted with polyethylene band with adhered layer GOST 20477-86 or fastened with twine IIIJI 4,0 (0,25) H1 “6” GOST 17308-88.

3.1.6 Preparation of engine for operation when removed from storage

3.1.6.1 Removal of engine from short-time storage

Remove protective seals from the engine inlet and outlet pipes and a breather.

Check the level of coolant and oil.

Fill (bleed) the supply system with fuel in conformity with clause 3.2.10.

Check and charge the accumulator battery if necessary.

Start the engine.

3.1.6.2 Removal of engine from long-time storage

Remove protective seals from the engine inlet and outlet pipes and a breather.

Remove plugs from inlet and outlet fuel pipelines and connect the fuel pipelines to their normal position.

Remove preservation oil from outer preserved surfaces of the engine with diesel fuel.

Fill oil sump with motor oil to the relevant level in conformity with Chimmotology list (Annex A).

Fill the fuel tank with recommended type of fuel (Annex A). Fill (bleed) the supply system with fuel in conformity with clause 3.2.10.

Turn off all drain cocks and fill the cooling system with coolant of recommended type to the relevant level in conformity with Chimmotology list (Annex A).

Mount and connect the accumulator battery. Charge the battery if necessary.

Disconnect oil delivery pipeline from the casing of central bearings of turbocharger. Previously lubricate the bearings, pouring oil to the hole up to the flange level. Connect the delivery pipeline using a new gasket, tighten bolts of the delivery pipeline flange.

Start the engine.

3.2 Technical maintenance of engine and its parts

3.2.1 Maintenance of cooling system

3.2.1.1 Check of cooling fluid level in cooling system

Carry out a shift-time check of cooling fluid level before engine start.

Remove radiator cap and check the cooling fluid level which shall reach the upper end of the filler neck. Do not let the level drop beyond 40 mm from the upper end of the filler neck.

3.2.1.2 Maintenance and washing of cooling system

Fill the cooling system with low-freezing-point cooling fluid.

Watch the cooling fluid temperature, the normal temperature shall be 85-95°C. If the temperature goes higher than the normal, check the level of the cooling fluid in the radiator, radiator integrity and fan belt tension.

Wash dirt out the cooling system if necessary but not less than every 2000 hours of engine work. Use solution of 50-60 g of calcined soda per 1 l of water for washing.

Wash the system in the following order:

pour 2 l of kerosene to the radiator and fill the system with the prepared solution;
start the engine and let it work for 8-10 h or 350-400 km of kilometrage, after that drain the solution and wash the cooling system with clean water.

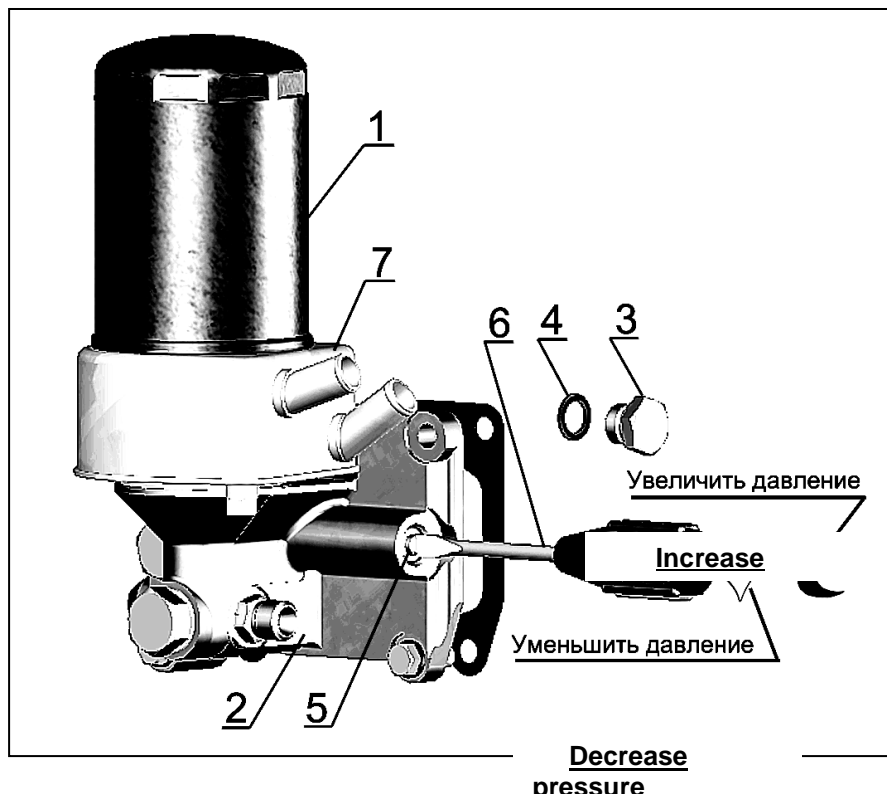
3.2.2 Maintenance of lubrication system

To ensure engine normal operation follow the instructions for maintenance of the lubrication system:

- fill the oil sump only with the oil, recommended for use in the present Manual (Annex A, “Chimmotology list”);
- timely replace oil and oil filter in conformity with periods, provided in clause 3.1.3;
- constantly watch the values of oil pressure on pressure indicator, located on the dashboard (when the engine works with rated speed and 85...95°C of coolant temperature, oil pressure shall be at 0.25...0,35 MPa, with the hot engine 0,8 MPa of pressure value is admitted);
- pressure value is adjusted in accordance with figure 11 in the following way:
- unscrew plug 3, remove gasket 4;
- using screwdriver 6 turn the adjusting plug 5 in the channel of oil filter casing 2 by one revolution to the side of increasing or decreasing of pressure (depending on the real pressure)

- mount gasket 4 and screw the gasket 3;
- repeat the abovementioned adjustment actions if necessary.

Making adjustments with the working engine is FORBIDDEN.



- 1 – oil filter; 2 – oil filter body; 3 – valve plug; 4 – plug gasket;
5 – adjusting plug; 6 – screwdriver; 7 – liquid-oil heat exchanger;

Figure 11 – Oil pressure adjustment.

3.2.3 Check of oil level in the engine crankcase

Carry out a shift-time check before starting the engine using oil dipstick, located on the engine cylinder block. The level of oil shall be between lower and upper marks of the dipstick in accordance with figure 12. The check is made not earlier than 3-5 min. after the engine stop, when oil fully drains to the crankcase.

It is forbidden to run the engine with oil level in the crankcase below the lower and above the upper marks of the dipstick.

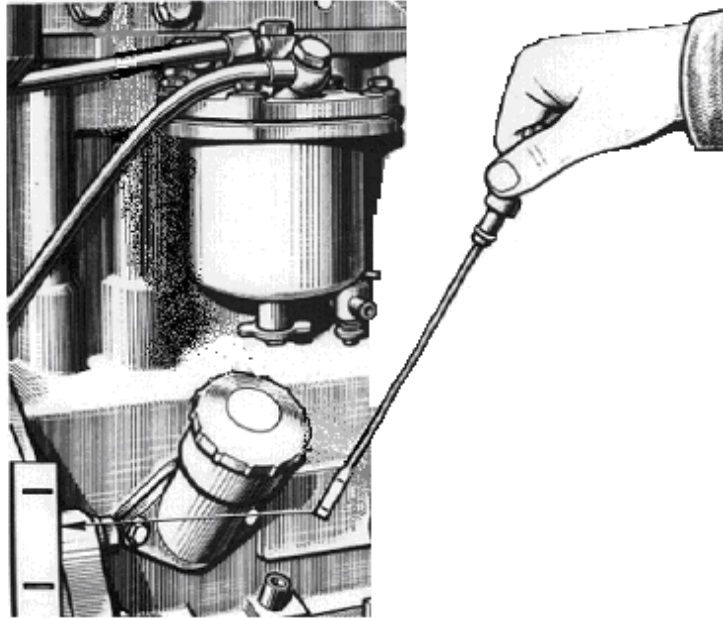


Figure 12 – Check of oil in the engine crankcase

3.2.4 Replacement of oil in the engine crankcase

Oil in the engine crankcase is replaced in every 250 hours of work and in the case of using duplicate types of oil and fuel with high sulfur concentration every 125 hours of work. Drain used oil only from the hot engine. To drain the oil unscrew oil sump plug. After the oil has leaked out of the crankcase, screw the plug back. Fill oil in the engine through oil filler pipe until it reaches upper mark on the dipstick. Fill in only the oil, recommended by this manual, according to the operation period.

3.2.5 Replacement of oil filter

Replace oil filter according to figure 13 simultaneously with replacement of oil in engine crankcase in the following order:

- unscrew filter ФМ 009-1012005 from the fitting, using a special wrench or any other materials at hand;
- screw a new filter ФМ 009-1012005 (JSC “Avtoagregat”, city of Livny, Russia) or M5101 (EJSC “DIFA”, Grodno, Republic of Belarus) on the fitting.

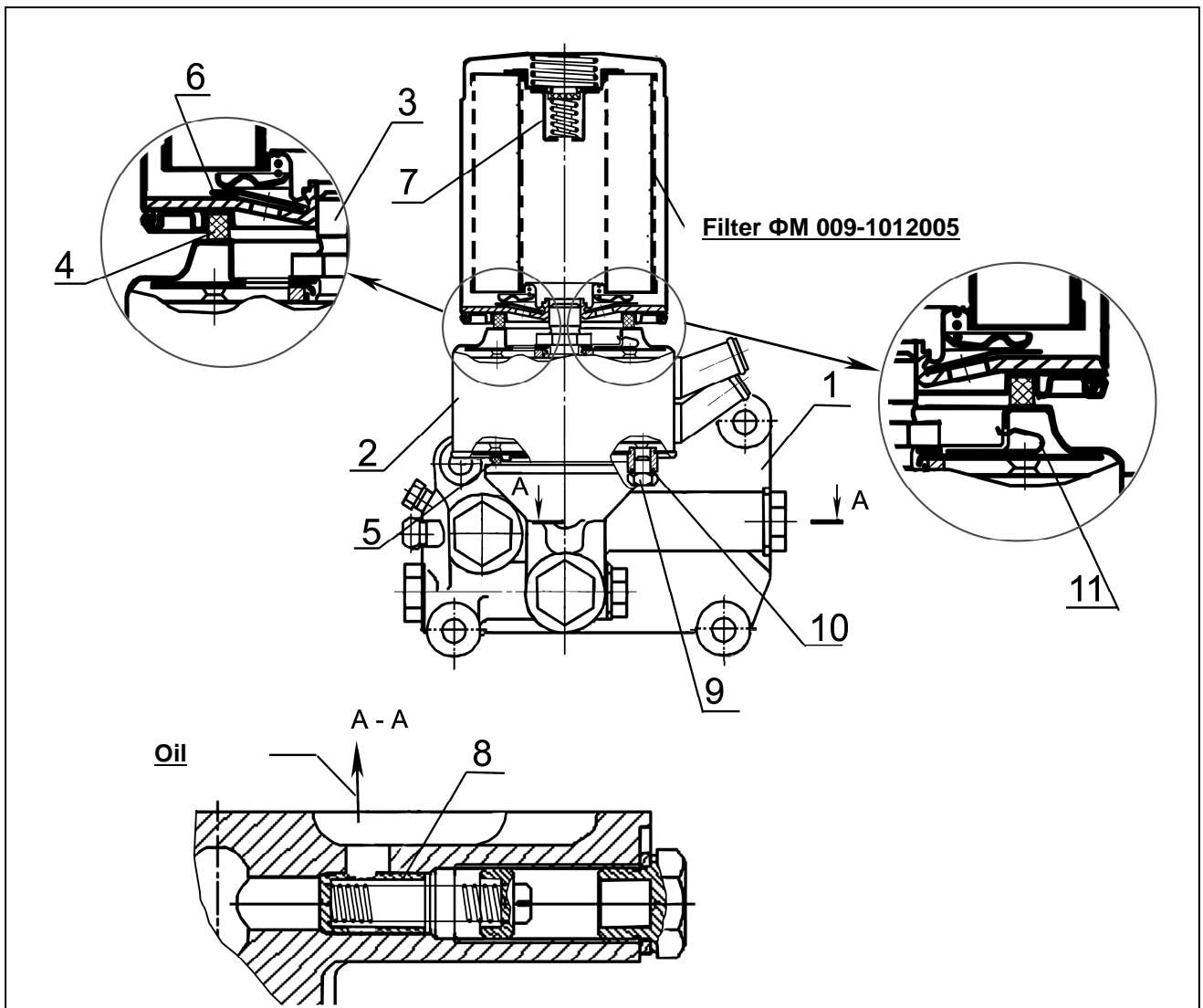
When mounting the filter, lubricate gasket 4 with motor oil. As soon as the gasket touches the mounting surface of filter gasket 1, turn the filter by 3/4 revolutions. Mount the filter in the body only by force of hands.

In future order the following oil filters:

- a) ФМ 009-1012005 at the address: JSC “Avtoagregat”, 303858, 2a Industrialnaya Street, Livny, Orlovskaya oblast, Russia;
- b) M5101 at the address: EJSC “DIFA” 230019, 45 Belusha Street, Grodno, Republic of Belarus

It is possible to install element filters of solid type: modification X149 by company

“AC Lelko” (France); modification L37198 by company “Purolator” (Italy).



1-filter body; 2 – liquid-oil heat exchanger (LOHE); 3 – fitting; 4 – filter gasket; 5 – LOHE gasket; 6 – contra-discharge valve; 7 – overflow valve; 8 – protection valve; 9 – plug for coolant drain; 10 – seal ring; 11 – LOHE protective valve.

Figure 13 – oil filter with LOHE

3.2.6 Drain of sediment from coarse fuel filter

Drain sediment in every 125 hours of engine operation.

Unscrew sediment drain plug, located in the lower part of the filter bowl in accordance with figure 14, and drain sediment until clean fuel remains. Screw the plug.

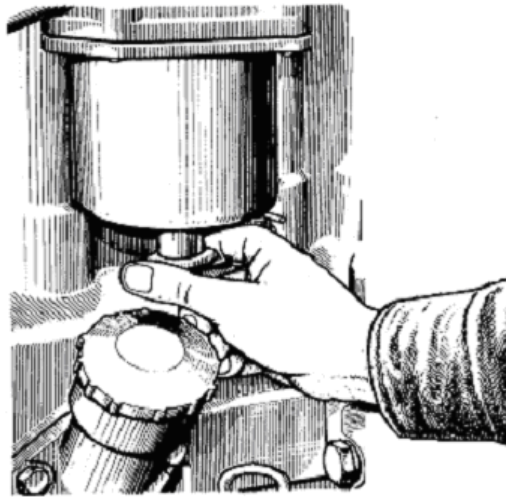


Figure 14– Drain of sediment from coarse fuel filter.

3.2.7 Washing of coarse fuel filter

Wash the filter in every 1000 hours of engine operation in the following order:
turn off the fuel tank valve;

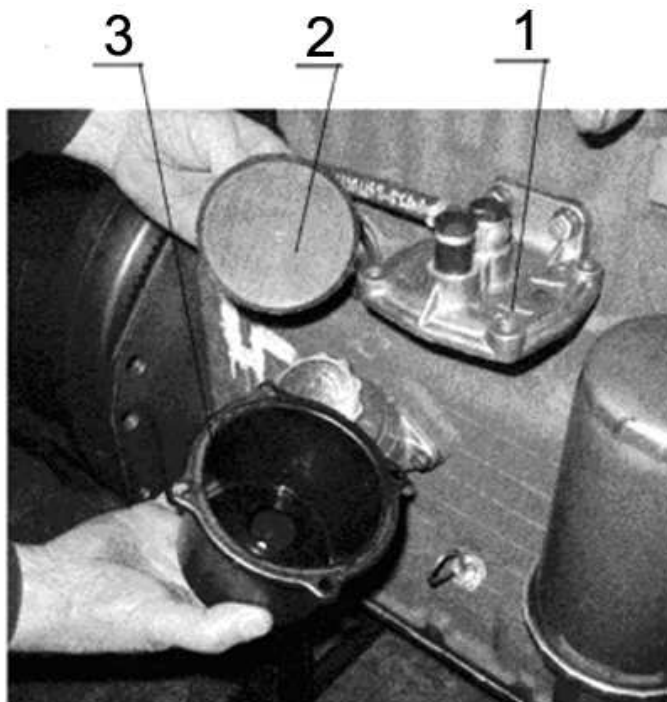
unscrew nuts of bowl attachment bolts;

remove the bowl 3 in accordance with figure 15;

using a wrench unscrew a deflector with net 2;

remove a diffuser;

wash the deflector with the net, the diffuser and the filter bowl with diesel fuel and mount them back.



1 – filter body; 2 – deflector with net; 3 – bowl

Figure 15 – Washing of coarse fuel filter

After the filter is assembled, fill the system with fuel.

3.2.8 Drain of sediment from fine fuel filter

Drain sediment in every 250 hours of engine operation.

Unscrew plug 4 in the lower part of fine fuel filter by 2...3 revolutions in accordance with figure 16 and drain sediment until clean fuel remains. Screw the plug.

3.2.9 Replacement of fine fuel filter

Life time of fine fuel filter depends on cleanliness of the fuel used.

Replace filter $\Phi T020-1117010$ when conducting TM-3 according to figure 16, for this purpose:

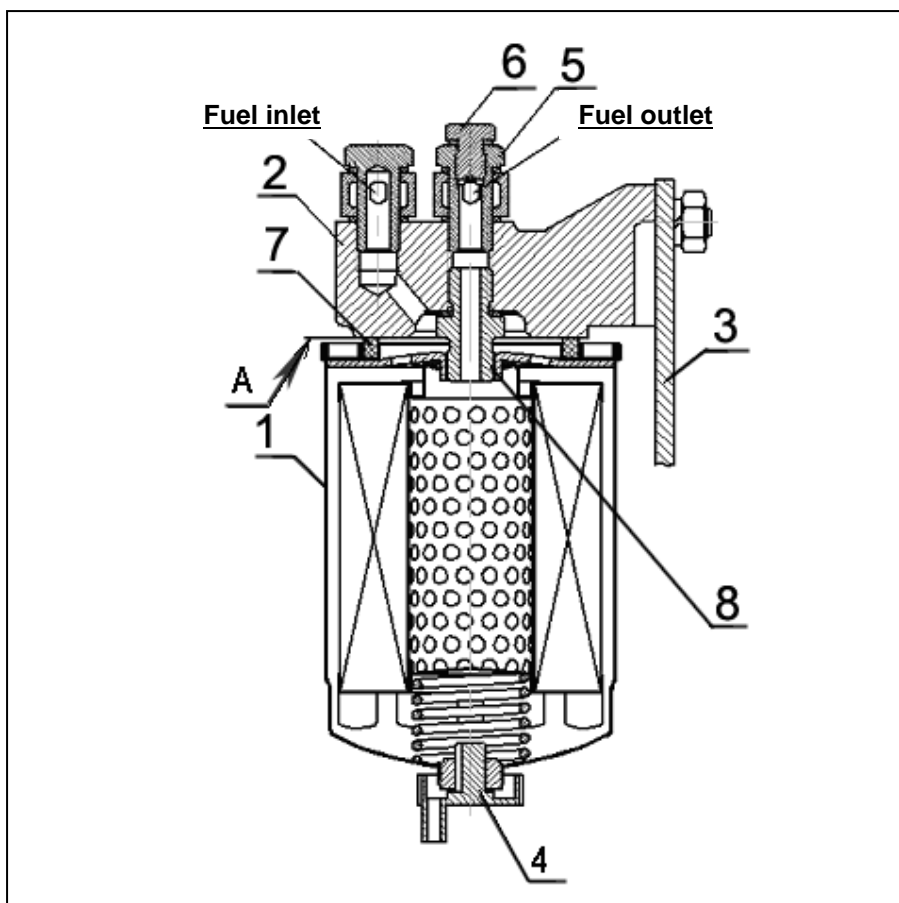
- drain fuel from the filter, having unscrewed plug 4 in the lower part of the body;

Do not let the fuel spill, drain the fuel only to a container.

- unscrew filter 1 from fitting 8 in body 2 and replace it with a new filter $\Phi T020-1117010$ (JSC “Avtoagregat”, Livny, Russia) or T6101 (EJSC “DIFA”, Grodno, Republic of Belarus), supplied in assembly with gasket 7, which shall be previously lubricated with motor oil;

- as the gasket 7 touches mounting surface A on the body 2, turn the filter by $\frac{3}{4}$ revolutions more. Herewith, turn the filter only by force of hands;

- turn on the fuel tank valve and fill the system with fuel.



1 – filter $\Phi T020-1117010$; 2 – body; 3 – bracket; 4 – plug (for drain of sediment); 5 – outlet union; 6 – plug (for air outlet); 7 – gasket; 8 – fitting.

Figure 16 – Replacement of fine fuel filter.

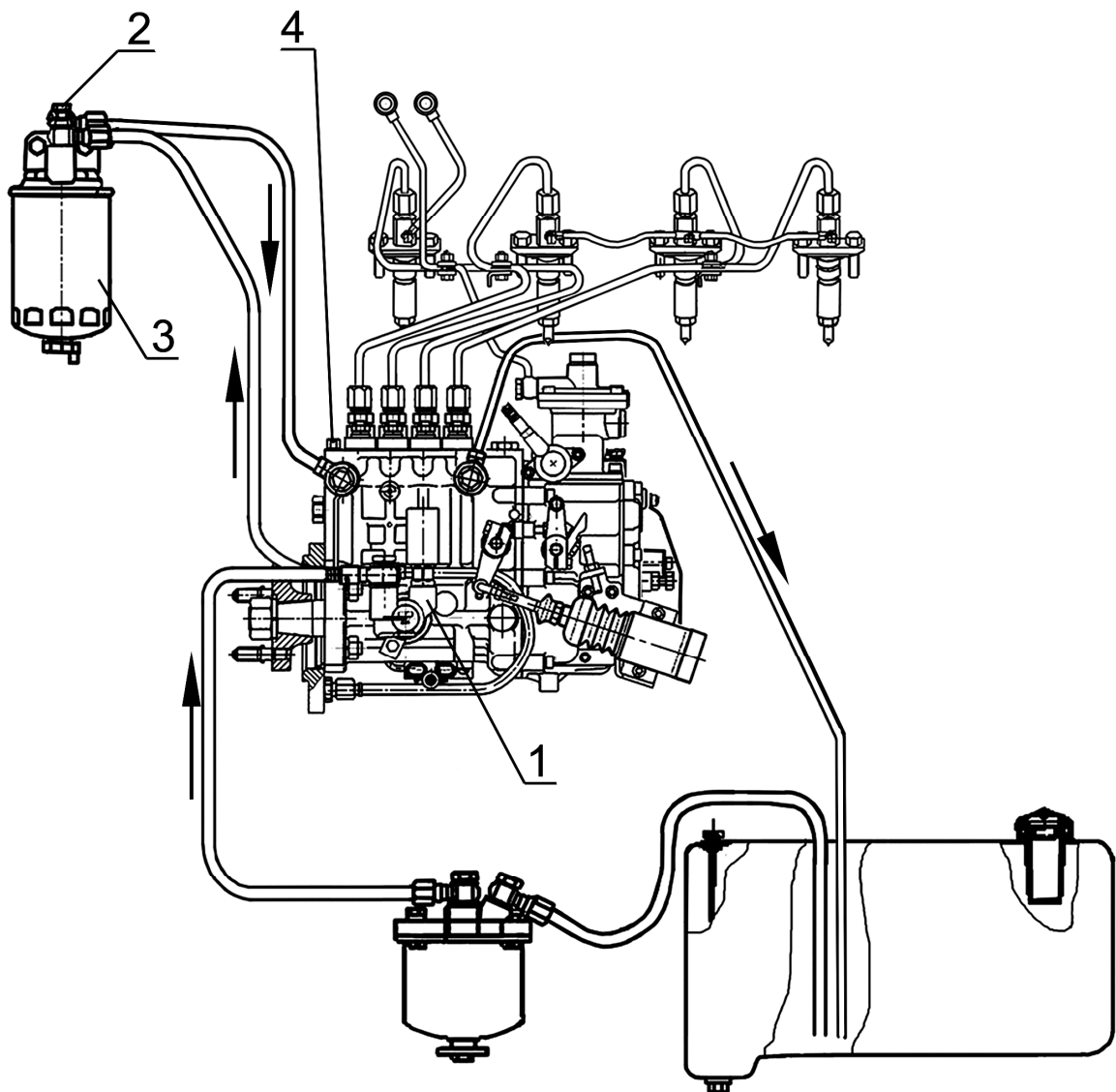
In future order the following oil filters:

- a) ФТ020-1117010 at the address: JSC “Avtoagregat”, 303858, 2a Industrialnaya Street, Livny, Orlovskaya oblast, Russia;
- b) T6101 at the address: EJSC “DIFA” 230019, 45 Belusha Street, Grodno, Republic of Belarus

3.2.10 Filling the fuel system

To de-aerate the system, unscrew plug 2 (Figure 17), located on bolt of outlet union attachment, by 2...3 revolutions. Bleed the system with manual purge pump 1, screwing in the plug when the fuel without air bubbles appears.

Unscrew the plug 4 on the body of fuel pump. Bleed the system with the boost pump until fuel without air bubbles appears, herewith screwing in the plug 4.



1 - purge pump 2 - plug (for air outlet); 3 - fine fuel filter;
4 - plug;

Figure 17 – De-aerating fuel supply system.

3.2.11 Maintenance of air cleaner

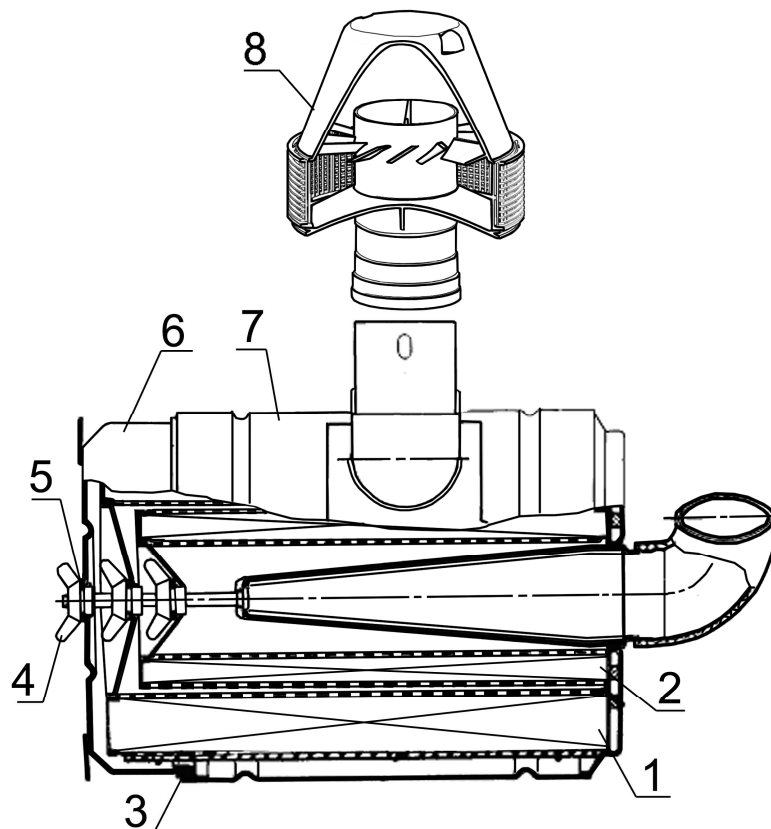
Carry out maintenance of air cleaner with paper filtering elements of special high-porous cardboard in every 500 hours of engine work or, if necessary, by indications of impurity annunciator. Maintenance of air cleaner consists in bleeding the main filtering element that captures dust entering the air cleaner. Contamination of the control filtering element points to failure of the main filtering element (tear of paper curtain, bedplates coming unstuck). In this case it is necessary to bleed the control filtering element and to replace the main one.

Carry out maintenance of the air cleaner in accordance with figure 18 in the following order:

- remove the monocyclone, clean the net, swirler and monocyclone discharging slits from dust and dirt;
- remove bottom 6;
- remove the main filtering element 1.

It is not recommended to remove the control filtering element 2 from the body.

Bleed the main filtering element with compressed air, first outside and then inside, until dust is fully removed. To prevent tearing of the paper curtain, air pressure should be not higher than 0,2-0,3 MPa.



1 – main filtering element; 2 – control filtering element;
3 – gasket; 4 – wing nut; 5 – ring; 6 – bottom; 7 – body, 8 – monocyclone

Figure 18 – Air cleaner

Air jet must be directed at an angle to the filtering element surface. During maintenance it is required to protect the filtering element from mechanical damages and oiling.

It is forbidden to bleed the filtering element with exhaust gases or to wash with diesel fuel.

Clear out the delivery pipe, inner surfaces of the air cleaner body and bottom.

Before assembling the air cleaner check the state of seal rings. When assembling make sure that all filtering elements are correctly mounted in the body and firmly tighten the wing nut manually.

3.2.12 Check of air cleaner and inlet channel for connections tightness

Check air cleaner and inlet channel for connections tightness when conducting TM-2.

Use a devise КИ-4870 ГОЧИТИ for tightness check.

If the devise is not available, check tightness of connections visually.

3.2.13 Washing of the engine breather

Maintenance of breather of the engine Д-245S3A M and its modifications is not required.

3.2.14 Check of cylinder head bolt tightening

Check cylinder head bolts for tightening after running-in and in every 1000 hours of operation on hot engine in the following order:

- remove a cap and a cover of the cylinder head;
- remove a rocker arm shaft with rockers and brackets;
- using a torque wrench check all cylinder head bolts for tightness in the order, given in figure 19, and if necessary tighten them.

Bolt torque is 200 ± 10 N·m

After checking of cylinder head bolt tightening mount the rocker arm shaft back and adjust the clearance between valves and rockers.

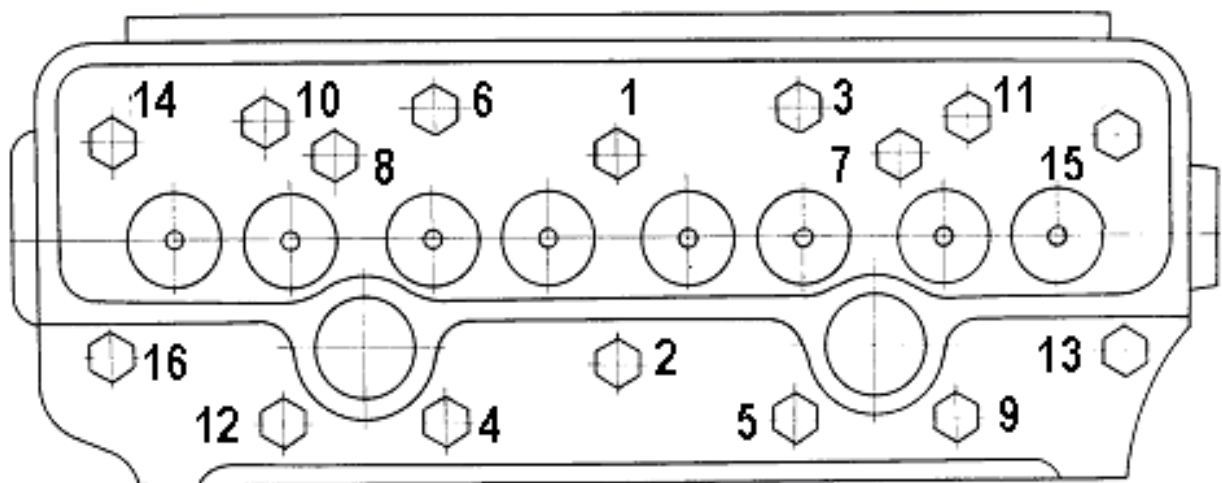


Figure 19 – Sequence diagram of cylinder head bolt tightening

3.2.15 Check of clearance between valves and rockers

Check clearance between valves and rockers and adjust, if necessary, in every 500 hours of work and also after removing cylinder head, tightening of cylinder head bolts and when there is knocking of valves.

When checked on cold engine (oil and water temperature not higher than 60°C), clearance between the rocker poll and valve-stem end shall be the following:

inlet valves – $0,25^{+0,05}_{-0,10}$ mm;

outlet valves - $0,45_{-0.10}^{+0.05}$ mm.

When making adjustments, set the following clearance between valve-stem end and the rocker poll:

inlet valves - $0,25_{-0.05}$ mm;

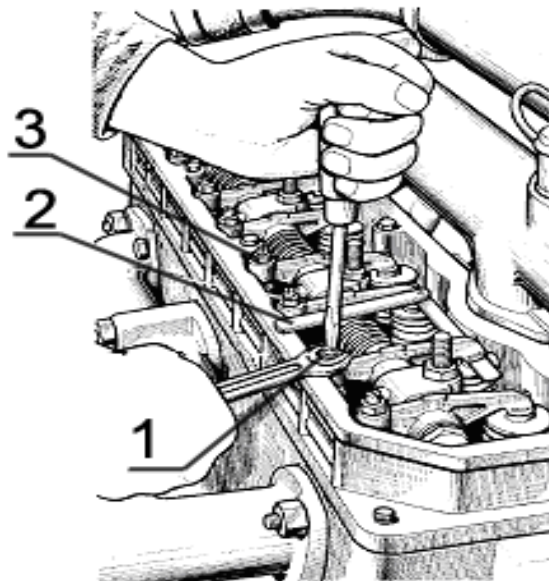
outlet valves - $0,45_{-0.05}$ mm;

Make adjustments in the following order:

- remove the cap of cylinder head cover and check the attachment of rocker arm shaft bracket;

- turn the crankshaft up to the moment of valve overlapping in the first cylinder (the first cylinder inlet valve starts to open and the outlet valve finishes to close) and adjust clearances in the forth, sixth, seventh and eighth valves (counting from the fan), then turn the crankshaft by one revolution, having set the overlapping in the forth cylinder, and adjust clearances in the first, second, third and fifth valves.

To adjust the clearance loose the screw locknut on the rocker of the valve being adjusted in accordance with figure 20 and turning the screw set a required clearance against the probe between the rocker poll and valve-stem end. Having set the clearance tighten the locknut. After finishing the adjustment of valve clearance, put back the cap of the cylinder head cover.



1 – adjusting screw; 2 – probe; 3 – locknut.

Figure 20- Valve clearance adjustment.

3.2.16 Maintenance of high-pressure fuel pump

During the operation of high-pressure fuel pump and upon wearing of the main parts, the adjustment parameters of the high-pressure fuel pump get violated.

Lubrication of high-pressure fuel pump is centralized from the engine lubrication system through a special oil pipeline.

If the high-pressure fuel pump is left without lubrication, it will break down!

Necessary level of oil in the pump crankcase is set automatically.

To reduce wears of precision parts operation of high pressure fuel pump without filtering element or with clogged fine fuel filter is not permitted. Neither operation with fuel having enhanced water concentration is permitted.

If necessary and when conducting engine technical maintenance 2TM-3 it is required to remove the high-pressure fuel pump from the engine and check the fuel pump on the stand for compliance with the adjustment parameters, presented in annex D, and also fixed fuel injection advance angle. If necessary, make appropriate adjustments.

Fuel pump shall be checked and if necessary adjusted by a qualified specialist in a workshop on a special adjustment stand equipped with instruments according to GOST 10578-96, in conformity with requirements of the fuel pump manufacturing works.

Fuel pump adjustment parameters for stand check are presented in Annex D.

3.2.16.1 High-pressure fuel pump sealing

After adjustment fuel pumps shall be sealed in a manner, which excludes the possibility of making adjustments without seal removing.

3.2.17 Check and adjustments of the fixed fuel injection advance angle

When it is difficult to start the engine or the exhaust is smoky and also when replacing, mounting the fuel pump after check on a stand through 2TM-3 or when repairing the engine, check the fixed fuel injection advance angle.

Parameters for the fixed fuel injection advance angle are presented in table 13.

Table 13

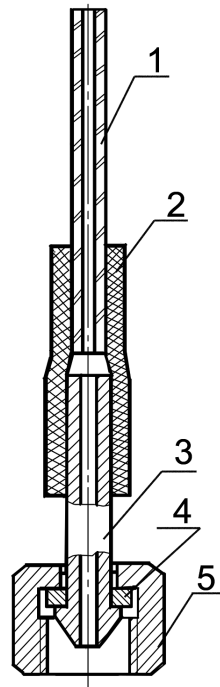
<i>High-pressure fuel pump</i>	<i>Diesel</i>			
	<i>Д-245S3A M</i>	<i>Д-245.2S3A M</i>	<i>Д-245.5S3A M</i>	<i>Д-245.43S3A M</i>
	<i>Fixed fuel injection advance angle, degrees of crankshaft turn</i>			
<i>PP4M10Uli-3794</i>	<i>3,5±0,5</i>			
<i>PP4M10Uli-3793</i>	<i>3,5±0,5</i>			
<i>PP4M10Uli-3795</i>	<i>4,0±0,5</i>			
<i>PP4M10Uli-3796</i>	<i>4,0±0,5</i>			<i>4,0±0,5</i>

The fixed fuel injection angle is checked in the following sequence:

a) for high-pressure fuel pump without camshaft position detent:

-set a governor control lever to the position of max. fuel supply;

-detach a high-pressure pipe from the fitting of pump first section and connect an ignition tester instead (a captive nut with short pipe, to which a glass pipe with inner diameter 1-2mm is connected through a rubber pipe, fig.21);



1 – glass pipe; 2 – rubber adapting pipe; 3 – segment of high-pressure pipe;
4 – washer; 5 – nut

Figure 21 – Ignition tester

-turn the engine crankshaft clockwise with a wrench until fuel without air bubbles appears outside the ignition tester glass pipe;

-release some air from the glass pipe by shaking it;

-turn the crankshaft back (contra-clockwise) by 30°-40°;

-turning the crankshaft clockwise slowly, watch fuel level in the pipe, as the fuel starts going up stop turning the crankshaft;

- screw the detent out of threaded hole of rear plate and insert it with its back side in the same hole until it stops against the flywheel (Figure 22), herewith the detent shall coincide with the hole in the flywheel (this means that the first cylinder piston is set in a position, corresponding to the fixed fuel injection angle given in table 13);

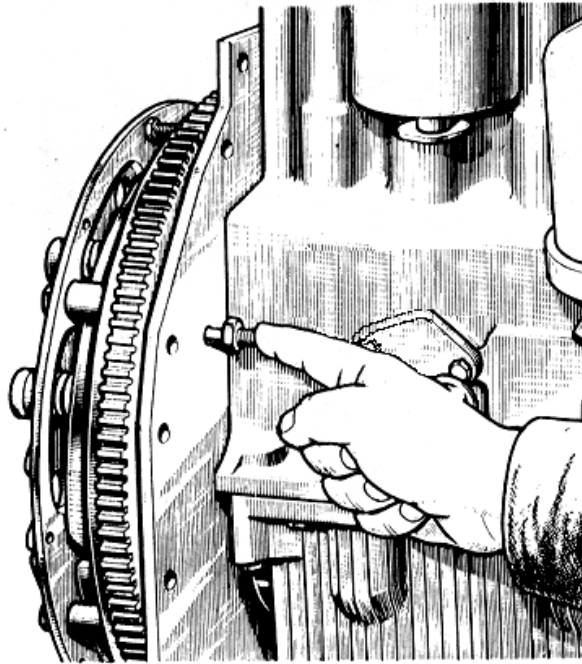
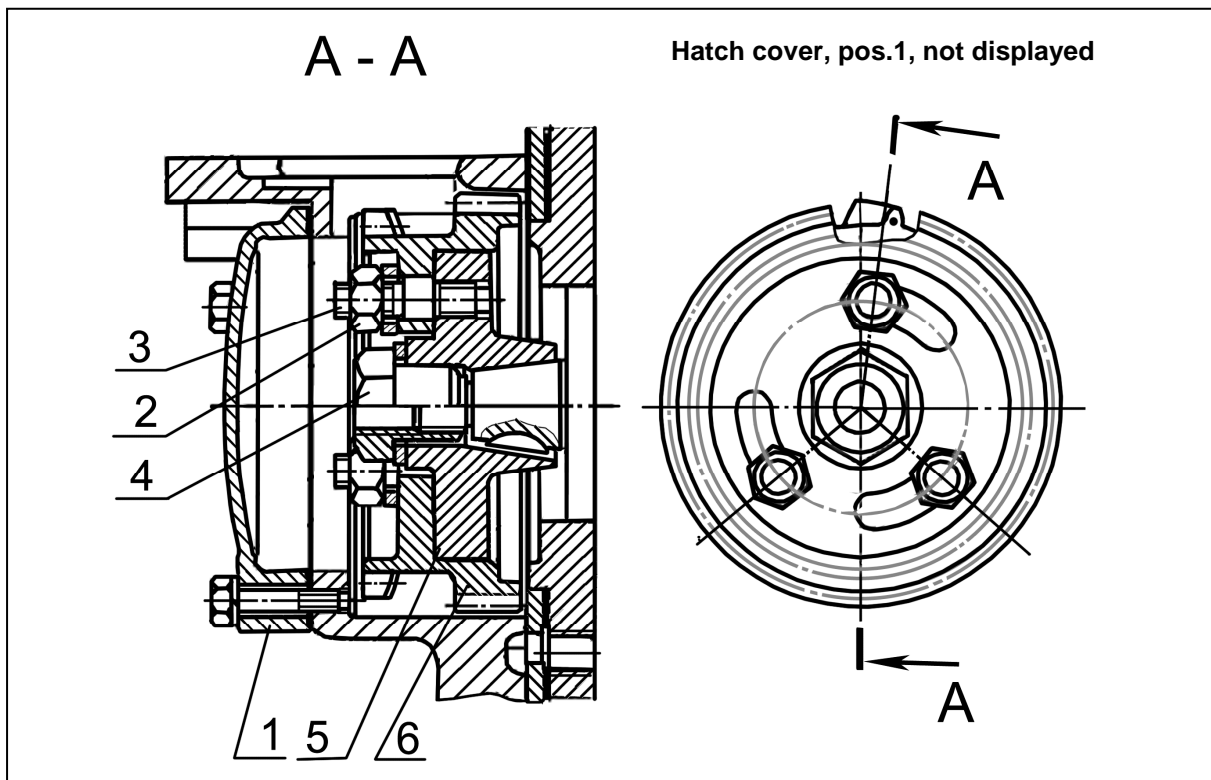


Figure 22 – Mounting a detent in the hole of rear plate and flywheel.

If the detent does not coincide with the hole in the flywheel, make adjustments, for this do the following:

- mate the detent with the hole in the flywheel, turning the crankshaft to this or that side;
- remove a hatch cover (Figure 23);



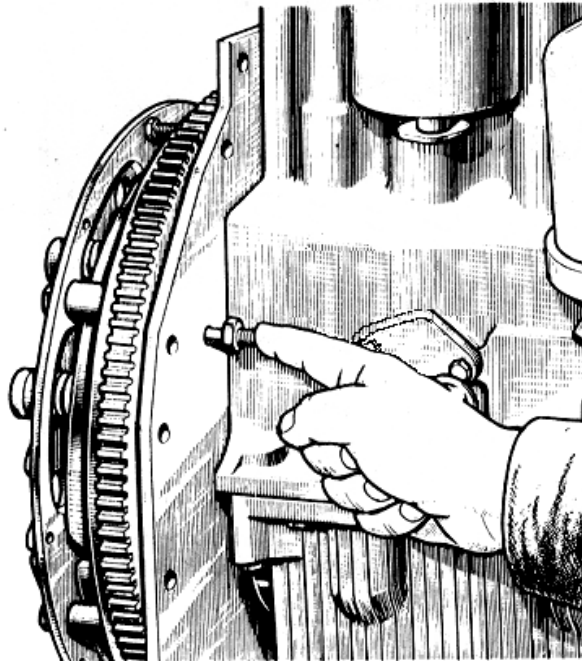
1 – hatch cover; 2 – nut; 3 – pin; 4 – special nut; 5 – drive half-coupling;
6 – fuel pump drive gear

Figure 23 – Fuel pump drive

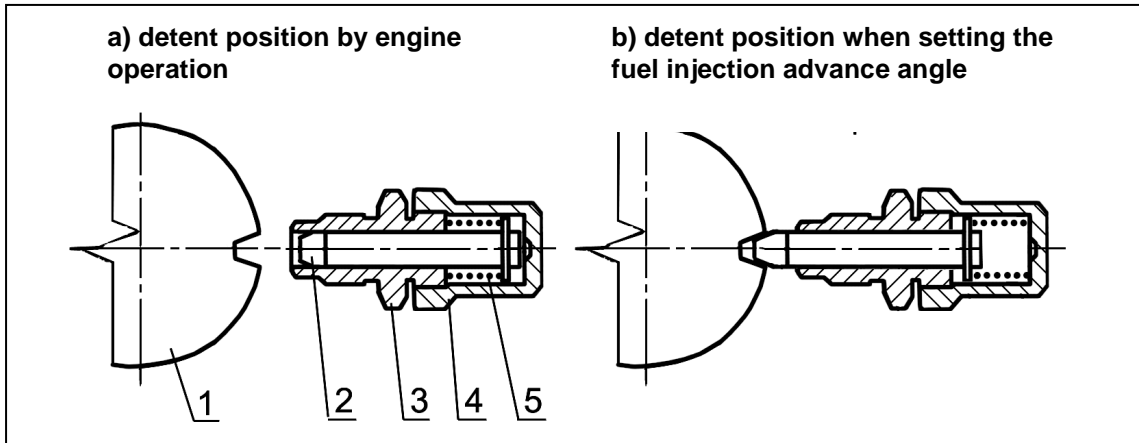
- release nuts of fuel pump drive gear attachment by 1...1,5 revolutions;
- remove some fuel from the ignition tester glass pipe if any;
- using a wrench turn the roller of fuel pump by the special nut forward and backward within the slots positioned on the end surface of the fuel pump drive gear until the ignition tester glass pipe gets filled up with fuel.
- set the fuel pump roller to the farthest (contra-clockwise) position within the slots;
- remove some fuel from the glass pipe;
- slowly turn the fuel pump roller clockwise until the fuel goes up in the glass pipe;
- as the fuel starts going up in the glass pipe, stop turning the roller and tighten the gear attachment nuts;
- carry out a repeated check of fuel supply starting moment;
- disconnect the ignition tester and mount back the high-pressure pipe and hatch cover;
- screw the detent in the hole of rear plate.

б) for high-pressure fuel pump with camshaft position detent (pos.27, Figure 5):

- screw the detent out of threaded hole of rear plate and insert it with its back side in the same hole until it stops against the flywheel (Figure 22);



- slowly turn the engine crankshaft clockwise until the detent coincides with the hole in the flywheel;
- remove the hatch cover 1 (Figure 23);
- release nuts 2 of the fuel pump drive gear attachment by 1...1,5 revolutions;
- unscrew cap 4 (Figure 23a) of the position detent of the high-pressure fuel pump camshaft 27 (Figure 5);



1 – camshaft segment disk; 2 – detent bar; 3 – detent body; 4 – cap; 5 – spring.

Figure 23a – Detent of position of high-pressure fuel pump camshaft

- remove spring 5 and sink in the detent bar until it touches the camshaft segment disk;

- turn the high-pressure fuel pump camshaft to one and other side using special nut 4 (Figure 23) within the slots of the fuel pump drive gear 6 until the detent bar 2 coincides with a hollow in the segment disk 1;

If the detent bar 2 has not coincided with the hollow in the segment disk 1:

- remove the detent bar 2 from the detent body 3;

- remove the detent from the hole in the flywheel and turn the crankshaft by one revolution (360°) until the detent coincides with the hole in the flywheel;

- turn the high-pressure fuel pump camshaft to one and other side using a special nut 4 (Figure 23) within the slots of the fuel pump drive gear 6 until the detent bar 2 coincides with a hollow in the segment disk 1;

- fix the camshaft position, screwing cap 4 with spring 5 on detent body 3 (Figure 23a, position b));

(such fixation of crankshaft and camshaft positions means that the first cylinder piston is set to a position corresponding to the fixed fuel injection advance angle, given in table 13, and section 1 of the fuel pump is set to the position of start fuel geometric delivery);

- tighten nuts 2 of fuel pump drive gear attachment;

- unscrew cap 4 and set spring 5 and detent bar 2 to the position a), shown in picture 23a;

- mount the hatch cover back and screw the detent to the rear plate hole;

3.2.18 Check of injectors for pressure at the beginning of injection and quality of fuel atomization

Check injectors in every 2000 hours of engine operation.

Take the injectors off the engine and inspect them on a stand.

The injector is considered in good order if it atomizes fuel in the form of fog from all five atomizer holes, without separately outcoming drops, solid streams and concentrations.

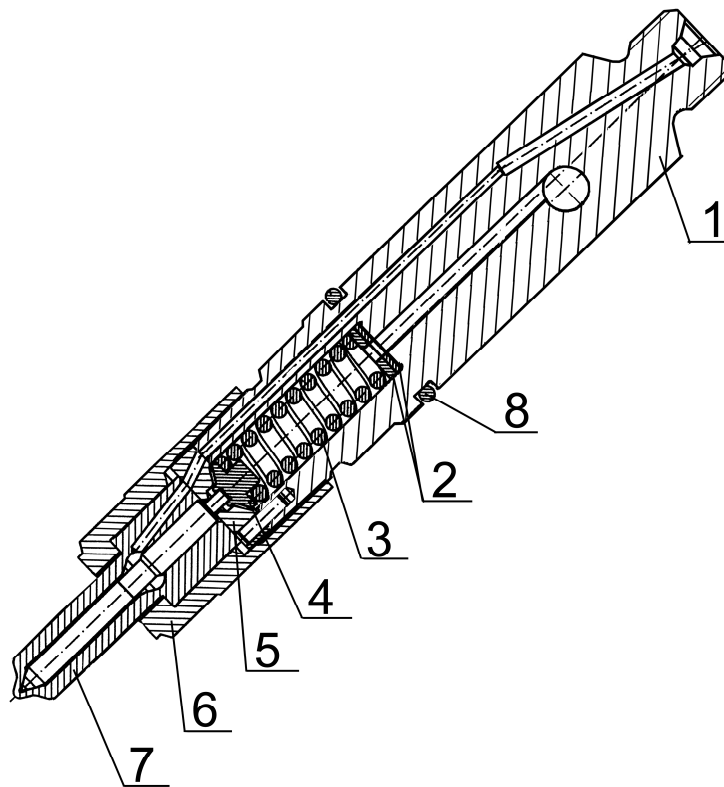
Beginning and end of injection shall be clear, appearing of drops on atomizer tip is not permitted.

Check atomization quality at frequency of 60-80 injections per minute.

If necessary adjust the injectors changing the total thickness of adjusting washers 2 (Figure 24): increase of total thickness of adjusting washers (increase of spring compression) enhances the pressure, their decrease reduces the pressure. Change of the washer thickness by 0,1 mm results in change of pressure of injector needle rise start by 1,3...1,5 MPa.

Value of injection start pressure for injectors is $28,0^{+1,2}$ MPa;

Mount injectors on the engine. Tighten bolts of injectors attachment evenly in 2-3 in 2-3 steps. Final tightening torque is 20...25 N·m.



1 – injector body; 2 – adjusting washer; 3 – spring; 4 – injector plunger; 5 – spacer; 6 – atomizer nut; 7 – atomizer; 8 – seal ring.

Figure 24 - Injector

3.2.19 Alternator maintenance

During engine operation special maintenance of alternator is not required. Seasonal adjustment of alternator voltage in accordance with figure 26 is made by a screw of voltage seasonal adjustment “winter-summer”, positioned at the alternator rear wall.

Engines can be completed with alternators with automatic seasonal voltage adjustment. Herewith there is no screw 1.

During operation watch the security of alternator and wires attachment as well as cleanness of the outside surface and terminals.

Check alternator working order with voltmeter or control lamp and ampere-meter, installed on instruments dashboard of a tractor (machine).

If the alternator is functioning properly a control lamp lights up when switching the

ground switch before engine start.

After the engine has been started and is operating with mean speed, the control lamp goes out (for engines started on electric starter) or dims (for engines started on pony motor), the voltmeter point shall be in green zone and the ampere-meter shall indicate some charge current, the value of which drops as the battery charge recovers.

3.2.20 Check of belts tension

Poly-V belt of Д-245S3A engines is equipped with automatic tensioner and doesn't require tension adjustment.

3.2.21 Check of starter state

Every 1000 hours of engine operation do the following:

- check fastening bolts for tightening, tighten them if necessary;
- scrape wire lugs coming to starter terminals and accumulator battery and tighten their attachments.

- Carry out preventative inspection and maintenance every 2000 hours of engine operation

Remove the cap on commutator side and check the state of brush-commutator group. The working surface shall be smooth and without significant burning. If the commutator is contaminated or has significant burning traces, clean it with a napkin, soaked in gasoline. When it is not possible to eliminate dirt or burning by cleaning, peel it with fine emery cloth. If there some significant burnings on the commutator which are impossible to clear, turn down the commutator.

Brushes shall freely move in brushholders and bear against the commutator. When the brushes are worn out up to the height of 13 mm and when there are significant spalls, replace them with new ones.

Bleed the brush-commutator group and cover on commutator side with compressed air.

Check the state of contact structure of the starter relay. In case of significant burning, peel contact bolts and contact plate with fine emery cloth or rasp-file, removing asperity caused by burning and herewith not infringing flatness of copper bolt contact surfaces. If the plate and bolts are significantly worn out, turn the contact plate over and turn the contact bolts through 180°.

Check the drive for ease of moving on rotor shaft. At the moment when the relay is being engaged and disengaged, the drive group shall smoothly move on rotor shaft splines.

Inner surfaces of the drive guide bushing (splined and flush), adjacent shaft parts shall be cleared from thickened grease with chips getting from the crankcase which hinder drive axial movement on the shaft splines when the gear engages flywheel gear rim. The cleared surfaces shall be covered with thin layer of grease ЦИАТИМ-221 (ЦИАТИМ-203, ЦИАТИМ-201).

Check the state of drive gear and thrust washers visually. The spacing between gear face and thrust washers at engaged condition shall be 2...4 mm.

3.2.22 Maintenance of turbocharger

During operation it is not required to carry out a special maintenance of turbocharger, its disassembly and repair are not permitted. Partial or complete disassembly as well as repair are only possible in a specialized enterprise and after the turbocharger has been removed from the engine.

Reliable and durable operation of turbocharger depends on compliance with rules and maintenance periodicity of lubrication system and system of air purification, type of oil recommended by manufacturing works, oil pressure control in the lubrication system, replacement and cleaning of oil and air filters.

Damaged pipelines of oil delivery and drain and also turbocharger attachment pipelines shall be immediately replaced. When replacing a turbocharger, pour clean engine

oil to the oil delivery hole up to the flange level and do not use joint sealants when mounting gaskets under flanges.

3.2.23 Maintenance of compressor

During operation, maintenance of compressor is not required.

In case of fault inception the compressor shall be sent to a repair shop where qualified specialists will spot the cause of trouble and eliminate it.

4 RUNNING MAINTENANCE

4.1 General instructions on engine assembly and disassembly

4.1.1 General instructions

Running maintenance is carried out in case of engine failures and damage (breakdown) which can be eliminated by way of adjustments.

Signs of necessity for carrying out running maintenance are: increased fuel consumption, increased oil burn-out loss, low lubrication pressure, worsening of starting capability.

The running maintenance shall be carried out under pooled method, according to which assignment of repairable parts to a definite engine is kept. With this method remaining life of parts and assembly units is preserved more fully by maintenance given that it is not required to increase alignment durability and herewith there is no increased worn-out of parts and mating, which are worthy without repair.

The running maintenance works shall be performed by workers that have been trained under the program of training engine repair mechanics and having 3-4 skill-category, possessing knowledge on organization and general operation principle of diesel engines.

For preliminary testing engine technical condition during its operation the following equipment is installed on the engine: sensor of lubrication system oil pressure gauge and emergency pressure sensor; sensor of coolant temperature gauge and sensor of emergency coolant temperature.

Air cleaner contamination rate is controlled by air cleaner contamination sensor, destined for engaging signal lamp when the air filter is contaminated above the admissible level.

Control instruments indicating sensor information are positioned on the dashboard of a tractor, agricultural machine.

List of possible failures and damages of engine components and conditions of their elimination by current repair are given in table 14.

Table 14

Engine component	Failures and damages eliminated by current repair in conditions of:	
	household shops	specialized maintenance rooms, enterprises
Turbocharger	-	all faults and damages
Fuel pump	-	all faults and damages
Cylinder head	valve leakage	Wear of inner surfaces of valve guides; limit of valve seat wear; distortion of surface of head adjoining block; cracks; damages of thread holes
Sleeve - piston	decrease or loss of conjugacy sealing capability	-
Water pump	all faults and damages	-
Oil pump	-	loss of efficiency
Gear pump	-	loss of efficiency
Clutch	-	loss of efficiency
Compressor	-	loss of efficiency
Starter	erosive wear of starter relay terminal pair; wear of brushes; of commutator	coil turn-to-turn short circuit; damage of coil insulation; wear of bearings; drive fault

4.1.2 Safety measures

The current maintenance can be performed by the workers that have passed special training and having a proof of a qualification, that have had safety training as well as training and check of knowledge on issues of labor protection and provided with special clothes, special shoes and other individual protection equipment.

Disassemble faulty units only with the engine stopped.

When inspecting the engine, use portable lamp up to 12V.

Drain fuel and oil only to relevant containers. Fuel and oil spilled on the ground shall be covered with chips or sand and removed from the working area.

When using lift-and-carry machines by disassembly it is necessary to fix the shift cargo firmly. Lift-and-carry machines shall contain data on their loading capacity and inspection date.

It is forbidden to use a lifter if cargo weight exceeds the machine loading capacity and to carry any cargoes above people.

It is inadmissible to position large parts and units one over the other making dangerous structures.

Wash engine and units at a specially equipped working place.

Work with unearthed washing equipment and having unearthed neutral wire of pump electric motor is forbidden.

Assemble and disassemble small units at a work bench, large ones – at special stands.

Fixtures used in work shall be in good order. Withdrawal tools shall have no cracks, bent rods, slipped or crushed thread. Use of worn-out or faulty withdrawal tools is forbidden.

Working tools shall be in good order and of proper size. Wrenches with worn or deformed opening are forbidden to use.

To check coincidence of holes, use an internal tool, a short crowbar or a bolt and never a finger.

When working on drilling or snagging grinder or when using pneumatic tools, it is required to follow specified safety precautions.

When using electric tools, it is required to follow measures of electrical safety: use tools with unfaulty electrical insulation, ground the equipment, use individual protection equipment.

The working place shall be provided with fire-extinguishing equipment.

4.2 Running repair of components

Table 15

Description of failure and damage results	Possible causes	Instructions on defining results of failures and damages of assembly unit	Instructions on eliminating results of failures and damages
<i>Diesel engine</i>			
1 Exhaust pipe exhausts blue smoke	1.1 Oil in combustion chamber because piston rings are worn-out	1.1; 2.1 Control oil burn-out loss by adding oil when carrying out STM; pay attention to rate of oil color change for the operating time set for oil replacement. Carry out engine and turbocharger faults identification	1.1 Replace piston rings (cl. 4.2.1)
2 Difficult to start the engine. Reduction of spinning up dynamics when the fuel supply is increased. Exhaust pipe exhausts white smoke	2.1 Insufficient hermiticity in combustion chamber when valve plates fit into valve seats.	according to the table (Annex E) by way of exclusions	Remove cylinder head from the engine and carry out valve grinding (cl.4.2.2)

Table 15 continued

Description of failure and damage results	Possible causes	Instructions on defining results of failures and damages of assembly unit	Instructions on eliminating results of failures and damages
<i>Water pump</i>			
3.Coolant leaks through drains orifice	3.1 Wear of contact surfaces of face seal	3.1 When conducting STM control coolant level in the cooling system	Remove water pump from the engine, disassemble the pump (cl.4.2.3)
	3.2 Wear of bearing unit	3.1.1 Inspect the water pump on started engine during warm-up. 3.2 Applying force to the pump pulley on stopped engine inspect radial play in bearing unit	Replace water pump sealing gland Replace bearings, water pump body (if necessary)
4.No coolant circulation in engine coolant system	Turning of impeller on pump shaft	Controlling temperature mode of engine cooling system on temperature indicator a steep rise of coolant temperature is observed	Remove water pump from the engine, disassemble the water pump (cl.4.2.3) Replace the impeller and (or) the pump shaft

4.2.1 Main instructions on piston rings replacement

Remove the cylinder head and oil sump from the engine. Set the piston to lower dead centre, manually turning the engine flywheel. Clear sludge from sleeve top chord, preventing sludge particles from getting inside the cylinder.

It is forbidden to use a steel scraper by cleaning with the aim to prevent the sleeve surface from damage.

Unscrew nuts of connecting rod attachment, remove the connecting rod cover and take piston-rod group out from the cylinder. Take the piston-rod group up – to the side of cylinder head installation.

Each piston of the engine is provided with upper trapezoidal compression ring, one compression V-ring and one oil scraper ring of box-type with spring extender.

Compression rings at the end surface by the lock have a mark “берх” and «TOP», which shall be turned to piston top by rings installation. Extender joint of oil scraper ring must not coincide with the ring lock.

Piston ring locks shall be positioned at equal distance round the circle.

Put the piston-rod group inside the cylinder, mount the rod cover.

To prevent piston rings from damages by piston-rod group installation inside the cylinder, use a tool for ring pinching.

Torque value of piston cover attachment nut is given in table (Annex D).

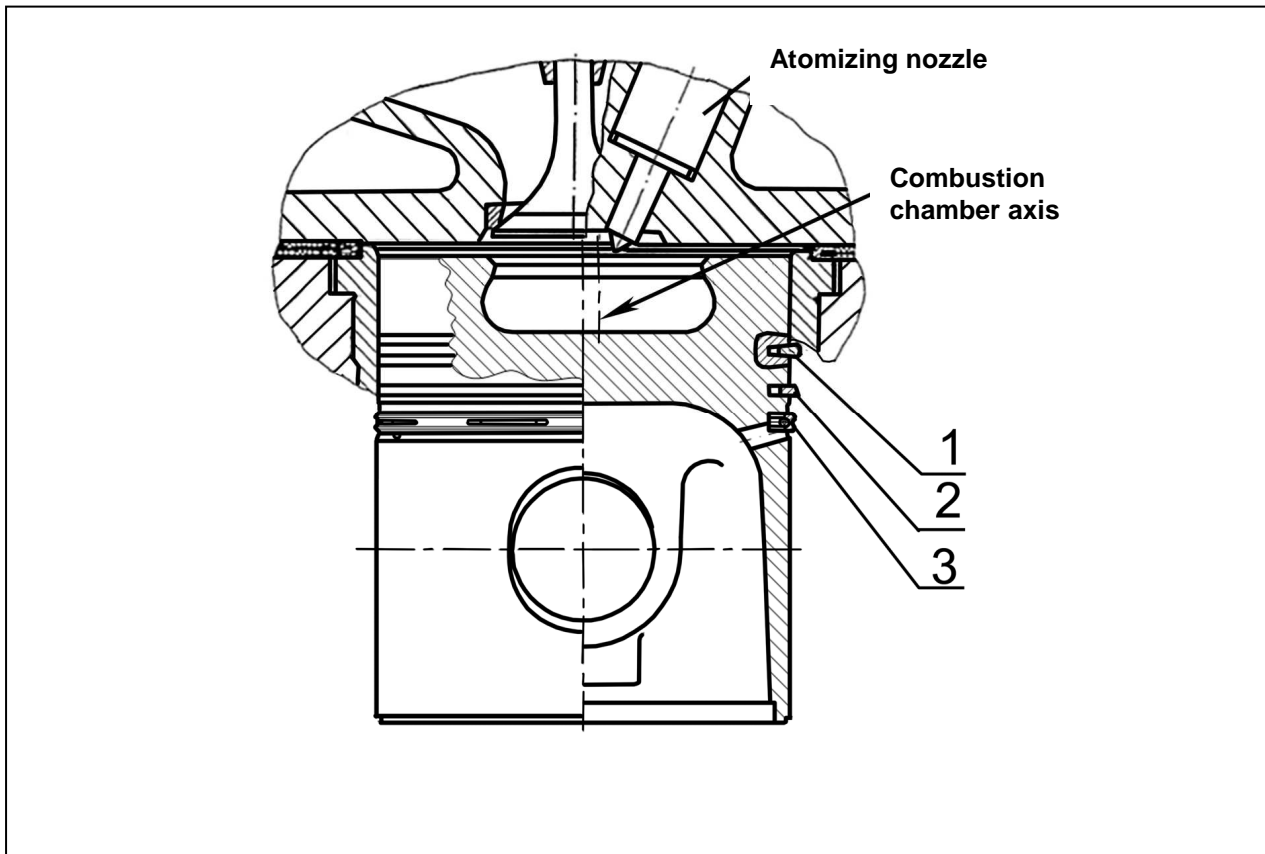


Figure 25- Diagram of piston rings installation

4.2.2 Main instructions on valve grinding

Unscrew attachment nuts of rocker arm shaft bracket and dismantle rocker arm shaft with springs and rockers.

Unscrew head attachment bolts, remove the head.

Remove the cotter from the valve, take off the plate of valve springs, valve springs, washers of valve springs; remove the sealing cup from the valve guide.

The valves shall be ground on special machines of OIP-1841A type or on stands OP-6687M. Valve face or cylinder head socket face shall be covered with paste, prepared with one of the following compositions:

boron carbide M40 – 10%; microcorundum M20 – 90%;

granular electrocorundum M14 – 87%; paraffin – 13%;

The solution is dissolved in diesel oil to reach sour cream state. To increase quality it is recommended to add oleinic or stearinic fatty acid.

Continue to grind until continuous dull string-course with width not less than 1,5 mm appears on valve face or on valve seat face, breakage of the strip and scratch marks are not admitted. Width variation of the string-course shall not exceed 0,5 mm.

After grinding valves and head shall be washed.

By the head assembly the valve rod shall be lubricated with motor oil.

It is possible to grind the valves manually, using a bench tool, but the labor content of grinding operation will thus significantly increase.

4.2.3.1 Water pump disassembly.

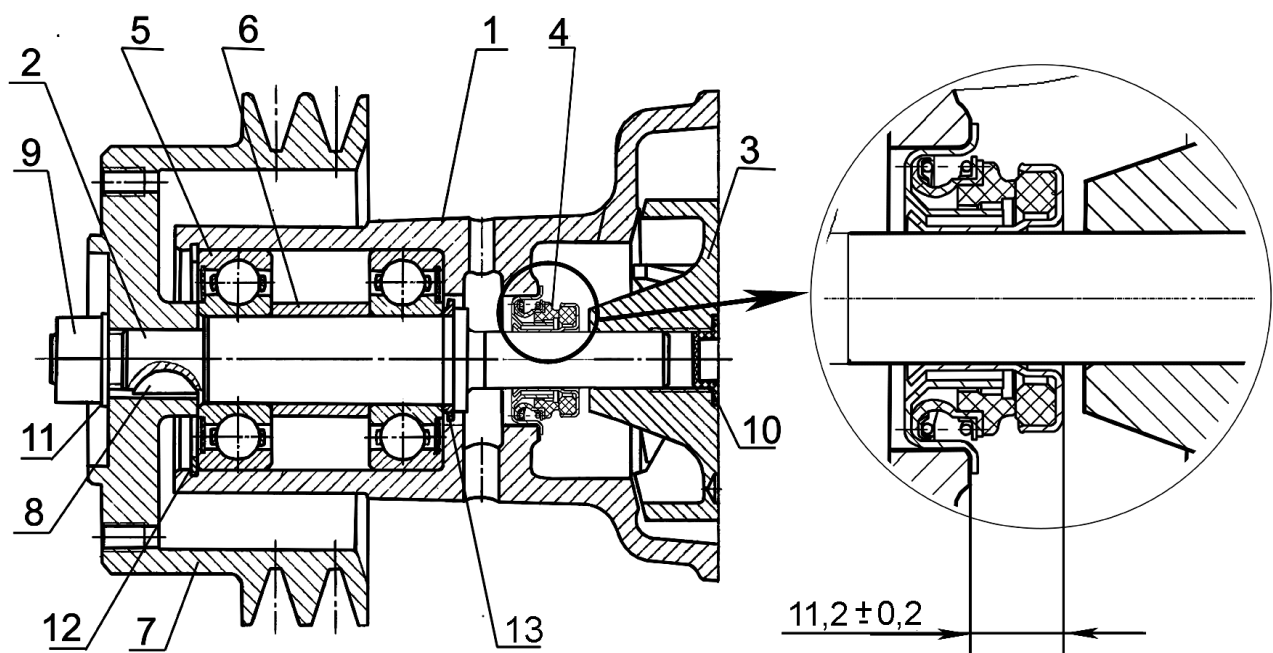
Unscrew nut 9 (figure 26) of water pump drive pulley.

Using a puller remove the pulley 7 of water pump. Remove ring 12, locking a bearing unit, from the pump body. Remove impeller 3 from pump shaft 2, using a thread hole at the impeller butt end (M18x1,5) by means of a special bolt.

Press shaft with bearings out of the water pump body. The direction of pressing-out is to the side of pulley installation. Press the bearings out of the shaft. Remove thrust ring 13.

Press a gland seal out of the pump body.

Inspect the parts for faults.



1 – body; 2 – pump shaft; 3 – impeller; 4 – water pump sealing SP/1341; 5 – bearing; 6 – liner; 7 – pulley; 8 – dowel; 9 – nut; 10 – blind plug; 11 – washer; 12 – lock ring; 13 – thrust ring.

Figure 26 – Water pump

4.2.3.2 Water pump assembly.

Mount thrust ring 13 on the shaft, press on the bearings. Fill bearings and bearing cavity with grease Litol 24-MLi 4/12-3 in the amount of 45g. Press the shaft with bearings in the pump body. Mount ring 12, locking the bearing unit.

Install the pump pulley, the washer and the nut. The nut shall be tightened providing for 120...140 N·m of turning torque.

Using the tool (Figure 27) press the water pump sealing 4 on the water pump shaft with inner housing and simultaneously press the sealing in the water pump body with the outer housing until the sealing body flange rests against the water pump mounting surface, herewith the tool design shall provide pressing-on the inner housing of the sealing so that the end surface of the inner housing was located at the distance of $11,2 \pm 0,2$ mm from the mounting surface of the pump body.

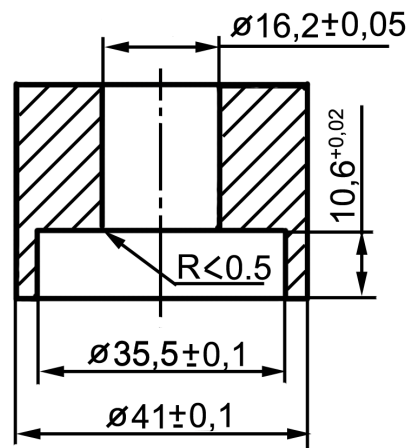


Figure 27- Tool for pressing-on water pump sealing (main structural dimensions)

Press the impeller on the shaft, install the blind plug in the impeller butt end. Sinking of the impeller butt end against the mounting surface of the water pump body shall not exceed 0,3 mm, jutting of the impeller is not allowed.

Install the water pump on the engine.

5. STORAGE

To insure engine workability, to save in material and monetary resources for their repair and preparation for work, it is strictly required to follow the rules of engine storage in idle time.

The engine shall be stored in absolute compliance with GOST 7751-85 irrespective of the time of the year. By long-time storage (over one month) a tractor, harvester or a machine with the engine installed shall be put in a closed room or under a tent. It is also allowed to store tractors, harvesters, machines in open improved space, obligatory having performed all works on preservation and encapsulation.

Engine preparation for storage shall be finished not later than 10 days from the moment of work ending.

Preparing the engine for long-time storage do the operations in accordance with clause 3.1.5.2.

If a tractor, agricultural machine is stored under the tent or at outdoor area, remove an alternator and a starter from the engine and sent then to a warehouse. Cover the place of starter installation with a cap.

Diesel engines that have been removed from tractors, harvesters, machines or received as spare parts shall be stored in a preserved condition in a closed room on special platforms. It is forbidden to store accumulator batteries, acids, salts, alkalies and other substances which can cause metal corrosion together with diesel engines and spare parts in one room.

In case of short-time storage of a tractor, a harvester, a machine in outdoor area or under a tent (10 days – 1 month), do the operations in accordance with clause 3.1.5.1.

Before placing a tractor, a harvester, a machine in operation, execute all preparatory works in accordance with clause 3.1.6.1 or clause 3.1.6.2.

6. TRANSPORTATION

By engine transportation all external orifices shall be closed with plugs.

Engine transportation shall provide protection against moisture attack and mechanical damages under storage conditions 2 (C) GOST 15150-69.

Positioning and fastening of engines when transported in closed railway cars shall comply with the requirements of “Technical conditions of freight handling and fastening”, Ministry of railway, 1969, and also “Rules of freight hauling”, published by “Transport”, Moscow, 1977.

In case of hauling by automobile transport, loading, positioning, fastening, covering and unloading shall comply with “Rules of freight hauling by automobile transport”, approved by Ministry of automobile transport of Russian Soviet Federative Socialist Republic on July 30, 1971.

7. RECYCLING

The engine does not contain substances which are dangerous for life, health, people and environment.

To recycle the engine after its life end it is necessary to do the following:

- drain oil from the lubrication system and send it for reprocessing in a set order;
- drain coolant from the cooling system (if it was used during engine operation) and put it into containers destined for storage;
- carry out complete engine disassembly into parts, sorting them to steel-made, iron-made, aluminum-made, made of non-ferrous and precious metals, rubber and plastic, and send for reprocessing in a set order.

In case of carrying out maintenance or running maintenance of the engine, parts and assembly units subjected to replacement (if necessary) shall be sent to reprocessing, herewith assembly units shall be taken into parts and sorted according to their material.

Annex A (referential)

Chimmotology list

Table A.1

Ref. number	Assembly unit name, index (stand-alone device, mechanism, friction unit)	Amount of assembly units in item, pcs	Designation and denomination of petroleum oil and lubricant (POLs) grades				Mass (volume) of POLs filled in an item by replacement (adding), kg (dm ³)	Periodicity of POLs replacement (adding), h	Note
			Basic	Duplicating	Reserve	Foreign			
1	Fuel tank	1	Diesel fuel, the specifications of which comply with requirements of STB 1658-2006 with sulfur content not more than 50 mg/kg (0,005%) of a grade (for moderate climate) or of a class (for arctic and cold climate) in accordance with ambient temperature at a place of engine operation.	Not available	Not available	Diesel fuel, the specifications of which comply with requirements of EN 590:2004 with sulfur content not more than 50 mg/kg (0,005%)		According to Directive 2004/26/EU and Rules of UN's Economic Commission for Europe No 96 (02) (stage IIIA) it is allowed to use fuel with sulfur content not more than 0,3g/kg (0,03%)	

Notice:

For **moderate climatic zones** it is recommended to use the following fuel **grades** with the given ambient temperature (C°):

<i>Temperature (C°) up to (not lower)</i>	<i>+5</i>	<i>0</i>	<i>-5</i>	<i>-10</i>	<i>-15</i>	<i>-20</i>
<i>Fuel grade</i>	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>	<i>F</i>

For arctic and cold climate it is recommended to use the following fuel **classes** with the given ambient temperature (C°):

<i>Temperature (C°) up to (not lower)</i>	<i>-20</i>	<i>-26</i>	<i>-32</i>	<i>-38</i>	<i>-44</i>
<i>Fuel class</i>	<i>0</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>

Seasonal use of diesel fuel grades in the Republic of Belarus depending on the ambient temperature

Summer period

Grade B

Up to 0° C (not lower)

*From May 1 till September 30 (5 months) –
agreed upon with a consumer*

Grade C

Up to -5° C (not lower)

*From April 1 till October 30
(7 months)*

Winter period

Grade F

Up to -20° C (not lower)

*From November 1 till March 31
(5 months)*

Table A.1 continued

Ref. number	Assembly unit name, index (stand-alone device, mechanism, friction unit)	Amount of assembly units in item, pcs	Designation and denomination of petroleum oil and lubricant (POLs) grades				Mass (volume) of POLs filled in an item by replacement (adding), kg (dm ³)	Periodicity of POLs replacement (adding), h	Note
			Basic	Duplicating	Reserve	Foreign			
2	Oil sump*	1	In summer (stationary ambient temperature higher than +5° C)				10,7 (12)**	250	For diesel engines, mounted in harvesters Use of motor oil depending on operation conditions: a) summer (plus 5°C and higher) – SAE 30; SAE 10W-40 (30); SAE 15W-40 (30); SAE 20W-40 (30) б) winter (minus 10°C and higher) – SAE 20; SAE 10W-40 (30) в) winter (minus 20°C and higher) – SAE 10W-20 (30, 40); SAE 5W-30 (40) г) winter (below minus 20°C) – SAE 5W-30 (40); SAE 0W-30 (40)
			Motor oil «Lukoil Avangard Extra» SAE 10W-40	Not available	Not available	Motor oils Liqui Moly Super Leichtlauf SAE 10W-40, BP Visco 3000 SAE 10W-40, Shell Helix Plus SAE 10W-40, Elf Competition SX SAE 10W-40, Agip 2000 GPX SAE 10W-40, Esso Ultra Oil X SAE 10W-40, Mobil Super Formula SAE 10W-40			
			In winter (stationary ambient temperature below +5° C)						
			Motor oil «Lukoil Avangard Ultra» SAE 5W-40	Not available	Not available	Motor oils Liqui Moly Diesel Synthoil SAE 5W-40, Ethyl Hitec 5909, Castrol TXT Softec Plus, Elf Synthese SAE 5W-40, Esso Ultron SAE 5W-40, Shell Helix Ultra SAE 5W-40, Mobil 1 Rally Formula SAE 5W-40			

* All oil grades presented in the chimmotology list shall comply with classes CH-4, CI-4 under classification API and with E4-99, 5-02 under classification ACEA

** - oil mass (volume) is defined by topping to the upper mark on oil dipstick when refilled.

Table A.1 finished

Ref. number	Assembly unit name, index (stand-alone device, mechanism, friction unit)	Amount of assembly units in item, pcs	Designation and denomination of petroleum oil and lubricant (POLs) grades				Mass (volume) of POLs filled in an item by replacement (adding), kg (dm ³)	Periodicity of POLs replacement (adding), h	Note
			Basic	Duplicating	Reserve	Foreign			
3	Water pump (bearing cavity)	1	Grease Litol-24-ML _i 4/12-3 GOST 21150-87	Not available		Shell Retinax EP, Shell Retinax HD	0,045 (0,05)	Once-through	Put in by a manufacturer. It is not required to add grease during operation
4	High-pressure fuel pump	1	Motor oil, the same as in engine crankcase				0,225 (0,25)		By installation of a new or a repaired pump
5	Cooling system volume (without a radiator and connection pipelines)	1	Low-freezing coolant «Tosol Dzerzhinsky TS-40», (up to minus 40°C) «Tosol Dzerzhinsky TS-65» (up to minus 65°C) produced by LLC «Tosol-Sintez», town of Dzerzhynsk, Russian Federation TU 2422-050-36732629-2003 Low-freezing coolant OZH-40 (up to minus 40° C), produced by JSC «Lesokhimik», Borisov, Republic of Belarus GOST 28084-89 Low-freezing coolant «Sibur-Premium» OZH-40 (up to minus 40°C), OZH-65 (up to minus 65°C) TU 2422-054-52470175-2006 produced by JSC «Sibur-Neftehim», Dzerzhynsk, Russian Federation Low-freezing coolant «Tasol-AMP 40» (up to minus 40°C) TU BY 101083712.009-2005 produced by RUE «Gomelkhimtorg», Gomel, Republic of Belarus	Coolant OZH-40 (up to minus 40°C) OZH-65 (up to minus 65°C) GOST 28084-89	Not available	MIL-F-5559 (BS 150) (CHIA) FL-3 Sort S-735 (England)	8,1 (7,5)	Once in two years	Check of coolants by a consumer is necessary against incoming inspection

Annex B (referential)

Quantity sheet of spare parts, tools and accessories (spare parts, instrument)

Table B.1 –Tools and fixtures

Designation of a tool, accessory	Product code	Name of a tool, accessory	Amount in a kit	Note
50-3901034	47 5341 2815	Plate 0,25x100	1	Lay-in point – CHP-10-01
60-3901034	47 5341 3054	Plate 0,45x100	1	

Annex C (referential)

Size groups of cylinders and pistons

Table C.1

Group marks	Sleeve diameter, mm	Piston skirt diameter, mm
Б (B – eng.)	110 ^{+0.06} _{+0.04}	110 ^{-0.05} _{-0.07}
С (S – eng.)	110 ^{+0.04} _{+0.02}	110 ^{-0.07} _{-0.09}
М (M – eng.)	110 ^{+0.02}	110 ^{-0.09} _{-0.11}

One engine kit shall consist of pistons, connecting rods and piston rings of the same weight group, weight difference of connecting rods in a set with pistons shall not exceed 30 g.

Nominal dimensions of crankshaft main and connecting rod journals

Table C.2

<i>Designation of liner rating</i>	<i>Journal diameter, mm</i>	
	<i>Main journal</i>	<i>Connecting rod journal</i>
<i>1H</i>	75,25 ^{-0.082} _{-0.101}	68,25 ^{-0.077} _{-0.096}
<i>2H</i>	75,00 ^{-0.082} _{-0.101}	68,00 ^{-0.077} _{-0.096}

Table C.3

Diesel engine Д-245.35Е3

<i>Designation of liner rating</i>	<i>Journal diameter, mm</i>	
	<i>Main journal</i>	<i>Connecting rod journal</i>
<i>1H</i>	85,25 ^{-0.085} _{-0.104}	73,00 ^{-0.100} _{-0.119}
<i>2H</i>	85,00 ^{-0.085} _{-0.104}	72,75 ^{-0.100} _{-0.119}

Main and connecting rod journals and crankshaft bearing liners are made in two rating dimensions.

Crankshafts, main and connecting rods of which are made according to the second rating dimension, have additional designation on the first cheek:

“2K” – main journals of the second rating;

“2III (2SH)” – connecting rods of the second rating;

“2KIII (2KSH)” – main and connecting rod journals of the second rating.

Annex D (referential)**Engine adjusting parameters**

Table D.1

Denomination	Unit of measure	Value	
		rated	accepted
1 System oil pressure (on hot engine) at rated crankshaft speed	MPa	0,25 - 0,35	0,13
2 Coolant recommended temperature (heating rate)	°C	85-95	100
3 Clearance between rocker poll and valve stem end on cold engine for inlet and outlet valves:	mm		
a) for inlet valves		0,25 ^{+0.05} _{-0.10}	0,15-0,30
b) for outlet valves		0,45 ^{+0.05} _{-0.10}	0,35-0,50
4 TDC timing angle for:		See table 13	
5 Torque of main threaded fasteners:	N·m		
- main bearing bolts		210-230	
- bolt nuts of rod bearings		180-200	
- cylinder head attachment bolts		210-230	
- flywheel attachment bolts		240-260	
- balance weight attachment bolts		120-140	
- nozzle attachment bolts		20-25	
- crankshaft pulley attachment bolt		270-300	

Annex E (referential)**Adjusting parameters of fuel pump PP4M10U1i 3793 when checked on the stand.**

Fuel pump shall be adjusted in the stand MOTORPAL NC132:

- nozzles BOSCH 1 688 901 101 (Ø0,6 mm, opening pressure is 20.7 MPa);
- fuel pipelines Ø6/Ø2 – 600 mm;
- test fluid ISO 4113 (SHELL S.9365), temperature - 40°±2° C;
- pressure valve is adjusted at 0,16 – 0,20 MPa.

Table E.1

Operation	Operation No	Revolutions (min ⁻¹)	Limiting values of fuel delivery (mm ³ /stroke)	Max. difference between sections (mm ³ /stroke)	Note
	1				Excessive pressure corrector shall be taken out of service by means of a fixture – refers to operation 2÷9. Negative corrector spring shall be displaced by a bolt from idle position by 90°±5° of bolt revolution – preliminary done during production.
Section adjustment for equal delivery	2	1100	153,0÷156,0	8,0	Jutting of control rod shall be adjusted by adjusting bolt up to the level of approximately 1,5 mm from high-pressure fuel pump body end.
Overtravel adjustment	3	1120÷1140	Beginning of control rod travel in “STOP” direction		Adjusted by regulator cam stop bolt
	4	max.1230	“STOP”. Setting lever stop bolt shall be screwed to contact the setting lever and then unscrewed by 1.25 revolutions (i.e. 1 mm)		Complete sleeve of idle running shall be unscrewed from the main lever.
Negative correction adjustment	1100	100	145,0÷148,0	8,0	If necessary adjust by changing of negative corrector shift.

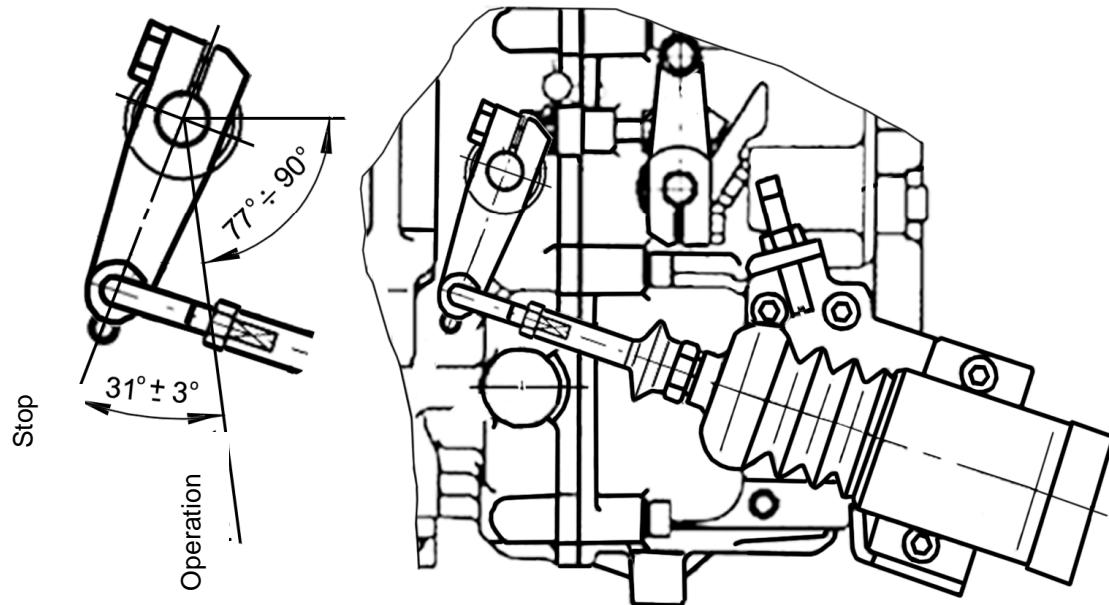
Adjustment of start ending	6	450÷490	A complete sleeve of idle running shall be screwed in the main lever so that automatic start ended at this speed. Start ending is controlled by speed decreasing.		
Positive correction adjustment	7	800	138,0÷142,0 (136,0÷144,0)	8,0 (10,0)	Fuel supply shall be adjusted by screwing a corrector in the regulator main lever.
Adjustment of start ending	8	420÷450	Automatic start ending is controlled (aligned if necessary) by the adjusted positive corrector.		
Delivery for starting	9	100	130,0÷150,0 (130,0÷150,0)	12,0 (20,0)	Mount a plug of control rod arrester. Control of supply for start in control lever position "MAKC" ("MAX") and "XO.I. XO.II" ("IDLE RUNNING").
	10		Bring the excessive pressure corrector into service by a fixture. Set the stop lever into position "STOP" and back into position "RUN". Connect a pressure air line. Adjustment and supply control are carried out by means of gradual increase of speed and air pressure by data under clauses 11÷19		
Excessive pressure corrector adjustment	11	500	122,0÷126,0 (122,0÷128,0)	8,0 (10,0)	The pressure is 0,0MPa. The control lever is in "MAKC" ("MAX") position. The supply shall be adjusted by the adjusting bolt of the excessive pressure corrector.
	12	700	128,0÷132,0 (126,0÷134,0)	8,0 (10,0)	The pressure is 0,113 MPa. The supply is adjusted by displacing the spring of excessive pressure corrector.
	13	800	138,0÷142,0 (136,0÷144,0)	8,0 (10)	The pressure is 0,120 MPa. Control of supply and correction ending by the excessive pressure corrector.
Control of idle running	14	400	20,0÷24,0 (18,0÷26,0)	6,0 (10)	The pressure is 0,0 MPa. The supply shall be adjusted by the bolt of idle running arrester. Control of stop setting function. In case of a stop the supply shall be zero.
	15	350	min. 40	-	The pressure is 0,0 MPa. Control of idle running supplement.
	16	max. 525			«STOP» of idle running.
			Mount a fixture with micrometer in a hole opposite the control rod. Adjust the supply in conformity with the instruction.		
Adjustment of control rod switch	17	1100	118,0÷122,0 (116,0÷124,0)	-	The pressure is 0,131 MPa. The disconnect switch shall be adjusted by turning the adjusting bolt. So that engagement/disengagement (light emitting diode glows/ doesn't glow) occurred in the supply interval. Mount the cover.
Control of Speed switch	18	1100 670 720	110,0÷113,0 The same position of micrometer	- - -	The pressure is 0,131 MPa. Adjust the supply with the fixture with micrometer so that all switches were linked (the LED glows). Control of switches disconnect (the LED doesn't glow). Control of switches disconnect (the LED glows)
Control of rated delivery	19	1100	145,0÷148,0 (143,0÷150,0)	8,0 (10,0)	The pressure is 0,131 MPa. Control of operation No2. Tighten bolts of sections, mark their position. Control of the stop setting function. In case of the stop the supply shall be zero.

Note: It is impossible to check clauses 5 and 6 by the pump maladjusted.

Values in brackets are given for adjustment on the other stand.

Annex E (referential)

Annex E (referential)

Adjustment control of stop lever by stop solenoid

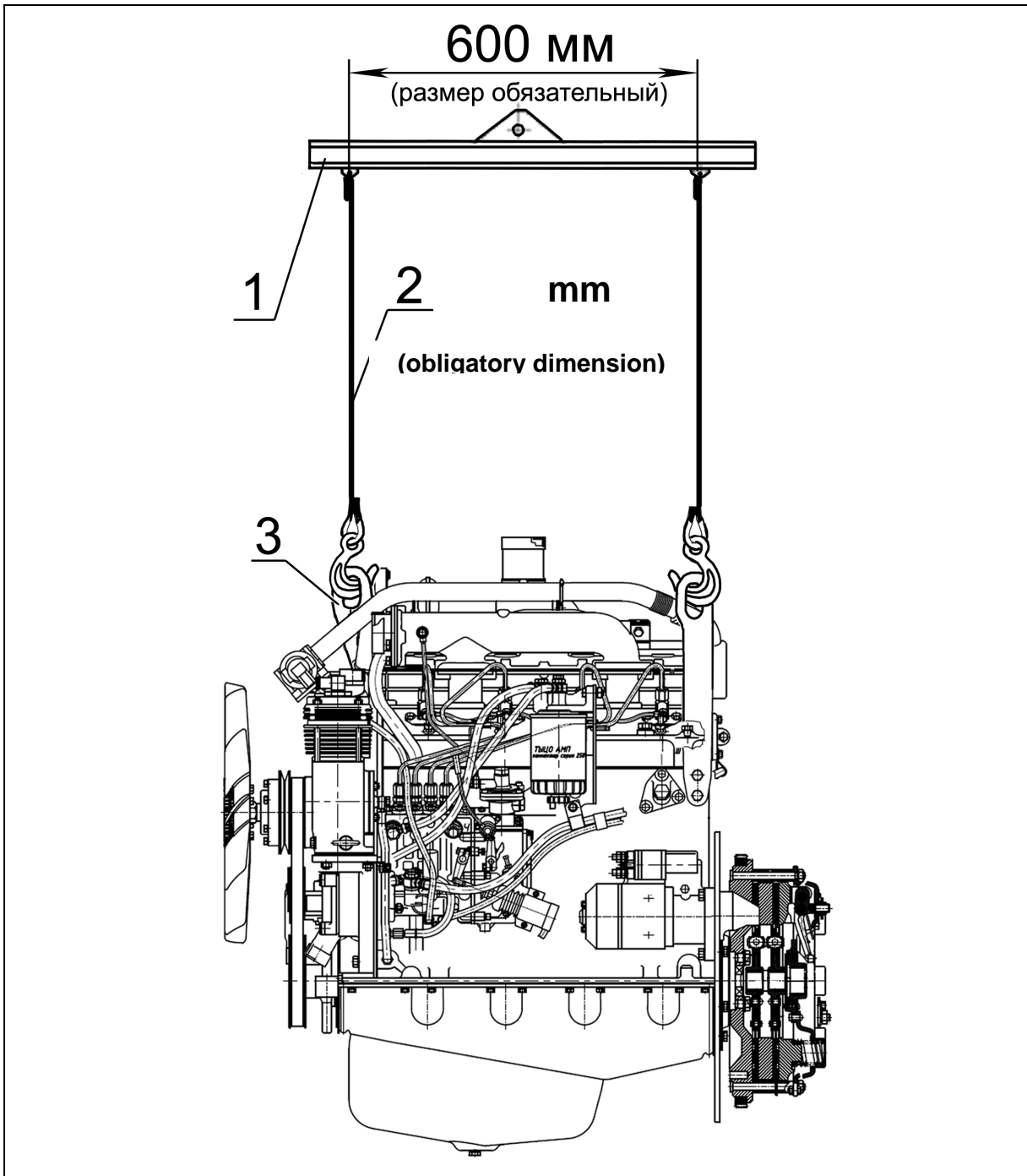
1. The stop lever shall be mounted and fixed on the control shaft in the extreme position OPERATION so that the angle between the lever axis and the horizontal was $77^{\circ} \pm 90^{\circ}$.
2. Holding the stop level in the extreme position OPERATION, screw out the articulated rod until the electromagnet core shifts against the stop and starts to force down the stop lever. From this moment on, screw out the rod by two revolutions more.
3. Fix the rod with a lock nut.

Annex F

Identification of engine and turbocharger faults

Symptom						Cause	Inspect	Symptom				
X	X	X	X		X	Air deficiency	Air filter for cleanliness. Air delivery pipe is too narrow, loose (leaky) connections.	X	X			
X	X				X	Boost pressure decrease	Constricted (damaged, leaky, loose) connection between the turbocharger and the engine).		X			
X	X				X	Exhaust pressure decrease	The outlet pipeline (sealing) is loose, damaged, leaky.					
X	X			X	X	High pressure in outlet pipeline	There are obstacles in the outlet pipeline, the outlet pipeline is damaged.					
		X	X			High pressure of crankcase fumes	Engine breather for cleanliness	X	X			X
			X		X	Insufficient lubrication	Turbocharger delivery pipeline for cleanness					
		X	X	X		Excessive lubrication	Turbocharger oil outlet pipeline is constricted	X	X			
X	X					Low compression	Condition of valves, pistons and piston rings					
		X	X	X		Oil in combustion chamber	Condition of valves and guides, piston rings for wear	X				
X	X					Bad injection	Fuel pump and injection nozzles					
X	X				X	Content of foreign particles	Air purifier (completeness, cleanness)			X		
X	X				X	Foreign particles in exhaust	The turbine casing is damaged, missing part of the turbine wheel				X	
					X	Vibration	Installation of turbocharger on the engine			X	X	
X	X	X	X	X	X	Turbocharger is out of order	Remove the turbocharger and send it for repair.	X	X	X	X	X
Power decrease	Black smoke	Blue smoke	Excessive oil consumption	Oil in outlet pipeline	Noisy turbocharger			Oil in turbine casing	Oil in compressor casing	Compressor wheel is damaged	Turbine operating wheel is damaged	Bearing case is damaged with carbon
Engine fault								Turbocharger fault				

Annex G (referential)



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1– beam 2 – hoist cable; 3 – clevis.

Figure 1 – Scheme of engine strapping