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SUBJECT	Soviet Technical Manual on the U1D6-150 Generator	DATE DISTR.	8 January 1964
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THIS IS UNEVALUATED INFORMATION. SOURCE GRADINGS ARE DEFINITIVE. APPRAISAL OF CONTENT IS TENTATIVE.

[redacted]

1. [redacted] English-language, Soviet technical manual entitled Model U1D6-150 Engine; Operating Instructions 50X1-HUM

[redacted] It consists of 127 pages and one diagram. No date or publication data appeared in the manual. 50X1-HUM

2. The U1D6-150 "engine" is a generator, a modification of the 1D6-150. It is a high-speed, six-cylinder, four-cycle, compression-ignited generator with direct fuel injection through nozzles. It develops 150 hp at 1500 rpm, with a net power output of approximately 140 hp. No specific uses for the generator are given in the manual.

Distribution of Attachment:

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MODEL OF THE У1Д6-150 ENGINE

OPERATING INSTRUCTIONS

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MODEL V1710-150 ENGINE

OPERATING INSTRUCTIONS

50X1

PREFACE

This book contains a brief general description of the Model УІІ6 engine and its specifications, as well as rules on its operation, care, and remedies to be used in case of various service troubles.

The main purpose of this Instruction book is to give the reader all basic information needed to ensure proper operation of the engine.

The personnel running the engine should bear in mind that the engine will work long and reliably only if due care is ensured to it and operating instructions are strictly followed.

The Model УІІ6-150 engine (with compactly arranged accessories) is a modification of the formerly built УІІ6-150 type. Its main distinctive features, compared with the latter, are:

1. Modified drive to oil pan accessories.

2. Altered design of crankcase body, Part No.501-16-3 (formerly 501-16-1) and oil pan, Part No.502-06-51 (formerly 502-06-3).

3. Metal-edge filter with "Kimaf-type" cardboard type fine filtering element (Ass.No. 04 313-00-10) used instead of former make (Ass.No. 04 313-00-1).

4. Water pump of new design (Ass. No.60-4313-00-1) used instead of old type (Ass.No. 04 311-00-3).

5. New type of oil pump (Ass.No. A16-00-1, formerly 04 312-00-1).

6. Cotter-type joint between connecting rod bearing

cap and big end (Ass.No. C6.504T-01-5, formerly C6.504-01).

7. Revised design of crankshaft oil seal, with oil drainage from seal chamber to oil pan.

The Model У1Д6-150 engine develops 150 Hp at 1500 r.p.m., disregarding fan losses. The latter being about 10 Hp, the net power output of the У1Д6-150 will practically be 140 Hp.

I. DESIGN

The Model У1Д6-150 is a high-speed, six-cylinder, four-cycle, water-cooled, compression-ignited engine with direct fuel injection through nozzles. The latter have six 0.25 mm dia. spray holes each.

The engine body comprises a crankcase and a cylinder block mounted on it. Attached either to the crankcase or to the block are the engine accessories including fuel pump, water pump, oil pump, fuel and oil filters, etc.

The Crankcase consists of two parts: upper frame and oil pan. Their joint plane is horizontal and located at the crankshaft centre line level.

The crankshaft is mounted (underslung) to the upper frame by means of seven bearing caps which enter snug between the guiding side surfaces of the crankcase bearing seats.

Through studs with nuts and washers hold the bearing caps to the frame.

The crankcase has transverse webs at the main bearings, in which seats for the shells are bored in assembly with the caps. The main bearing shells are steel-backed, thick-walled,

lined with copper lead.

The crankcase frame takes the main loads taking place while the engine is running. It is therefore well ribbed and stiff.

The crankcase oil pan serves as a mounting base for the fuel supply pump, oil pump, and water pump. It has the form of a trough reinforced by ribs.

The faces of both crankcase frame and oil pan are machined in assembly. A fan drive with a front supporting beam is bolted to the timing gear end, and the flywheel housing to the opposite end of the crankcase.

The Flywheel Housing has lugs for attaching the engine to its base, and a flange for the flexible coupling guard.

The Cylinder Block is mounted on the machined top face of the crankcase, to which it is secured with fourteen anchor studs. The cylinder block assembly includes a cylinder jacket and a cylinder head. The jacked accomodates six liners made of steel and having a nitrided, precision-finished (honed) inner working surfaces. Fitting bands provided both at top and bottom of each liner, keep the latter concentrically in the jacket bores. The upper ("gas") joint between the liner ridge and the cylinder head is sealed with a cold-hardened aluminium gasket. One such gasket is used for all the six cylinders.

The bottom joint between the cylinder block and crankcase is sealed by rubber grommets slipped onto the liners and jammed in the jacket bores.

Fuel injectors and valves (two intake and two exhaust

valves per cylinder) are installed in the cylinder head. Two camshafts, one for the intake and the other for the exhaust valves, are mounted on its outside. The cams act direct upon the valve shank heads.

The intake and exhaust valve ports open at both side surfaces of the cylinder head, to which the intake and exhaust manifolds are attached. These are steel pipe assemblies welded of stamped halves.

The Crankshaft has six crank throws and seven bearing journals. It is fixed in the crankcase by means of No.7 bearing which is a thrust bearing.

A flange pressed onto one end of the crankshaft is bolted to the flywheel. The face of this flange prevents also the shaft from axial travel. An extension piece is pressed into No.1 bearing journal at the opposite end of the crankshaft.

All main bearing journals and crank pins of the crankshaft have bores plugged at both ends and intercommunicating through passages drilled in the crank webs. Oil circulates through the cavities inside the crankshaft to lubricate the bearing journal working surfaces. The oil is centrifugally cleaned in the crank pin bores to retain solid particles, while the engine is in operation.

The Connecting Rod is made of alloy steel and is finished throughout. Its shank is I-shaped, the cross-section dimensions increasing towards the big end. The top of the shank has a transition into a small end head, by means of which the connecting rod is joined to the piston with the

help of the piston pin. A bushing of bronze is pressed into the connecting rod small end. Six holes in the small end provide lubrication to the piston pin.

The big end is split. Its ribbed cap has projecting ends entering corresponding seats in the big end body, and is attached to the latter by means of two taper pins. Shells clamped in the big end opening are steel-backed and lined with copper lead.

The Pistons are forged of duralumin. The piston crown is specially shaped to ensure effective mixture formation. Five piston rings are provided on each piston. Two upper ones of these are cylindrical compression rings. The three other ones acting simultaneously as compression- and oil scraper rings, due to their tapered form.

The Camshaft and Accessory Drive begins from the splined end of the crankshaft extension and the crankshaft gear fitted on it. This gear actuates a drive system comprising a number of bevel gears and shafts. Drive trains located in the upper crankcase transmit the rotation to the camshafts, fuel pump, and current generator. Other ones, arranged in the oil pan, are for the fuel-supply, oil- , and water pump, respectively.

The Fan receives its rotation from the crankshaft extension through a spring shaft, a friction coupling, and a V-belt drive. The coupling consists of two members connected by a set of steel plates.

The Fuel System supplies fuel into the engine cylinders. It comprises the following items:

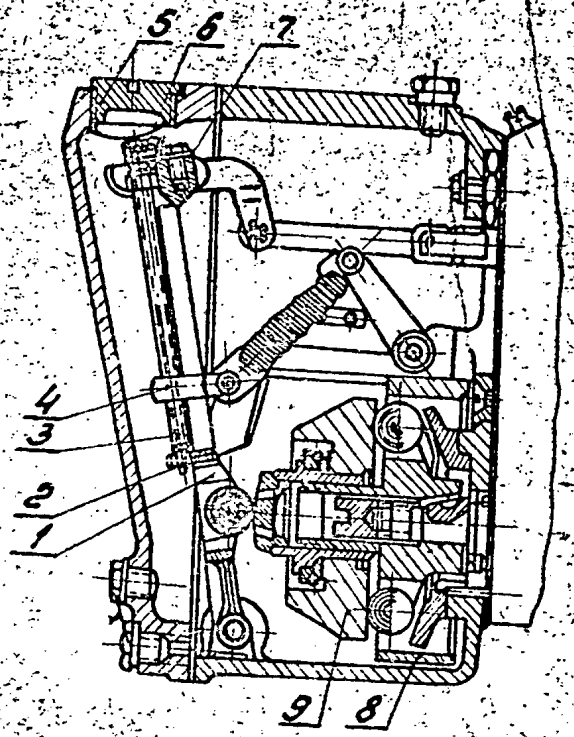
1. Fuel supply pump.
2. Fine fuel filter (felt type).
3. Six-plunger fuel pump with variable-speed governor, the latter equipped with speed droop adjusting mechanism and dash pot.
4. Six closed-nozzle fuel injectors.
5. Low-pressure piping.
6. High-pressure piping.

Fuel is drawn from the tank by the fuel supply pump, which delivers it along low-pressure pipes and through the felt filter to the fuel pump. This feeds the fuel to the injector nozzles through high-pressure lines.

The fuel pump used in the Model УIД6-150 engine is equipped with a pneumatic pulsation damper (dash pot) and with a precision governor having a speed droop control mechanism.

The fuel pump governor of the УIД6-150 engine (see Fig.1) has a speed droop adjusting device comprising a lever (1) with an adjusting screw (3) revolving in its bosses, and a yoke (4) sliding along the adjusting screw (3) and connected to the fuel feed control arm by means of springs.

A locking plate (7) prevents axial displacement of the adjusting screw. A cup (6) pressed onto the screw head permits to turn easily the screw with a screwdriver.



Fuel Pump Governor of Model YID6-150 Engine.

(Fig.1)

The governor body cover has a boss with a hole closed by a plug (5) against the adjusting screw (3). Turning the screw with a screwdriver through the plughole (5) makes the yoke (4) slide along the lever arm, thus changing the spring tension. By removing the plug (5) and turning the screw (3) with a screwdriver, the speed droop can be adjusted on the running engine.

Rotating the screw counter-clockwise will reduce the speed droop, and vice versa.

The engine speed may become altered after the speed droop has been changed. To restore the previous speed, the spring tension must be adjusted as necessary, by means of the governor outer lever. The governor spider (8) has grooves arranged at 60 degrees to the radial direction, which

ensure steady running of the engine and reduce temporary speed deviations in case of abrupt load changes. The flat disc (9) of the governor is made extra heavy for the same reason.

The fuel pump plunger has an additional bevel which reduces the rack travel and, accordingly, the time required for bringing it into a new position. This feature likewise decreases temporary speed deviations after cutting out the engine load.

An oil baffle (2) ensures proper lubrication of the governor disc thrust piece and sleeve.

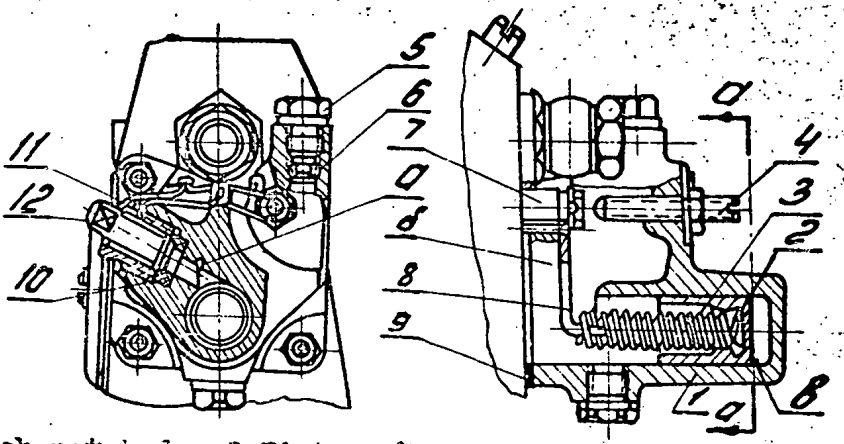
The springs used in this governor are of moderate stiffness.

All the above features of the revised governor design permit to keep the engine speed changes in close limits even at abrupt variations of load.

The pneumatic pulsation damper (dash pot) used in the fuel pump of the УДМ6-150 engine makes the latter run steadily at any speed and load.

The Dash Pot (see Fig.2) comprises a body, a piston, a spring, an air valve, a stop screw, filling and drain plugs, and fastenings. Mounted on the drive end face of the fuel pump, the dash pot is held to it by four studs and located with two dowels.

Section "a-a"



I.Dash pot body; 2.Piston; 3.Spring; 4.Rack stop screw; 5.Oil filler plug; 6.Strainer; 7.Fuel pump rack; 8.Spring bar; 9.Drain plug; I0.Rubber gasket; II.Threaded bushing; I2.Adjusting valve.

(Fig. 2.) Fuel Pump Dash Pot.

The dash pot body (1) is cast of aluminium alloy. A piston (2) is placed in the body bore. The piston is precision finished, and is connected to the fuel pump rack (7) with the help of a spring (3) and a bar (8).

Screwed into the body bosses are a filler plug (5) and a drain plug (9) for the oil. A strainer (6) is placed under the filler plug.

A screw (4) fitted in the body front wall and locked with a jam nut and a look plate, serves as a stop for the fuel pump rack.

Space "B" behind the piston, communicates with dash pot chamber "6" and can be separated from it, by means of

a valve (12). This is a needle with a cylindrical bevelled end, closing hole "a". A rubber ring (10) is placed under the valve cone. The valve is pressed to its seat by means of a threaded bushing (11).

Air flows from space "B" into space "C" through hole "a". The air passage is restricted by valve 12, the cylindrical end of which closes hole "a".

The dash pot ensures stable operation of the engine at any load and speed, provided that:

a) There is lubricant on the piston. Pour filtered Diesel fuel, not more than 10 ccm, into the dash pot body.

b) The piston slides freely in the dash pot body.

Lack of lubricant on the piston will result in increased or decreased crankshaft speed in case of load changes. To safe-keep the lubricant in the dash pot body watch to see that no fuel is leaking from it, and store the dash pot in vertical position while the fuel pump is removed. Pour only thoroughly filtered Diesel fuel into the dash pot, to avoid binding of the piston in the body.

In case of excessive or insufficient speed after load changes, remove the dash pot and remedy the piston binding as follows:

1. Unbolt the body and take it off with caution. Be careful not to damage the dash pot spring or the gasket under the flange body. Then remove the spring bar together with the spring and the piston.

2. Wash thoroughly all dash pot parts, the fuel pump body wall, and the rack end entering the dash

3. Check to see that the piston moves freely. It should fall slowly under its own weight, together with the spring and bar, without any binding, until it reaches the body bottom.

Should the piston stick in the body, remedy this by polishing its projecting burrs, without affecting the bore and piston dimensions. Then wash the parts again and re-check the piston movement.

4. After the piston slides as free as necessary, re-install the dash pot on the pump, taking care to properly tighten and look the fastenings. Then pour into the opened upper plughole 10 ccm of filtered Diesel fuel. Adjusting the dash pot valve (12) is allowed, if necessary.

To adjust it back off nut (11) one turn to prevent damage of rubber ring (10). It should be borne in mind, when carrying out the adjustment, that reducing the valve opening (by turning the valve clockwise) contributes to steady running of the engine but increases the speed jumps after abrupt removal or application of engine load.

Changing the setting of rack stop screw (4)is not permitted.

The Remote Control Mechanism of the engine permits to adjust the engine speed from a central control panel located at some distance from the engine.
It is delivered according to the customer's demand

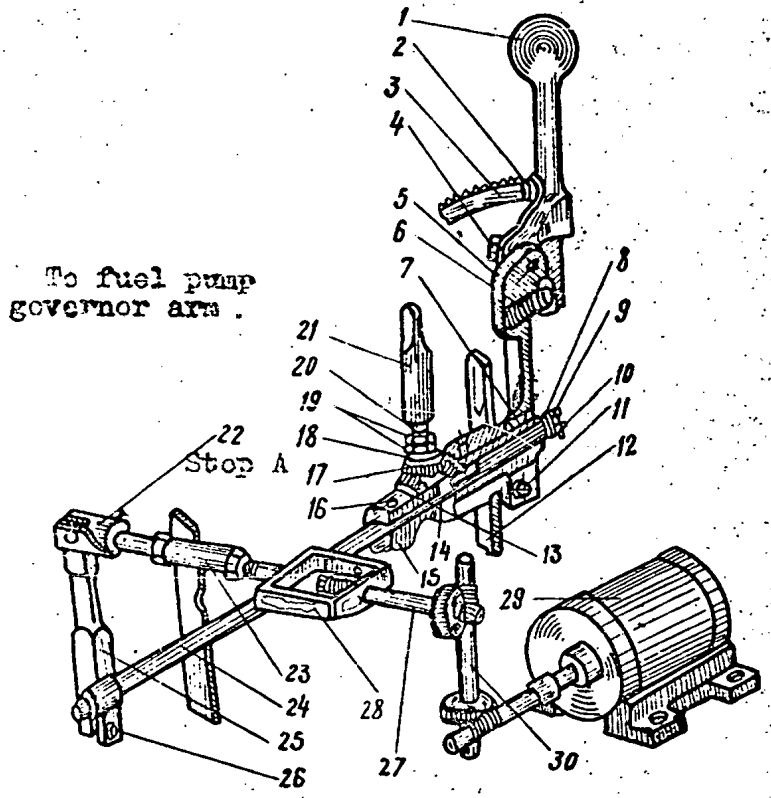
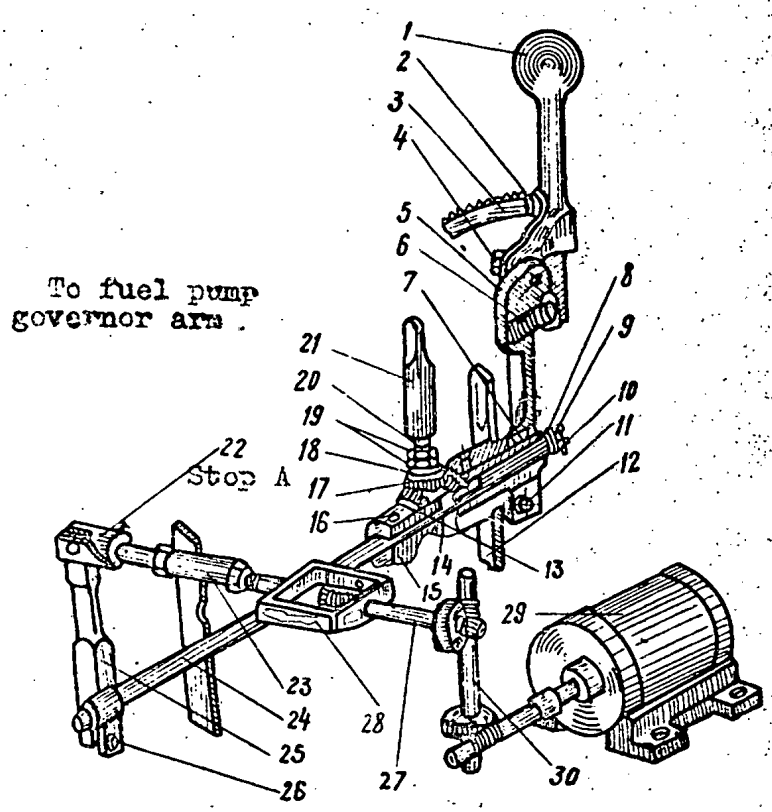


Fig.3. Diagrammatic View of Remote Control Mechanism with Differential Gear.

I. Control lever; 2. Control lever locking tooth; 3. Toothed sector; 4. Precision adjustment screw; 5. Manual control lever; 6. Lever spring; 7. Woodruff key; 8. Washer; 9. Slotted nut; I0. Cotter pin; II. Bolt; I2. Control panel; I3. Manual control side gear; I4. Washer; I5. Remote control side gear; I6. Dowel; I7. Idler pinion; I8. Washers; I9. Nut with jam nut; 20. Pinion arm; 2I. Clevis; # 22. Clevis; 23. Pull rod; 24. Shaft; 25. Arm; 26. Bolt; 27. Lead screw; 28. Slide; 29. Electric motor; 30. Reduction gear drive.



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The motor actuating the remote control mechanism should be connected to a local power source by the User when installing the engine. The electrical connection diagram should be selected by the User so as to ensure reversing the motor rotation.

Care required by the remote control mechanism consists in ensuring proper lubrication of its working parts and sub-assemblies, and watching the fastenings.

20ccm of aviation oil should be poured into the plughole at the top of the reduction gear housing. The plug should then be screwed in place.

The oil supply in this unit should be checked and, if necessary, replenished, about every 300 or 500 hours of engine operation. Care should be taken to avoid prolonged slipping (for more than 1 or 2 minutes) of the safety coupling, otherwise the worm wheels will wear out.

The bevel gears in the differential gear drive at the control panel need likewise to be lubricated with aviation oil.

The remote control mechanism has a lever (1) connected to the manual control arm (5) by means of a precision adjusting screw (4). The locking tooth (2) of this lever enters under the force of a spring (6) one of the grooves in a toothed sector (3) fastened to the control panel.

A key (7) couples the arm (5) with a planetary bevel gear (13) revolving around a shaft (24).

A pinion arm (20) revolves freely around the same shaft between two bevel gears (13 and 15). An idler pinion (17) is free fitted on the pinion arm.

A clevis (21) screwed onto the threaded shank of the pinion arm (20) is hinged to a pull rod running to the fuel pump lever.

Another arm (25), fitted on the shaft (24), is clamped on a key by means of a bolt (26). This arm is connected to the lead screw (27) of the reduction gear drive (30) by means of a clevis (22), a pull rod (23), and a slide (28).

Manual control is effected by turning the control lever (1) when the speed is to be changed or the engine is to be stopped.

The idler pinion (17) will then roll around the stationary gear (15) and move the pinion arm (20) in the same direction in which the control lever is being pulled. The arm, in turn, will act upon the fuel pump governor lever by means of the pull rod.

If remote control is required, the control lever (1) must be released and its locking tooth (2) be placed in the slot in the sector (3). The manual control gear (13) will thus be locked.

Starting now the motor (29) with the reduction gear (30) makes the lead screw (27) rotate and the slide (28) move along it.

The slide, while travelling along the lead screw(27), turns with the help of the arm (25) and shaft (24) the other bevel gear (15). The idler pinion (17) will then roll around the stationary gear (13) and carry with it the pinion arm (20) which acts, through the pull rod, upon the governor lever.

The pinion arm (20) moves in the same direction as the

slide (28) does. Before starting the motor check the position of the slide (28) with respect to stop "A" limiting the lead screw travel.

If the slide (28) is just at the stop ("A"), the remote control motor (29) should be started in such direction as required to move it towards the reduction gear.

Lubrication of the engine is of the circulating type, and provides pressure oil feed to all bearing journals of the crankshaft, camshafts, accessory drive shafts, and fan driving shaft bearings. It is achieved with the help of a geared pump having three sections. One of these is the pressure section supplying oil to the engine lubricating system, the other two ones being transfer sections drawing oil from the front and rear end of the crankcase oil pan.

The lubricating system equipment includes a metal-edge oil filter with a "Kimaf-6TZ" cardboard type fine filtering element for cleaning the oil, and an oil radiator for its cooling.

The Cooling System of the engine uses water delivered by a centrifugal pump. The cooling equipment comprises a water radiator and a fan which effects the necessary air draft through the radiator.

Starting the engine can be performed either by means of an electric starter motor, or by compressed air, through an air distributor and a piping system. A storage battery feeds the electric starter.

The Electrical Equipment of the engine includes power sources and consumers, auxiliary equipment, instruments, and wires.

Power sources are the starter storage batteries and a current generator. The starter motor is the main consumer of electric power.

Auxiliary equipment items are the starter control button, starter relay, current-and-voltage regulator, fuse blocks with fuses, a portable lamp receptacle with a plug, and a battery switch ("body switch").

A combined volt-and-ammeter with shunt and wires and an electric tachometer comprising a tachometer generator and a speed indicator, are the electric instruments furnished with the engine.

All electrical equipment is of the single-wire type. The "body", i.e. the metallic parts of the engine, serves as the negative conductor. The negative pole of the storage battery set is connected to the engine body through the body switch.

The Control Panel of the УИ6-150 engine with the instruments installed on it is fastened to the crankcase frame and to the intake manifold behind the fuel pump.

Arranged in the upper portion of the control panel are instruments indicating the engine operations, namely: a remote pressure gauges reading the pressure in the main oil supply line, two remote dial thermometers indicating the oil temperature at the oil pump discharge and the water temperature after the engine cylinder head, the speed indicator of the

electric tachometer set reading the crankshaft speed, and the volt-and-ammeter indicating the storage battery and generator action. A stamped cover at the centre of the control panel encloses the fuse blocks which protect the generator and the starter relay against overload. The panel is mounted on brackets with rubber cushions to protect the instruments against vibration.

A stamped steel plate at the bottom of the control panel serves as a mounting base for the manual fuel feed control lever, starter push-button controlling the starter motor operation during the engine starting period, and a receptacle for a portable lamp.

A hand-operated oil priming pump and the differential gear drive of the remote control mechanism are installed on the back side of the engine control panel.

II. SPECIFICATIONS

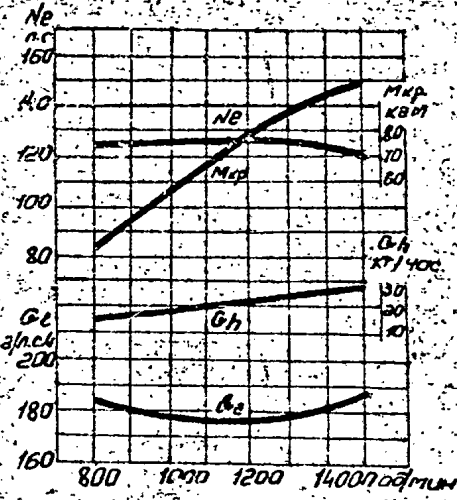
Engine Model Designation	У1Д6-150
Number of Engine Cylinders	6
Cylinder Arrangement	Vertical, single-bank
Cylinder Numeration	From vertical drive-shaft towards fly-wheel.
Firing Order	1-5-3-6-2-4
Cylinder Bore	150 mm
Piston Stroke	180 mm
Total Swept Volume	19.1 litre
Compression Ratio	14 to 15

Crankshaft Rotation	Clockwise (Viewed from end opposite to flywheel).
Performance:	
Rated (Continual Service), on Flywheel Coupling Flange, at 1500 r.p.m.	150 Hp
Minimum Stable Idling Speed	500 r.p.m. (not more).
Maximum No-Load Speed	1560 r.p.m.(not more).
Maximum Torque, at 1100 to 1300 r.p.m.	75 kg/m (not less).
Specific Fuel Consumption at Rated Performance	210 grammes per Hp. hr.eff.(not more).
Fuel	USSR Standard ГОСТ 4749-49 (High-Speed Diesel Fuel) or ГОСТ 305-42.
Valve Timing:	
Number of Valves per Cylinder:	
Intake	2
Exhaust	2
Intake Valve Opens (Crankshaft Travel) ..	20(±3)deg.before TDC
Closes	48(±3)deg.after BDC
Duration of Intake	248 deg.
Maximum Valve Lift	13 mm
Clearance between Valve Head and Cam Relief	2.34(±0.1) mm
Exhaust Valve Opens	48(±3)deg.before BDC
Closes	20(±3)deg.after TDC
Duration of Exhaust	248 deg.

Maximum Valve Lift ..... 13 mm

Clearance between Valve

Head and Cam Relief ..... 2.34(±0.1)mm



Performance Characteristics.
(Fig.4.)

Starting:

Main Starting System	Electric Starter
Starter Engaging Device	Solenoid
Auxiliary Starting System	Compressed Air
Air Pressure at Distributor Inlet	30 kg per sq.cm.min., to 90 kg per sq.cm.max.
Beginning of Air Admission	6(±3)deg.(of crankshaft travel) after TDC, on compression stroke.

Electrical Equipment Data:

Generator: Type	Г-73 : or Г-731
Rated Output	1200 Watt
Voltage	24 V

	Generator Shaft to Crankshaft Speed Ratio	1.75
	Rotation (Viewed from Drive End)	Clockwise
	Driving Device	Flexible Coupling
	Current-and-Voltage Regulator Type	РРТ-24
Starter Motor:	Type	СТ-710 (CW Rotation)
	Voltage	24 V
	Maximum Power Developed	15 Hp
	Starter Relay Type	РС-400
Storage Batteries:	Type	6-СТЭ-128, or 6-СТК-180М
	Number of Batteries per Engine	4
	Battery Capacity	256 (or 360) АНr
	Battery Voltage	24
	Wiring System	Single-conductor, 24 V, body negative.

Electric Tachometer Set

Type	ТЭ-3
Tachometer Generator	ДТ-5 (АС)

Air Cleaner:

Type	Multi-Cyclone
Number Installed	One

Control Panel

Arranged on Panel are:

Manual Fuel Feed Control Lever	
Portable Lamp Receptacle	ШР-51 (24 V)

Starter Button	KC-31

Electric Equipment and Instrument Panel

Arranged on Panel are:

Combined Volt- and Ammeter	BA-240, Aircraft type, with external shunt, scales 20-0-60A, 0-30 V.
Oil Pressure Gauge	Aircraft type, with transmission bulb, scale 0 to 16 kg per sq.cm.
Dial Thermometers (Oil and Water)	Aircraft type, with bulb, scale 0 to 125°C.
Speed Indicator	TE-3
Fuse Blocks with Fuses	BE-30
Fuse Types	П-20 and ПВ-50
Allowable Incline of Crankshaft	15 deg., not more.
Weight of Engine with Piping and Accessories, less Fuel, Oil and Water	1320 kg.
Weight of Water in Engine	22 kg.
Weight of Oil in Engine	12 kg.

Overall Dimensions of Engine:

Length, less Air Cleaner	1778 mm
Width, less Air Cleaner	864 mm
Height, less Fan	1095 mm
Height, Crankshaft Axis above Extreme Bottom Point	325 mm

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Fuel System:

Fuel Supply Pump:	Type	8HK-12TK (Rotary)
	Number of Pumps	One
	Pump Shaft to Crankshaft Speed Ratio ..	0.93
	Fuel Pressure after Fuel Filter	0.5 to 0.7 per sq. cm.
Fuel Pump:	Type	Six-plunger, enbloc, with dash pot.
	Number of Pumps	One
	Numeration of Pump Sections	From drive end towards flywheel.
	Pump Section Operating Order	1-5-3-6-2-4.
	Fuel Feed Advance Angle	24 to 26 deg. of crankshaft travel before TDC, on compression stroke.
	Pump Shaft to Crankshaft Speed Ratio...	0.5
	Rotation	Counter-clockwise, viewed from drive end.
	Remote Control System	Electro-mechanical.
Governor:	Type	Mechanical, centrifugal, variable-speed, direct-acting, with speed droop adjusting device.

Fuel Injector: Type	Closed-nozzle, with clearance filter.
Spring Setting	210(±3) kg per sq.cm.
Lubricating System:	
Type	Circulating, forced, dry-sump.
Number of Oil Pumps	One, three-sectional, with one pressure section and two transfer sections.
Type of Oil Pump	Geared.
Oil Pump Shaft to Crankshaft Speed Ratio	1.5
Oil Pressure, at Operating Conditions:	
After Oil Filter	6 to 9 kg per sq.cm
In Camshafts	1 kg per sq.cm, not less
In Generator Drive Shaft	1 kg per sq.cm, not less
After Oil Filter, at Minimum Stable Idling Speed	2 kg per sq.cm, not less
Oil Temperature: at Engine Inlet	40°C min. to 80°C max.
at Engine Outlet	95°C max. (Recommended temperature 80 to 90°C).
Oil Pump Capacity, at 1500 r.p.m.	3900 litres per hr, not less.
Engine Heat Rejected to Oil, at Rated Performance	8000 to 10000 Cal. per hr
Specific Oil Consumption, at Rated Performance	12 grammes per BHp.hr (not more).
Oil Grades: Summer	MK-22 or MC-20 Aviation Oil, USSR Standard ГОСТ 1013-49.

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Winter ..... MC-14 Aviation Oil, USSR Standard GOST 1013-49.

Note: Grade "MT-16p" Oil, USSR Standard GOST 6360-52, Tentative Specifications BTU449-55 and BTU615-57 is also allowed for summer as well as for winter operation.

Hand Oil Pump: Type ..... Reciprocating, double-acting.

Number of Pumps ..... One

Drive ..... Manual, by lever

Pressure Built Up .... 1.5 to 2 kg per sq.cm.

Normal Speed ..... 40 to 50 strokes per min.

Capacity, at Oil Temperature 50 to 60°C ..... Not less than 2 litres per 100 full strokes.

Oil Filter: Type ..... "Kimaf-STZ", metal-edge, with cardboard type fine filtering element.

Number of Filters ..... One.

Cooling System:

Type ..... Forced water cooling.

Water Pump ..... Centrifugal.

Number of Pumps ..... One.

Pump Shaft to Crankshaft Speed Ratio 1.5

Water Temperatures:

at Engine Inlet ..... 55°C (not less).

at Engine Outlet ..... 95°C max., 70 to 85°C recommended.

Water Pump Capacity, at 2250 r.p.m. .. 250 litres per min. (not less).

Engine Heat Rejected to Water at Rated Performance ..... 60000 to 70000 Cal. per hr.

III. RECOMMENDED COOLING AND LUBRICATING SYSTEM ARRANGEMENTS

1. COOLING SYSTEM

Cooling of the Model Y1/6-150 engine is effected by the following cooling circuits:

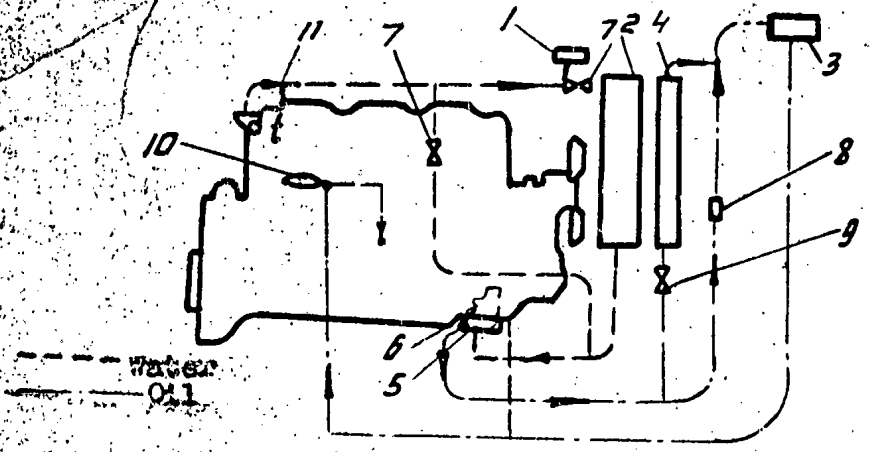
a) Internal cooling circuit, providing direct cooling of hot parts in the engine, and

b) External circuit, where the circulating water is being cooled.

The internal cooling system includes parts and assemblies mounted on the engine, namely: water pump, piping from pump to cylinder jackets, cylinder block jacket and head, pipe branches and a dial thermometer indicating the temperature of the water leaving the engine.

The external circuit equipment comprises the radiator, expansion tank, pipes, and valves.

Fig.5 illustrates the recommended flow diagram of the external cooling circuit.



1. Expansion tank 2. Water radiator; 3. Oil tank; 4. Oil radiator; 5. Oil pump; 6. Water pump; 7. Valve; 8. Relief valve; 9. Valve; 10. Hand oil pump; 11. Vent pipe.

Fig.5. Recommended Flow Diagram of External Cooling and Lubricating Circuits for Model YID6-150 Engine

2. LUBRICATING SYSTEM

Lubrication of the Model YIД6-150 engine is effected by two oil circuits, e.g.:

a) Internal oil circuit delivering oil to all working parts of the engine, and

b) External oil circuit, the purpose of which is to cool the oil transferred by the oil pump, from the crankcase to the engine oil tank.

The internal oil circuit comprises the following parts and assemblies installed on the engine: oil pump, oil filter, piping with valves, dial thermometers reading the oil temperatures at the engine outlet, and a pressure gauge indicating the oil pressure in the main oil delivery line after the oil filter.

The external oil circuit (see Fig.5) includes the oil

tank, oil radiator, pipes, and valves. The external circuit should be connected to the internal one after the engine is installed on the frame of the driven equipment.

IV. PREPARING THE V1П6-150 ENGINE FOR OPERATION AND GENERAL RULES ON ITS INSTALLATION

1. GENERAL NOTES

The engine installation should be so designed and carried out, as to ensure free access for inspection and servicing to the fuel pump, fuel supply pump, fuel filter, valve mechanism and fuel injectors, water pump, oil pump, oil filter, air distributor, generator and starter motor, control and instrument panel, as well as to the water-, oil-, and fuel piping and its connections.

It is not permitted to include in the engine installation design any changes in the arrangement of the engine accessories, or to locate any pipes etc on the engine, without the Manufacturer's approval. Fastening any kind of additional equipment to the engine should likewise be avoided.

Neither must the adjustment or the completeness of the engine be disturbed in any way.

2. PREPARING THE ENGINE FOR ERECTION ON THE FRAME

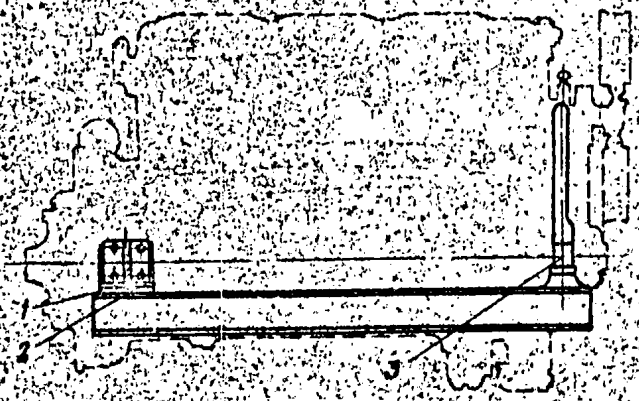
To ensure normal performance of the engine, it is advisable to place it on a rigid frame having machined mounting pads under the engine supports. Welding 15 to 20 mm thick steel

plates to the frame, followed by their milling or planing, is allowed for this.

It is desirable to place 5 to 12 mm thick textolite spacers between the engine lugs and the frame.(See Fig.6).

Using rubber cushions under the engine lugs is not permitted.

The shape of the textolite spacers should correspond to that of the engine lugs.



1. Steel pad; 2.Textolite spacer; 3.[illegible] beam; 4.Flywheel housing support.

Fig.6. Engine Mounting on Frame.

A. Flywheel housing supports; B. Fan beam.

Fig.7. Engine Supports.

The following holes should previously be drilled in the frame:

a) Two 18 mm dia. holes for the fan beam fastening bolts marked "1" and "2" on Fig.7.

b) Two 16 mm holes for the engine support bolts indicated by "4" and "5" thereon.

Other holes are to be drilled after the engine is finally located on the frame.

The following work should also be done before placing the engine on the frame:

1. Prepare a set of shims made of 0.3 to 0.5 mm thick sheet iron, including 6 or 8 shims for the fan beam and 12 or 15 shims for the flywheel housing supports.

   The shims should be even and smooth.

2. Prepare four 14 mm bolts with cotter pin holes for the flywheel housing supports and two 16 mm bolts for attaching the fan beam.

   The bolts should be made of Grade 40 or 45 steel, USSR Standard ГОСТ 1050-52. Their length should be determined on the spot.

3. Prepare four slotted nuts with M14 thread and two with M16 thread, also washers and cotter pins for the nuts. The necessary quantity of these is 6 to 8 per engine.

4. Check the longitudinal clearance between the fan beam and the fan drive housing. This should be at least 1.5 mm.

   In case the clearance is less, shift the beam with respect to the drive housing until the required

clearance is obtained.

Fix the above clearance by placing steel strips in it. Remove these strips only after the fitted bolts (see below) are tightened in place.

Installing the Engine

Model YI76-150 engines are to rest on the frame with its front beam and flywheel housing supports.

To install the engine in place proceed as follows:

1. Lift the engine by means of a hoisting device attached to the eye-bolt at the crankcase and to the eye-bracket at the fuel filter on the cylinder head.
2. Wipe the engine support bottom surfaces and the top surfaces of the frame. Use a scraper to remove burrs or nicks from the engine support faces, if found there.
3. Locate the engine on the frame so that the frame holes register with the holes in the engine lugs.

NOTE: Before placing the engine on the frame remove the driven flange of the flexible coupling, and bore it to fit the driven machine shaft. The following conditions should be fulfilled while doing this:

a) The flange should pass full way along the shaft end with an interference of 0.03 mm.

b) The finished face of the flange should be perpendicular to the hob bore within 0.1 mm per 270 mm dia.

c) The deviation of the bolt hole centres in the flange with respect to the hub bore should not exceed 0.1 mm.

The latter can be ensured best by centreing the flange in the lathe by the bolt holes before machining the bore.

4. Secure the engine on the frame with the corresponding bolts. Tighten the bolts evenly.

5. Install all external piping (water, fuel, and oil), and connect it to the engine.

6. Recommission the engine by removing the factory slushing.

7. Align it with the driven equipment.

The maximum allowable offset misalignment is 0.05 mm, and angular misalignment 0.1 mm per metre.

8. Install fitted bolts in the lug holes. The bolts should enter the holes under light hammer taps. Then tighten the fitted bolts evenly in two steps.

9. Lock all engine support bolts with cotter pins.

10. Connect the shaft coupling.

3. ALIGNING THE ENGINE WITH THE DRIVEN EQUIPMENT

Fig.8 is a sketch drawing of the aligning device, with general dimensions.

The way in which the device is to be attached to the engine flywheel can be seen from Fig.9.

The following is the procedure required for aligning the

engine with the driven unit and for checking the alignment in the course of No.2 and No.3 servicings:

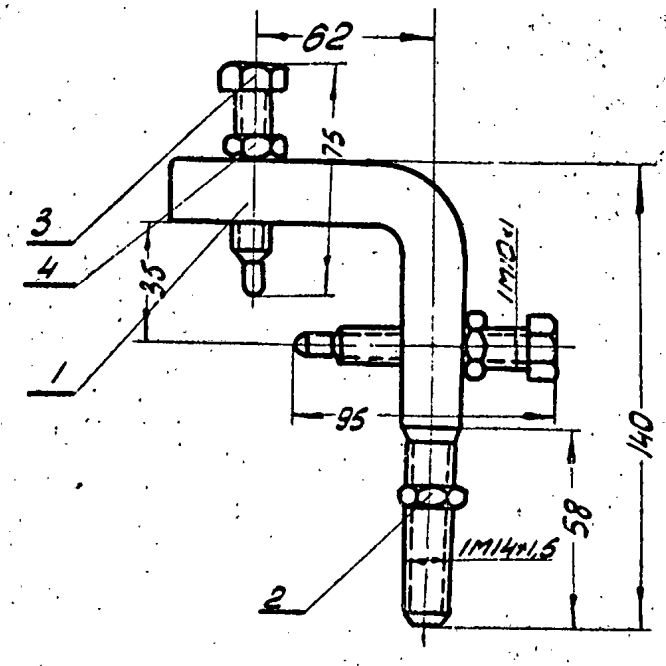
1. Install aligning devices in two opposite threaded holes in the flywheel, and secure them in place. Remove all coupling bolts connecting both halves of the flexible coupling.

2. With the help of the adjusting screws provided in the devices ensure such clearances in points а, б, в' and г , which can easily be measured with a feeler gauge. A clearance of 0.3 mm is recommended.

3. Measure the clearances in vertical plane, first in the initial position, then turn both shafts simultaneously by 180 degrees and re-check the clearances.

4. One-quarter the difference of summary clearance а+г measured in both positions gives the amount of offset misalignment in the shafts in vertical plane ("M"):

$$M = \frac{(а+г) - (б+г_1)}{4}$$ (All dimensions in mm).



I. Pointer; 2.Pointer jam nut; 3.Adjusting screw; 4.Adjusting screw jam nut.

Fig.8 Aligning Device for Model YID6-150 Engine.

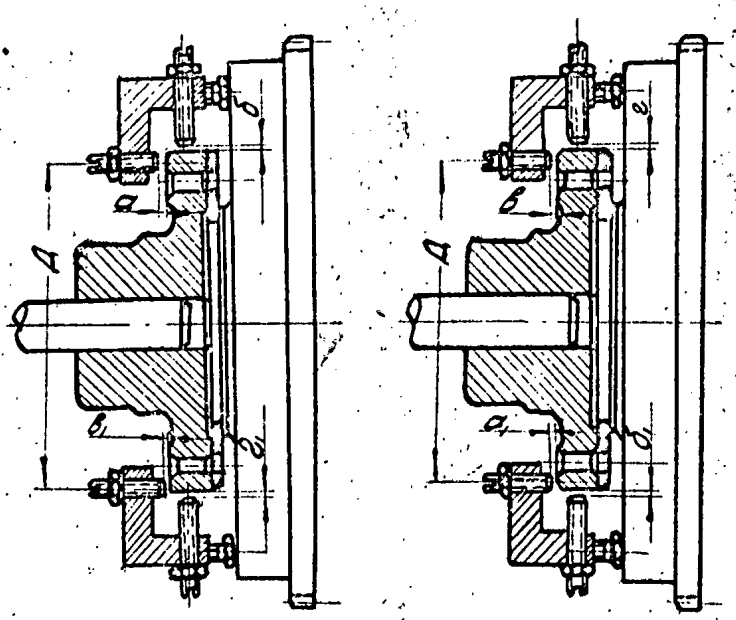


Fig.9.Arrangement of Shaft Aligning Device on Engine Flywheel.

x/=Pointer No.I xx/=Pointer No.2 xxx/=Position I xxx/=Position II /After turning at 180 degrees

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Half the difference of summary clearance a + в measured in both positions gives the amount of angular misalignment in vertical plane ("H"):

$$H = \frac{(a + в) - (a_1 + в_1)}{2} \quad \text{(All dimensions in mm).}$$

This amount should be related to one metre in length as follows:

$$K = 1000 \frac{H}{Д}$$

where "Д" is the diameter (in mm) where clearances "a" and "в" were measured.

5. In the same way as described above find the offset and angular misalignments in horizontal plane.

NOTES: a) The two-pointer method is used in order to eliminate any error in the angular misalignment measurements, which might result from axial displacement of the shafts during their turning.

б) The outer diameter of the driven coupling flange, where the feeler gauge measurements are taken, must be turned true after the bore is finished to size, otherwise erroneous readings may be expected.

6. The misalignment checking results obtained during erection as well as in the course of No.2 and No.3 servicings, should be entered in a special misalignment record form (see Form У-12У).

4. OTHER HINTS ON ENGINE INSTALLATION

1. An expansion joint should be provided between the engine exhaust manifold and the exhaust line, to prevent

compression forces in the exhaust manifold and pipes resulting from their heat expansion.

2. The air cleaner should be tightly connected to the intake manifold, particularly when the engine is to run in dusty conditions.

V. COOLING AND LUBRICATING SYSTEM

INSTALLATION RULES

The following recommendations should be fulfilled when installing the YaZ-238 -150 engine cooling and lubricating systems, in order to make it run normally:

1. COOLING SYSTEM

Before placing the engine on its frame find or fabricate all necessary assemblies, pipes, and auxiliary equipment for the cooling system. Before installing these, test them for tightness, fit them in their respective places, and wash them.

An expansion tank (1, see Fig.5) having a capacity of 15 or 20 litres and provided with a water level gauge, a filler neck, and a drain pipe, should be installed at the engine to ensure troublefree operation of the cooling system.

The filler neck should be equipped with a strainer for filtering the water being poured into the engine cooling system.

The water level in the expansion tank should be higher than the engine cylinder head, to ensure complete filling of the head cavities with water. The elevation of the water level above the cylinder head should be about 150 mm.

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The expansion tank should be connected to the cooling water pipe running from the engine to the radiator. The cylinder head vent pipe should likewise be cut into this line. It is advisable to make this connection at the top of the tank and without unnecessary bends, to permit any steam to flow freely from the cylinder head into the tank. It can also be recommended to have a cock on the vent line, permitting also to check the water level in the system.

The pipe connecting the expansion tank with the main water line should be cut into the latter in the direction of the water flow in it. This will help to avoid water blowouts from the expansion tank during operation of the engine.

NOTE: No expansion tank is required if a Type C-80 tractor radiator is used.

All water lines within the cooling system should be at least 32 mm I.D.

Sharp bends should be avoided, wherever possible.

The connections between the water lines and the engine nozzles, valves, and accessories, should preferably made of oil-resistant rubber hoses fastened on the pipe ends by means of metal band clamps.

The rubber hose size should be selected accordingly to the pipe diameter. The gap between both pipe ends connected by a hose piece should be not less than 2 mm and not more than half the pipe diameter. The length of the rubber hose should be such as to overlap each of the pipe ends by 40 mm, approximately.

If any of the external cooling circuit pipes must be

located below the drain valve at the water pump, another drain valve must be provided at the lowest point of the pipe system to permit full removal of water.

A valve (7) and a by-pass with another valve should be installed before the radiator, permitting to deliver water into the latter and to shut it off when warming up the engine after starting.

2. LUBRICATING SYSTEM

The engine oil tank should have a volume not less than 50 litres. The minimum quantity of oil in the tank, at which the engine can run without trouble, is 30 to 35 litres.

Reliable operation of the engine can not be ensured if there are less than 30 litres of oil in the tank.

The oil tank should be located so that the minimum oil level in it be 200 or 300 mm above the oil pump suction opening (depending on the form of the tank), and the maximum oil level be 800 or 900 mm above the pump.

Provisions should be made in the tank arrangement for releasing from it the water and sediment accumulating at the bottom. A sump with a drain cock should be provided in the tank. If there is none, the bottom point of the oil outlet opening in the tank should be elevated 50 to 80 mm above the tank bottom. A froth baffle should also be provided inside the tank, to reduce foaming.

It is most recommendable to have a strainer gauze installed at the point where the oil is to be drawn from the tank. A level gauge is also necessary, permitting to check the

oil quantity in the tank.

The filler neck should obligatorily be equipped with a filtering device, to prevent intrusion of dirt into the tank in the course of its priming. A breather should communicate the tank interior with the atmosphere. A fitter should be provided in the breather to protect the tank against penetration of dust, if the engine is to run in a dusty locality.

A relief valve (8, see Fig.5) should be provided in the oil piping system, to prevent the oil radiator tubes from overpressure when starting the engine in cold weather. This valve should open when the pressure in the oil radiator feed line exceeds 1.5 kg per sq.cm. A shut-off valve (9) should also be installed, permitting to cut out the oil radiator in order to speed up the oil warming process after starting.

The following pipe sizes (I.D.) can be recommended for the oil lines:

a) 25 to 32 mm for the lines running from the tank to the oil pressure and transfer pumps, if these are less than 3 m long. Larger pipes should be used if the length is greater.

b) 20 to 32 mm for the oil lines leading from the oil pump to the radiator and to the engine oil tank.

c) 10 to 15 mm for drain lines.

All oil lines should be as short as possible, and have a minimum of bends.

Installing any shut-off valves between the engine oil tank and the oil pump should be avoided, to exclude any possibility of starting the engine without oil feed.

Nipple joints are preferable for the oil pipe connections. It is also allowable to apply for this oil-resistant rubber hose pieces fastened on the pipe ends by means of clamps.

If any reducer couplings, etc, are used on pipes in order to connect larger pipes with smaller ones, the minimum bore diameter in these should never be less than 18 mm. Application of smaller or too long pipes, as well as using fittings with insufficient passage area, may cause severe troubles in the engine operation.

An oil priming pump (10) is provided on the engine for pumping oil into the main distribution line before starting.

It is recommended to use steel pipes and to clean them thoroughly inside before installation.

VI. RECOMMISSIONING

Starting a non-recommissioned engine may cause a breakdown, because the heavy slushing grease prevents normal delivery of lubricating oil to the friction surfaces.

A special recommissioning procedure must be used to remove the protective compound from all outer surfaces of the engine sub-assemblies and parts, as well as from the inner surfaces.

All engines shipped from the factory are slushed for a period of six months with a compound consisting of 50 per cent gun grease and 50 per cent aviation oil.

A corresponding document, the slushing record, is furnished with each engine in two copies. One of these is glued onto the cylinder head, the other being placed in the engine report form.

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Immediately after arrival of the engine check the condition of its packing and of that one in which the storage batteries, air cleaner, and individual set of spare parts and tools are placed. A statement should be drawn up in every case of damaged packing, indicating the status of the goods and the causes which have affected the packing quality.

A claim should be raised against the railway administration if the package has been damaged or any parts been lost in transit.

Care should be taken, when unpacking the engine, not to disturb the continuity of the protective compound on all slushed surfaces, nor to remove the wax- or parchment paper from the breather cap and from other points where present.

The recommissioning should be begun with only at the end of the erection process, just before coupling the engine to the driven equipment.

It is strictly forbidden to turn the engine crankshaft until the engine has been recommissioned.

If the crankshaft is permitted to revolve, the solidified slushing compound will fall off from the liners, drive gearing, and valve mechanism parts. Absence of protective compound on the liners and other parts may, in case of prolonged erection, result in corrosion on the liner face, cams, or other parts.

Care must be taken during erection to avoid:

a) damaging the protecting compound layer on any slushed surfaces (restore the slushing if disturbed);

b) destroying the painting of engine parts.

Immediately coat with enamel all points where the original painting has been damaged. If there is any corrosion, remove it as described below.

Before starting the recommissioning check the following items:

a) see that the water-, oil-, fuel-, and air starting system (the latter if used), as well as the storage battery and the current-and-voltage regulator, are connected to the engine in the right way.

b) Check the slushing record to see which type of protective compound has been used for slushing, and for what a period it has been applied.

To recommission an engine which has been subjected to a six-months slushing proceed as follows:

1. At the moment when the recommissioning begins remove the factory seals to be found at the manifold flanges, water and oil inlet nozzles, etc., except these which are to remain in place. Leave intact, in particular, the seals at the following points:

Oil pump relief valve (one)
Fuel pump (four)
Fuel supply pump (one).

2. With a soft brush or with rags wetted with Diesel fuel remove the slushing compound from the outer surfaces, and wipe the latter to dry state.

3. Remove the slushing grease from the fan and fan

drive outer surfaces. Wash both pulleys, driving and driven, as well as the friction plates in the driving pulley, with gasoline or kerosene.

4. Let the fluid run down.

Check to see that the V-belt grooves are washed satisfactorily.

5. Install the belts, and adjust their tension.

6. Remove all wrapping paper, labels, plywood covers (for manifolds), plugs, etc., from the engine parts and units.

7. Screw out the drain plugs from the crankcase oil pan (at the rear sump near the flywheel housing and at the front sump to the left of the crankcase).

8. Warm the engine by pouring into the cooling system, through the filler neck, hot water of 90 or 95°C into which 0.3 per cent of potassium bichromate or 1 per cent of sodium nitrate has been added. If none of these chemicals is available, at least pure boiled water should be used for warming the engine. (The above salts are applied in order to prevent corrosion).

In winter, when the engine is quite cold, the cylinder blocks should be warmed with water the temperature of which is gradually raised from 40 to 95°C. It is best to warm the engine with the help of hot circulating solution running down continually through the water pump drain valve.

Less potassium bichromate or sodium nitrate will be spent if the solution flowing from the drain valve is returned into the tank where the water is being heated.

At least 6 or 7 hours are required for complete warming of the engine to be recommissioned.

It is allowed to carry out the warming by pouring hot solution into the cooling system, followed by draining it and replacing by a new portion every 5 or 6 minutes. The solution must be removed from the engine before its temperature falls to 65°C. This method requires 9 or 10 hours.

A tarpaulin or a plywood hood can be placed over the engine to speed up the warming process by reducing the heat losses into the surrounding air.

Warming in winter can also be accelerated by pouring 6 to 9 kg of hot aviation oil of 100 or 110 °C into the engine through the breather, followed by draining it. This should be repeated every 3 or 5 minutes for a total of 30 to 40 minutes.

Under no circumstances should any attempt be made to recommission the engine by blowing it outside with steam, or by admitting steam into the cylinder block, without filling the cooling system with solution.

Corrosion will appear without doubt on the engine parts if steam is used for recommissioning.

9. While the engine is being heated, drain the slushing compound through the oil pan plugholes. This compound can be reused for future slushing.

10. Three or four hours after the recommissioning has begun, give the crankshaft one or two turns by hand in both directions. Then rotate it with the starter motor for 5 to 8 revolutions to remove as much of the slushing compound from

the combustion chamber, cylinder liners, and crankcase, as possible.

Don't turn the crankshaft with the starter without rotating it previously by hand, otherwise breakage may occur in the engine as a result of large grease accumulations in the combustion chamber.

11. After the warming is completed remove the remainder of protective grease from the engine outer surfaces. Use for this rags wetted with Diesel fuel. Then wipe the engine with clean dry rags, and re-install the drain plugs in the oil pan.

12. Connect the exhaust pipe to the engine, and align the latter as described in a foregoing chapter. Couple the engine with the driven equipment, and attach to it the air cleaner.

Finally prime the engine accessory systems with fuel, oil, and water, in accordance with instructions given herein. Check the fastenings holding the engine and the driven unit to the frame.

VII. FUEL, OIL, WATER, AIR

1. FUEL

Diesel fuel, USSR Standard ГОСТ 4749-49 or ГОСТ 305-42, should be used in the given engine.

Running it with any other fuel grade is not permitted.

Diesel fuel is made either as summer ("ДЛ"), or as winter grade ("ДЗ"). Summer grade should be used at ambient temperatures not below +5°C. As soon as the air temperature falls below +5°C, change over to winter fuel. The latter can,

however, be applied in summer as well. If the engine is to run at ambient temperatures below minus 15°C, add tractor kerosene to the winter fuel in the following proportion:

25 per cent kerosene for temperatures from -15°C to -25°C;
50 per cent " " from -25°C to -35°C;
75 per cent " " below -35°C

The kerosene should be mixed up with the fuel before the latter is filled into the engine tank.

2. OIL

Reliable operation of the engine and its service life depend highly on the quality of the lubricating oil applied and on regular replacement of used oil by fresh one. The fresh oil must be free of solid particles, water-soluble acids and alkalies, and of moisture as these, if present, will cause corrosion of engine parts, affect normal operation of working parts, binding, or breakage in the mechanisms. Mineral aviation oil should be used for lubrication of the engine, according to the following Schedule.

Application of any other oil grades is not allowed.

LUBRICATING SCHEDULE FOR SUMMER AND WINTER

Application Points	Lubricant Grades		Lubricating Intervals
	Summer	Winter	
Oil tank and crankcase	MK-22 or MC-20 Aviation Oil, ГОСТ 1013-49	MC-14 Aviation Oil, ГОСТ 1013-49	Daily check oil level in tank. Change oil in lubricating system every 100 hours of engine operation.
Fuel pump	MK-22 or MC-20 Aviation Oil, ГОСТ 1013-49	MC-14 Aviation Oil, ГОСТ 1013-49	Check oil level every 50 hours of running. Add oil to overflow pipe connection level.
Fuel pump governor	MK-22 or MC-20 Aviation Oil, ГОСТ 1013-49	50% MC-14 Aviation Oil, mixed with 50% winter Diesel Fuel	Add to level plughole every 50 hours of running.
Remote control gear drive	Aviation Oil	Aviation Oil	Every 500 hours.
Fan pulley (driven) bearings	"Solidol" grease	"Solidol" grease	Every 500 hours flush pulley cavity with

gasoline through hole in pulley, then pour 150 to 180 grammes of hot grease (80 or 90°C) into pulley, or squeeze into it cold grease from grease gun.

NOTE: Grade MT-16П Oil, ГОСТ 6360-52, Tentative Specifications BTY449-55 and BTy 615-57, may also be used, for summer as well as for winter operation.

3. WATER

It is recommendable to use in the engine cooling system an emulsion consisting of water and "Emulsol" cutting oil. To prepare the above emulsion proceed as follows:

Warm clean river- or rain-water to +60 or +70°C. Then mix it with Grade "A" or "B" Emulsol Oil, USSR Standard ГОСТ 1975-43 in a proportion of one litre of Emulsol per 60 or 70 litres of water. In case neither river- nor rain-water is available, well water may be used, but this must be boiled for 15 or 20 minutes and left to precipitate before it is used for the emulsion.

In the course of service, every 20 hours of running or so, add one litre of water into the system to make up evaporation losses.

"Emulsol" should also be added, 0.2 litre about every

200 hours of engine operations, i.e. every time after 10 litres of water have been added. The intervals at which the water and Emulsol additions must be made varies, however, with the actual operating conditions.

If there is no "Emulsol" at hand, the engine may be run with clean river-, rain-, or well-water, but the cylinder liners and jackets will then be subjected to more intensive corrosion.

In case of long-time shutdowns a recommended measure against liner and jacket corrosion consists in flushing the jacket space with clean water, drying it, and filling with hot aviation oil. The oil can then be drained, and the engine may be left so for the entire standstill period.

The cooling system of such an engine should later, before starting, be flushed with hot water.

Antifreeze or other special compounds may be used in the cooling system during winter operation.(For details of their application refer to Chapter IX).

4. AIR

The air which enters the engine cylinders should be fairly clean. Dust, if drawn with the air into the cylinders, will cause premature wear of the piston rings and liner bore.

Dust penetrating into the oil will speed up the wear of the crankshaft journals and accesory drive components.

Where the air contains much dust, special attention should be paid to regular removal of dust from the air cleaner, otherwise the engine may get out of condition long before the guarantee period expires.

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VIII. STARTING PREPARATIONS, STARTING, OPERATION, AND STOPPING

1. PRIMING THE ENGINE WITH FUEL, OIL, AND WATER

Filling the Fuel Tank

To avoid penetration of dirt or water into the fuel system, fill the fuel tank only through a funnel equipped with a wire gauze strainer or covered with double silk linen or flannel.

All priming accessories should be kept clean and be used only for priming.

Prime the tank with fuel several hours before you start the engine, to give the fuel time enough to precipitate. Just before starting drain the water and sediment from the tank sump.

Filling the Oil Tank

Pour oil into the tank only from a closed container and through a strainer funnel with a fine gauze strainer (of No.60 wire gauze). Don't fill up the tank completely, as a margin of volume is necessary in it, in view of possible foaming.

Fill the tank to not more than 80 per cent of its volume, or to the mark on the dipstick, if provided. There must be at least 30 litres of oil in the tank to ensure reliable running of the engine.

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Lubricating the Fuel Pump and
Remote Control Mechanism

Fill oil into the fuel pump to the level of the overflow nipple connected to the overflow pipe. Pour also oil into the fuel pump governor to the level plughole. Squirt 20 ccm of aviation oil into the gear drive housing through the hole in its top.

Filling the Cooling System

Use water for engine cooling in compliance with instructions given in Chapter VII of this Book. Use only clean containers for priming the cooling system. Pour the water into the system through a strainer funnel only. At the beginning of filling drain some water from the water pump and radiator drain cocks to make sure that the system is in normal condition. It is advisable to make up losses only as the water evaporates, and not to change the water fully. This will reduce scale deposits.

2. INSPECTING THE ENGINE BEFORE STARTING

Prior to starting the engine inspect the entire power plant installation and see whether it is ready for starting. To check this proceed as follows:

Fuel System

Check the fuel level in the tank. See that there are no leaks in the joints. Check the condition of all levers and rods connected to the fuel pump governor lever. Check the

position of the marks on the fuel pump claw coupling against the data stated in the engine report form.

Lubricating System

See whether the oil tank is filled. Inspect all joints for absence of leaks . See whether the grease cups on the clutch housing seal cover and on the clutch control fork shaft are full of grease. Check the oil level in the fuel pump and in its governor.

Cooling System

Check the water supply in the cooling system. See that no leaks appear at the piping joints, between cylinder head and liners, between cylinder block and crankcase, or from the tell-tale holes in the cylinder block walls and water pump. See that all hose clamps are tightened well.

Intake Pipe

Inspect the joint between the engine intake manifold and the air cleaner.

Air Sparting System

Check the air pressure in the starting air bottle and the condition of the air piping system. The air pressure should be at least 45 kg per sq.cm in summer and 65 kg per sq.cm in winter.

Storage Batteries and Starter Motor

Turn on the "Body" switch, and check the battery voltage. This should be at least 23V, the normal value being 24V. Check the wire fastenings at the starter motor and batteries. Test the starter motor action.

Visual Inspection of the Engine

Inspect the engine visually, paying special attention to the fastenings of the accessories to the engine and of the engine to its frame.

Start the engine only after all troubles and defects revealed by the inspection are positively eliminated.

3. STARTING THE ENGINE

The engine is equipped with an air starting system and with an electric starter motor. The electric starting system is the main one, the air starting device being provided for emergency purposes only.

To start the engine proceed as follows:

1. Open the shut-off valve at the fuel tank.

2. Release all air from the fuel pump and filter.

This should be done by building up in the system a pressure of 0.2 or 0.3 kg per sq.cm by means of the hand pump, followed by opening the bleeder cock and permitting fuel to flow out until air bubbles discontinue to appear.

3. Open the oil tank shut-off valve.

4. With the hand oil pump build up a pressure of at least 2.0 kg per sq.cm in the lubricating system. If the oil is

cold, cut out the oil radiator with the help of its valve.

5. Set the fuel feed control a lever in a position giving somewhat more feed than for stable idling.

6. Start the engine.

Using the Electric Starter Motor

a) Press the starter button, and keep it so for 2 or 3 seconds.

b) As soon as the engine begins to fire, release the button.

c) Make the engine run at its minimum stable idling speed (500 to 600 r.p.m.), and fix the fuel feed control lever in this position.

Using the Air Starting Device

a) Open the bottle valve, and bring up the air pressure in the distributor inlet line to a value not exceeding 90 kg per sq.cm.

b) With a quick motion open the by-pass valve.

c) After the engine has begun to fire, close the by-pass valve and the bottle valve.

d) Adjust a minimum stable idling speed of 500 to 600 r.p.m., and fix the fuel feed control lever in this position. The air pressure at the distributor inlet should be within the following limits, to ensure reliable functioning of the air starting device: not more than 90 kg per sq.cm., and not less than 45 kg per sq.cm. in summer and 65 kg per sq.cm. in winter.

4. WARMING UP THE ENGINE

Having started the engine, watch the instrument readings. The oil pressure in the main distribution line should within one minute after starting reach at least 2.0 kg per sq.cm at minimum speed.

The engine must be well warmed up after starting, in order to bring all parts of the engine, as well as the water and oil in it, to the required temperature. The engine should be warmed gradually, uniformly,at idling speeds from 600 to 800 r.p.m.,followed by a gradual transition to a speed within 1000 and 1100 r.p.m. The engine should then run so until the oil outlet temperature reaches 45°C, and the water outlet temperature 50 or 55°C.

Applying any load to the engine can be permitted only after it has been warmed up to the above temperatures.

Warming up the engine at speeds higher than 1000 to 1100 r.p.m. is not allowed.

Only a short-time acceleration test at higher speeds, not exceeding several seconds, is permitted during the warming-up period.

The engine speed should be raised and reduced gradually only.

5. RUNNING THE ENGINE UNDER LOAD

The normal service performance of the engine is 150 Hp at 1500 r.p.m.

Change the engine speed smoothly.- Watch the instrument

readings while the engine is running. The following readings should be kept at normal running conditions:

Oil outlet temperature: recommended +80 to +90°C
max.allowable +95°C

Water outlet temperature: recommended +70 to +85°C
max.allowable +95°C

Oil pressure after filter, at normal running conditions: 6 to 9 kg per sq.cm.

NOTE: Should the oil pressure after the oil filter fall below 6 kg per sq.cm, or the oil and water temperatures rise abruptly while the engine is in operation, stop it immediately, investigate the cause, and eliminate it.

6. STOPPING THE ENGINE

Sudden stopping of the engine while running at rated performance or near to it, is not permitted, as the result might be dangerous heating of the engine.

Prior to stopping the engine bring down its speed to within 600 and 800 r.p.m., and let it run idle until it cools down to a water outlet temperature within 55 and 70°C in summer, or 70 and 75 °C in winter (read by the dial thermometer).

After the engine has cooled down to the above temperatures, slowly swing the fuel feed control lever into the zero feed position. In summer close the oil tank and fuel tank shut-off valves, after the engine is fully stopped.

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IX. SPECIAL RULES ON WINTER OPERATION

1. PREPARING THE ENGINE FOR WINTER SERVICE

"Winter operation" should be understood as operation of the engine in open air, or in non-heated premises, at ambient temperatures below +5°C. The following winter operation rules should be observed, to ensure easy and reliable operation of the engine in winter:

1. Use winter grade Diesel fuel or, at ambient temperatures below minus 15°C, a mixture of Diesel fuel and tractor kerosene (see under "Fuel" in Chapter VII.)

2. Use Grade MC-14 lubricating oil. The summer oil should be fully removed from the lubricating system before winter grade is poured into it.

3. Use the following lubricants in the fuel pump: MC-14 oil in the pump body and a 1:1 mixture of MC-14 oil and Diesel fuel in the governor housing.

4. Whenever possible, apply "Antifreeze" or other special mixtures in the cooling system, instead of water.

2. PRIMING WITH OIL AND WATER OR ANTIFREEZE

Oil Priming Rules

Pour into the oil tank only oil heated to within 80 and 100°C.

Pour into the engine crankcase, through the breather hole, 5 or 6 litres of hot oil to warm the oil pipes in the oil pan and the oil pump. The oil quantity filled into the oil tank should be correspondingly less. See, while pouring the oil, that neither water, no snow gets into it.

Prime the cooling system simultaneously with the oil system.

Priming with Emulsion or Water

Before you begin to pour water into the cooling system, open the drain valves at the water pump and radiator. Then pour into the cooling system 3 or 4 pails of water warmed to 60°C (which the hand can just withstand). After this continue the filling with hot water of 80°C, until hot water begins to run from the drain valves and the water pump casing becomes fairly warm. Now close the drain valves, and fill up the cooling system with hot emulsion or water. The filling should take place uninterruptedly, to avoid freezing in the cooling system or water pump.

Priming with Antifreeze

The following anti-freeze mixture can be recommended: 55 per cent ethylene glycol and 45 per cent of water.

The above mixture will ensure reliable running of the engine at low ambient temperatures. It may be left in the cooling system during prolonged shutdowns at temperatures as low as minus 30°C.

The following rules should be strictly observed if anti-freeze is used:

1. When filling the cooling system with antifreeze, pour into it 5 or 6 litres less of this fluid, than in case of water, because antifreeze increases intensively its volume when heated.

2. Warm the antifreeze to 80°C in a closed container before pouring it into the engine. Fill up the cooling system completely, when priming it with hot antifreeze.

If the antifreeze quantity in the cooling system

becomes less as a result of evaporation (but not of leaks), add clean water to the normal level.

3. Check the quality of the antifreeze every 25 or 30 hours of engine operation.

4. While the engine remains in service, watch the condition of hoses installed within the cooling system, as antifreeze dissolves rubber. Immediately replace all damaged hoses.

5. See that the temperature of the antifreeze in the cooling system does not exceed 90°C.

6. In case of long-time shutdowns at ambient temperatures below minus 30°C, drain the antifreeze from the cooling system.

7. At ambient temperatures down to minus 15°C the cooling system can be filled with hot antifreeze without circulating the latter through the drain valves.

8. The following procedure can be recommended for filling the cooling system with antifreeze after prolonged shutdowns at ambient temperatures below minus 30°C.

a) Warm the engine by running through the cooling system 10 to 15, and at very low temperatures 20 pails of hot antifreeze.

b) Gradually increase the temperature of the antifreeze circulated through the cooling system, from 25 or 30°C to 70 or 80°C.

c) Close the drain valves, and fill up the cooling system with hot antifreeze of 80 or 90°C.

Remember that antifreeze is a poison which may cause

heavy accidents, and even death, if getting into the human alimentary canal.

Special Mixtures

The following mixtures, consisting of alcohol, glycerine, and water, may be adopted for use in lieu of antifreeze:

Mixture proportions			Freezing Temperature, °C
Water, %	Alcohol (Denaturated), %	Glycerine, %	
60	30	10	-18
45	40	15	-28
43	42	15	-32

Alcohol evaporates first in the course of engine operation. For this reason a mixture of 50% water and 50% alcohol only should be added into the cooling system.

The mixture must obligatorily be drained before prolonged shutdowns, if the ambient temperature is lower than the freezing temperature.

3. STARTING THE ENGINE

It is strictly forbidden to turn the engine crankshaft in winter until the engine has been duly pre-warmed with hot water and hot oil.

Under no circumstances should any attempt be made to start the engine which is not warmed to the necessary degree. Starting and loading the engine should be carried out in compliance with instructions contained in Chapter VIII.

It is not allowed to run the engine with water- and

oil outlet temperatures below +45°C, otherwise gum deposits will appear on the engine valves, pistons, and liner walls.

4. STOPPING THE ENGINE

In case of prolonged standstill drain fully the water from the cooling system and the oil from the lubricating system. The water should be drained only after its temperature falls to 50 or 55°C. Oil, on the contrary, should be drained immediately after the engine is stopped.

To drain the water open the drain valves at the water pump and radiator. Let these valves remain open after the water has run out.

It is good practice to give the crankshaft several revolutions without fuel feed after the water has been drained, the drain valve being open, to make positively sure that no water is left inside the engine.

X. CARE AND SCHEDULED INSPECTIONS

Daily and sheduled inspections are obligatorily as long as the engine is in service.

Three types of sheduled servicing procedures are established in addition to routine care, namely:

No.1 Servicing, to be executed every 100 hours of running, consisting in washing the engine filters, accessories and accessory systems, changing the oil, and checking the fastenings.

No.2 Servicing, to be carried out every 500 hours of running. This includes all operations of No.1 servicing, plus

checking the engine and accessory adjustments, and care of the electrical equipment.

No.3 Servicing, required every 1000 hours of running. It includes lapping the valves, in addition to procedure No.2.

A deviation not more than ±10 hours against the specified intervals of servicing is permitted.

Troubles appearing in the engine should be remedied without waiting till the next scheduled servicing or inspection.

The engine should be dismantled and dispatched to a repair shop, after its guaranteed running period has expired.

Note. The engine may be in serviceable condition after the guarantee period, if good care was offered to it. The decision about its fitness for future operation without overhaul should be set up by corresponding executives of the User's engineering staff. Manufacturer's guarantee do not pertain to operation of the engine after the official guarantee period.

1. LIST OF MAIN SERVICING OPERATIONS

Daily Care

Before starting the engine check the following items:

1. Oil level in oil tank.
2. Water level in cooling system.
3. Level and specific gravity of fuel in fuel tank.
4. Free and even movement of fuel feed control lever.
5. Tightness of air cleaner and intake manifold

joints.

Inspect the following:

1. Fuel and oil piping, for absence of leaks.
2. Electric wiring system. (Tighten terminal nuts, where necessary).
3. Fastenings holding accessories to engine. Tighten all loosened nuts and bolts.
4. Air starting system - for tightness and for adequate air pressure in bottles.
5. Engine to frame fastenings.
6. Absence of blow-by at exhaust manifold flange. Tighten nuts on connection bolts if blow-by is observed.
7. Condition and fastening of oil-resistant rubber hoses in cooling system piping. Eliminate leaks found there.
8. Tension of fan belts. Adjust it, if necessary.

All defects revealed should be eliminated before the engine is started again.

Having started the engine, check the following:

1. Absence of leaks in the oil-, fuel-, and water piping joints, as well as of air inflow in the intake joints.
2. Functioning of the engine instruments.
3. Absence of abnormal knocking, caused by failures in the engine, during the warming-up period. Should knocking appear, stop the engine and eliminate the cause.
4. Absence of excessive vibration of the power set after application of load to the engine. Such effect might

result from loosening of the bolts holding the engine to the frame, or from misalignment between the engine and the driven equipment.

Examine the following points:

1. Cylinder head to block jacket joint, to make sure that no exhaust gases blow by past the gasket.
2. Telltale holes in cylinder block and block-to-crankcase joint, for absence of oil and water leaks.

No.1 Servicing. In addition to the daily care work described above, every 100 hours of engine operation perform the following:

1. Check the engine fastenings.
2. Wash the oil filter.
3. Check fastenings of the fuel pump, generator, and other accessories, also the fuel feed advance angle setting and the fastenings of the fuel pump drive unit.
4. Add oil (to the level plughole) into the fuel pump governor housing.
5. Wash the main oil duct and the oil tank, replace the fine filtering element, and change fully the oil in the lubricating system.
6. Disassemble the air cleaner, and remove all dirt and dust from its packing holders, then re-assemble and re-install it. Subject the cleaner to such a procedure every day, if the engine is running in dusty air.
7. Check the battery voltage and the specific gravity

of electrolyte.

8. Tighten the nuts at the intake and exhaust manifold studs.

9. Check condition and tightness of the bolts holding the fan rotor to the driven pulley.

10. Fill the tachometer drive housing with "Konstalin" grease. This should be done by unlocking and unscrewing the plug provided for this, followed by filling the drive housing with grease and by reinstalling and re-locking the plug.

NOTE: The last operation can be carried out every 200 running hours.

No.2 Servicing. Every 500 hours of engine operation perform all work required for No.1 Servicing and, in addition, do the following:

1. Wash the fuel strainers (before the fuel supply pump), drain the sediment from the fuel tanks or tank, and flush the tanks and all fuel lines.
2. Remove the scale from the cylinder block jacket space, and flush the cooling water system.
3. Check condition of the generator and of the current-and-voltage regulator (in accordance with instructions given below).
4. Remove the starter relay front cover, and inspect the contacts. Clean them if burnt.
5. Check the valve timing.
6. Check the fuel feed advance setting of the fuel pump.
7. Check the fuel injector adjustment by testing both

injection pressure and spray quality. If necessary, clean restricted orifices and adjust the injectors.

6. Check the tightening of the cylinder block anchor- and through studs.

9. Check the alignment of the engine with respect to the driven machine.

10. Wash the driven fan pulley cavity with kerosene, and pack it with fresh grease. (150 to 180 grammes required).

11. Check the coupling flange fastening on the shaft. Pull tight the nut holding the flange on the shaft, if necessary.

12. Pour 20 ccm of aviation oil into the remote control gear drive.

No.3 Servicing. This is to be undertaken every 1000 hours of engine running.

In addition to all steps prescribed for No.2 servicing, proceed as follows:

1. Lap the valves, if their fit to the seats in the cylinder head is affected.

2. Check the fuel pump adjustment.

3. Inspect the fan drive slip coupling, fan belts, and driven pulley bearings.

2. CARE OF THE FUEL SYSTEM

Proper and well timed care of the fuel system will ensure dependable operation of its equipment. It must be borne in mi-

that the main cause of premature wear and unserviceability of the fuel system accessories is dirty fuel, usually being the result of poor care to the fuel system. In case the fuel pump, injectors, or fuel supply pump get out of order, remove them from the engine and have them repaired in a specially equipped shop.

Clean the fuel filter of dirt, and wash it, every 600 hours of engine operation.

The sediment accumulating in the filter cup should be removed in the course of routine servicings.

To wash the fuel filter proceed as follows:

1. Unscrew the nut at the top of the filter head, and take off the cup with the filtering element from the filter head attached to the bracket.
2. Extract from the cup the filtering element, seal ring and spring, and wash the filter cup in Diesel fuel.
3. Clean the filtering element, remove the outer strips, and rinse it in assembly in gasoline or kerosene.
4. Disassemble the filtering element, take off the filter discs, and wash them in two changes of gasoline or kerosene, then squeeze them out.
5. As far as possible, note those sides of the discs, which were directed towards the inlet spacers before disassembly.

   Rinse the cardboard spacers in gasoline or kerosene.
6. Wash the strainer cage with the jacket in clean gasoline or kerosene.
7. Re-assemble the filtering element. Do this in the following order:

   a) Slip the inlet cardboard spacer (with four slots on

the outer circumference) onto the strainer cage.

b)Slip onto the cage a felt disc.

c)Put onto it an outlet cardboard spacer (having four slots on the inner circumference).

d)Slip the next felt disc onto the filter cage.

Continue the assembling work by repeating the above steps (a, b, c,and d) in sequence. An important condition is that the projecting teeth provided on the outer circumference of the inlet and outlet spacers be in a common plane.

As far as possible, place the felt discs in the same position as they occupied before disassembly, i.e. so that the same side of each disc which faced towards the inlet spacer before the element was taken apart, points towards it afterwards.

8. Place the assembled filtering element in the filter cup, nut down (towards the seal ring located above the spring), and attach the cup to the filter head.

9. Air may penetrate into the fuel system while the latter is being filled anew with fuel after the flushing. This may cause starting difficulties and affect the normal performance of the engine. To force out the air from the fuel system, pump into it fuel with the priming hand pump until the engine runs reliably.

3. CARE OF THE LUBRICATING SYSTEM

While the engine is running, the oil in it becomes diluted by fuel seeping into the crankcase and contaminated by fume, carbon, dust, and particles separating from wearing parts.

This is why the oil must be completely changed at regular intervals, if the engine is to run satisfactorily.

Change the oil in the lubricating system and replace the cardboard filtering element in the oil filter every 100 hours of engine operation.

Drain the old oil from the oil tank and crankcase immediately after the engine has been stopped, i.e. while the engine has not yet lost its heat and the oil is still warm. It is advisable to flush the oil tank and pipes after the used oil has been drained, to have them as clean as practically possible. In the event that the engine runs in dusty atmosphere, obligatorily flush the tank and pipes with fresh hot oil after the old one has been drained. Having completed the flushing, pour fresh oil into the lubricating system. Every 50 hours of running add oil into the fuel pump to the overflow connection level, and into the pump governor to the level plughole.

Every 100 hours of engine operation clean the oil filter of dirt and wash it. Proceed for this as follows:

1. Unscrew the clamping stud screw.
2. Remove the filter cover with its rubber gasket.
3. Pull out the coarse (metal-edge) filter section by its handle.
4. Extract the fine filtering element, likewise using its handle for this.
5. Remove the cover plate from the fine filtering element. Previously remove three cotter pins holding it in place.
6. Take out the cardboard filter element from its jacket.

7. Having disassembled the filter, remove all dirt from the filter body, coarse filter section, and fine filtering element jacket. Wipe them with clean dry rags, and rinse them in kerosene or Diesel fuel.

8. On completion of the washing, place a new cardboard element in the fine filtering element housing. Then put the cover plate in place, and fix it there with the cotter pins.

9. Re-install the fine oil filtering element into the filter body.

10. Install the filter cover with its seal ring in place, and secure it with the clamping stud screw.

4. CARE OF THE COOLING SYSTEM

Every 500 hours of engine operation flush the cooling system, and remove the scale from the cylinder block jacket space. To clean the cooling system of scale use a solution of 1 kg soda ash and 0.5 litre of kerosene per pail (10-litres) of water. Fill the cooling system with this solution. Then start the engine and let it run 20 or 25 minutes at a speed within 800 and 1000 r.p.m. Leave the solution in the system for two hours, after which start the engine again for another 20 or 25 minutes. Then, having stopped the engine, drain the solution. Now fill the cooling system with clean soft water and again warm up the engine, followed by its stopping and draining the water. After such a cleaning procedure fill the engine with clean and soft water for further operation. In winter pay particular attention to the

cooling system and strictly follow all winter operation rules. Don't tolerate any leaks in the cooling system joints. All rubber hoses should be held tightly by their clamps. If replacement of the rubber hoses becomes necessary, see that the inner diameter of the new hose corresponds to the outer diameter of the pipes to be connected.

5. CARE OF THE AIR CLEANING EQUIPMENT

Cleanliness of the air entering the engine cylinders is in direct dependence on proper care of the intake air cleaner. The latter should therefore be regularly cleaned of dust and washed. The following procedure should be used for this:

1. Disconnect the air cleaner from the engine, and take it apart.
2. Clean the hopper of dust, and wash it thoroughly.
3. Rinse all parts of the cleaner in Diesel fuel, wipe them, and let them dry out. Particular care should be used to duly clean the dust rejector cones.
4. Wash the filter packing holders (without removing the wire wool from them).
5. Re-assemble the holders, and dip them for 5 or 10 minutes into fresh or used lubricating oil. Then take them out and let the oil run down.
6. Wipe the cleaner head, and install in it the holders.
7. Re-assembled the air cleaner, and attach it to the engine. Prior to the reassembling examine the felt seal rings to be sure about their condition, and coat

them generously with "Solidol" type grease.

See that there is a circular contact trace on the seal rings. This should be visible along the entire circumference, to ensure tightness of the joints between the cleaner parts being connected, and thus to prevent inleak of dusty air into the engine.

Care should be taken, when assembly the air cleaner, not to leave any misalignment of its parts, and to have tight joints between the cleaner body and its head and hopper, as well as between the cleaner head and the engine intake manifold.

When installing the cleaner on the engine see that the fastening bands grip it tightly. Felt gaskets, 2 to 4 mm thick, may be placed between the cleaner and bracket to ensure their tight fit.

A liner of wood should be placed under the cleaner hopper. Hanged mounting of the air cleaner on the running engine is not allowed.

6. CARE OF THE FAN

Removing and Re-installing Fan and Fan Drive

Full dismantling of the fan and of its drive is required in case of:

a) disassembling the engine for repair purposes,

b) replacement of fan drive housing,

c) replacement of entire fan drive by new one.

Full dismantling of the fan with the drive unit is possible only after the engine is lifted from its frame.

Having done this, proceed as follows to disassemble the fan drive and fan:

1. Back off for one or two turns the jam nut at the fan shaft nut.
2. By turning out the adjusting screw for 8 or 10 turns, loosen the fan belts.
3. Remove the fan drive belts from the driving pulley.
4. Turn the driving pulley by hand so as to make its threaded holes register with the holes in the thrust plate. Then screw two M8 x 45 mm bolts into the holes. Screw them in until the dowel, which fastens the thrust plate to the shaft, becomes free.
5. Drive out the dowel, and take off the driving pulley together with the thrust plate, friction disc, and spring.
6. Unlock nine cap screws holding the rear friction disc, screw them out, and remove the friction disc.
7. Unlock eight cap screws fixing the fan drive seal cover, screw them out, and remove, together with the seal cover, the fan drive with the ball bearing and spring shaft.
8. Separate the front beam together with the driven pulley and fan from the drive housing.
9. Unscrew the fan drive body fastening nuts. Disconnect the pipe from the oil filter, and remove the drive body and its gasket from the engine crankcase studs. Also remove the rubber rings from the oil passage nozzles.

The dismantling can be considered completed as far, if

no further disassembly of individual fan or drive components is required.

Having washed the parts with gasoline or kerosene, examined them, located their defects, and replaced by new ones, begin to re-assemble the units. Proceed as follows:

1. Slip the rubber rings onto the crankcase oil nozzles. Place a "Paronite" asbestos gasket onto the crankcase face, and guide in place the fan drive body over the crankcase studs. Screw onto the studs the drive body mounting nuts, and lock them by bending up the lock-plate lugs. Connect again the oil filter pipe.
2. Install on the fan drive body the front beam with the driven pulley and fan.
3. Lubricate the fan drive shaft and bearing with aviation oil. Place a gasket on the fan drive body, and the protecting disc (plate) into the drive body bearing. Insert the fan drive spring shaft into the crankshaft extension end. Then insert the fan drive shaft, together with the seal cover, seal, and bearing held on the shaft by its nut, into the fan drive body.
4. Fasten the seal cover to the fan drive body with its eight cap screws, and secure these with lockwire.
5. Re-install the friction disc on the fan drive shaft, and fasten it with the nine cap screws. Tie the latter with lockwire.
6. Coat the working surfaces of the fan drive shaft and driving pulley sleeve with grease or aviation oil, and slip onto the shaft the driving pulley assembly

with the thrust plate, friction disc, and springs. Check to see that the driving pulley revolves smoothly around the fan drive shaft.

7. Drive the dowel into the shaft. Screw out the M8 x45 mm auxiliary bolts, and watch to see that the thrust plate rests against the shaft dowel without misalignment.

8. Install the fan drive belts on the driving pulley, and by means of the adjusting screw give them the required tension.

9. Screw the nut and the jam nut onto the fan shaft. Check the fastening of the fan to the driven pulley flange.

Servicing the Fan and Fan Drive Parts

(to be carried out without removing the fan).

Replacing and Installing Fan Belts

To replace worm belts act as follows:

1. Back off the driven pulley shaft mounting nuts and release the adjusting screw as described above.

2. Remove, one by one, the belts from the driven and driving pulley. Be careful not to distort the fan blades, while doing this.

3. Select three new V-belts which differ from each other in length by not more than 2 mm.

4. Wash the pulley grooves with gasoline or kerosene, and let the fluid run down.

5. Slip the belts, one after another, onto the fan pulleys. With the help of the adjusting screw adjust

the belt tension, then secure the fan shaft to the front beam.

The belt tension must not be excessive. With correct tension of the belts, the driven pulley should obligatorily slip if a torque of 3 to 3.2 kg/m is applied to the fan rotor.

Dismantling the Slip Coupling in the Driving Pulley

(To be performed every 1000 hours of running).

To disassemble the slip coupling act in the following way:

1. Remove the fan belts from the driving pulley (as outlined above).
2. With the aid of M8 x 45 mm bolts remove the driving pulley together with the thrust plate, friction disc, and springs. For details see above.

   NOTE. The thrust plate can be pressed off by hand, without the back-out bolts, if sufficient force is used.
3. Unscrew both back-out bolts, remove the thrust plate and the friction disc, and extract the nine springs from the driving pulley.
4. Unlock nine cap screws holding the other friction disc on the fan drive shaft. Unscrew these cap screws, and remove the shaft disc.

Rinse the slip coupling parts and sub-assemblies in gasoline or kerosene, and inspect the disc and pulley contact surfaces.

There should be no deep notches, pits, or other defects on these surfaces. No considerable wear should be visible on the friction disc linings. The thickness of each friction disc must not be less than 8.5 mm.

If the friction disc lining rivets are loose, strike them tight by light hammer taps through a special snap tool. Cracked rivets must be replaced.

Check the diameters of the fan drive shaft and driving pulley sleeve. The diameter clearance between these parts should not exceed 0.135 mm in a new pulley, and 0.3 mm after repair. Replace broken springs.

To re-assemble the slip coupling proceed in reverse order:

1. Slide the friction onto the fan drive shaft, screw the nine cap screws in place, and tie them with lock-wire.
2. Slip the pulley onto the fan drive shaft. Coat previously the pulley sleeve bore with aviation oil. Then insert nine springs into their seat holes in the pulley body, and guide the other friction plate onto the pulley dowels.
3. Put the thrust plate onto the fan drive shaft, and with its help compress the springs, either by hand or by means of the auxiliary bolts mentioned above, to permit inserting the dowel which will hold the thrust plate on the shaft.
4. Place the fan belts on the driving pulley, adjust their tension, and secure the fan shaft in place.

NOTE: The slip coupling in the driving pulley should be taken apart only if any failures are observed in the fan operation. Disassembling it in a normally operating fan is not obligatory.

7. CHECKING TDC

1. Remove the access hole cover on the cylinder head guard, take out the fuel injector of cylinder No.1, and install a timing gauge in the injector seat hole.
2. Press down the timing gauge by hand and, while turning slowly the crankshaft forward, watch the gauge pointer. When the piston comes into its TDC position (in which the gauge pointer ceases to move), turn back the crankshaft to 5 or 10 divisions on the timing gauge scale, and note the pointer position on the timing gauge and at the flywheel scale.
3. Now turn the crankshaft forward, until its pointer reaches the TDC position and returns to the formerly marked point. In this new position make again a mark on the flywheel scale against the pointer.
4. Divide the arc between both marks on the flywheel scale into two halves, and place a third mark in the middle of the arc. By turning the crank shaft (in forward direction) so as to make the pointer on the flywheel housing register exactly with the last mark, you will bring the piston in cylinder No.1 into its top dead centre.

To ascertain yourself that the result is correct, repeat this checking several times.

8. CHECKING AND ADJUSTING FUEL FEED ADVANCE ANGLE

The original setting of the fuel feed advance angle in the engine may become disturbed during operation, as a result of loosening of two bolts holding the fuel pump coupling flange to the coupling claw plate, or of the clamping bolts securing the coupling on the pump drive shaft.

The position of the mark on the coupling flange and claw plate should therefore be checked at regular intervals and compared with the data registered in the engine report form.

Should any change be detected in the position of these marks, unlock and screw out the bolts connecting the coupling flange with the claw plate, replace their lockplates and lockwire, and restore the required position of the timing marks. The bolts mentioned above should be screwed tight, otherwise the failure may repeat.

9. CARE OF THE ELECTRICAL EQUIPMENT

General

The following rules should be observed while operating the engine with its single-wired equipment:

1. Turn on the battery ("Body") switch only just before starting the engine.
2. Keep all electrical equipment and instruments perfectly clean.

3. Regularly check the condition of all terminals and contacts to which any cable lugs are attached. Tighten the terminals if loose.

4. Protect the wiring against any injury which might cause short-circuit.

5. See that neither fuel nor oil can get onto the electrical equipment units, instrument panel, or wires, as this might affect the contact at the terminals or damage the wiring insulation.

6. If any of the power consumers is inoperative, remedy the trouble by checking the corresponding fuse in the consumer circuit and the consumer unit itself, as well as the respective tumbler switch controlling the given unit. Also check the wiring connections throughout all inoperative circuit sections.

7. Never use discharged storage batteries to start the engine by means of the electric starter motor, as this might result in melting of the starter relay contacts or in racing of the starter motor.

The storage batteries should be kept fully charged all the time. Easy starting of the engine and normal functioning of all electrical equipment depends widely on this factor.

8. Turn off the battery ("Body") switch at every long-time stopping of the engine, at inspections and maintenance of the electrical equipment and wires, at fuse replacement at overcharging symptoms

(gassing) in the storage batteries, and in case of any dangerous failures in the electrical equipment system.

9. Carry out all servicing procedures as recommended for the electrical equipment items.

CARE OF THE ELECTRICAL EQUIPMENT

Type Г-73 and Г-731 Generators. Care of the generator consists in regular watching of its operation and in routine maintenance whenever necessary.

Routine maintenance includes blowing the commutator and brushholders with air, replacing worn brushes, grinding or machining the commutator surface, and changing the lubricant in the bearings.

1. To blow out the commutator and the brushholders remove the protecting band and blow them with air, by means of a bellows.

2. As soon as an inspection of the brushes reveals that their height became less than 20 mm, replace them by new ones taken from the individual set of spares.

When installing new brushes, wear them in to the commutator so that at least 2/3 of the brush face is in contact with the commutator surface.

The new brushes, which should be Type М-20, should have the following dimensions: width = 8 mm, length = 20 mm, and height = 25 mm.

3. If the commutator surface shows signs of burning, clean it with a rag slightly moistened in gasoline,

or grind it with No.00 glass paper.

A considerably worn or burnt commutator must be restored by machining in a lathe. The generator must be fully disassembled for this.

A minimum layer only should be removed from the commutator when machining it. The runout of the commutator surface after this should not exceed 0.03 mm.

Having finished the turning operation, clean the grooves between the commutator bars, and remove all burrs from the bar edges.

If the surface was turned to a considerable depth, cut off the mica isolation between the commutator bars 0.8 to 1 mm deep.

4. Change the grease in the generator bearings at least once in 1½ or 2 years, irrespective of the number of running hours passed, as the grease loses its qualities after such a time. Each fresh grease charge in the bearings is adequate for 2000 hours of generator operation.

Before changing the grease take apart the generator, wash the ball bearings in gasoline, and let them air-dry.

"Konstalin" grease (USSR Standard TOCT 1957-52), or any other suitable ball bearing grease, such as Grade "Ts", or "1-13", TOCT 1631-52, may be used for the generator bearings.

Worm bearings must be replaced. A No.206 ball bearing (USSR Standard OCT 6121-39) is installed at the commutator end, and a No.306 one of the same standard at the drive end.

To check the generator assembly test it by running it idle with the engine, or run it in a special test stand at an armature speed of 2700 r.p.m.

The generator should take not more than 18A at 24 Volts.

Current- and Voltage Regulators. These require only regular watching of their operation and routine maintenance at intervals as necessary. The latter includes such work as cleaning the contacts in the voltage regulator, overcurrent relay, and reverse-current relay, and re-adjusting these instruments.

Badly worn contacts should be replaced by new ones taken from the individual set of spares. The following contacts should be used, in particular: No.1- МГ-86 tungsten bottom contact with screw in the voltage regulator, and No.РРС-10-999 silver contacts, upper and bottom, in the overcurrent and reverse-current relays.

Voltage Regulator. Clean the regulator contacts cautiously with a needle file until all burning traces, ripples or pits, are removed from their surface.

The adjustment, to be carried out after the contacts are cleaned or replaced, should give the following result: the voltage maintained by the regulator at a current load of 48A, should be within 27.5 and 28.5 Volts.

The voltage regulator should be adjusted at a generator speed of 3000 r.p.m., the overcurrent relay contacts being wedged dead, and the storage batteries switched off.

To adjust the regulator, change the tension of its armature springs. This should be done with the help of the eccentric device provided for this. A locking screw must be released first.

Prior to the spring tension adjustment bring the clearance between armature and core to a magnitude of $2(\pm 0.2)$mm. This should be done with the help of the upper contact screw with the tungsten contact.

The Overcurrent Relay should be set for a current limit within 53 and 58A at a generator speed of 3500 r.p.m., with voltage regulator contact wedged and storage batteries disconnected.

The adjusting procedure is here the same as for the voltage regulator, i.e. a clearance of $2(\pm 0.2)$ mm is first established between the armature and core, and then the spring tension is to be adjusted by means of an eccentric device locked with a screw.

The Reverse Current Relay is likewise adjustable by changing the armature spring tension with the help of an eccentric device. The clearance between armature and core should here be within 1.7 and 2.2 mm, and the contact gap within 0.6 and 1.0 mm. The reverse current relay should close within 25 and 27 volts, and open at a reverse current within 2 and 8 amperes.

Starter Motor and Starter Relay. The starter motor care consists in regular watching of its operation, and in routine maintenance work, the latter to be performed in case of

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necessity.

The following rules should be observed while the engine is in service:

1. Before you use the starter motor, first prepare the engine carefully for starting. This will save the storage battery and the starting equipment.
2. Press the starter button not longer than for 5 or 6 seconds. After every starting attempt make a pause of 7 to 10 seconds, to let cool down the starter motor, and to preserve the storage batteries.
3. After two or three futile starting attempts inspect the engine and eliminate its defects before you start it again.
4. Should the starter pinion fail to get out of mesh with the flywheel ring gear after the engine has fired (which is evidenced by a specific sharp gear noise), immediately turn off the battery ("Body") switch.
5. Don't engage the starter while the engine is running, as this would result in shearing off the starter pinion teeth by the flywheel ring gear.
6. At daily inspections check the fastenings of the starter motor and starter relay, as well as the condition of the wiring connections of the terminals.
7. At least once in three months inspect the commutator and the brushes and blow the commutator and the brushholders with air (from a belows) to remove dust from it. If the commutator surface is dirty, wipe it with a clean rag wetted with gasoline, and check the fit between brushes and commutator. In case of

considerable burning symptoms on the commutator surface grind it with No.00 glass paper, after which wipe it with a rag slightly moistened with gasoline.

8. At least once a month, or every 250 hours of engine running, inspect the starter relay contacts. Grind the contacts with glass paper, if burnt. Remove only the projecting metal particles, when doing so, and don't scratch the flat faces of the fixed contacts and the curved surfaces of the moving ones. Having completed the grinding, remove all metal dust. To inspect and grind the relay contacts detach the relay from its mounting base, and open the cover with the terminal screws.

9. Every 1½ or 2 years, irrespective of the number of engine running hours passed, change the grease in the tail bearing and inside the pinion shaft. Disassemble the starter motor, wash its parts in gasoline, and let them dry, after which use a grease grade as recommended for the generator bearings ("Konstalin," "FCA", or "1-13").

10. Should a necessity arise in renewing the lubricant in the starter slip coupling, coat the friction plates with Grade "15" stearine-graphite lubricant containing 15 per cent of s dim, soap.

The above grease has the following composition:

Stearine	112.5 parts (by weight)
Industrial tallow	37.5 parts
Machine oil	850.0 parts
Caustic soda	25.0 parts
Graphite	150.0 parts

Under no circumstances should a badly discharged storage battery be used for starting the engine, as this might result in ruining the starter by fusion of the starter relay contacts.

Such fusion of the relay contacts occurs most in case of burnt or misaligned contacts (the latter after repair). Intensive destruction of the even contact surface takes place at the moment when the starter control button is released while heavy currents are to be broken, which flow through the relay contacts during slow rotation of the flywheel by the starter motor if the engine has failed to fire. Slow starter rotation when turning the engine crankshaft, or even its full braking, may occur in case of starting attempts with badly run down batteries, or if the engine is not properly prepared for starting (or defective).

The fully-closed contact voltage increases if the surface of the relay contacts is uneven (burnt), because the rolling of the moving contacts along the fixed ones meets then difficulties in the form of increased friction. For this reason, the electro-magnetic force developed by the "PC" relay winding at the moment when the starter is being switched on, will prove insufficient to fully compress all relay springs combined with overcoming the contact rolling resistance. The result is that the contacts remain poorly pressed to each other.

Incomplete closing of the contacts at the moment of switching-on, i.e. incomplete deflection of all relay springs, may cause fusion of the contacts, due to the fact that after the "PC" starter relay coil has been switched off, the resilient force of the incompletely compressed springs cannot afford to break the welded contacts, and the latter remain closed.

With closed contacts of the PC-400 starter relay, the starter pinion can not get out of mesh with the flywheel ring gear after the engine has fired, and this will destroy the starter motor armature by racing.

If the engine fails to start by means of the starter motor, and the relay contacts remain closed, the starter motor may be damaged in case the engine will be started by another method (with compressed air, in particular).

Should welded contacts be detected in the Type PC-400 starter relay, immediately turn off the battery ("Body")switch, and eliminate the cause of the trouble.

The storage batteries are shipped discharged and without electrolyte. To bring them into serviceable state fill them with electrolyte (which is battery grade sulphuric acid diluted with distilled water). The electrolyte should have a specific gravity of 1.1[illegible] at 15°C. Then give the battery two or three charge-and-discharge cycles. The battery can be considered as ready for use if, after the second or third charge with a 10-hour current (11.2A) it gives up at least 90% of its nominal capacity (nominal capacity for the given discharge rate is 117 A.Hr). If so, the battery may be put into normal service.

The following rules on battery operation should be

observed:

1. Every 10 or 15 days check the battery charge by measuring the specific gravity of electrolyte in it (see Table below) and the battery voltage under load. If a battery proves discharged to half its capacity, have it recharged in a charging station.

   The battery discharge degree can also be determined with the aid of the volt-and-ammeter readings. The more discharged the battery, the more is the changing current. The latter is about 15A if the battery is fully charged, but may rise to 55A in a discharged battery. The current should be checked 10 or 15 minutes after the generator has been put into action.

2. Irrespective of the battery charging degree, every 30 or 35 days have it charged in a station with 8A current until both voltage and specific gravity remain constant.

3. Keep up the normal level of electrolyte by adding distilled water into the battery cells. In winter charge the batteries after such water additions. Adding electrolyte or acid into the cells is forbidden, except if it is positively known that the level of electrolyte become low as result of its spilling. In such case fill the elements with battery acid diluted with distilled water to a density exactly the same as of the remainder of electrolyte in the cells.

4. Keep the battery clean. Regularly clean the vent holes in the plugs and wipe off all dust and dirt with a clean rag. Every 15 days wipe the battery surfaces and

the asphalt compound filling points with a clean rag wetted in 10 per cent ammonia solution, after which wipe it dry with another clean rag.

Also lightly coat the battery terminals and the cable lugs connected to them with a thin layer of commercial petrolatum or grease. Remove oxides from the terminals, and clamp tightly the cable lugs.

5. In winter ensure reliable winterizing and heating of the storage batteries. While warming up the engine by running it idle, maintain such a crankshaft speed as to make the engine generator charge the batteries.

A battery in which cracks appear in the sealing compound should be dispatched to a repair shop.

Under no circumstances should the battery terminals be direct connected for "spark testing".

Watch to see that the specific gravity of electrolyte is as specified in the Table below.

Depending on the ambient temperature increase or reduce the specific gravity.

It should be borne in mind that the data given in this Table can be applied only if both specific gravity and level of electrolyte in the cells were kept normal as long as the engine was operating. If the temperature of the electrolyte exceeds 15°C by more than 5°C, make a temperature correction, basing on the fact that a temperature rise of 1°C decreases the specific gravity of battery electrolyte by 0.0007, and vice versa.

Specific Gravity of Electrolyte at Various Charging Degrees:

Charging Degree	Sp.Gravity of Electrolyte, at 15°C	Freezing Point of Electrolyte, °C
Fully Charged	1.285	-74
3/4 Charged	1.255	-54
½ Charged	1.225	-40
Fully Discharged	1.166	-16

XI. ENGINE TROUBLES, THEIR CAUSES AND REMEDIES

Trouble Symptoms and Causes	Remedies
1. Engine Fails to Start	
1. No fuel delivered by fuel pump.	
a)Fuel tank shut-off valve closed, fuel can not reach supply pump.	a)Open shut-off valve.
b)Fuel tank empty.	b)Fill tank with fuel.
c)Air trapped in fuel system. (Air bubbles appear after fuel pump plugs are unscrewed).	c)Release air from fuel system as described in Chapter VIII, Paragraph 3.
d)Fuel line or filter restricted. (No fuel runs from fuel pump plugholes after their opening).	d)Clean the fuel line and wash it.

Trouble Symptoms and Causes	Remedies
2.Engine not warmed up sufficiently.Check this by dial thermometer readings or by feeling the wall temperature of the jacket, cylinder block,and cylinder head.	Drain the cooling system and fill it with hot water of 70 or 80°C.
3.Electric starter motor unable to develop sufficient speed.	a)Check condition of starter motor and battery charge.Have the battery recharged in a shop if insufficiently charged. b)Start the engine by means of the air starting system.
4.Air starting system failures:	
a)Insufficient pressure of starting air.	a)Check air pressure in starting bottle.It should be at lest 45 kg per sq.cm in summer and 65 kg per sq.cm in winter.
b)Starting valves carbonized or binding.(Symptom: slow rotation of crankshaft during starting.)	b)Unscrew valve caps, and check moving freedom of starting valves. Remove valves in case of binding,and eliminate it.

Troubls Symptoms and Causes	Remedies
2. Engine Fires but Stalls after First Revolutions	
1. Air trapped in fuel system. Misfiring and bright exhaust observed in cylinders. Air bubbles appear in fuel coming from fuel pump plugholes.	Release air from fuel system as described in Chapter VIII, Paragraph 3.
2. No fuel delivered by fuel supply pump. Fuel will not flow into filter when crankshaft is rotated.	Check to see whether fuel flows to the supply pump. If not, remove the pump and inspect it. Replace the pump if any part is broken in it.
3. Fuel pump inoperative. (Discharge valves bound).	Check the pump operation. Replace bound discharge valves without detaching the pump from the engine.
3. Engine Lacks Power	
1. Insufficient fuel feed by fuel pump, caused by:	
a) Disadjusted control rods transmitting motion from fuel feed control lever or pedal to fuel pump arm.	a) Adjust rods so that gap of 0.2 or 0.3 mm is left between fuel pump arm boss and lower stop screw when pedal or lever is depressed full way.
b) Changed fuel feed advance angle.	b) Set normal angle of fuel feed advance. (Marks on fuel pump

Trouble Symptoms and Causes	Remedies
	coupling should be in position specified in engine repair form.)
2.Fuel pump inoperative. Test it as follows:	
a)With engine running at minimum stable speed disconnect one after another the injector feed lines from the fuel pump nipples. If no fuel flows from the nipple, this means that the given pump section is disabled (piston stuck, piston spring broken, ring gear to revolving sleeve clamping screw broken, etc).	a)Remedy the trouble without removing the fuel pump from the engine. If this can not be achieved, detach the fuel pump and have it repaired in a shop. Adjust the repaired pump for equal fuel feed by all its plungers.
b)Disconnect the fuel lines from the fuel pump, and with the hand pump build up a pressure in the fuel system (or crank the engine by hand). Continuous flow from any of the pump nipples evidences breakage of the discharge	b)Replace broken valve springs and defective valve-and-seat sets (with the fuel pump in place).

Trouble Symptoms and Causes	Remedies
valve spring or of disrepair of the valve-and-seat set.	Renew.
3.Fuel injector failure. To find out inoperative injectors run the engine at half load (1000 to 1200 r.p.m.) and cut out the injectors one after another. For this slightly unscrew the coupling nuts connecting the fuel injector line to the pump. The tachometer will indicate a drop in the crankshaft speed, which also can be heard, if an acting injector has been cut out. On the other hand, if a defective one is disengaged, no change will be observed in the engine operation and in the crankshaft speed in particular.	Remove the defective injector or injectors, and have them repaired in a suitable shop. Install serviceable injectors in the engine. Injectors troubles and remedies: 1.Spring broken. Replace the spring. 2.Atomizer needle sticking. a) Try to eliminate the sticking. b) Replace the spray tip and needle set. 3.Spray tip orifices clogged. Clean the orifices. 4.Needle and spray tip considerably worn. Replace both.
4.Fuel not conforming to USSR Standard [illegible] 4749-79.	Change the fuel.
5.Insufficient fuel flow to fuel pump,caused by restricted fuel	Wash the fuel filter.

Trouble Symptoms and Causes	Remedies
filter.	
6.Air cleaner clogged.	Wash the air cleaner.
4.Engine Smoking	
1. Load applied to engine without warming it up sufficiently.(Check dial thermometer readings).	Warm up the engine according to instructions. (See Chapter VIII).
2.Fuel injectors considerably dribbling or failing to deliver fuel evenly as result of needle binding. (Black exhaust).	Replace defective injectors.
3.Fuel feed advance angle decreased.(Check position of marks on fuel pump coupling.)	Bring marks into position shown in engine report form.
5. Engine Knocking	
1.Load applied to engine not warmed up sufficiently.(Knocking heard in all cylinders).	Warm up the engine according to instructions. (See Chapter VIII)
2.Wrong setting of fuel feed advance angle.(Check position of marks on fuel pump coupling.)	Bring marks into position shown in engine report form.
6. Engine Hunting	
1.Uneven fuel feed into engine	If speed fluctuation exceeds

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Trouble Symptoms and Causes	Remedies
cylinders by fuel pump. (Engine speed varying, jerks can be observed.)	50 r.p.m., remove the fuel pump, and have it serviced in a special shop.
2.Misfiring in engine cylinders, caused by injector failures.	Replace defective injectors.
7. Engine Racing	
Governor inoperative, or fuel pump rack binding.(Engine accelerates quickly without the driver's intervention. Speed exceeds allowable limit and continues to rise quickly.)	Immediately stop the engine as follows: 1.Close the fual tank valve. It should, however, be borne in mind that this alone will not stop the engine at once, because the fuel filter and pump are full of fuel. 2. Load the engine. Have the fuel pump repaired in a special shop.
8. Oil Pressure Less than 6 kg per sq.cm Read by Pressure Gauge	
1.Lack of oil in oil tank.	Add oil
2.Air inleaks in lubricating system.(Pressure pulsates).	Tighten all joints.
3.Poor oil quality, or oil diluted with fuel.	Change the oil.
4.Oil pressure gauge not in order.	Replace the gauge.
5.Oil filter restricted.	Wash the oil filter.
6.Oil temperature too high, as result of engine overload.	Reduce the load and let the engine cool down. If the oil overheating repeats, stop

Trouble Symptoms and Causes	Remedies
	the engine, investigate the cause, and remedy the defect.
Fan and Fan Drive	
1.Fan friction coupling discs slipping.(Driven pulley speed remains unchanged when driving pulley speed is increased).Possible causes:	
a)Friction surfaces oily.	a)Remove the driving pulley,and rinse the friction discs in kerosene or gasoline. Then let the fluid run down, and reassemble the friction coupling.
b)Coupling springs broken or relaxed.	b)Replace the spring by new ones. Place washers under relaxed springs.
c)Friction discs considerably worn.	c)Check condition of friction discs. If the wear has not yet reached the rivets, place washers under the coupling springs. In case the rivets began to wear out, replace the linings.
2.Friction coupling running hot, due to:	
a)Oil penetration onto the friction disc lining.	a)Disassemble the fan drive unit and check the condition of the seal.
b)Driving pulley sleeve binding on fan drive shaft.	b)Remove the driving pulley,and dress both fan drive shaft and sleeve.Clearance between shaft and sleeve should not exceed 0.14 mm.

Trouble Symptoms and Causes	Remedies
c)Relaxed coupling springs.	c)Replace the springs, or add washers under them.
3.Oil leaking from under the driving pulley, due to:	
a)Worn seal or shaft.	a)Replace the seal.
b)Ball bearing spoiled by overtensioning of belts.	b)Replace the ball bearing. Adjust the belts tension.
4.Oil leaking from under the fan drive shaft plug, due to:	
a)Insufficient tightening of fan drive shaft plug.	a)Tighten the plug until the leakage discontinues.
b)Considerable distortion of copper gasket under plug.	b)Replace the gasket by a new annealed copper gasket. Screw the plug tightly in place. No leakage is permitted after the plug is finally tightened.
5.Fan belts badly worn, due to:	
a)Belt overtension.	a)Replace worn belts with new ones, and adjust properly the belt tension.
b)Use of belts not suitable for the fan drive (of other type, insufficient length, etc.)	b)Install fan belts recommended by the engine Manufacturer.
6.Bearing overheating in driven pulley, due to:	
a)Lack of grease.	a)Pack the bearing with grease.
b)Bearing defects.	b)Replace the bearing.

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Trouble Symptoms and Causes	Remedies
c)Fan belts slipping.	c)Adjust the belt tension and check the fan shaft fastenings.
7.Considerable vibration of fan, caused by:	
a)Loosened front (fan) beam to engine frame fastening.	a)Check tightening of front beam bolts, and tighten these by pulling down the nuts full way, if necessary. Don't forget to lock the nuts after this.
b)Loosened fastenings holding fan rotor to driven pulley.	b)Tighten nuts on fan rotor fastening bolts.
c)Loosened fan fastening.	c)Check fan shaft fastening. Pull down nut and jam nut full way.
d)Poor balancing of fan rotor. (Blades bent, poor workmanship of blade fabrication, etc.)	d)Balance the fan rotor. Maximum unbalance 135 g/cm allowed.
8.Fan inoperative although engine is running, due to:	
a)Unserviceable fan belts.	a)Replace the belts.
b)Fan drive spring shaft out of condition.	b)Disassemble the fan drive and replace the spring shaft.
Remote Control Mechanism	
1.Reversible motor refuses to rotate when remote control button is depressed. Probable causes:	
a)Wiring defects.	a)Eliminate the defects.

Trouble Symptoms and Causes	Remedies
b)Misalignment of motor with respect to reduction gear.	b)Check to see whether motor armature runs evenly when turned by shaft end. It should rotate freely under hand force. Re-align the motor, if necessary, until it runs freely.
2.Motor rotates, but remote control mechanism does not slide, due to slippage in friction coupling.	a)Check position of slide (see Fig.3.).If this is pressed to its stop, let the motor run in reverse direction to bring it into its initial position.
	b)Check all levers and shafts for absence of jamming. Eliminate any binding found there.
	c)Safety coupling spring may be broken.Open the reduction gear, inspect the safety coupling, and replace the spring or other parts, if worn.
3.Reduction gear running hot, due to:	
a)Lack of oil in gear housing.	a)Pour 20 ccm of fresh oil into the gear housing.

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Trouble Symptoms and Causes	Remedies
b)Safety coupling slippage.	b)Eliminate slippage as described above.

APPENDICES

Appendix No.1.

RULES ON KEEPING RECORDS IN REPORT FORM

The engine report form is the document where all information about operation, repair work, and servicings of the engine should be registered.

As long as the engine remains in service, all data concerning operation, maintenance, and inspections of the engine, washings of the air cleaner, oil filter and fuel filter, oil changes in the lubricating system, and adjustments of the valve mechanism, air starting equipment, and fuel feed advance angle, should be noted down in the report form.

Entrances should be made in the report form in the following cases:

1. After completion of the engine at the factory, and after its commissioning by the User.
2. After every scheduled servicing.
3. After every, even minor, repair.
4. When handing over the engine to the repair shop.
5. On completion of each overhaul.
6. At every breakdown.

The records should be comprehensive, without any marks or corrections. Data about the number of running hours passed should be entered immediately after completion of work.

The correctness of the records made in the report form should be checked by the personnel in charge of the engine operation.

Appendix No.2.

DOCUMENTS TO BE FORWARDED TO THE USER WITH EACH MODEL V1?6-150 ENGINE

The following documents are shipped with each engine:

1. Engine Report Form.
2. Manufacturer's Reports and certificates of all engine accessories purchased from other Manufacturers (electrical equipment, instruments, fuel pump, fuel supply pump).
3. Model V?6-150 Engine Operating Instructions.

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Appendix No.3.

LIST OF TOOLS AND ACCESSORIES FOR MODEL V156-150 ENGINE

Description, Size, and Drawing No.	Application
32 mm Wrench, No.330-100-4	Anchor stud nuts.
17 mm Socket Wrench, No.330-122-3	Air starting device clamp; lubricating system elbow fitting clamps; middle nut of camshaft bearing cap; fuel pump coupling fastening bolts, etc.
9x11 mm Engineer's Wrench, No.333-131-1	Water pump drain cock; hose clamp nuts at oil and fuel lines; starting air pipe clamp nuts; oil pipe to cylinder head fastening bolt.
Screwdriver, No.330-138	Starting air pipe clamp screws; fuel pipe clamp fastening screws. All other small screws.
11x14 mm Socket Wrench, No.330-148-3	Oil pump to oil pan holding nut; fuel pump to crankcase bracket fastening bolt, and others; generator coupling clamp screw; injector spring adjusting nut; oil pump body clamping bolt nuts; central handhole cover nuts; crankshaft end seal sleeve nut, etc.
24x27 mm Engineer's Wrench, No.330-163-1	Air distributor cap; oil tank line to fuel supply pump connection nipple; fuel pump suction line connection; oil pan front drain

Description, Size, and Drawing No.	Application
	nipple nut; starting valve body; oil pan rear end drain plug.
19 mm Socket Wrench, No. co. 330-327-2	Fuel pump coupling clamp bolt nut, etc.
10 mm Pin Handle, No.330-125-1	
8 mm Pin Handle, No.330-723	
22x24 mm Engineer's Wrench,No.330-738A	Fuel pump inlet line coupling nut; oil pan front drain nipple; fuel supply pump elbow fitting clamps.
17x19 mm Engineer's Wrench,No.330-739A	Fuel filter clamping nut and plug; fuel pump discharge nipple, etc; oil pump relief valve body; vertical shaft oil supply elbow clamps; cylinder head vent pipe clamp; air distributor cap inlet line clamp; fuel line coupling nipple and nut; fuel pump oil drain line clamp; fuel filter fastening nut.
22 mm Socket Wrench, No.330-788-2	Fuel supply pump elbow clamps; also, where possible, all items mentioned for No.330-738A wrench.
32x36 mm Engineer's Wrench;No.430-240	Oil pump and oil filter elbow clamps; crankcase drain plug, etc.
Timing Gauge, No co. 330-179	Finding TDC of engine pistons. (One per lot of up to 10 engines shipped

Description, Size, and Drawing No.	Application
	to same User).
Special Wrench, No.330-27-4	Fuel injector hold-down nuts.
Jacket, M c6.330-04	For fuel pump lines.
Bag, M c6.330-321-3A	For tool kit and spares.
Puller, M c6.330-867-1	For removing fuel injectors.
Feeler Gauge, No.530-70	For checking clearance between cam relief and valve.
10x14 mm Socket Wrench, No.330-152-1A	
Wrench, No.330-132	For camshaft nut.
Wrench, M c6.330-175-1	For screwing on valve shank heads.

Appendix No.4.

LIST OF UNITS AND PARTS SHIPPED WITH ENGINE BUT NOT INSTALLED IN IT

Description	Part or Assembly No.	Quantity
Storage Battery (6-CT or 6-CTK-180M)	538-58-1	4
Drive End Piece	538-49	2
Battery Wire, Short	C6.538-03-1	2
Wire, Current-and-Voltage Regulator to Engine "Body"	C6.538-04-2	1

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Description	Part or Assembly No.	Quantity
Wire, Current-and-Voltage Regulator to Generator Shunt	C6.538-09-2	2
Wire, Generator-to-Current-and-Voltage Regulator	C6.538-10-2	1
Battery Wire, Long	C6.538-15	2
Current-and-Voltage Regulator, Type PPT-24	538-28-1	1
Body Switch, Type PB-404	538-30	1
Plug, Type MR-51	537-182-1	1
Air Cleaner	C6.536-03	1
Bracket	536-10-1	1
Clamping Bolt	536-19	2
Gasket	536-20	1
Air Cleaner Fastening Band	C6.536-02-1	2
Fan Belt	514-24-1	2
Compression Screw	301-59	3
Suction Pipe	34-04-69 C6.	1
Hose	34-04-162	1
Clamp	34-04-163	2
Gasket	34-04-223	1
Water Radiator Assembly	08550	1
Oil Radiator Assembly	09370	1

Appendix No.5

LIST OF INSTRUMENTS AND ELECTRICAL EQUIPMENT

Name	Type (Model) and Specifications	Quantity per Engine
Electric Tacho-meter Set	T33, electric, remote, comprising AC Tachometer Generator and Speed Indicator, measuring range up to 3000 r.p.m.	1
Pressure Gauge	Aircraft type, measuring range 0 to 15 kg per sq.cm	1
Dial Thermo-meter	Remote, measuring range 0 to 125°C	2
Combination Volt-and-Ammeter	BA-240, with external shunt, current range 20-0-60A, voltage scale 0 to 30 V	1
Current-and-Volt-age Regulator	PPT-24, Electro-magnetic	1
Starter Relay	PC-400, Electro-magnetic	1
Starter Button	KC-31	1
Battery Switch	BB-404, Mechanically operated	1
Receptacle	MP-51	1
Plug	MB-51	1
Fuse Block	B3-30	2
Fuses	MB-50, for 50A current	1
	MB-20, for 20A current	1

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Appendix No.6

INDIVIDUAL SET OF SPARE PARTS AND UNITS
FURNISHED WITH EACH ENGINE

Description	Part or Assembly No.	Quantity per Engine
Spherical Washer (for Fuel Pump Mounting Bolt)	301-53	1
Lockplate (for Fuel Pump Fastening)	301-55	4
Seal Ring	301-161	1
Seal Ring	303-10-2	12
Cylinder Liner Seal Ring (Lower)	303-12	6
Compression Piston Ring	3304-06-2	12
Oil Control Piston Ring (Tapered)	304-08-3	6
Injector Hold-down Nut	306-71	2
Woodruff Key (for Fuel Pump Camshaft)	308-90-P1	1
Valve Spring, Large	306-65-3	1
Valve Spring, Small	306-66-2	1
Fan Belt	514-24-1	6
Gasket	413-94-1	2
Fuse, MB-20	538-23	3
Fuse, MB-50	538-24	3
Seal Ring	308-57-1	1
Valve Disc (for Drain Valve Stem)	311-34-2	2
Replaceable Filtering Element	C6.513-02-10	10
Cover Ring	313-17-2	4
Seal Ring	317-22	1
Fuel Injection	C6.317-60-3 B	3
Ferrule (for Cylinder Head Oil Drain Pipe Seal)	320-57-2	1

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Description		Part or Assembly No.	Quantity per Engine
Hose Clamp (for Water Pipe Connections)	Co.	321-04-1	1
Hose (for Water Pipe to Water Pump Connection)		321-20	2
Fuel Pump Discharge Line	Co.	523-06	1
Rubber Ring (for Fuel Pump Discharge Line Connection)		323-31-1	1
Washer (for Fuel Supply Line Connector Screw)		310-18-1	2
Discharge Valve, Complete	Co.	3327-08-1	2
Gasket, for Fuel Pump Connector Screw	Co.	3327-61-2	2
Discharge Valve Spring		3327-78-1	2
Gasket, for Bleeder Plug		327-86	2
Gasket		329-28-2	2
Gasket (for Fuel Filter Cup Drain Plug)		329-30	2
Gasket (for Filter Bleeder Plug)		329-31	2
Nut, M8 x 1.25 mm		351-02	10
Nut, M6 x 1 mm		351-06	5
Lockplate		553-04	6
Washer, 6 mm		353-04-1	5
Washer, 8 mm		353-05-1	3
Washer, 10 mm		353-07-1	5
Lockwasher, 6 mm		353-23	10
Lockplate		353-15	1
Lockplate		353-16-1	10
Lockplate		353-20	10

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Description	Part of Assembly No.	Quantity per Engine
Lockwasher, 8 mm	353-24	16
Cotter Pin, 2 x 20 mm	354-12	20
Cotter Pin, 3 x 25 mm	354-15	4
Ring, 12 x 16 mm	355-06	5
Ring, 14 x 20 mm	355-07	10
Ring, 18 x 24 mm	355-08	10
Ring, 24 x 30 mm	355-10	4
Ring, 16 x 22 mm	355-11	5
Ring, 22 x 30 mm	355-13	5
Fuel Pump Fastening Bolt	356-15	1
Seal Ring		
Set of Spare Parts for BHK-12-TK Fuel Supply Pump		1
Set of Spare Parts for P-73 Generator		1
Set of Spare Parts for PPT-24 Current-and-Voltage Regulator		1
Set of Spare Parts for CT-710 Starter Motor and PCT-20 & PC-400 Relays		1
Set of Spare Parts for Electric Tachometer Outfit		1
Cotter Pin	354-17	6
Pumping Element	C0527-07	1
Plunger Spring	3327-79-1	1

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Appendix No.7

[illegible] AND PACKING INSTRUCTIONS

General Requirements

Premises assigned for storage of engines should be dry, well ventilated and heated. The relative air humidity in these premises must not exceed 65 to 70%.

An air temperature within 10 and 30°C should be maintained in the premises. Daily temperature fluctuations must not exceed 5°C, and humidity fluctuations must be within the limits of 15%.

The storage room should be provided with a tight wooden, ceramic or xylolite floor. No corrosive gases or fumes should penetrate into the room where engines are stored. It is strictly forbidden to store in the same room with engines any materials or goods which might cause corrosion, such as acids, alkalies, chemicals, rubber products, storage batteries, etc.

Any liners or supports, if used for temporary or long-time storage of engines, should be made of dry lumber with a moisture content not over 18%, and should be kept clean. The use of parchment, paper soaked in wax, or of tracing paper, can be recommended as a separating layer between metal and wood surfaces.

The premises used for storing engines should be kept clean. Moistened sawdust should be used for sweeping the floor. Clean rags slightly dampened with oil may be applied for removing dust from the storage racks. Under no circumstances should the floor be swept while dry, or abundantly watered.

The engines must never be packed in damp or defective cases. The original Manufacturer's packing, if to be re-used

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[illegible] transportation of the engines, should be stored in-doors, in premises well protecting them from atmospheric precipitations.

Leaving the engines in the open air, even in cases, is strictly forbidden.

Storing the Engines.

Cases with engines should after arrival at the warehouse be cleaned of dust and dirt and brought into closed storage premises.

The cases should be opened the next day only, to give the engine time to attain the room temperature.

After uncrating inspect the engine thoroughly from outside. If the protective coating is damaged restore it. Wipe with clean dry rags all non-slushed surfaces, where moisture appears.

The engines should be stored without packing, and be placed on supporting blocks.

Engines received as a lot, or otherwise within 15 days, should be stored in separate groups and provided with tags indicating the dates of arrival, factory slushing and shipment.

It is strictly forbidden to rotate the engine crankshaft in the course of storage or inspection, otherwise the solidified slushing compound is liable to separate from the parts surfaces.

Once a month inspect all engines to detect any corrosion appearing on its outer surfaces. Where coating is missing, slush the parts additionally with gun grease.

Never touch the engine parts with dirty, damp or clammy hands, while inspecting or disassembling the engine. Wash your

hands thoroughly, and coat them with a thin layer of vaseline.

If corrosion is detected on any engine parts, remove it as follows:

1) From aluminium parts - by cleaning with a sandpaper.

2) From other parts - by grinding cautiously with fine emery cloth wetted with mineral oil.

Then wipe the cleaned surfaces, first with a cloth wetted with gasoline, then with clean rags, and coat them with gun grease.

Note: The gasoline used should be free of any anti-knock additives containing lead (B-10 products).

Checking Condition of Engines.

Six months after the day of leaving the Manufacturing Works (shown on the stamping tag attached to the engine) let 5 per cent selected arbitrarily from the total quantity of the engines stored undergo the following procedure:

1) Disconnect the high pressure pipes from the fuel pump and injectors, remove them from the engine, put them on clean wax paper, oil-cloth or linoleum, in a place protected from dust, and cover them with wax paper.

2) Wrap the pump and injector pipe connections with insulating tape, clean oil-cloth or other equivalent material.

3) Remove the valve mechanism cover, and see whether the valve mechanism is slushed on all visible surfaces, and whether any corrosion traces can be detected under the protective coating.

If corrosion is found, a statement should be drawn up by a special commission, and further measures be determined, to be applied to all engines stored, depending on the character

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and degree of corrosion.

If no corrosion is found on the engines inspected, the commission will decide, depending on the storage conditions, whether storing of the entire lot of engines is to be continued without reslushing till the next scheduled inspection, or reslushing is required.

Rubber parts and hoses must be protected against lubricants. If slushing compound, kerosene, Diesel fuel or gasoline gets onto their surface, remove it with a clean dry cloth.

Every scheduled inspection or reslushing should be entered in detail in the engine Report Form, and dated.

Preparing the Slushing Compound.

To prepare the slushing compound mix equal portions of gun grease and aviation oil. The quality of both should be certified by a laboratory, to make sure they are suitable for slushing. The components should be absolutely free of any acid or moisture.

Moisture present in the lubricants can be removed by heating the latter to 110 or 120°C for 1½ - 2 hours (until froth disappears).

A special clean container should be available in the storage room for preparing, dehydrating and heating the lubricants. Steam or electric current should be used for heating, as the lubricant is liable to carbonise when heated over an open fire.

The slushing compound recovered by draining in the course of the slushing procedure can be re-used.

Appendix No.8.

INSTRUCTIONS ON STORING AND CHARGING STARTER BATTERIES

Storing

New batteries, which have not yet been in service, should be stored in dry storage premises, preferably heated in winter. The batteries should be arranged on racks, in normal position. The cell plugs should be screwed tight. The sealing discs should remain in place, and the battery terminals be coated with petrolatum and wrapped with wax paper.

The storage period of batteries in dry state must not exceed two years.

Batteries which have already been in use should be treated as follows before there are put into the storage: they should be fully charged, the level and density of electrolyte be brought to the normal values, the cell covers be plugged, the battery surfaces be wiped dry, the terminals and intercell connections be cleaned and coated with petrolatum.

Batteries which are stored filled with electrolyte, should be charged up at monthly intervals with 8A current, and once in three months be subjected to a check-and-training cycle (see below under "Charging Batteries in Service").

The maximum storage duration allowed for batteries filled with electrolyte is one year.

Preparing the Electrolyte

Electrolyte can be prepared in a hard-rubber, stoneware, or glass container. Under no circumstances should any iron, copper,

or lead vessels be applied for this. The electrolyte should have a specific gravity of 1.120 at 15°C, and should be produced by pouring battery grade sulphuric acid (USSR Standard ГОСТ 667-41) into distilled water, and never vice-versa.

NOTES: 1. Remember, when checking the specific gravity of electrolyte, that the specific gravity decreases by 0.0007 if the temperature rises by 1°C, and vice versa. 15°C is generally accepted as a reference temperature.

2. Under no circumstances should commercial (non-battery) sulphuric acid be used in the batteries.

3. If no distilled water is available, melted clean snow, or rainwater may be applied, provided that the latter is not collected from iron roofs nor in ferrous metal containers.

The prepared electrolyte should be cooled down to 25 or 30°C before it is poured into the battery cells.

First Charge and Discharge

1. Begin to charge the battery only 4 hours after the cells have been filled, and be sure that the temperature of the electrolyte does not exceed 35°C at that moment. The level of electrolyte in the cells should be 3 to 5 mm above the hard-rubber protecting plate.

2. The first charging, as well as all following ones, should be carried out in two current steps. 1st-stage current is to be used for charging to a voltage of 2.4 at the terminals

of most of the cells. After this the current is to be reduced, and the charging to be continued and completed with 2nd-stage charging current.

The 1st-stage current to be used for initial charging of the given battery is 8A, and the 2nd-stage current is 4A. The total charging time is from 50 to 75 hours.

3. While charging the batteries, see that the temperature of the electrolyte inside the cells does not rise above 45°C. Should it exceed this limit, reduce the current, or switch it off for some time, to bring down the temperature of electrolyte to within 35 and 40°C.

4. Should the electrolyte level fall in the course of the charging, make it up to normal (3 to 5 mm above protecting plate) by adding distilled water only, and not any acid or electrolyte.

5. Having started to charge a battery every 3 or 4 hours check and note in a record book the voltage at individual cells (measured under the charging current), as well as the specific gravity and temperature of electrolyte. Later, when the charging nears its end, measure the above values every hour.

6. The end of the first charging with 2nd-stage current can be determined by abundant gassing in all battery cells, and by the specific gravity of electrolyte and voltage in all cells remaining constant for two hours.

If the specific gravity of electrolyte at the end of the first charging does not exceed 1.2400 to 1.260, don't change it anyway. Should it, however, go higher, bring it down to within 1.2400 and 1.260 by drawing off some electrolyte from the cells,

and adding distilled water instead.

The specific gravity correction should be made without interrupting the charging current. Care should be taken to observe exactly the charging completion symptoms mentioned above in this Paragraph.

7. Upon completion of the 1st charging, let the battery undergo a continuous discharge with 11.2A (10-hour discharge rate).

The discharging should be discontinued as soon as the voltage in at least one of the cells falls to 1.7V.

8. During the discharge cycle every 2 hours check and enter in the record book the cell voltage, current starting and interrupting time, and specific gravity and temperature of electrolyte at the end of the discharging cycle. Make these checkings hourly at the end of the cycle.

Second Charge and Discharge

9. The second charge, and all following ones, should be conducted with the following two current stages: 1st stage - from 16 to 24A, 2nd stage - 8A. The total quantity of ampere-hours varies within 200 and 240.

NOTES: 1. Changing over to 2nd stage charging current should take place as soon as the cell terminal voltage reaches 2.4 V in most of the cells.

2. For temperature of electrolyte at the end of the second charging refer to Paragraph 3 above.

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3. The end of the [illegible]
by the cryptos [illegible]

4. The 1-st step charging should be [illegible]
with 1A current, as a rule only [illegible]
ordinary cases, when the battery [illegible]
charged most quickly, it may [illegible]
current values up to 2A.

10. At the end of the 2nd charging and of all succeeding ones, the specific gravity of electrolyte should be brought up to the normal value of 1.209 (at 15°C).

The specific gravity should be adjusted without interrupting the charging current. This can be done by drawing off some of the electrolyte from the cells with the help of a syringe, and adding in its place either battery acid of high gravity if the electrolyte gravity is below 1.209, or distilled water in case it exceeds 1.209.

Having achieved the necessary specific gravity, [illegible] time to charge the battery for another 10 or 15 minutes, after which re-check the specific gravity and, if necessary, repeat the operations described above.

11. After the 2nd charging is completed and the specific gravity of electrolyte is brought into the [illegible] let the battery undergo a continuous discharge with a current of 11.2A (10-hour rate). All readings [illegible] made and recorded, as stated in Paragraph 8.

12. If the battery gives up at least 90% of [illegible] its nominal capacity in the second discharge cycle, [illegible] nominal capacity [illegible] (10-hour discharge) [illegible]

it can be put into normal service after a third charging, which should be performed in compliance with Paragraph 9 above.

Should the battery output during the 2nd discharge be less than 90 per cent of nominal capacity, normal operation should be started with the 5th discharge only, provided that the output equals then at least 100 per cent of nominal capacity, i.e. at least 112 A.Hr at 10-hour discharge rate.

Before the battery is put into service, as well as later during service, the specific gravity of electrolyte in all cells (under current) should at the end of the charging be brought to the values shown in the following Table:

Climate conditions in which the battery is to operate	Specific gravity of electrolyte at end of charging, at 15°C
Extreme northern regions with winter temperatures below minus 35°C	1.310
Central and majority of northern regions with winter temperatures not below minus 35°C	1.285
Southern regions, in winter	1.270
Southern regions, in summer	1.240

NOTE: A temperature correction must be made for temperatures other than +15°C.(See above).

13. Prior to putting the batteries in service, close the cells, and wipe the cover surfaces and case edges with a rag wetted with a 10-per cent soda or ammonia solution, after which wipe them with a clean dry clothpiece.

Also coat the battery terminals with petrolatum after the wire lugs have been attached to them.

Charging Batteries in Service

1. Batteries which already were in use should, on arrival at the charging station, be wiped clean of dust and dirt, tested with a voltmeter for absence of short circuits between the plates, checked for level of electrolyte (with addition of distilled water into the cells, if necessary), and connected to the charging current source. Charging should be conducted with currents specified above for repeated chargings.

2. The temperature of electrolyte should not exceed 45°C during the charging.

3. As long as charging goes on, check every hour the temperature of electrolyte and the cell voltage. If the level of electrolyte falls in the course of the charging, restore it by adding distilled water into the cells.

4. The end of the charging should be determined by both specific gravity of electrolyte and cell voltage remaining constant during the last two hours of charging, accompanied by abundant gassing. In the event that the specific gravity in individual cells of a battery differs by more than 0.010, let the battery stay idle for an hour after charging, and then

continue to charge it for another two hours with 2nd-stage current. If after this the specific gravity of electrolyte in the cells differs less than by 0.01, such a battery may be put into service again.

3. Batteries which were in use and now are in storage, should once in 3 months be subjected to a check-and-training cycle, to be conducted as follows:

Charge the battery with two current stages as recommended for the first charging. Continue to charge it until both gravity of electrolyte and voltage remain constant for 4 hours.

Then let the battery rest for an hour, after which start to charge it again with 2nd-stage current. If abundant gassing begins then within two minutes, the recharging procedure can be considered complete. If, however, gassing begins later than two minutes after the charging current has been switched on, charge the battery for another two hours with 2nd-stage current, followed by an interruption of one hour, etc.

Having accomplished the charging, check carefully the specific gravity of the electrolyte in all cells, and bring it to the normal magnitude, if necessary.

After normal specific gravity is achieved, let the battery undergo a discharge cycle with 11.2A, to be continued until the voltage drops to 1.7V at least in one of the cells. Relate the obtained output to 30°C.

If the battery output in the above cycle is less than 90 per cent of nominal capacity (112 A.Hr), recharge the battery with a check charge current of 11.2A, after which re-

check the discharge output.

Should this continue to be less than 90 per cent of nominal capacity (112 A.Hr at 10-hour discharge rate), the battery is evidently not in order. Such a battery must not be kept in storage any more.

A battery which has produced the guaranteed output, or at least 90 per cent of it, should be charged again with two normal current stages as recommended for repeated charging, and may then be left in storage for a further period.

Appendix No.9.

Instructions on Presenting Claims

Should, by fault of the Manufacturing Works, a defect occur in the engine within 12 months from the day it has been put into service, the engine having been in operation for not more than the guaranteed hours specified in the Report Form, the User has the right to lay a claim to the Works.

The User should, within 5 days after the defect was detected, forward to the Manufacturing Works full information on the engine operation and the circumstances under which the trouble was evidenced. This information should contain the following data:

1) Time and location when and where the defect was observed first.
2) Serial number of the engine, dates of its shipment by the Works and arrival, railway station and full postal address of consignee.
3) Number and date of invoice against which the engine was purchased.

4) Operating conditions, number of running hours passed, speed and load conditions, fuel and lubricating oil grades used.

5) Data about the driven equipment (type, model and power rating of generator, type of pump, etc.).

6) Detailed description of circumstances and external symptoms of the defect encountered.

If the User's opinion is that the Manufacturing Works are responsible for the defect, the User is entitled to summon a representative of the Works, in order to draw up a bilateral statement on the spot to ground the claim.

If a representative of the Works has been called out, no disassembly work should be started in the engine until the representative, or a reply of the Works, has arrived.

The Manufacturing Works undertakes to mail a reply, or to notify the User about sending a representative, within 5 days after receiving the information and call.

Drawing up a bilateral statement confirming the responsibility of the Manufacturing Works for the defect will entitle the User to demand replacement, free of charge, for all parts or units found defective or prematurely got out of condition. A conclusion stating the User's responsibility will, in turn, give the Manufacturing Works the right to demand compensation for the expenses involved in sending a representative to the User.

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NOTE: In case the bilateral statement calls for free replacement of defective parts or units at the Works' cost, all unserviceable parts and units become property of the Works, and are to be returned by the User to the Works upon request of the latter.

Replacement of parts or units from the individual set of spare parts furnished with the engine cannot be regarded as a ground for laying a claim.

The Manufacturing Works will not consider any request on extra spare parts not included into the standard set. Such requests should be addressed to the corresponding administration department.

The Manufacturing Works will assume no responsibility for satisfactory operation of the engine, if rules on its installation, storage, care, and operation, given in this Manual, have been violated by the User.

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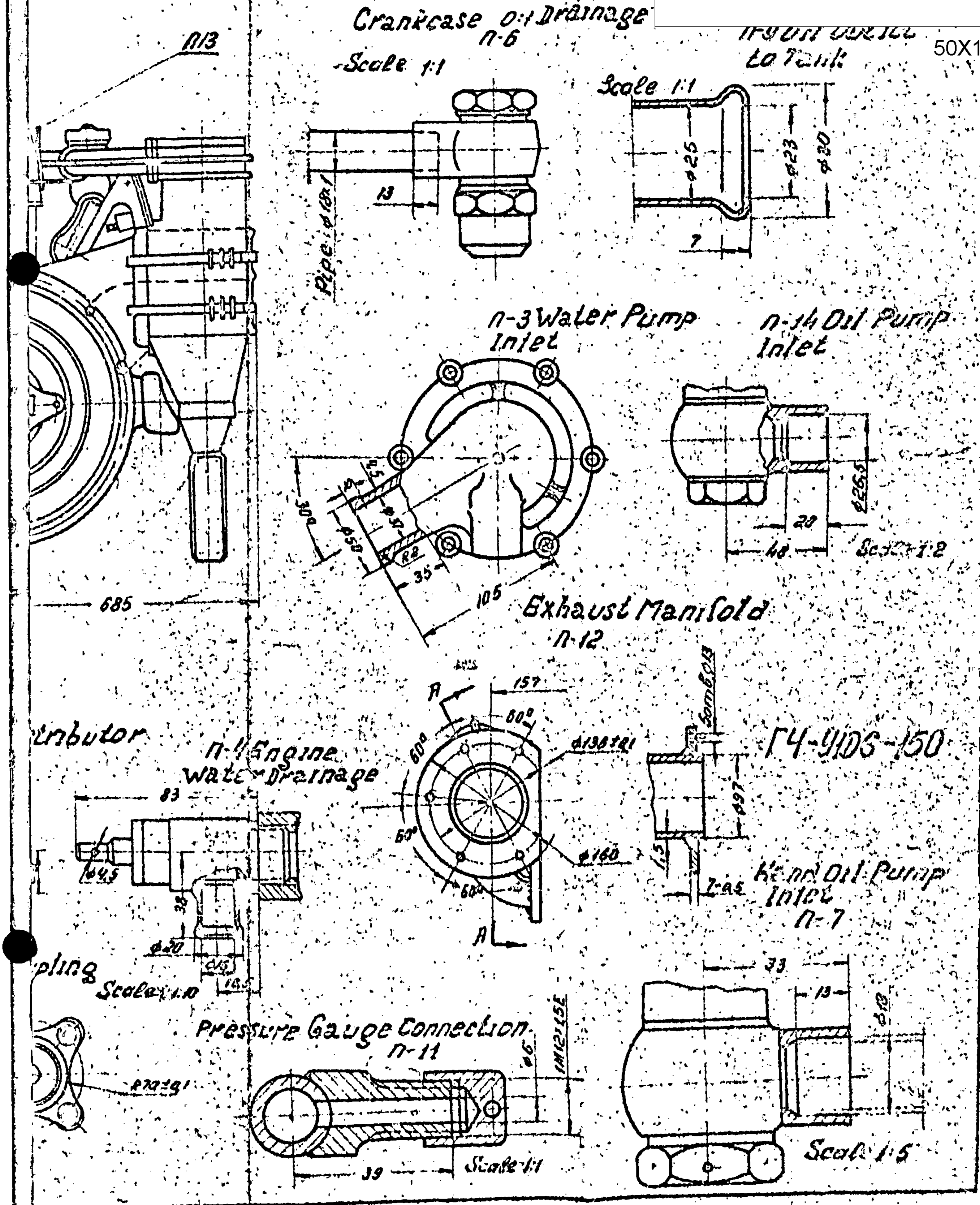

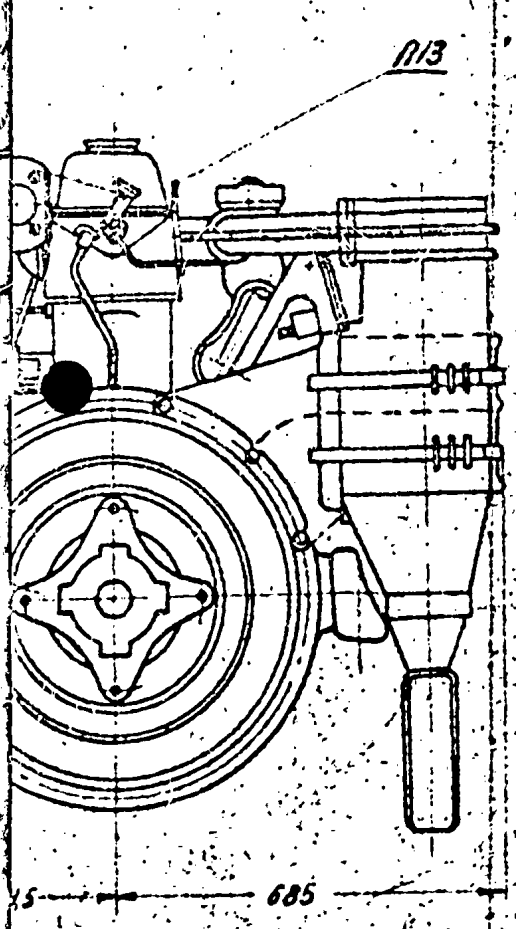

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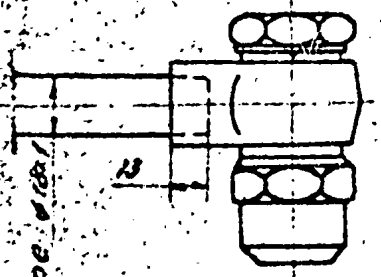

п-9 Oil Outlet
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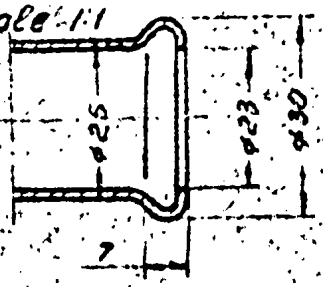

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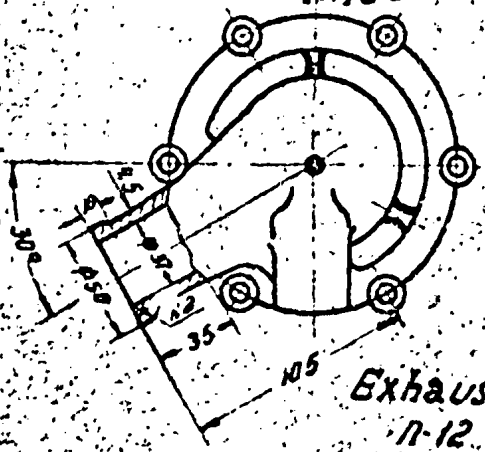
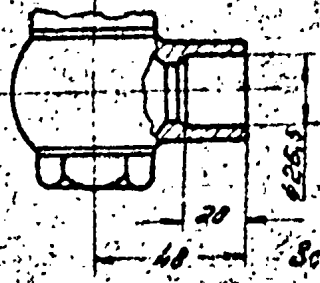
Inlet



п-14 Oil Pump
Inlet



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Exhaust Manifold
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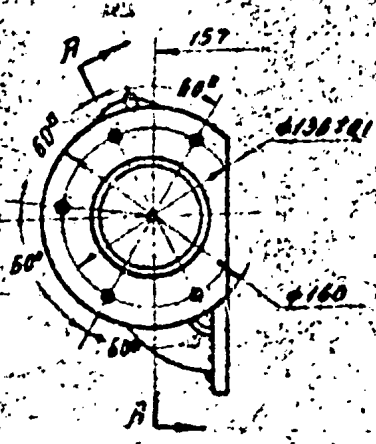

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1 Air Distributor
Jet

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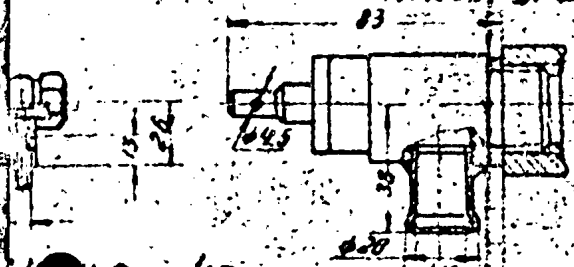

Hand Oil Pump
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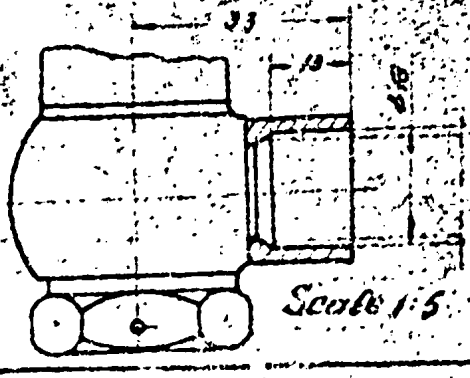

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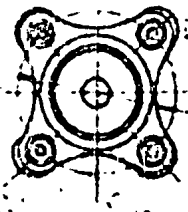

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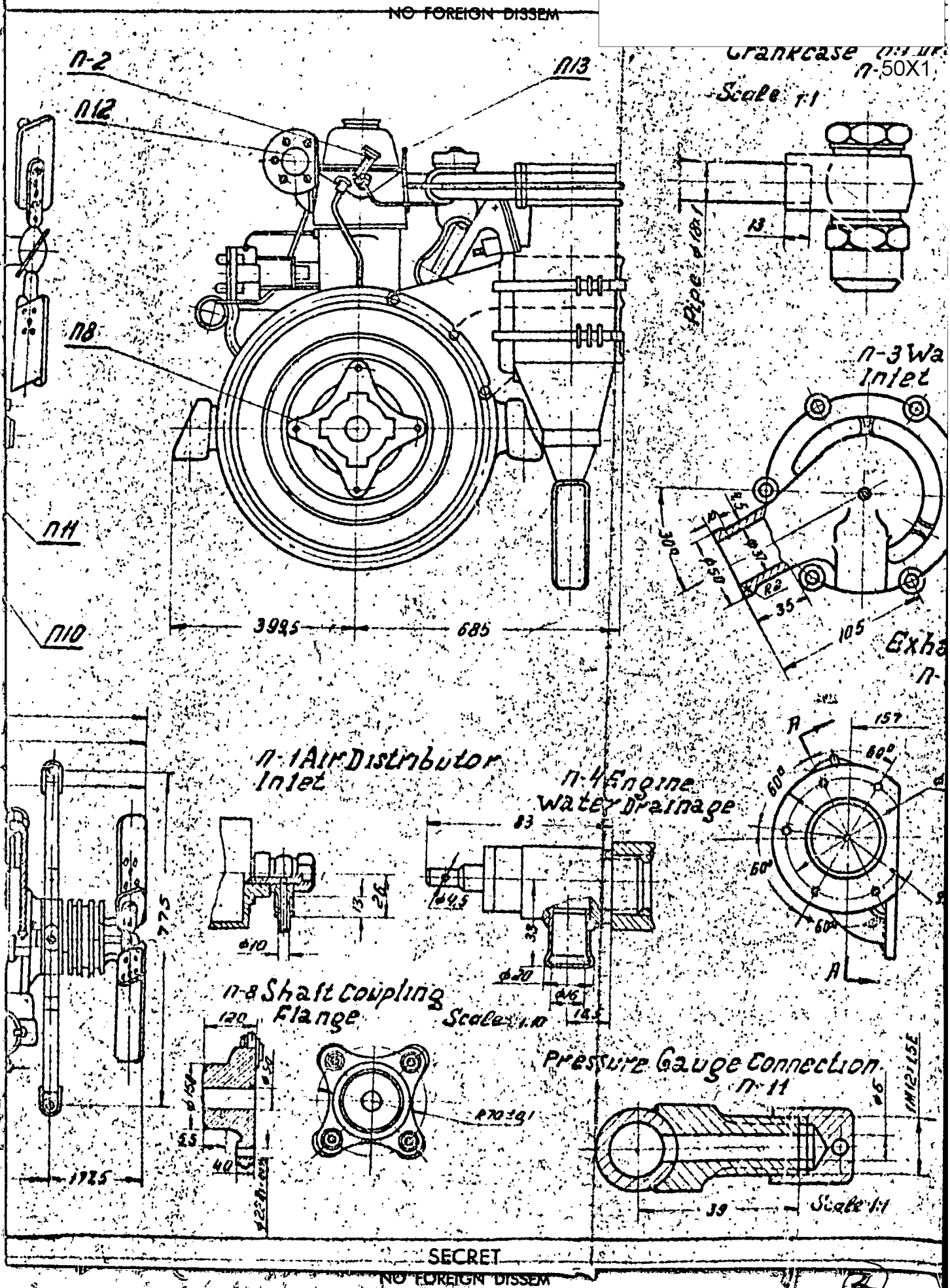

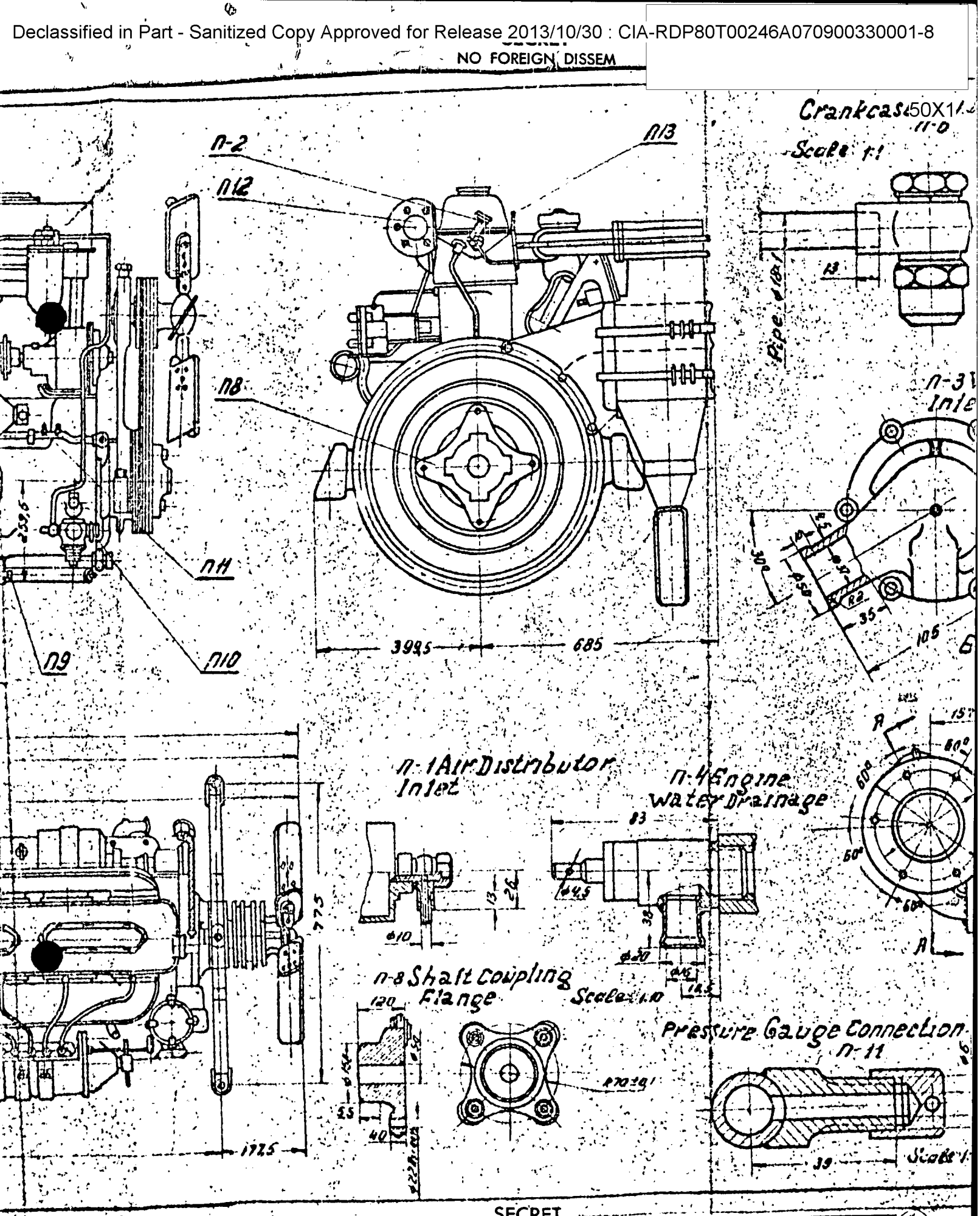

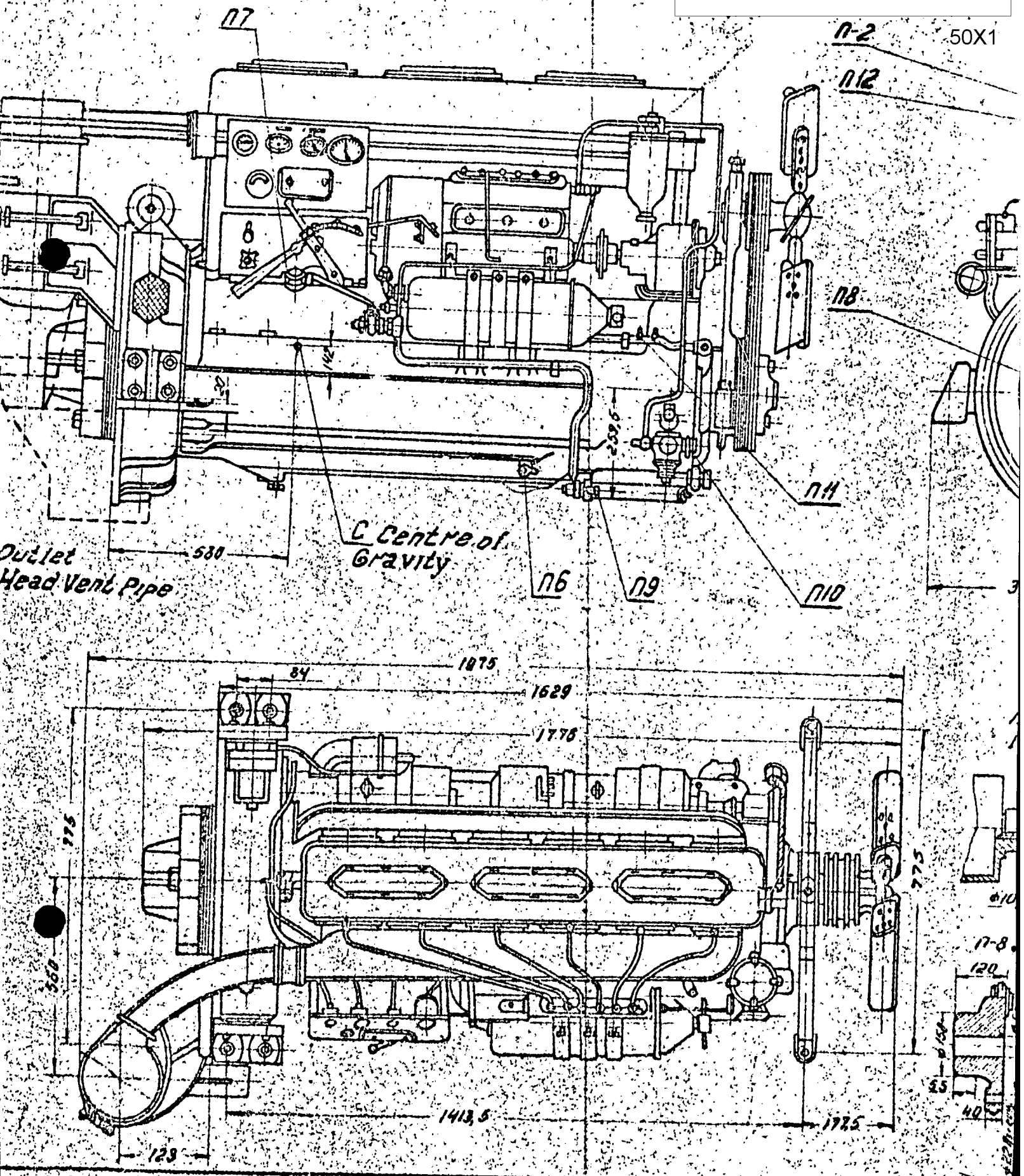

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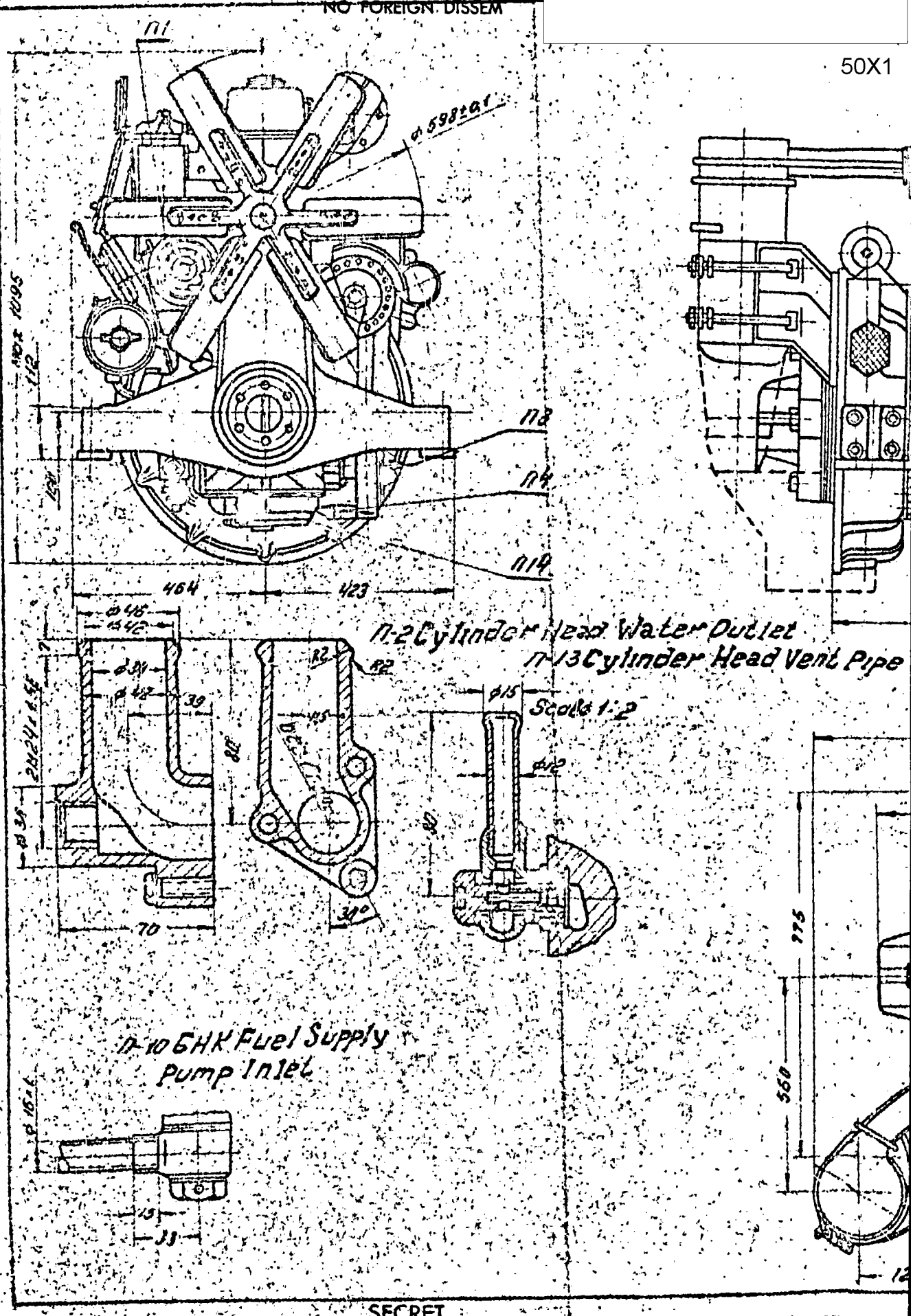

11-2 Cylinder Head Water Outlet

11-13 Cylinder Head Vent Pipe

Scale 1:2

11-10 6HK Fuel Supply Pump Inlet

(2)