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COUNTRY USSR

REPORT

SUBJECT English-Language Manual on Soviet Helicopter Engine ASh-82V

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THIS IS UNEVALUATED INFORMATION. SOURCE GRADINGS ARE DEFINITIVE. APPRAISAL OF CONTENT IS TENTATIVE.

1. 105-page, English-language manual on the engine for the Soviet helicopter MI-4 /HOUND/, entitled Description and Operation and Service Instructions for the ASh-82V Engine, Series 4, With R-5 Main Gearbox. No date or publishing data appeared on the manual. 4/50

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2. Differences between engines of series 4 and series 5 are given on the first page.

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3. The main sections of the manual, as listed in the Table of Contents, are:

Section I: General information on the ASh-82V engine and R-5 main gearbox

Section II: Principal technical data of ASh-82V engine and R-5 main gearbox

Section III: Preparation of engine and R-5 gearbox for flight

Section IV: Operating the engine and R-5 main gearbox in flight

Section V: Dilution of oil with gasoline in engine and R-5 main gearbox oil systems

Section VI: Installation and adjustment of engine and R-5 main gearbox

Section VII: Engine troubles, their causes and remedy

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Section VIII: Maintenance of engine, R-5 main gearbox and main drive shaft

Section IX: Unpacking and depreserving engine and R-5 main gearbox

Section X: Preserving of engine and R-5 main gearbox installed in helicopter.

The Table of Contents also lists an Appendix entitled Engine Tool Kit; this did not accompany the manual.

When removed from the covering report, the manual is classified CONFIDENTIAL.

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DESCRIPTION
and
OPERATION AND SERVICE INSTRUCTIONS
for
the ASh-82V ENGINE, SERIES 4, WITH R-5 MAIN GEARBOX

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C A U T I O N:

When operating the AM-82B engines, series 5, bear in mind that they differ from the engines, series 4, in the following:

1. Oil pressure on the friction clutch piston underside is changed from "not below than 1.5 kg./cm.^{2}" to "not below than 1 kg./cm.^{2}".

2. Due to modification of the friction clutch design (Fig.1):

a) The "Washing the clutch" paragraph is not required, because the new clutches are not fitted with washing devices.

b) Dilute oil in the engine oil system without washing the clutch.
Engage the friction clutch only once at the end of oil/gasoline mixing procedure with the dog (cam) clutch engaged.

c) Do not decrease the engine speed to 700-800 r.p.m. specially for filling the friction clutch with diluted oil, on accomplishing the mixing procedure.

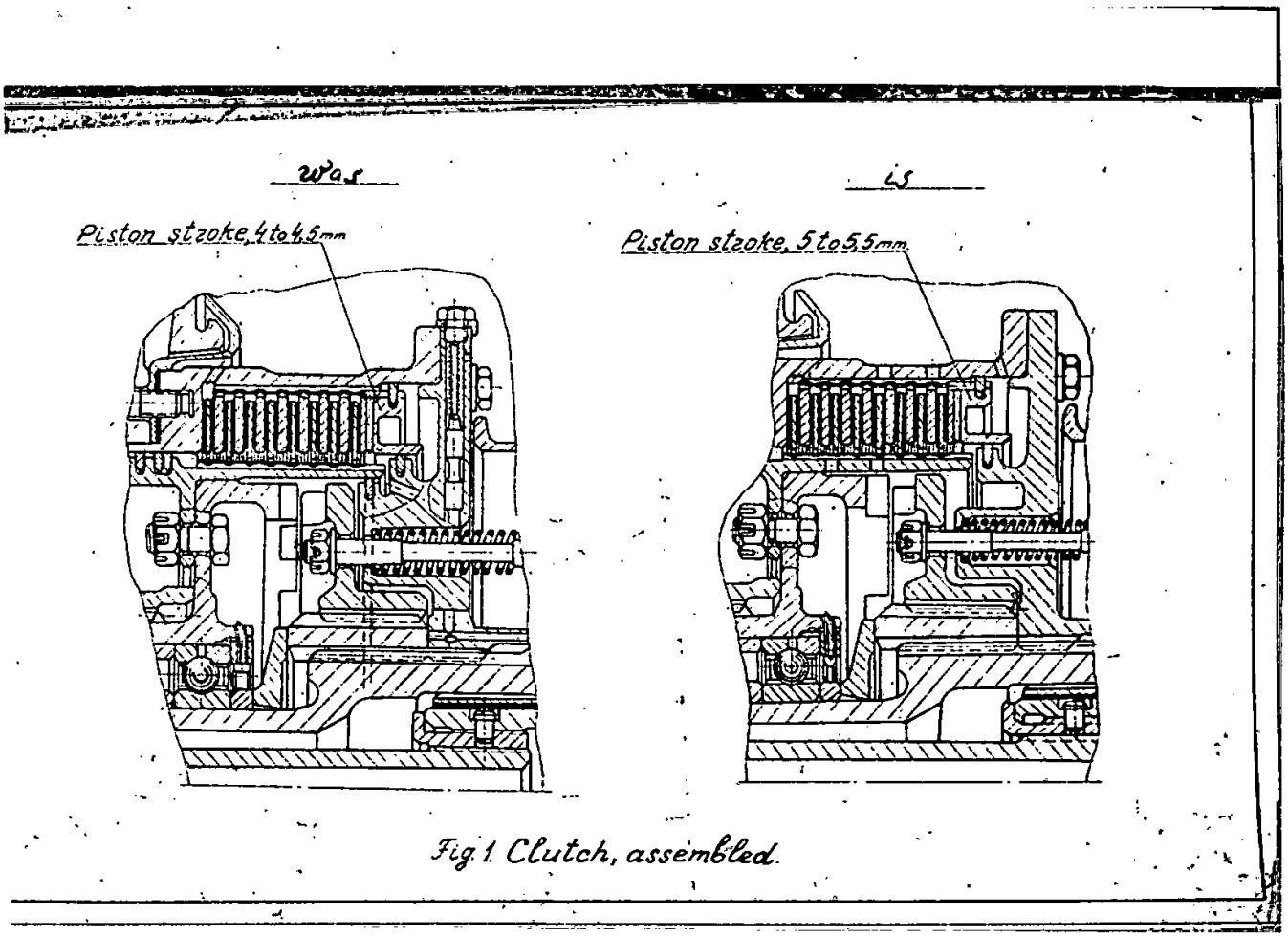

Fig. 1 Clutch, assembled.

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D E S C R I P T I O N

and

OPERATION AND SERVICE INSTRUCTIONS

for

the AM-82B ENGINE, SERIES 4, WITH P-5 MAIN GEARBOX

C O N T E N T S.

Section I. General information on the AM-82B engine and P-5 main gearbox.
1. Engine brief description and design.
2. P-5 main gearbox and main drive shaft with flexible couplings.
Section II. Principal technical data of AM-82B engine and P-5 main gearbox.
1. Engine.
2. P-5 main gearbox technical data.
3. Main drive shaft with flexible couplings.
Section III. Preparation of engine and P-5 gearbox for flight.
1. Preparation for starting.
2. Heating-up the engine and P-5 main gearbox.
3. Starting the engine.
4. Warming-up the engine.
5. Engine and its accessories ground test.
6. Filling and replenishing the oil in engine and P-5 main gearbox oil system.
7. Manual starting the engine.
Section IV. Operating the engine and P-5 main gearbox in flight.
Section V. Dilution of oil with gasoline in engine and P-5 main gearbox oil systems.
1. Oil dilution in engine oil system.
2. Oil dilution in P-5 main gearbox oil system.
Section VI. Installation and adjustment of engine and P-5 main gearbox.
1. Adjusting the engine oil pressure.
2. Adjusting oil pressure in the P-5 main gearbox.
3. Adjusting the friction clutch variable jet.
4. Adjusting the fuel pressure.
5. Installing the magneto on engine.
6. Depreserving and installing spark plugs on engine.
7. Installation and adjustment of MB-82B direct injection fuel pump.

8. Installing and adjusting the RAG manifold pressure regulator.
9. Adjusting the engine low speed.

Section VII. Engine troubles, their causes and remedy.

Section VIII. Maintenance of engine, P-5 main gearbox and main drive shaft.

1. After-flight inspection of engine and P-5 gearbox.
2. Periodic maintenance operations on engine and P-5 main gearbox, after first test and every 50 hours of engine operation.
3. Periodic maintenance operations on engine and P-5 main gearbox after every 100 hours of engine operation.
4. Washing the oil filters, oil tank and changing the oil.

Section IX. Unpacking and depreserving engine and P-5 main gearbox.

1. Unpacking and de-preserving engine.
2. Unpacking and de-preserving P-5 main gearbox and main drive shaft with flexible couplings.

Section X. Preserving of engine and P-5 main gearbox installed in helicopter.

1. General.
2. Preserving the engine for one month's storage and de-preserving it after storage.
3. Preserving the engine for two month's storage and de-preserving after storage.
4. Preserving the engine for six month's storage and de-preserving after storage.
5. Preserving of P-5 main gearbox and main drive shaft for one-two month's storage and de-preserving them after storage.
6. Preserving of P-5 main gearbox and main drive shaft for six month's storage and de-preserving after storage.

Appendix : Engine Tool Kit.

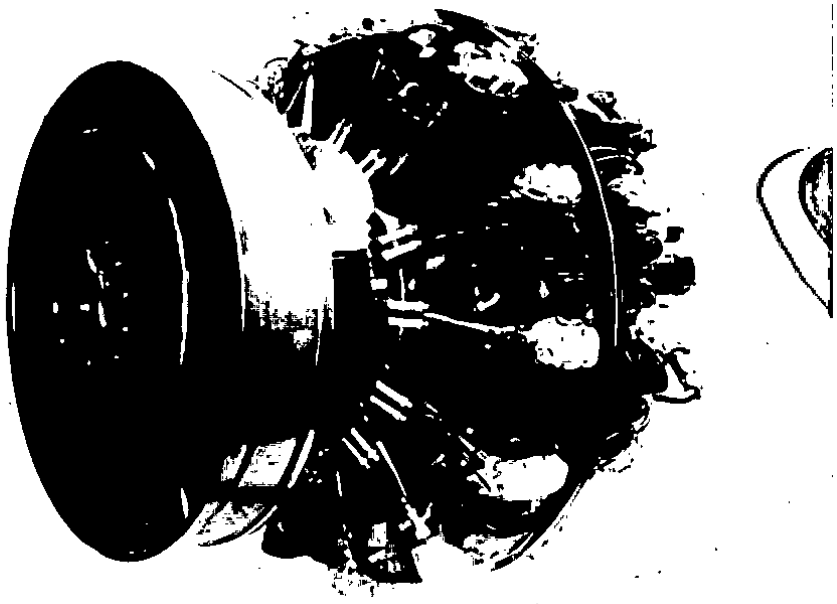

FIG. 1. AW-82B ENGINE (FRONT LEFT VIEW)

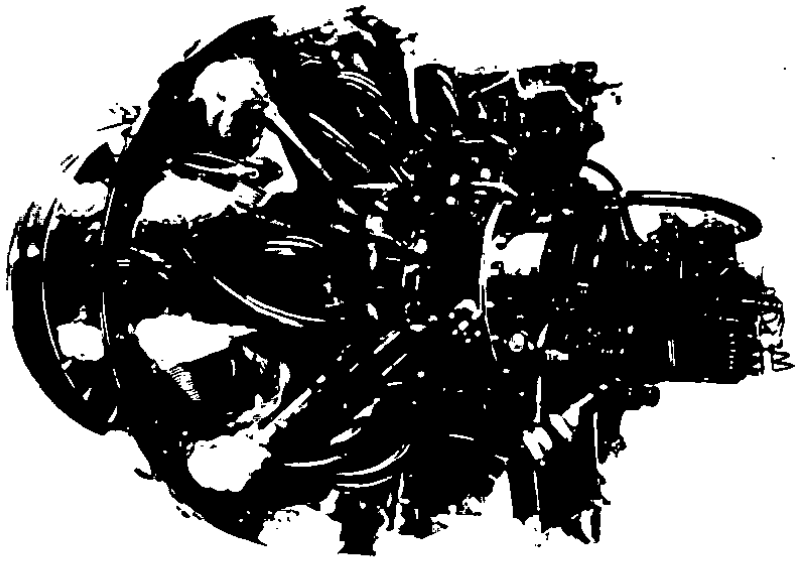

FIG. 2. AW-82B ENGINE (REAR LEFT VIEW).

S E C T I O N I.

GENERAL INFORMATION

ON THE AM-82B ENGINE AND P-5 MAIN GEARBOX.

1. ENGINE BRIEF DESCRIPTION AND DESIGN.

The AM-82B (Fig.1,2) is a 14-cylinder, four-stroke cycle, two row, radial, gasoline, air-cooled engine. It has a two-speed supercharger, direct fuel injection and the torque is transmitted through the combined clutch. The AM-82B engine is designed for installation in helicopters, and can operate both in the horizontal position and at an angle of 28 deg. to the horizontal axis.

The engine is air-cooled by an axial fan installed in front of the engine. The air from the fan provides cooling of the engine and oil coolers.

The engine is equipped with the following accessories: on the crankcase front section (Fig.3) - two МБ14Т-2 magnetos, ПНН-В oil pump and two ЭП-19 or ЭП-19МР solenoid switches; on the supercharger rear housing (Fig.4) and the crankcase rear cover - НВ-82В direct injection pump, БНК-10КВ fuel pump, СКД-2В electric inertia starter, ГСР-3000М generator, РПД-10МР automatic manifold pressure regulator, МШ-6СВ oil pump; on the cylinder heads - two СД-38-5С spark plugs and one ФБ-10КР fuel injection nozzle per a cylinder; on the throttle box - ЭК-505 solenoid - controlled priming valve.

Besides, there are two auxiliary drives, the upper and lower, on the crankcase rear cover, and combined drive to БНК-10КВ fuel pump and 4УГ-1-48 tachometer transmitter on the supercharger rear housing.

The engine crankcase consists of the crankcase front section, 6-parts of the crankcase main section, supercharger front and rear housings and rear cover joined one to another by studs and special bolts.

The clutch parts and the drives to the accessories installed on the crankcase front section are located in the crankcase front section. The crankcase main section consists of four steel and two aluminum alloy parts. The crankshaft with connecting rod assembly, valve timing mechanism drives and counterweights are located inside the crankcase.

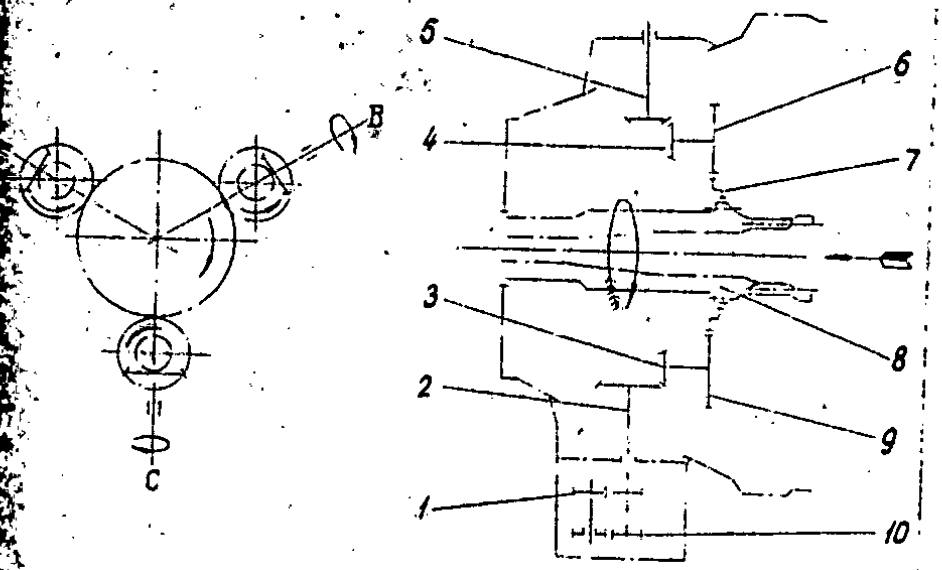

Fig. 3. Crankcase front section accessory drives diagram.

A - Drive to magneto, L.H.; B - drive to magneto, R.H.; C - drive to front oil pump; 1) Oil pump scavenge section; 2) bevel gear (Z=29) with oil pump drive shaft; 3) bevel rim (Z=16), oil pump drive double gear; 4) bevel rim (Z=15), magneto drive double gear; 5) bevel gear (Z=18) with magneto drive shaft; 6) spur rim (Z=30), magneto drive double gear; 7) accessory drive main gear (Z=63); 8) coupling shaft; 9) spur rim (Z=30), oil pump drive double gear; 10) oil pump scavenge section.

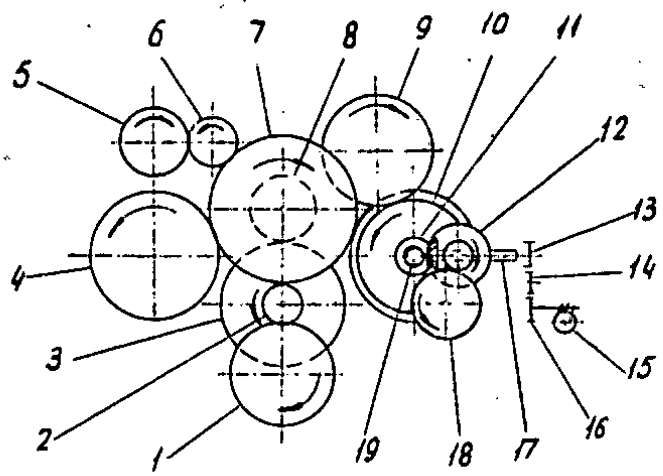

Fig. 4. Diagram of accessory drives mounted in supercharger rear housing and on the crankcase rear cover.

1) Lower auxiliary drive gear (42); 2) small rim (18), supercharger drive double gear; 3) gear rim (60), 2-speed friction clutch; 4) gear (56), rear oil pump drive; 5) gear (23), generator drive; 6) intermediate gear (21) generator drive; 7) elastic gear (63), accessory drive shaft; 8) gear rim (21), supercharger impeller shaft; 9) gear (Z=52), upper auxiliary drive; 10) double gear (40 and 56), HB-82B pump drive; 11) bevel gear (16), fuel pump and tachometer drives; 12) double intermediate gear (12 and 27), HB-82B pump drive; 13) driving gear (18), fuel pump and tachometer drives; 14) intermediate gear (Z=18); 15) shaft ((16) tachometer drive; 16) gear rim (18), fuel pump and tachometer drive shaft; 17) shaft with bevel gear rim (18), fuel pump and tachometer drive; 18) gear (30), HB-82B pump driven shaft; 19) gear (10), HB-82B pump driving shaft.

Two rows of the cylinders are installed on the crankcase main section steel parts. Each cylinder is attached to the crankcase by 20 bolts (screws) through the spherical washers.

The lower part of the crankcase main section is fitted with four flanges to attach the crankcase oil drain pipes.

Attached to the crankcase rear section is the supercharger front housing, which separates the crankcase rear cavity from the supercharger and provides air distribution to the cylinders.

The expansion-chamber with labyrinths for the engine breathing is formed between the supercharger front housing vertical wall, fitted with several fins, and the box-type diaphragm attached to the wall (from the crankcase main section side).

The supercharger rear housing is attached to its front housing thus forming a cavity where the impeller and diffuser are located.

The crankcase rear cover is attached to the supercharger rear housing and in the cavity between them is the gear train driving the supercharger impeller and other accessories, installed on the supercharger rear housing and the crankcase rear cover.

The accessories drive shaft, on the journals of which the impeller shaft rotates, passes through the vertical walls of the supercharger front and rear housings.

The following units are installed on the supercharger rear housing: on the top - throttle box (through an adapter), on the right - 4ТГ-1-48 tachometer transmitter and БНК-10КВ fuel pump combined drive, on the left - МФС-19 oil filter installed at oil inlet to the main oil pipeline. The accessories are attached to the rear cover which carries their drive gear shafts.

The engine cylinders are placed on the crankcase main section in two-rows in staggered order and are provided with "floating" seats and cast-iron guides for the exhaust valves and the "stiff" seats and bronze guides for the intake valves.

The air supply from the supercharger to the cylinders is provided through 14 induction pipes connected by one end to the cylinder, and by the other to the supercharger front housing.

The exhaust pipes of the front and rear row cylinders are directed backwards.

For effective use of the cooling air and levelling the cylinders temperatures all the cylinders are fitted with air deflectors and the cylinder head finning low in the front and high in the rear.

For lubricating the exhaust valve stem guides of the front row cylinders the rocker boxes of the front and rear row cylinders are breathered.

The piston has five grooves and graphitized bearing surface. The piston has three compression and three oil scraper rings. The compression rings are wedge - shaped. The upper ring is made of steel, chrome-plated, with cylindrical bearing surface and two other are made of cast iron, with conical bearing surfaces. The piston - pin is secured with bronze plugs against the cylinder wall.

The connecting rods. The engine is provided with two connecting rods assemblies. Front and rear assemblies each comprises one master rod and six articulated rods.

The big end of each master rod - houses bushes and the master rods are located in the second cylinder of the front row and in the 5-th cylinder of the rear row.

The crankshaft consists of three detachable main pieces and is carried in three roller bearings.

The crankshaft is fitted with two dynamic dampers for damping the torsional vibrations and for counter-balancing the moments of the 1-st order inertia forces due to reciprocating movement of masses and centrifugal forces due to rotation of masses.

For counter-balancing the moments of the 2-nd order inertia forces due to reciprocating movement of masses the 2-nd order balancers are mounted on the crankshaft main bearing journals (Fig.5).

Valve timing mechanism. The front and rear cylinder rows have separate valve timing mechanisms. The valves are actuated by cams through tappets, push-rods and rockers.

The front and rear cams rotate on steel supports centered on the extended lugs of the vertical walls of the crankcase main section front and rear halves.

The front cylinder row valves are actuated by the cam and the valve mechanism gears located in the crankcase front adapter section.

The rear cylinder row valves are actuated by the cam and the valve mechanism gears located in the crankcase rear adapter section. (Fig.5).

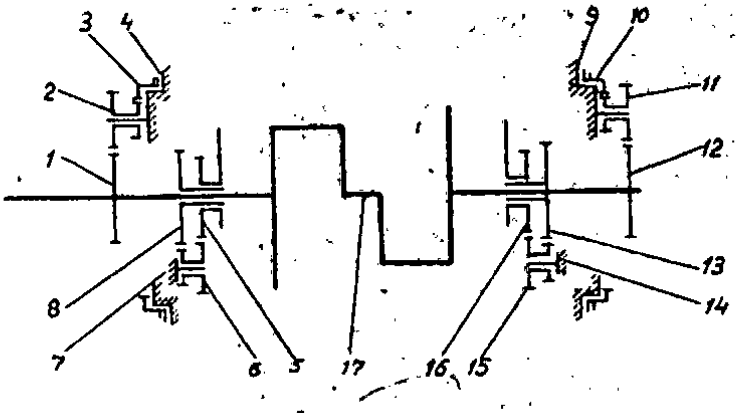

Fig. 5. Cam and balancer drives diagram.

1) Driving gear (45), front valve timing mechanism; 2) intermediate double elastic gear (large rim -40, small rim -16), front valve timing mechanism; 3) front cam (108); 4) cam support; 5) front balancer (50); 6) intermediate double gear (large rim-25); small rim-15),balancer drive; 7) axle, balancer drive intermediate double gear; 8) front driving elastic gear (60), balancer drive; 9) cam support; 10) rear cam (108); 11) intermediate elastic double gear (large rim - 40, small rim - 16), rear valve timing mechanism;12)driving gear (45), rear valve timing mechanism; 13) rear driving elastic gear (60),-balance drive; 14) axle,intermediate double gear; 15) intermediate double gear (large rim-25, small rim - 15), balancer drive;16) rear balancer (50); 17) crankshaft.

The double (intermediate) valve mechanism gears of the front and rear cylinder rows are elastic. The valve tappets with their guides for each cylinder row are located in the sockets of the crankcase front and rear adapter sections, respectively.

The rear cylinder row valve tappet guides have no holes to drain the oil from the rocker boxes.

Supercharger is of centrifugal type with mechanical two-speed drive. The supercharger impeller is manufactured from aluminum alloy stamping and represents one assembly with the guide vane assembly.

The supercharger diffuser is made of aluminum alloy and installed in the supercharger rear housing with a clearance between its blades and the supercharger front housing vertical wall.

The impeller drive mechanism (Fig.6) is located in the supercharger rear housing and consists of an elastic gear for the accessory drive shaft, two-speed transmission and the impeller shaft fitted with gear teeth rim.

The accessory drives. The engine accessory drives take power from the engine crankshaft through the gear train. The drive shafts of the HB-82B direct injection pump, the combined drive of the tachometer transmitter and fuel pump are placed in the individual housings installed on the engine. Other accessory drive shafts are installed in the crankcase front section and rear cover on the bearings.

CLUTCH.

The torque is transmitted from the crankshaft to the main rotor drive shaft through the combined clutch which is mounted in the crankcase front section. Smooth engagement of the transmission and rotation of the main rotor is provided by the friction clutch. After accelerating the main rotor the cam clutch is engaged. The clutch is operated by solenoid switches installed on the crankcase front section flanges and used to actuate the sliding valves passing the oil from the engine pressure line into the cavity under the piston of the friction and cam clutches.

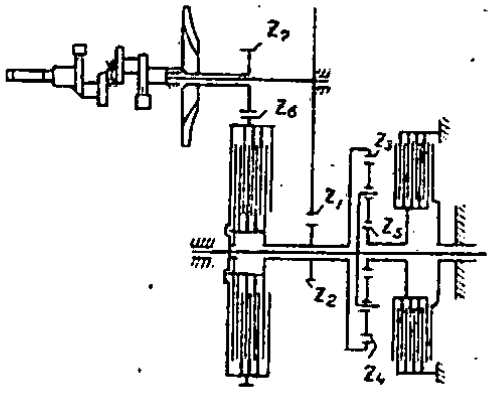

Fig. 6. Supercharger impeller drive diagram.

Z_1 - Elastic gear (63);
Z_2 - Gear outer rim (18);
Z_3 - Double gear inner rim (50);
Z_4 - Planetary gear (15);
Z_5 - Gear small rim (20), for one direction of rotation;
Z_6 - Friction gear rim (60);
Z_7 - Impeller shaft gear rim (27).

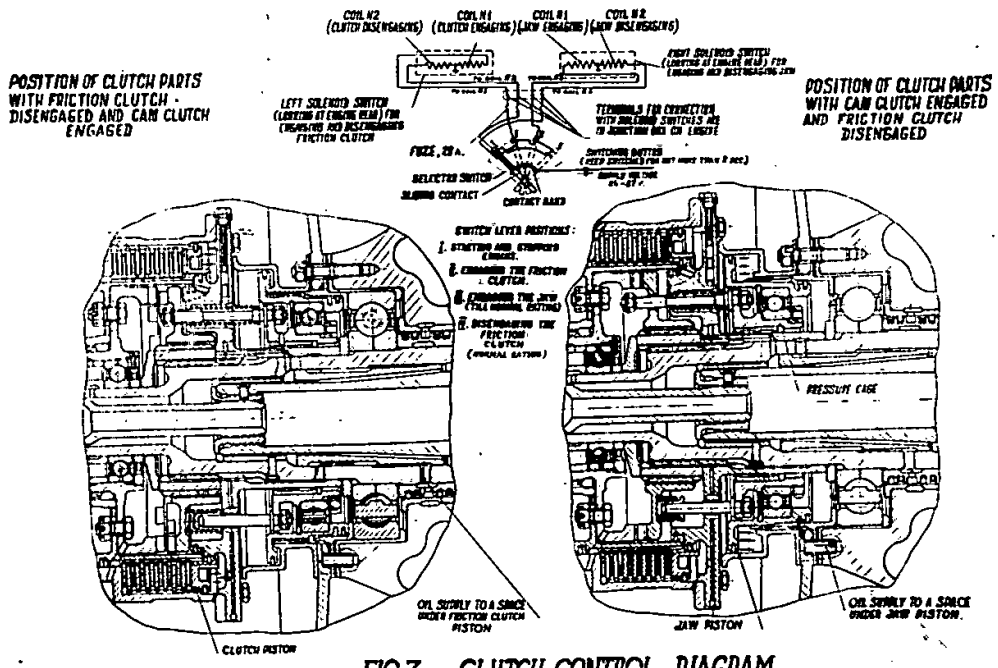

FIG.7 CLUTCH CONTROL DIAGRAM

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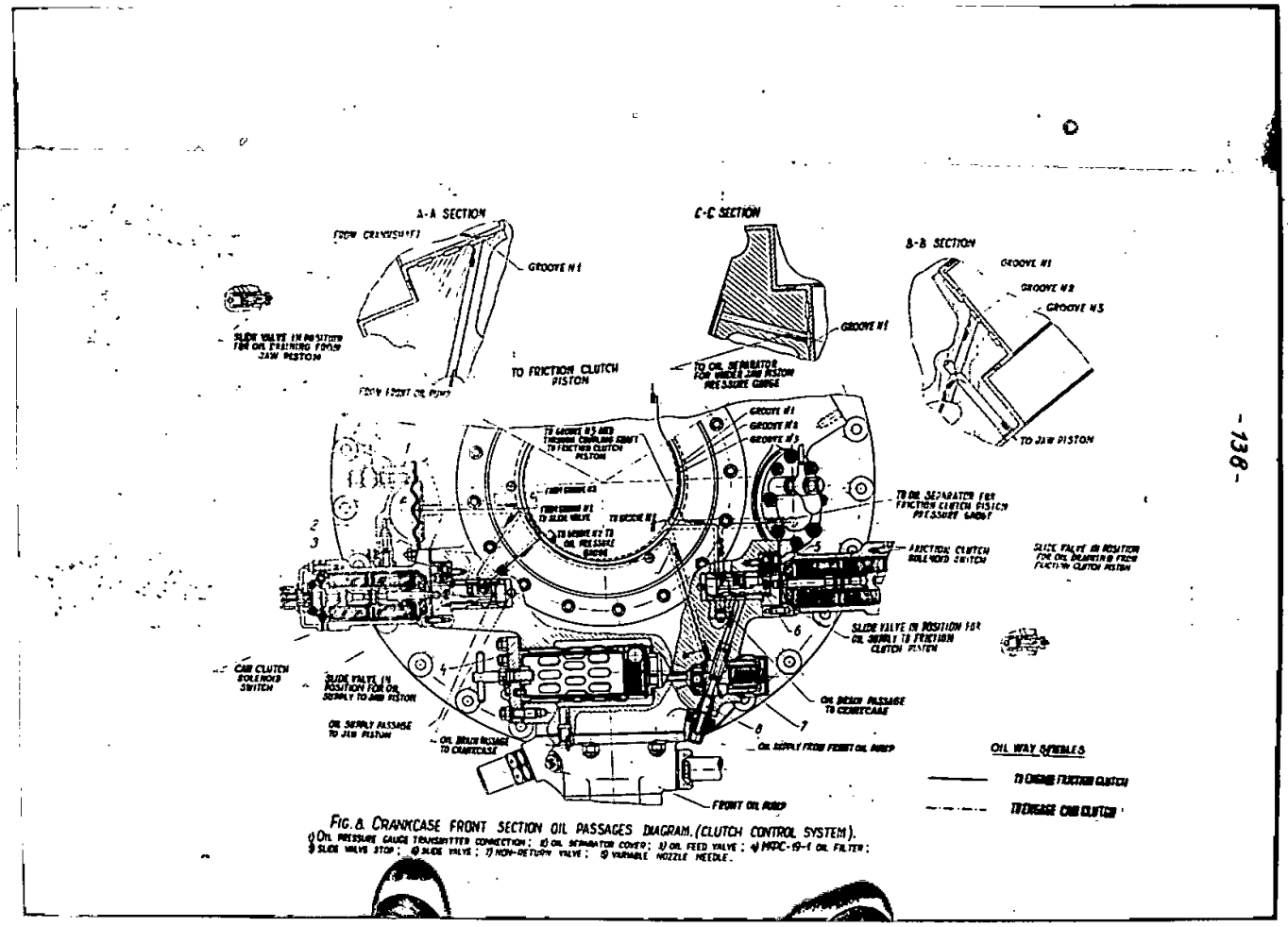

FIG. 8. CRANKCASE FRONT SECTION OIL PASSAGES DIAGRAM. (CLUTCH CONTROL SYSTEM).
1) OIL PRESSURE GAUGE TRANSMITTER CONNECTION; 2) OIL SEPARATOR COVER; 3) OIL FEED VALVE; 4) MOC-19-1 OIL FILTER; 5) SLIDE VALVE STOP; 6) SLIDE VALVE; 7) NON-RETURN VALVE; 8) VARIABLE NOZZLE NEEDLE.

STARTING SYSTEM.

The engine is started by means of an electric inertia starter. To facilitate starting the engine is equipped with a solenoid - controlled priming valve and two injection nozzles spraying the fuel into the supercharger inlet, (while starting).

LUBRICATING SYSTEM.

The oil is delivered under pressure to the parts subject to friction. The oil circulation is provided by two oil pumps. The oil is scavenged from the engine by the scavenge pump sections of these oil pumps.

From the rear oil pump, the oil flowing to the engine, passes through the MPC-19 gauze filter and then through a special passage is admitted to the crankcase rear cover main bush. From the inner circular groove of the rear cover bush the oil is supplied to the inner passage of the accessory drive shaft and to the crankshaft rear section to lubricate the engine parts.

The oil leaking from the clearances between the surfaces subject to friction is splashed, lubricating the engine parts, and flows from the crankcase walls to its bottom section. From the clutch cavity the oil is drained through a special pipe to the scavenge section of the front oil pump. The scavenge section of the front oil pump forces the oil via the outer pipe into the pipe, leading to the oil sump.

From the cavities of the crankcase front section with front valve mechanism, crankcase main section and rear valve mechanism the oil passes through the outer pipes to the oil sump.

From the supercharger rear housing the oil passes to the oil sump directly through the holes in the flanges of the supercharger housing and oil supmp.

The engine oil and breather systems diagram is shown in Fig.9.

BREATHER SYSTEM.

For equalizing pressure in the crankcase front section and the crankcase main section the vertical walls of the crankcase main section are provided with breather holes.

Two breathers installed on the supercharger front housing are used for decreasing pressure inside the engine and equalizing it to the atmospheric one.

The breathers communicate through passages with the engine breather cavity. The supercharger rear housing cavity also communicates with the engine breather cavity. Both breathers of the supercharger front housing communicate with one common brenther pipe which communicates with the atmosphere.

The oil tank communicates with the supercharger rear housing cavity through the holes in the rear cover and the drain pipe (Fig. 9).

2. P-5 MAIN GEARBOX AND MAIN DRIVE SHAFT WITH FLEXIBLE COUPLINGS.

The P-5 main gearbox is designed to transmit the torque from the engine shaft to the shaft of the helicopter main rotor. The driving shaft of the P-5 main gearbox is connected to the engine through the main drive shaft (assy. 316984) fitted with two flexible couplings.

The main gearbox has a freewheel and the drive of the tail rotor. The freewheel is mounted on the driving shaft of the main gearbox and disengages the engine shaft at autorotation regime.

The housing of the P-5 main gearbox has flanges for installation of the constant speed governor, tachometer transmitter, hydraulic pump and swash-plate.

The bottom section of the P-5 main gearbox accommodates an oil sump with a gear oil pump with pressure and scavenge sections. The oil sump is also used as an oil tank for the main gearbox.

S E C T I O N II.

PRINCIPAL TECHNICAL DATA OF AM-82B ENGINE AND P-5 MAIN GEARBOX.

I. ENGINE.

1. Model	AM-82B
2. Cooling	air fan cooling
3. Cylinder arrangement	two-row, radial
4. Number of cylinders	14
5. Numbering of cylinders (as viewed from the supercharger side, and beginning with the top cylinder of rear row)	clockwise
6. Master rods are located in cylinders	Nos. 2 and 5

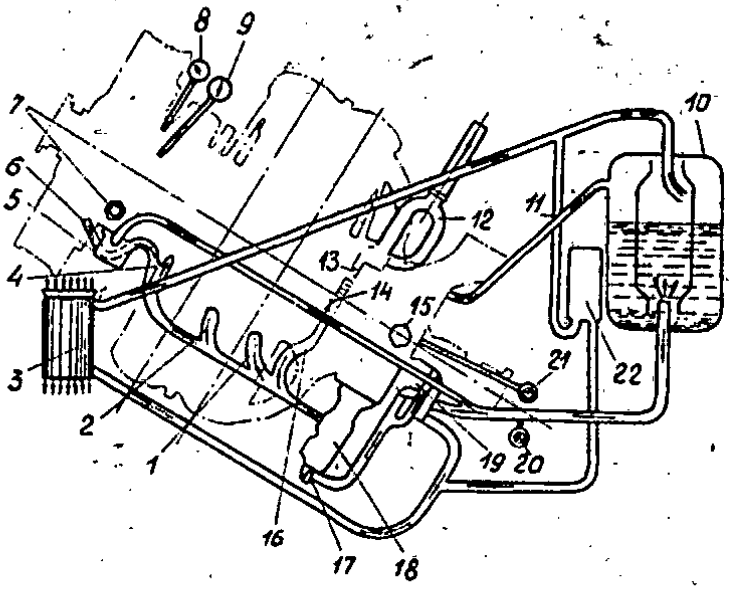

Fig. 9. Engine external oil and breather systems diagram.

1) Oil drain pipe, cylinder rear row crankcase; 2) oil drain pipe, cylinder front row crankcase; 3) oil cooler; oil drain pipe, front valve timing mechanism drive; 5) front oil pump; 6) oil drain pipe, clutch; 7) MFC-19-1 oil filter; 8) oil pressure gauge (front oil pump pipeline), crankcase front section; 9) oil pressure gauge cam clutch; 10) oil tank; 11) vent pipe; 12) breather pipe; 13) breather chamber; 14) breather chamber diaphragm hole; 15) MFC-19 oil filter; 16) oil drain pipe, breather chamber and rear valve timing mechanism drive; 17) oil sump drain cock; 18) oil sump; 19) rear oil pump; 20) oil inlet temperature gauge; 21) oil pressure gauge (rear oil pump pipeline); 22) MFC-29 oil filter.

7.	Bore, mm	155.5
8.	Stroke, mm	
	a) For cylinders No.2 and 5 with master rods	155.0
	b) For cylinders with articulated rods:	
	Nos. 3,4,7,14	155.0465
	Nos. 8,10,11,13	155.474
	Nos. 1,6,9,12	155.832
9.	Total displacement, litres	41.2
10.	Compression ratio	6.9 $^{+0.15}_{-0.10}$
11.	Direction of rotation (as viewed from the supercharger):	
	a) crankshaft b) clutch flange c) fan rotor	clockwise
12.	Clutch:	
	a) type	combined
	b) gear ratio (clutch flange to crankshaft r.p.m.)	1:1
13.	Fan:	
	a) type	axial with guide vane assembly
	b) gear ratio (to crankshaft r.p.m.)	1:1
	c) rotor outer diameter,mm	880
	d) hub diameter	680
14.	Supercharger:	
	a) type	two-speed,centrifugal with expanding ring on 2-d speed coupling piston
	b) gear ratio (to crankshaft r.p.m.)	
	first speed	7.14:1
	second speed	10:1

15. Engine ratings

Engine ratings	Power, h.p.	Crankshaft Speed, r.p.m.	Manifold pressure, mm Hg.	Fuel consumption on the ground, kg/hr (reduced)	Position of HB-82B pump manual control lever
	At supercharger 1-st Speed.				
1. Take-off rating (continuous run for not more than 5 min)	1,700-2%	2,600	1,125±10	555-615	Auto-normal
2. Normal rating	1,430-2%	2,400	970±10	410-450	Do
3. 75% normal rating	1,070-2%	2,200	810±10	250-270	Do
4. 65% normal rating	930-2%	2,100	760±10	200-220	Do
5. 50% normal rating	725-2%	2,100	660±10	155-170	Do
	At supercharger 2-nd Speed				
1. Normal rating	1,150-2%	2,400	970±10	360-395	Do
2. 75% normal rating	860-2%	2,200	810±10	218-235	Do
3. 65% normal rating	750-2%	2,100	760±10	179-195	Do
4. 50% normal rating	575-2%	2,100	660±10	135-150	Do

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Engine nominal power at rated altitude:

a) at supercharger 1-st speed				Altitude,m
1,530-2%	2,400	970±10		-1,550
b) at supercharger 2-nd speed				
1,350-2%	2,400	970±10		-4,550

NOTE: 1. This fuel consumption is provided at an air temperature in the throttle box inlet of +15°.

2. Do not run the supercharger at 2-nd speed while on the ground for more than 5 min at an ambient air temperature above +20°C.

CRANKSHAFT SPEED RANGE.

16. Maximum permissible speed during 1 min, r.p.m. — not more than 2,700

17. Minimum speed, with the clutch thrown in (low speed), r.p.m. — 550-650

18. Maximum permissible speed with the clutch thrown out, r.p.m. — 1,400

19. Engine acceleration (time required for changing from idling to take-off rating):

a) During block test - 5-7sec.
b) During test of the engine installed in a helicopter -12 sec.

The temperature of the cylinder heads should not be below 120°C and the oil inlet temperature below 40°C.

FUEL SUPPLY SYSTEM

20. Fuel grade and octane number — gasoline B-95/130, Octane number - not below 95 except (ГОСТ1012-54) fuel with extraline addition.

21. Direct fuel injection pump

a) number — one, right-hand rotation

b) type — НВ-82 plunger pump specially adjusted for increased capacity within 5+8% (2-nd and 5-th plungers).

	c) gear ratio (to crankshaft r.p.m.)	1:6
	d) number of plungers	14
22.	Start of fuel injection into the cylinder, in crankshaft degrees (the pump is set by cylinder No.4)	30° $^{+3°}_{-2°}$ past TDC during suction stroke
23.	Working order of HB-82B pump plungers	1-10-5-14-9-4-13-8-3-12-7-2-11-6-1
24.	Type of mixture control	PC-24B
25.	Fuel pressure at HB-82B pump inlet, kg/cm²:	
	a) at operating speeds	1.5 to 2
	b) at low speed	not less than 1.0
26.	Injector nozzle:	
	a) number	1 per cylinder
	b) type	ФБ-10КТ, open-type
27.	Fuel pump:	
	a) number and direction of rotation	one, left-hand
	b) type	rotary (unit БНК-10КБ)
	c) gear ratio (to crankshaft r.p.m.)	1:1
28.	Fuel filter	one (gauze-type)
29.	Solenoid-controlled priming valve	one, ЭК-506
	LUBRICATING SYSTEM.	
30.	Winter and summer oil grades	mineral oils МК-22 and МС-20 (ГОСТ1013-49)
31.	Oil pumps, number	two
	FIRST PUMP	
	a) type	МШ-6СВ gear-type with pressure and scavenge sections
	b) direction of rotation	right-hand
	c) place of installation	On back cover
	d) gear ratio (to crankshaft r.p.m.)	1.125:1
	SECOND PUMP	
	a) type	ПМН-В, gear-type with pressure and scavenge sections
	b) direction of rotation	left-hand
	c) place of installation	on crankcase front section
	d) gear ratio (to crankshaft r.p.m.)	1.158:1
32.	Non-return valves at engine oil inlet:	
	a) number	two
	b) place of installation:	

	1-st valve 2-nd valve	in MM-6CB pump in the crankcase front section behind the pressure section of the front oil pump MM-B.
33.	Desired oil pressure at 75% normal rating with oil inlet temperature of 65°C, kg/cm²:	
	a) in oil pump, on the engine rear cover	6.0-6.5
	b) in friction clutch oil line under the jaw piston	not less than 4.5
	Oil pressure at normal and 75% normal ratings and oil inlet temperature	within 40°-90°C, kg/cm²
	a) in engine rear oil pump	not less than 5.0
	b) in cam clutch oil line	not less than 3.0
	c) in supercharger first speed oil line	not less than 3.5
	d) in supercharger second speed oil line	not less than 3.5
34.	Minimum oil pressure in the rear oil pump at low speed (n=550-650), kg/cm²	not less than 2.5
35.	Specific oil consumption at cruising rating, grm/h.p./hr	not more than 10
36.	Engine oil pressure at normal rating and oil inlet temperature of 65°C, kg/min	not more than 60
37.	Heat transfer to oil at normal rating and oil inlet temperature of 65°C, kg-cal/min.	not more than 950
38.	Oil inlet temperature, °C:	
	a) desired	60-70
	b) maximum permissible during continuous operation	80
	c) maximum permissible during not more than 10 min.	90
	d) minimum	40
39.	Oil outlet temperature °C:	
	a) desired	not more than 115
	b) maximum permissible during not more than 10 min.	125
40.	Cylinder heads temperature in °C (measured by the thermocouple under rear spark plug cylinder No.5):	
	a) desired	not more than 225
41.	b) maximum permissible during not more than 15 min.	250
	c) minimum required for good acceleration	120

IGNITION SYSTEM

42.	Magneto:	
	a) number	two
	b) type	screened, M514T-2
	c) direction of rotation	left-hand
	d) gear ratio	1.75:1
43.	Spark advance of both magnetos in degrees of crankshaft rotation (both magnetos are set by cylinder No.2)	21° ± 1° before TDC, in compression stroke.
44.	Engine firing order	1-10-5-14-9-4-13-8-3-12-7-2-11-6-1
45.	Magneto breaker contact points gap, mm	0.2-0.3
46.	Spark plugs:	
	a) type	screened, СД-38-6С
	b) number per cylinder	2

VALVE TIMING

47.	Valve timing in degrees of crankshaft rotation (cylinders No.5 and 2):	
	a) intake begins	23^{0+7} before TDC
	b) intake ends	$66^{0}\pm4$ past BDC
	c) exhaust begins	$74^{0}\pm3$ before BDC
	d) exhaust ends	$25^{0+8^{0}}$ past TDC
48.	Clearance between the rocker arm roller and the valve stem (engine cold) for all intake and exhaust valves, mm:	
	a) while checking valve timing	1.9
	b) set for operation	$0.35\ ^{+0.25}_{-0.1}$

ENGINE ACCESSORIES

49.	Generator:	
	a) number	one
	b) type	ГСР-3000М
	c) direction of rotation	left-hand
	d) gear ratio	2.74:1
50.	Starting system	combination type, electric inertia starter СКД-2
51.	Manifold pressure regulator	
	a) type	РПД-1ФМР
	b) number	one.
52.	Solenoid switch	
	a) type	ЭП-19 or ЭП-19МР
	b) number	2

53.	Auxiliary drive, lower	right-hand rotation, gear ratio 1.9 (to crankshaft r.p.m.)
54.	Auxiliary drive, upper	right-hand rotation, gear ratio 0.865 (to crankshaft r.p.m.)
55.	Drive to tachometer generator (4Gf -1 -48)	right-hand rotation, gear ratio 0.5 (to crankshaft r.p.m.)

NOTE: Direction of rotation of engine accessories drives is given if looking at their flanges from drive shafts side.

56.	Dry weight of engine, kg	not more than 1,100
57.	Engine dimensions, mm	
	a) length with MB-82B pump	1,887 $^{+4}_{-9}$
	b) diameter (including rocker boxes covers)	1,300 + 5

2. P-5 MAIN GEARBOX TECHNICAL DATA

1.	Model	P-5
2.	Gear ratio	0.07407:1
3.	Drive shaft direction of rotation (as viewed from freewheel)	right-hand
4.	Direction of rotation of main rotor drive shaft (as viewed from reduction gear)	left-hand
5.	Hydraulic pump:	
	a) number	two
	b) type	gear-type, NN-11
	c) direction of rotation	left-hand
	d) gear ratio	0.933:1 and 1:1
6.	Tachometer generator	
	a) number	one
	b) model	4Gf-1 -48
	c) direction of rotation	right-hand
	d) gear ratio	0.5:1
7.	Drive of main rotor blades heating generator:	
	a) gear ratio	0.771:1
	b) direction of rotation (as viewed from main gearbox.)	left-hand
8.	Oil pump:	
	a) number	one
	b) type	gear-type, MN-5
	c) direction of rotation	left-hand
	d) gear ratio	1.145:1

9.	Tail rotor drive:	
	a) direction of rotation (as viewed from main gearbox)	left-hand
	b) gear ratio	1.0:1
10.	Summer and winter oil grades	MK-22,MC-20 (ГОСТ 1013-49)
11.	Oil pressure at 75% normal rating, kg/cm^2	3.0-6.5
12.	Oil pressure at low engine speed, kg/cm^2	not below 1.0
13.	Oil temperature at oil sump inlet with engine running at 75% normal rating, °C	40-70
14.	Dry weight of main gearbox, kg	471±2%
15.	Main gearbox dimensions, mm:	
	a) height	1,600
	b) diameter	670

NOTE: 1. Direction of rotation of engine accessories is given if the accessory flanges are viewed from the drive shaft sides.

2. The gear ratios of the accessory drives are indicated with respect to main gearbox driving shaft.

3. MAIN DRIVE SHAFT WITH FLEXIBLE COUPLINGS. (assy. 316984)

1.	Purpose	transmission of torque from engine crankshaft to P-5 main gearbox shaft
2.	Number	one
3.	Length, mm	1,860±11.5
4.	Weight, kg	40±2%
5.	Centering of drive shaft	When mounting in a helicopter, the centering flanges play at outer diameter in relation to semi-couplings during one complete revolution should not exceed 0.65

S E C T I O E III.

PREPARATION OF ENGINE AND P-5 MAIN GEARBOX FOR FLIGHT.

I. PREPARATION FOR STARTING.

To prepare the engine and main gearbox for starting carry out the following operations:

1. Check whether the helicopter tanks are filled with gasoline and oil.

2. Drain gasoline sediment from the filter sump and fuel tank sump.

3. Check the fuel system and the fuel booster pump as follows:

a) see whether the shut-off cock is closed;

b) start the fuel booster pump (with the shut-off cock air-tight the fuel pressure gauge should indicate "0").

c) open the shut-off cock and see whether the gauge registers gasoline pressure;

d) check the condition of the solenoid-controlled priming valve by switching the priming switch two or three times. After the solenoid valve is switched on, fuel leakage should occur from the pipe connection of the supercharger rear section;

e) switch off the booster pump and close the shut-off cock.

WARNING. With the engine inoperative the shut-off cock must be always closed, otherwise gasoline may flow from fuel tank into the engine interior through HB-82B pump.

4. Check the proper operation of :

a) throttle control ("Collective pitch control");

b) HB-82B pump manual control lever;

c) supercharger two speed drive switch;

d) clutch;

e) oil cooler shutters;

f) outer cowl shutters.

5. With the ambient air temperature below +5°C for the engine and below +10°C for the main gearbox, delute the oil while starting and warm up the engine and main gearbox according to the operation instructions (see paragraph 2, section III).

6. Before starting the engine and engaging the main gearbox with oil diluted, make sure that the oil temperature in the engine and main gearbox lubricating systems correeponds to the temperature for which the oil has been diluted (see Table 1).

Table 1.

Oil temperature in engine and main gearbox oil systems, °C.	Percentage of gasoline in oil
From +5 to -5 (for engine)	5-6
From +10 to -5 (for main gearbox)	5-6
From -5 to -15	10-12
From -15 to -30 (for engine)	18-20
From -30 and below (for engine)	18-20
From -15 and below (for main gearbox)	10-12

7. When by the time of starting the oil temperature in engine and main gearbox lubricating systems is below the minimum for which the dilution was made, the engine should be started and the main gearbox engaged only after the oil in the oil systems has been heated 5°C above the minimum temperature for which the oil was diluted.

If the oil temperature in the oil systems exceeds the temperature for which the oil was diluted the engine may be started and the main gearbox engaged without heating the oil in the oil systems.

8. If by the time of starting the oil temperature in the engine and main gearbox lubricating systems diluted for -30°C is below -30°C it is necessary to heat the oil in the oil systems up to a temperature of not below -25°C before the engine is started and the main gearbox engaged.

2. HEATING UP THE ENGINE AND P-5 MAIN GEARBOX.

1. Before starting heat up the engine by ground heaters when operating at an ambient air temperature below -5°C with oil diluted and below +5°C with oil non-diluted.

2. Cover the powerplant with the heatproof cover.

3. Heat up the engine through the bottom access door to the fan having removed the lower section of the inner cowl and directing the hot air flow to the engine clutch, and through the bottom access door of the cowl to the supercharger rear section (Fig.10).

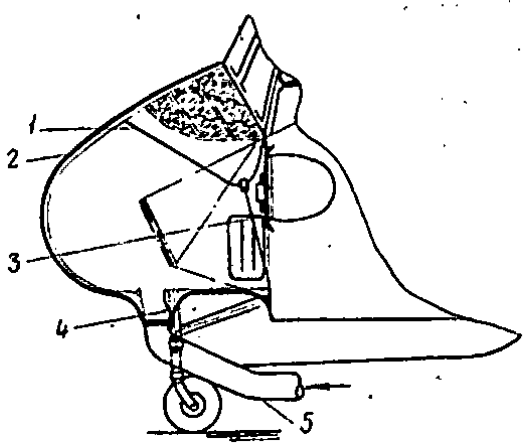


Fig. 10. Engine heating diagram.

1) Intake cover; 2) cowl cover;
3) cap; 4) adapter; 5) hot air sleeve.

4. Heat up the engine till the cylinder head temperature reaches +30°-40°C with oil non-diluted or +5°C with oil diluted.

5. The air temperature at the heater outlet should be within 100°-120°C.

6. As soon as the cylinder head temperatures have reached those indicated in paragraph 4, replace the sleeve from the cowl bottom access door to the main gearbox.(Fig. 11).

NOTE: Should the engine be started several times during a flying day, do not heat up the engine if the cylinder heads and oil inlet temperature is not below +5°C.

USE OF DILUTED HYPOID OIL FOR WINTER OPERATION OF INTERMEDIATE AND TAIL ROTOR GEARBOXES.

1. During winter operation (at an ambient air temperature below 0°C) fill the intermediate and tail rotor gearboxes with diluted hypoid oil consisting of 2/3 hypoid oil (GOST 4003-53) and 1/3 aviation oil AMG-10 (GOST 6794-53) by volume.

Prior to using, the diluted hypoid oil should be thoroughly mixed up for 3-5 minutes.

2. When operating with diluted hypoid oil in winter, do not heat up the main gearbox, intermediate and tail rotor gearboxes before starting if their oil temperature is not below -5°C.

3. With the oil temperature in the main gearbox from -15° to -30° heat up only the main gearbox till its oil temperature is not below -5°C.

4. Should the oil temperature in all the gearboxes be below -30°C, heat up the main gearbox till its oil temperature is not below -5°C and the oil temperatures in the intermediate and tail gearboxes are not below -15°C.

CAUTION: a) When operating the intermediate and tail gearboxes with diluted hypoid oil, the oil filled in the P-5 main gearbox at an ambient temperature below -15°C should not be diluted by more than 12 per cent.

b) Prior to throwing in the engine friction clutch, turn the main rotor manually two or three complete revolutions.

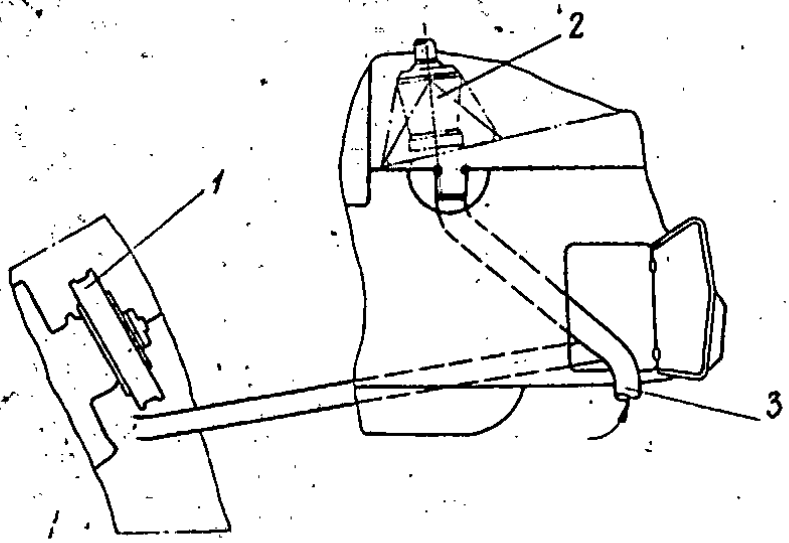


Fig. 11. P-5 gearbox and clutch heating diagram.

1) Clutch;

2) P-5 gearbox;

3) hot air sleeve.

c) Throw in the engine friction clutch not later than in 10 minutes after manual turning of the main rotor and checking the oil temperature in the gearboxes provided they were heated up.

5. When changing the winter for summer operation of the intermediate and tail rotor gearboxes, drain out the winter oil mixture through the drain plugs and fill the system with non-diluted hypoid oil.

NOTE: The oil residue in the gearboxes is allowed not to be drained prior to refilling.

6. In case of occasional increase of an ambient air temperature up to +30°C it is allowed, as an exception, to operate the intermediate and tail rotor gearboxes filled with diluted hypoid oil.

7. Change the oil as specified in periodic maintenance operations in accordance with valid operating instruction irrespective of what kind of oil the system is filled with.

3. STARTING THE ENGINE.

Prior to starting the engine:

1. Make sure that the engine ignition switches are set in the "ВЫКЛЮЧЕНО" ("Off") position.

2. See whether the supercharger two speed gear drive valve switch is in the "1-ая скорость" ("1-st speed") position.

3. See whether the clutch switch is in the "I" position. (keep the button pressed for 1.5-2sec).

4. Set the cowling flaps in positions: "ОТКРЫТО" ("open") in summer and "ЗАКРЫТО" ("closed") in winter and the shutters of the oil coolers in the "ЗАКРЫТО" ("closed") position.

5. Release the transmission brake.

6. Force the oil to the main gearbox. Start the engine when, after it has been heated up, the main drive shaft (from the engine to the P-5 main gearbox) with the flexible couplings can be rotated manually by the flexible coupling in the direction opposite to the engine normal rotation.

The main drive shaft is allowed to be turned both by the coupling located closer to the engine and by that located closer to the P-5 main gearbox; if the main drive shaft does not rotate by hand, heat up the engine, P-5 main gearbox and tail rotor gearbox by the ground heater till the main drive shaft can be turned by hand in the direction opposite to its normal rotation.

7. Immediately before starting, turn the engine crankshaft by the starter with the ignition switch "off" and the manual control lever of the НВ-82В direct-injection pump in the "Стоп" ("stop") position without accelerating the starter flywheel, engage this, mesh the starter and keep it engaged for 6-7 sec.

The engine crankshaft should rotate 5 revolutions.

If the engine crankshaft cannot be turned by the starter motor (at a supply voltage of 24v), remove one spark plug from cylinders Nos.6,7,8 and 9 and turn manually the crankshaft 3-4 revolutions by the fan blades to drain the accumulated gasoline and oil from cylinders Nos. 6,7,8 and 9 through the spark plug holes.

WARNING. Do not turn the engine crankshaft by the starter after accelerating the flywheel since the presence of gasoline and oil in the cylinder combustion chambers may cause a hydraulic impact.

8. The time between turning the engine crankshaft by the starter and engine starting should not exceed 15 min. Otherwise, turn the crankshaft again.

9. Before starting the engine, after cold cranking by the starter, turn the main rotor manually 1/2 revolution in the direction opposite to its normal rotation to provide the engagement of the P-5 gearbox freewheel.

10. Open the shut-off valve and set the lever of the НВ-82В pump in the "Автомат. нормал." ("Auto. normal") position.

11. Push the collective pitch lever fully downward and set the throttle control grip in the position corresponding to 800-900 r.p.m.

12. Operating the hand-operated pump build up a pressure of 1 kg/cm^2 x) (not earlier than 30 sec before starting the engine) in the main gearbox oil system and maintain it during 1 min. after the engine has been started in order to fill the cavities of the gear parts with oil (Fig. 12).

13. Set the starter switch in the "Раскрутка" ("start.") position. The duration of the starter acceleration at a supply voltage of 24v should not exceed 18 sec. and at a voltage exceeding 24v - 15 sec.

x) If the oil system of the P-5 main gearbox is filled with hot oil the oil pressure should be not less than 1 kg/cm^2.

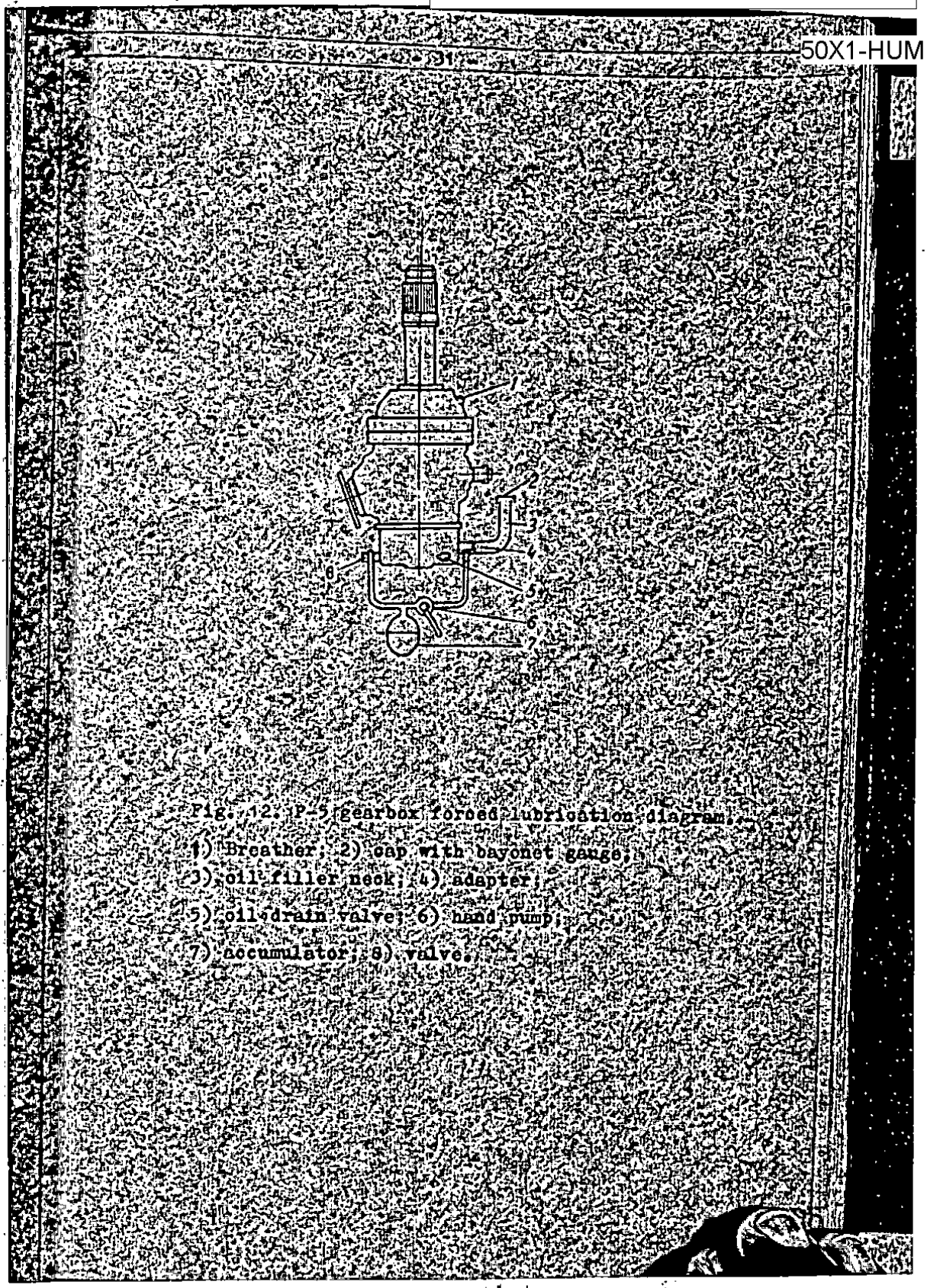


Fig. 12. P-5 gearbox forced lubrication diagram.

1) Breather; 2) cap with bayonet gauge; 3) oil filler neck; 4) adapter; 5) oil drain valve; 6) hand pump; 7) accumulator; 8) valve.

CAUTION: While the starter flywheel is accelerated the engine crankshaft should not rotate. Otherwise, stop accelerating the starter flywheel and by meshing the starter several times try to disengage the jaw from the crankshaft or turn the crankshaft manually in the direction of normal rotation by the fan blades with the ignition switch "Off".

14. Start the fuel booster pump (the indicated gasoline pressure should be 0.5-1.0 kg/cm^2).

15. As soon as the starter flywheel is accelerated sufficiently, move the switch to the " Сцепление " ("Mesh ")position and switch on the ignition and prime the engine after 1-2 sec.

Fuel must be primed by separate portions at 2-3 sec intervals until the engine begins to run smoothly.

Keep the starter switch in position "Сцепление" ("Mesh ") for not more than 7 sec.

WARNING. 1. Do not mesh the starter jaw by hand control lever with the flywheel accelerating electrically since, in this case, the electric motor brushes being energized will rise which will cause the starter failure.

2. The starter electric circuit must incorporate a fuse for not more than 500 a.

3. Do not turn the engine crankshaft with the starter after preliminary flywheel acceleration as the presence of fuel or oil in the cylinder combustion chambers may cause a hydraulic impact.

4. The time between cranking the engine crankshaft by the starter and the engine starting should not exceed 15 min. Otherwise repeat cranking.

5. Switch on the electric starter for not more than 5 times with 2 minutes' intervals between each switching, after that cool the starter during 10 minutes. It is allowed to switch on the starter once with combined operation time of not more than 22 sec. (acceleration time is not included), in the other four starting attempts the starter combined operation time should be 7 sec. (acceleration time is not included too).

6. If, after the crankshaft turning by the starter, the starter jaw does not disengage from the accessory drive shaft, turn the crankshaft manually by the fan blades in the direction of its rotation till the jaw disengages.

16. As soon as the engine has started, set the starter switch to the "Выключено" ("off") position and watch the readings of the oil pressure gauges. If during 5-8 sec. after the engine has been started the oil pressure in the rear oil pump does not reach kg/cm^2, stop the engine, find and eliminate the cause of trouble.

CAUTION: After starting the engine, watch the main rotor operation. Should the rotor not rotate, do not engage the clutch, and stop the engine immediately. Having stopped the engine, check the freewheel for engagement by turning the rotor blade 1/2 revolution in the reverse direction and repeat the engine starting.

17. With the engine running smoothly, stop priming, switch off the fuel booster pump and run the engine at 900-1,000 r.p.m. by smoothly moving the mixture control lever.

18. If the engine fails to start after three attempts, stop starting, find and eliminate the cause of trouble.

19. When starting the engine, observe the following instructions:

a) do not move the collective pitch lever and do not increase the speed in excess of 900-1,000 r.p.m. by operating the throttle control since, with the clutch thrown out, this may result in the engine overspeed;

b) do not move the HB-82B pump manual control lever from the "Автонормально" ("Auto. normal") position to the intermediate position;

c) do not overprime the engine since the overprimed engine will not start properly, especially when the hot engine is started for the second time.

4. WARMING UP THE ENGINE.

SEQUENCE OF WARMING UP THE ENGINE AND ENGAGING THE CLUTCH WITH NON-DILUTED OIL IN THE ENGINE OIL SYSTEM.

1. Warm-up the engine at 1,000-1,100 r.p.m. until the oil inlet temperature reaches 40°C and that of the cylinder heads 90-100°C.

Do not run the engine at a speed exceeding 1,400 r.p.m. with the clutch thrown out.

2. After the engine has been warmed up to the temperature of oil and cylinder heads indicated in paragraph 1, throw in the clutch, as follows:

a) some 10-15 sec before throwing in the clutch, build up the pressure of 3 kg/cm^2 in the oil system of the P-5 main gearbox by operating the hand pump x) If the oil system of the main gearbox is filled with hot oil, the oil pressure should be not less than 1 kg/cm^2. Pump the oil until the oil pressure is built up in the main gearbox by its own pump (after throwing in the clutch), which will be indicated by an increased force on the pump handle;

b) run the engine at 1,100 r.p.m.;

c) set the clutch control switch in the "II" position and press the button for 1.5-2sec., which will correspond to the "On" position of the friction clutch slide valve switch (see Fig.7).

After the friction clutch has been engaged the speed of the main rotor should gradually and smoothly increase accompanied by the simultaneous decrease of the engine speed (the crankshaft speed) to approximately 600 r.p.m.

d) complete engagement of the friction clutch takes 17-50 sec. from the moment the power button is pressed and is determined by coincidence of the pointers of the engine and P-5 main gearbox tachometer indicator (2T34-2).

WARNING. 1. The friction clutch must be engaged within not more than 50 sec. to prevent overheating of its parts.

2. To control the solenoid switches of the friction clutch the voltage in the electric circuit should be not less than 24v.

x) If the oil in the P-5 main gearbox oil system is hot, the oil pressure should not be less than 1 kg/cm^2.

e) After equalizing the engine (crankshaft) speed with that of the main gearbox driving shaft within ±50 r.p.m. by the ZIM-2 tachometer, throw in the cam clutch without throwing out the friction clutch, by moving the switch of the friction clutch control in the "III" position and simultaneously press the button for 1.5-2 sec.

To protect the parts of the friction clutch from overloads during the engagement of the transmission, it is recommended to decrease the engine (crankshaft) speed by operating the throttle control grip till the pointers of the combined tachometer coincide after the speed of the main gearbox driving shaft reaches 600 r.p.m. After equalizing the r.p.m. of the engine and the rotor, throw in the cam clutch as indicated above without throwing out the friction clutch.

f) Run the engine for 1 min with the cam and friction clutches engaged and then throw out the friction clutch by moving the clutch control switch from the "III" to "IV" position (see Fig.7) by pressing the button for 1.5-2 sec. This position corresponds to the "off" position of the slide valve of the friction clutch switch with the cam clutch thrown in.

WARNING: 1. With the friction clutch thrown in and the cam clutch thrown out under no condition increase the engine (crankshaft) speed over 1,200 r.p.m.

2. While throwing in the clutch, do not use the throttle control to maintain the engine (crankshaft) speed in the sense of increasing the r.p.m.

If, during throwing in the clutch of the P-5 main gearbox and the transmission gearboxes, the engine stalls, check and adjust the mixture at low speed.

3. If, 50 sec after the button has been pressed to engage the friction clutch, the speed of the P-5 main gearbox driving shaft does not coincide with the engine (crankshaft) speed, throw out the friction clutch. The clutch can be thrown in again not earlier than 5 min after it has been thrown out.

4. When the oil pressure in the cam clutch oil line (after throwing the clutch in and out) is below 3 kg/cm², throw it out by moving the clutch control switch in the "I" position and press the button for 1.5 sec. Stop the engine to remedy the trouble.

4. After the clutch has been engaged, smoothly increase the engine speed at 1-2 min intervals after every 100-200 r.p.m. Warm up the engine at 1,400 r.p.m. until the temperature of the cylinder heads reaches 100°C and that of inlet oil - 30°C, then smoothly change the engine speed for 2,100 r.p.m. and complete warming up to this speed.

The main gearbox is considered warmed up when the oil inlet temperature reaches 40°C.

SEQUENCE OF WARMING UP THE ENGINE AND THROWING IN THE CLUTCH WITH DILUTED OIL IN THE ENGINE OIL SYSTEM.

1. Warm up the engine at 1,000-1,100 r.p.m. with the fan air inlets closed until the temperature of the cylinder heads reaches 40° and the temperature of inlet oil is:

at 5-6% gasoline content in oil 30°C
at 10-12% gasoline content in oil 15°C
at 18-20% gasoline content in oil 0°C

NOTE: Before throwing in the clutch, do not warm up the engine above the indicated oil temperatures since this will decrease oil viscosity and increase the time necessary to throw in the friction clutch.

2. After the engine has been warmed up to the temperature indicated in paragraph 1, throw in the clutch as indicated in paragraph 2a,b,c,d,e,f of the preceding section.

3. After the clutch has been thrown in, gradually increase the engine speed at 1-2 min intervals after every 100-200 r.p.m. Warm up the engine at 1,400 r.p.m. until the temperature of the cylinder heads reaches 100-120° (for better evaporation of gasoline) and of inlet oil - 30°C, then change the engine speed for 2,100 r.p.m. and complete warming up at this speed.

4. After warming up the engine, if the oil in the oil system is diluted by more than 10%, evaporate gasoline from oil again.

Evaporate gasoline with the fan air inlet shutters closed, at 2,100 r.p.m. and the manifold pressure of 500-550 mm Hg. until the normal oil pressure is built up at a temperature of the cylinder heads within 200-220°C and the oil inlet temperature within 40-50°C.

After accomplishing the evaporation, run the engine at normal rating and maintain for 7 min. the oil inlet temperature not

above 50°C.

NOTE: When evaporating gasoline from oil, strictly observe the rules of evaporation not performing other ground test operations.

5. Do not evaporate gasoline with the oil in the engine, oil system diluted by less than 10%.

6. When the engine runs with the main gearbox engaged, maintain the oil inlet temperature of the main gearbox within the following limits:

with oil diluted by 5-6% from +30 to +65°C

with oil diluted by 10-12% from +10 to +45°C

5. ENGINE AND ITS ACCESSORIES GROUND TEST.

(Fig. 13).

CHECKING THE MAGNETO AND SPARK PLUGS OPERATION.

1. Run the engine at 2,200 r.p.m. and manifold pressure of 820 mm Hg. (75% normal rating) for 10-15 sec., then switch off each magneto in succession for 5-10 sec.

With one magneto switched off, the engine will normally lose not more than 100 r.p.m. The drop of r.p.m. below the indicated limit shows improper functioning of the spark plugs or the magneto.

2. After testing one magneto and before switching off the other, run the engine on two magnetos for 5-10 sec in order to heat the spark plugs.

CHECKING THE GENERATOR OPERATION.

The generator is tested in the following sequence:

a) with the engine running at 2,000-2,200 r.p.m., make sure that the helicopter storage battery and ground electric supply are switched off;

b) move the generator switch to the "ВКЛЮЧЕНО" ("on") position at a voltage of 28.5v.

c) by switching on the power consumers build up a load of 100 a;

d) decrease the engine speed to 1,000 r.p.m. and make sure that the reverse current relay operates and the ammeter reading is zero;

e) increase the engine speed again to 2,000-2,200 r.p.m. With the generator, voltage regulator and reverse current relay operating normally the voltmeter should again indicate 28.5v.

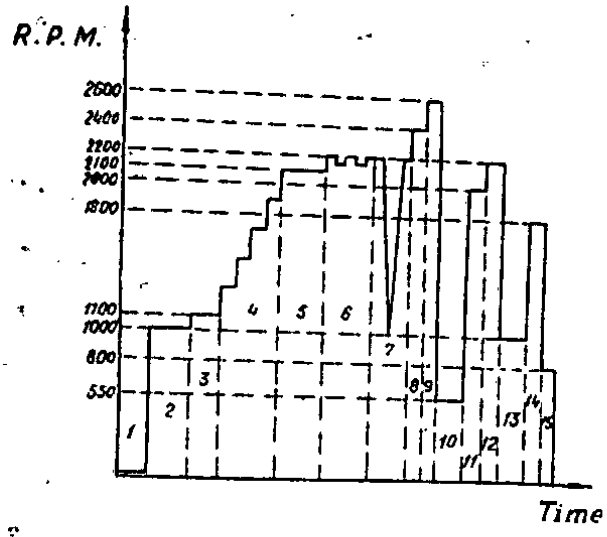


Fig.13. Engine and its accessories operation check diagram.
(engine warm-up time depends on ambient temperature).

1) Starter acceleration; 2) engine warming; 3) clutch engaging; 4) engine and main gearbox warming; 5) fuel and oil evaporation; 6) magneto and spark plugs operation check; 7) generator operation check; 8) engine operation check at normal ratings; 9) engine operation check at take-off rating; 10) engine operation check at low speed; 11) engine operation check with supercharger running at 2-nd speed; 12) oil pressure check; 13) engine cooling; 14) spark plugs heating; 15) clutch disengaging.

f) after checking the generator operation, switch off the power consumers.

CHECKING THE ENGINE AND P-5 MAIN GEARBOX OPERATION AT NORMAL RATING.

1. Run the engine at normal rating and the supercharger at the first speed and check the engine instruments readings.

2. The instruments should indicate:

a) speed, r.p.m.	2,400
b) manifold pressure, mm Hg.	970±10
c) fuel pressure, kg/cm^2	1.5-2.0
d) oil pressure in the rear oil pump, kg/cm^2	5.0-6.5
e) oil pressure in the cam clutch oil line, kg/cm^2	not below 3.0
f) oil inlet temperature, °C	
for non-diluted oil	40-80
for diluted oil	30-60
g) recommended temperature of the cylinder heads, °C	not more than 225

2. The main gearbox instruments should indicate:

a) gearbox oil inlet temperature, °C	
with non-diluted oil	from 40 to 70
with diluted oil	
by 5-6%	from 30 to 65
by 10-12%	from 10 to 45
b) oil pressure in the gearbox at the temperatures indicated above, kg/cm^2	from 3 to 6.5

CHECKING THE ENGINE AND P-5 MAIN GEARBOX OPERATION AT TAKE-OFF RATING.

1. Run the engine at take-off rating and check the engine instruments readings.

The instruments should indicate:

a) speed, r.p.m.	2,600
b) manifold pressure, mm Hg.	1,125±10
c) fuel pressure, kg/cm^2	1.5-2.0
d) oil pressure in the rear oil pump, kg/cm^2	5.0-7.0
e) oil pressure in the cam clutch oil line, kg/cm^2	3.0-6.0

f) engine oil inlet temperature, °C:
for non-diluted oil 40-80
for diluted oil 30-50

g) maximum temperature of the cylinder heads, °C not more than 250

Run the engine at take-off rating for not more than 5 min. This check should be performed if required by the conditions of flight only.

NOTE: If the manifold pressure does not equal to 1,125±10 mm Hg adjust it.

2. The regulator instrument readings should remain within the limits indicated for checking the main gearbox at normal rating.

CHECKING THE ENGINE AND P-5 MAIN GEARBOX OPERATION AT LOW SPEED.

Move the rotor blades to the minimum pitch by operating the collective pitch lever and run the engine at low speed by operating the throttle control grip. The engine should operate smoothly without vibration and show no signs of mixture enrichment or leaning out.

The readings of the engine and main gearbox instruments should be as follows:

speed, r.p.m.	550-650
fuel pressure, kg/cm^2	not less than 1.0
oil pressure in the rear oil pump, kg /cm^2	not less than 2.5
Oil pressure in P-5 main gearbox	not less than 1.0

CHECKING THE ENGINE OPERATION AT THE SUPERCHARGER SECOND SPEED AND WASHING THE SECOND SPEED CLUTCH PARTS.

1. If during the flight it will be necessary to switch on the supercharger second speed, its operation should be checked while testing the engine on ground. With this aim in view, run the engine at 2,100-2,200 r.p.m. and move the supercharger switch from the "1-ая скорость" (1-st speed) to "2-ая скорость" (2-nd speed) position, which should increase the manifold pressure (Pk) by 20-30 mm Hg.

CAUTION: 1. Do not switch on the supercharger second speed again in less than 2 min after it has been switched off since this may overheat the friction clutch discs.

2. Do not run the supercharger at 2-nd speed at manifold pressure exceeding the normal rate to prevent knocking and at the engine speed below 1,200 r.p.m. as this may spontaneously switch off the 2-nd sp

3. Do not run the supercharger at 2-nd speed on th ground for more than 5 min. at a temperature of the ambient air above +20°C.

2. After every 2 hours of engine operation at 2-nd speed of the supercharger, remove sediment from under the piston of the clutch as follows:

a) with the engine running on the ground at supercharger 1-st speed, decrease the engine speed to 1,000 r.p.m.;

b) move the supercharger switch from the "2-ая скорость" (1-st speed) to "2-ая скорость" (2-nd speed) position and run the engine at 1,000 r.p.m. for 5 min. (with the 2-nd speed of the supercharger switched off);

c) move the supercharger switch from the "2-ая скорость" (2-nd speed) to "1-ая скорость" (1-st speed) position.

CHECKING THE OIL PRESSURE IN THE ENGINE AND P-5 MAIN GEARBOX

Oil pressure in the engine and P-5 main gearbox is checked with the engine running at 2,200 r.p.m., at manifold pressure of 820 mm Hg. (75% normal rating) and the oil inlet temperature of 65°C.

Oil pressure should be:

in the rear oil pump, kg/cm^2 ..... 5.0-6.5

in the oil line of the cam clutch, kg/cm^2 ..... not less than 4.5

Oil pressure in the P-5 main gearbox should be within 5.0-6.5 kg/cm^2 at the following oil inlet temperatures and the degree of oil dilution:

with non-diluted oil ..... +60°C

with oil diluted by 5-6% ..... +50°C

with oil diluted by 10-12% ..... +20°C

If the oil pressure exceeds these limits, adjust it by the oil pump reducing valve.

STOPPING THE ENGINE.

1. Before stopping the engine, proceed as follows:

a) open fully the emitters of the engine cowling for better cooling of the cylinders;

b) run the engine at 1,000-1,200 r.p.m. until the cylinder heads cool down to 175°C;

c) after cooling the engine, increase its speed to 1,800 r.p.m. for 2-3 seconds heat the plugs;

d) cut down the speed to 800 r.p.m. and throw out the cam clutch by moving the clutch control switch from the "IV" to "I" position (see Fig.7) and press the button for 1.5-2 sec. Disengoging of the cam clutch is indicated by decrease of the rotor speed and increase in the engine speed and by the oil pressure drop under the cam clutch piston;

e) after the cam clutch has been thrown out, decrease the engine speed to 800 r.p.m. and stop the engine by moving the HB-62B pump manual control lever to the "Стано" (stop) position. After the engine stops firing, open the throttle valve by operating the throttle control grip to blow out the cylinders and the intake system. After the engine has been stopped, switch off the ignition and move the HB-62B pump manual control lever to the "Автонормално" (Automatic normal) position. The manual control lever must be left in this position till the next time the engine is started.

WARNING: 1. Do not stop the engine at a temperature of the cylinder heads above 175°C since this will cause uneven cooling of separate engine parts and permit the oil to run down from the cylinder walls.

2. The engine may be stopped without throwing out the clutch in emergency only. After stopping the engine throw out the cam clutch.

2. Close the shut-off cock, the shut-off cock should remain closed until the next starting to prevent fuel flow into the engine crankcase.

3. If the temperature of the ambient air during 24 hours before the next starting is expected to be +5°C or below for the engine and +10°C or below for the P-5 main gearbox, dilute the oil with gasoline prior to stopping the engine.

If the oil cannot be diluted with gasoline or the oil temperature cannot be maintained above +5°C for the engine and +10°C for the P-5 main gearbox until the next starting, the oil must be drained and filled again before the next starting according to the instructions in the section "Filling and Replenishing the Oil in the Oil System".

4. After the engine has been stopped, open the outer cowling of the engine and the main gearbox and perform the following operations:

a) check for the engine and main gearbox fuel and oil leaks and for any unlocked parts (especially drain plugs and cocks), whether parts contact each other and whether there are worn and damaged places;

b) switch on the fuel booster pump and check the fuel system and NB-82B pump for tightness;

c) check the oil level in the main gearbox oil sump and, if necessary, replenish the oil system.

5. Close the shutters of the engine and main gearbox outer cowling and check their fastenings.

CAUTION: To prevent damage to the ignition wires insulation do not close the cowling shutters and do not cover the engine with the canvas cover when the temperature of the cylinder heads exceeds 120°C.

6. FILLING AND REPLENISHING THE OIL IN ENGINE AND P-5 MAIN GEARBOX OIL SYSTEM.

1. Fill the engine and main gearbox oil system so as to secure a required duration of flight.

2. Fill oil into the system of the engine or the main gearbox (in addition to the filters of the oil servicing truck) through a gauze filter installed on a hose discharge cock with a gauze having not less than 1,600 holes per 1 cm^2 (gauze No. 40).

3. When filling the engine system (if all oil has been drained), discharge the air through the cock installed on the pipe feeding oil to the rear oil pump. After a dense spray of oil appears, close the cock and lock it. The tank should contain 50-60 litres of oil.

4. Fill oil into the main gearbox until the oil level in the filler neck of the gearbox oil sump no longer drops. The oil level should be between the marks of the dipstick which corresponds to 35-40 lit. of oil in main gearbox oil system. After the main gearbox oil system has been filled with oil, force the oil to the main

gearbox by operating the hand pump for 2-3 min. simultaneously turning the rotor manually.

5. Depending on the temperature of the ambient air, fill the engine and main gearbox oil systems as follows:

a) at a temperature of the ambient air above +5°C for the engine and +10°C for the main gearbox - with non-diluted oil heated up to +80°C; MAX.;

b) at a temperature of the ambient air +5°C or below for the engine and +10°C or below for the main gearbox, as a rule, with diluted oil as indicated in Table 2.

Table 2.

Minimum temperature of ambient air during 24 hours before starting, °C	Gasoline content in oil in per cent and by volume	Temperature of oil being filled °C.
1	2	3
From +5 to -5 (for engine)	5-6% (19/20 parts of oil and 1/20 part of gasoline	not more than +20
From +10 to -5 (main gearbox)	5-6% (19/20 parts of oil and 1/20 part of gasoline)	not more than +20
From -5 to -15	10-12% (7/8 parts of oil and 1/8 part of gasoline)	not more than +20
From -15 to -30 (for main gearbox)	Do	not more than +
From -15 to -30 (for engine)	18-20% (4/5 parts of oil and 1/5 part of gasoline)	not more than +20
Below -30 (for engine)	Do	from -30 to +20
Below -30 (for main gearbox)	10-12%	from -30 to +20

NOTE: At a temperature of the ambient air below +5° for the engine and below +10°C for the main gearbox, the oil systems may be filled with non-diluted oil heated up to 75-80°C.

6. Before filling the engine and main gearbox oil systems with diluted oil at a temperature of the ambient air below -30°C, heat up the engine, oil sump and the gearbox oil system to a temperature of not less than -25°C.

While heating up watch the readings of the thermometers indicating the oil inlet temperature to the engine, gearbox and oil tank.

7. The engine oil system can be replenished both before and after testing the engine.

If the engine oil system is filled with diluted oil, replenish it with diluted oil before testing or with non-diluted oil after testing.

8. Replenish the main gearbox oil system with diluted oil both before and after testing.

9. The oil dilution percentage of the replenished oil should correspond to the oil dilution percentage in the oil systems of the engine and the main gearbox.

WASHING THE CLUTCH (ENGINES OF THE 4-th SERIES).

Wash the clutch at the end of every flying day and after the engine five hours' operation.

Wash the clutch as follows (without disengaging the cam clutch):

with the cam clutch engaged, run the engine at 700-800 r.p.m. by moving the clutch selector switch from the "IV" to "III" position and pressing the button for 1.5-2 sec.

In this position the friction clutch sliding valve is on. With the cam clutch being engaged, increase the engine speed up to 2,100 r.p.m. and run the engine at this rating for 5 min., then run the engine at 700-800 r.p.m. and throw out the friction clutch by moving the clutch selector switch from the "III" to "IV" position (Fig 5) and pressing the button for 1.5-2 sec.

In this position the friction clutch sliding valve is off with the cam clutch engaged.

7. MANUAL STARTING THE ENGINE.

The sequence of manual operation when starting the engine i as follows:

1. Install the starter manual gear on a special bracket, an connect the flexible shaft to the CKД-2B starter.

2. Raise the starter motor brushes.

NOTE: The brushes are raised to facilitate the starter fly wheel acceleration and to reduce their wear.

3. To prevent a hydraulic impact turn the engine crankshaft by hand 2-3 revolutions in the direction of the fan rotation with the ignition switched off.

4. Insert the handcrank into the starter manual gear and rotating it counter-clockwise with increasing speed (up to 60-90 r.p.m.) accelerate the starter flywheel.

5. Engage the starter jaw by turning the jaw control lever counter-clockwise as far as it will go (by the cable) and keep it engaged until the engine starts.

6. After the engine is started, release the lever, remove the handcrank from the starter manual gear and the starter manual gear from the bracket.

S E C T I O N IV.

OPERATING THE ENGINE AND P-5 MAIN GEARBOX IN FLIGHT.

1. Before the helicopter takes off, make sure that the eng and main gearbox are warmed up and their instrument readings a within the limits specified by the operating instructions.

2. During flight see that the manifold pressure, engine r.p.m. oil and fuel pressure, engine and gearbox oil inlet and the tempe rature of the cylinder heads correspond to the following values:

a) manifold pressure and engine r.p.m. should correspond to the selected engine rating;

b) fuel pressure, kg/cm^2 ..... 1.5-2.0

c) oil pressure, kg/cm^2:

rear oil pump 5.0-6.5

cam clutch pipe line ..... not less than 3.0

d) engine oil inlet temperature, °C:

recommended	60-70
maximum permissible during continuous operation	80
maximum permissible for not more than 10 min.	90
minimum	40
e) temperature of cylinder heads, °C:	
recommended	not more than 225
maximum permissible for not more than 15 min	250
minimum for good acceleration	120
f) gearbox oil inlet temperature, °C, (oil line) should be:	
for non diluted oil	40-70
for oil diluted with gasoline:	
by 5-6%	30-65
by 10-12%	10-45
g) oil pressure in the gearbox at the temperature indicated above should be within 3-6.5 kg/cm^2.	
Oil pressure may vary by 0.7 kg/cm^2 /within the specified limits/.	

3. If the temperature of the cylinder heads or the engine or gearbox oil inlet temperature exceeds the limits specified by operating instructions, change the engine rating. If after this the temperature does not drop, land the helicopter.

4. Change the supercharger 1-st speed for the second speed at an altitude most advantageous for the given type of helicopter and with the engine running at 2,100-2,200 r.p.m.

The repeated switching-on of the supercharger 2-nd speed is permitted not earlier than 2 min. after it has been switched off.

5. It is not recommended to run the supercharger at the 2-nd speed if the helicopter flight condition is secured by the supercharger running at the 1-st speed since fuel consumption at the 2-nd speed is greater than at the first.

S E C T I O N V.

DILUTION OF OIL WITH GASOLINE IN ENGINE AND P-5 MAIN GEARBOX OIL SYSTEMS.

The oil in the engine and gearbox oil systems is to be diluted only when the minimum ambient air temperature during 24 hours before starting is expected to be +5°C or below for the engine, and +10°C or below for the gearbox.

CAUTION! All grades of oil used in the engine and gearbox are to be diluted. The oil is diluted with gasoline of the grade used for the engine.

I. OIL DILUTION IN ENGINE OIL SYSTEM.

1. Dilute the oil in the lubricating system of the running engine by supplying gasoline into the oil feed-pipe line delivering oil to the rear oil pump through a special ЭКР-3 oil dilution valve.

2. Check the system for leaks and tightness before the first dilution, after the replacement of the oil dilution valve and during 100- hours' maintenance operations.

The system should be checked for fuel leaks with the engine running at 1,200 r.p.m., with the clutch thrown out and the fuel pressure in the system from 1.5 to 2.0 kg/cm^2 as follows:

a) disconnect the fuel pipe, leading from the ЭКР-3 dilution valve, from the oil pipe line;

b) open the ЭКР-3 oil dilution valve and, as soon as the fuel begins flowing continuously, measure the fuel flow from the fuel pipe during 2 min. The fuel quantity should be within 5.4-6.2 litres.

c) Close the ЭКР-3 oil dilution valve and check it for tightness. There must be no gasoline leakage.

3. Dilute the oil at the end of the flying day (with the engine running at 1,200 r.p.m. and the friction clutch selector switch only in the "IV" position; the oil capacity being 35-45 litres) in the following manner:

a) when the engine oil inlet temperature reaches 40-45°C, run the engine at 1,200 r.p.m.;

b) open the ЭКР-3 oil dilution valve and keep it so during the period indicated in Table 3.

Table 3.

Minimum ambient air temperature (expected during 24 hours before starting), °C	Time during which the oil dilution valve is kept open, min.	Gasoline percentage in diluted oil
From +5 to -5	2.0	5-6
From -5 to -15	4.0	10-12
From -15 or below	6.0	18-20

CAUTION! During oil dilution the oil pressure in the rear oil pump may drop to 3 kg/cm^2 and in the cam clutch pipe line - to 2.5 kg/cm^2.

c) on the expiration of the time indicated in Table 3 open the 3KP-3 oil dilution valve and continue to run the engine at 1,200 r.p.m. with the friction clutch selector switch only in the "IV" position for 6 minutes until the oil in the engine oil system mixes up completely;

d) when mixing up the oil, throw in and out the friction clutch twice (with the cam clutch thrown in) to fill it with diluted oil. The time of the friction clutch operation being engaged must not exceed 50 sec.

The friction clutch is thrown in and out when the clutch control selector switch is moved from the "IV" to "III" position and back with subsequent pressing of the power button;

After the oil has been mixed up, decrease the engine speed to 700-800 r.p.m. and run the engine at this rating for 1.5-2 min. (to fill the friction clutch with diluted oil).

e) Run the engine for 2-3 sec. at a speed increased up to 1,800 r.p.m. (the friction clutch selector switch must be in the "IV" position, heat the spark plugs, then decrease the engine speed to 700-800 r.p.m., disengage the transmission, set the selector switch in the "I" position and stop the engine.

f) Make entries in the engine log-book as to the oil dilution with gasoline and the temperature for which it was performed.

4. If the engine has been started with diluted oil and for some reason or other is to be inoperative for a long period (during which the oil in the oil tank may cool to an ambient air temperature) perform additional oil dilution before the engine stopping as indicated in Table 4.

Table 4.

Previous dilution at an air temperature, °C.	Necessary additional dilution at the expected air temperature, °C.	Duration of the preceding engine operation on the ground and in the air including the evaporation time, min.				
		from 10 to 20	after 20	after 40	after 60	after 90
From +5 to -5(two-minute dilution)	+5 -5 time -5 -15 during -15 -30 which	1 3 5	- - -	- - -	2x 4x 6x	
From -5 to -15 (four-minute dilution)	+5 -5 the valve -5 -15 is kept -15 -30 open	- 2 4	1 2.5 5	- 3 -	2x 4x 6x	
From -15 to -30 (six-minute dilution)	+5 -5 -5 -15 -15 -30	- 2 2	- 2.5 2.5	- 2 3	1x 3x 5x	2x 4x 6x

Note: 1. When calculating the time necessary for an additional oil dilution, the time of the preceding engine operation at a speed below that required for evaporation should be taken as 50%.

2. After additional oil dilution, mix up the oil for 2-3 min. After the first dilution or during additional dilution (see figures marked "x" in Table 4) mix up the oil in accordance with paragraph "d", section I.

3. The percentage of gasoline in the oil may be determined by the oleometer.

5. If the engine has been run with diluted oil for more than 90 min., dilute the oil with gasoline again in accordance with Table 3.

6. In summer when dilution is not required, disconnect the gasoline supply pipe leading to the ZKP-3 oil dilution valve and plug it.

2. OIL DILUTION IN P-5 MAIN GEARBOX OIL SYSTEM.

1. Do not dilute the oil with gasoline directly in the gearbox oil system. The gearbox oil system is filled with diluted oil through a funnel with gauze No. 24 (576 holes per 1 cm^2). Before filling the lubricating system with diluted oil, completely drain the non-diluted oil from the oil system.

2. While diluting oil in the oil servicing truck, take into unt the minimum ambient air temperature expected during 24 s prior to starting the engine in accordance with Table 5.

Table 5.

inimum ambient air temperature pected during 24 hours before arting, °C	Necessary percentage of gasoline in oil (by volume)
rom +10 to -5	5-6% (19/20 parts of oil and 1/20 part of gasoline)
rom -5 to -15	10-12% (7/8 parts of oil and 1/8 part of gasoline)
rom -15 and below	10-12% (7/8 parts of oil and 1/8 part of gasoline)

3. The gearbox parts are heated to a less degree than the ine parts, and during operation but an insignificant quantity of bline evaporates from the oil. Therefore, to maintain the requ viscosity of oil, check the percentage of gasoline in the oil ing the following periods:

a) after the first 2 hours of operation (or after the first flight) upon dilution;

b) every 10-15 hours of operation after the oil dilution.

4. The percentage of gasoline in the oil is determined by ne of a oleometer as indicated in Table 6.

Table 6.

Specific gravity of mixture at 20°C (reduced)		Gasoline Percentage in oil (by volume)
-22 oil with asoline	MK-20 oil with gasoline	
.894	0.879	4.0
.890	0.876	6.0
.887	0.873	8.0
.883	0.871	10.0
.881	0.868	12.0

The gasoline percentage in the oil is determined in the llowing way:

a) feed the oil from the oil system into a special elongated vessel (of the same length as the oleometer);
b) heat the oil in the vessel up to 20°C;
c) submerge the oleometer into the vessel and keep it there for 5 min.;
d) read the specific gravity of the mixture on the oleometer scale and determine the gasoline percentage in the oil according to Table 4.

5. If the gasoline percentage in the oil is less than required (for the ambient air temperature expected by the next starting) perform additional dilution of the oil by filling through the filler neck 0.35-0.4 litres of gasoline per each missing per cent dilution (with 35-40 litres of oil in the system).

EXAMPLE. The oil must be diluted (according to the ambient air temperature) by 12 per cent.
The measurement shows that the oil is diluted with gasoline by 9 per cent. To restore a 12 per cent dilution, add (12-9)x0.4=1.2 litres of gasoline.

6. After additional dilution, force the oil to the gearbox by operating the hand pump for 5 min. For better mixing of the gasoline and oil it is also necessary to turn the main rotor blades 5 revolutions.

S E C T I O N VI.

INSTALLATION AND ADJUSTMENT OF ENGINE AND P-5 MAIN GEARBOX.

1. ADJUSTING THE ENGINE OIL PRESSURE.

Check the oil pressure adjustment after the oil pumps have been replaced and the reducing valves of the oil pumps disassembled and adjusted.

ADJUSTING THE OIL PRESSURE IN FRONT OIL PUMP (ПМН-Б).

Adjust the oil pressure in the front oil pump as follows:
a) unlock and unscrew cap 1 of the reducing valve (Fig.14).
b) remove lock 2 from the hole of the adjusting plug;
c) turn the adjusting plug with a screwdriver clockwise to increase the oil pressure and counter clockwise to decrease it; one revolution of the adjusting plug changes the pressure by approximately 0.5 kg/cm^2;

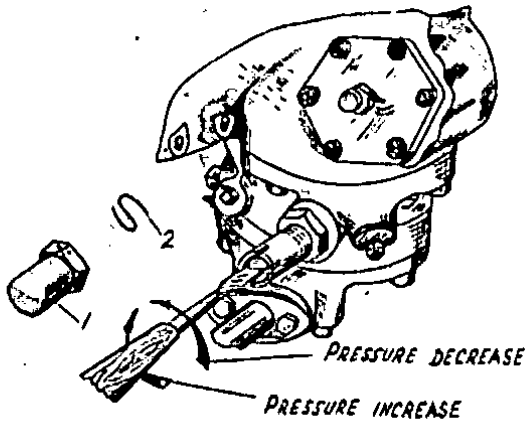


Fig. 14. Oil pressure adjustment (front oil pump).

1) Reducing valve cap; 2) adjusting plug lock.

d) after adjusting the oil pressure, place the lock into the hole of the adjustment plug through the slots in the valve body, screw down the cap tightly and secure it with a safety wire.

Check the oil pressure adjustment with the engine running.

ADJUSTING THE OIL PRESSURE IN REAR OIL PUMP (MM-6CB).

Adjust the oil pressure in the rear oil pump as follows:

a) unlock and unscrew cap 1 of the reducing valve adjusting screw (Fig.15);

b) loosen the locknut of the adjusting screw with a wrench;

c) holding the locknut with a wrench, turn screw 2 clockwise to increase the oil pressure and counter-clockwise to decrease it; one revolution of the screw changes the pressure by approximately 0.7-0.8 kg/cm^2;

d) after adjusting the oil pressure, tighten the locknut of the adjusting screw, screw down and lock the cap.

Check the oil pressure adjustment with the engine running at 2,200 r.p.m., manifold pressure of 820 mm Hg. (75% normal rating) and the engine oil inlet temperature of 65°C. The oil pressure should be:

in the rear oil pump (before the filter), kg/cm^2 5.0-6.6

in the cam clutch pipe line, kg/cm^2 not less than 4.5

2. ADJUSTING THE OIL PRESSURE IN THE P-5 MAIN GEARBOX.

Adjust the oil pressure in the P-5 main gearbox in the same manner as in the engine front oil pump.

Check the oil pressure adjustment with gearbox operating.

NOTE: Adjust the reducing valves of the oil pumps only after the oil pipes are thoroughly checked for tightness and the instruments for accuracy of readings.

3. ADJUSTING THE FRICTION CLUTCH VARIABLE JET.

1. If it takes less than 17 sec. to engage the friction clutch, adjust the jet as follows:

a) unlock and remove the jet coupling nut;

b) unlock and turn the jet needle 1/8-1/4 revolution;

c) look the jet needle, screw up and lock the coupling nut;

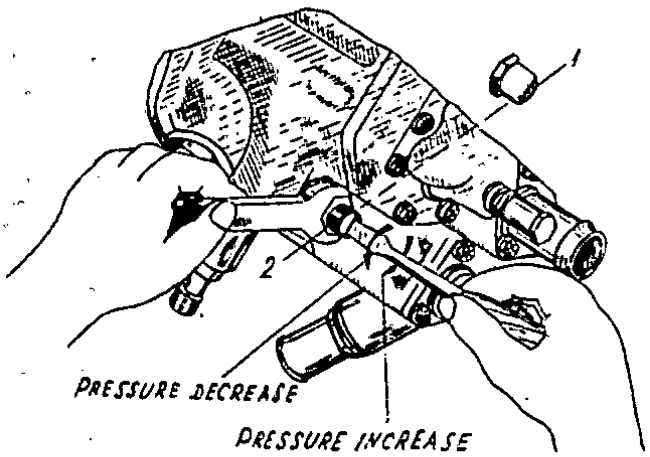


Fig. 15. Oil pressure adjustment (rear oil pump).

1) Reducing valve adjusting screw cap;

2) adjusting screw lock nut.

d) start the engine and see that the clutch is engaged.

2. If the friction clutch fails to be engaged during 60 sec., turn the jet needle 1/8-1/4 revolution as indicated in paragraph 1.

4. ADJUSTING THE FUEL PRESSURE.

If the fuel pressure does not meet the specified values, adjust it as follows:

a) unlock and loosen the cap;

b) turn the adjusting screw clockwise to increase the fuel pressure and counter-clockwise to decrease it.(Fig.16).

One revolution of the adjusting screw changes the fuel pressure by approximately 0.15-0.20 kg/cm^2.

c) lock the head of the adjusting screw, tighten the cap with a wrench and secure it with a safety wire.

5. INSTALLING THE MAGNETO ON ENGINE.

When replacing the magneto, a new magneto may be installed on the engine according to the setting of the removed magneto or with the help of the timing disc or top dead centre indicator.

PREPARING THE MAGNETO FOR INSTALLATION.

1. Before installing the magneto on the engine treat it as follows:

a) remove the grease from the drive shaft;

b) remove the shield together with the distributor block and wipe the grease from the cam using a dry and thick cloth or a piece of chamois;

c) remove the cellophane cap from the breaker and thoroughly clean the breaker spring stop and its attaching parts, prevent the grease from getting on the breaker contact points and the textolite pad.

2. After depreserving, coat the cam with a thin layer of turbine oil grade "A" /GOST 32-47/; prevent the oil from getting on the breaker contact points and adjacent surfaces.

3. When depreserving the magneto after an extended storage (for more than a year), wipe the cam dry with a clean cloth dampened in turbine oil until it begins to shine. See that there is no oil leak.

Apply 5-8 drops of turbine oil to the oil hole and 2-3 drops on the felt of the breaker pad.

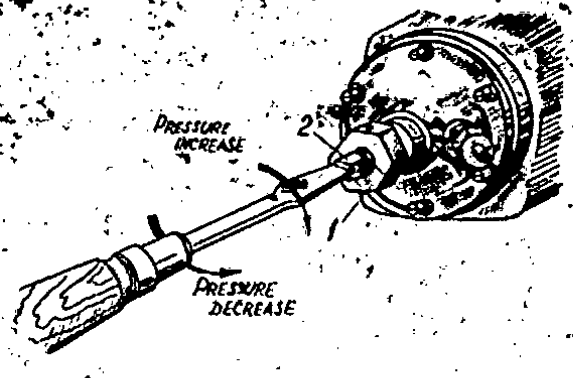


Fig. 16. Fuel pressure adjustment.

1) Adjusting screw nut;

2) adjusting screw.

4. Wipe dry the breaker contact points with a piece of chamois moistened in alcohol.

CAUTION! 1. Under no condition will gasoline be used for washing the parts of the magneto breaker and nappy cloth be used for wiping them.

2. The magneto will not operate without being previously depreserved.

When corrosion appears on the breaker springs and on the cam working surface replace the cam, for the cams affected by corrosion cannot be used.

INSTALLING A NEW MAGNETO ACCORDING TO THE SETTING OF THE MAGNETO REMOVED.

The magneto is installed as follows:

1. Remove the shield and the distributing block from the magneto to be replaced.

2. Turn the engine crankshaft (by the propeller) in the direction of normal rotation until the magneto breaker contact points are fully open and then check the gap between them.

The gap should be 0.2-0.3 mm. Adjust it if necessary.

3. Turn the crankshaft in the direction of normal rotation until the working electrode of the distributor finger is opposite the timing mark on the flange of the breaker housing; the breaker contact points being closed. Insert a 0.03-0.05 mm thickness gauge between the breaker contact points and slowly turning the crankshaft by the fan in the direction of normal rotation, determine the begining when the breaker contact points open. After this, do not rotate the engine crankshaft until the new magneto has been installed.

4. Unlock and unscrew the magneto attaching nuts and remove the magneto from the engine.

5. Depreserve the magneto to be installed, check the breaker contact points gap and turn the drive shaft in the direction of normal rotation until working electrode 2 of the distributor finger is opposite the timing mark 1 on the flange of the magneto rear cover (Fig. 17).

With the distributor finger in this position, the breaker contact points are just begining to open, which can checked by inserting a 0.03-0.5 mm thickness gauge between the contact points.

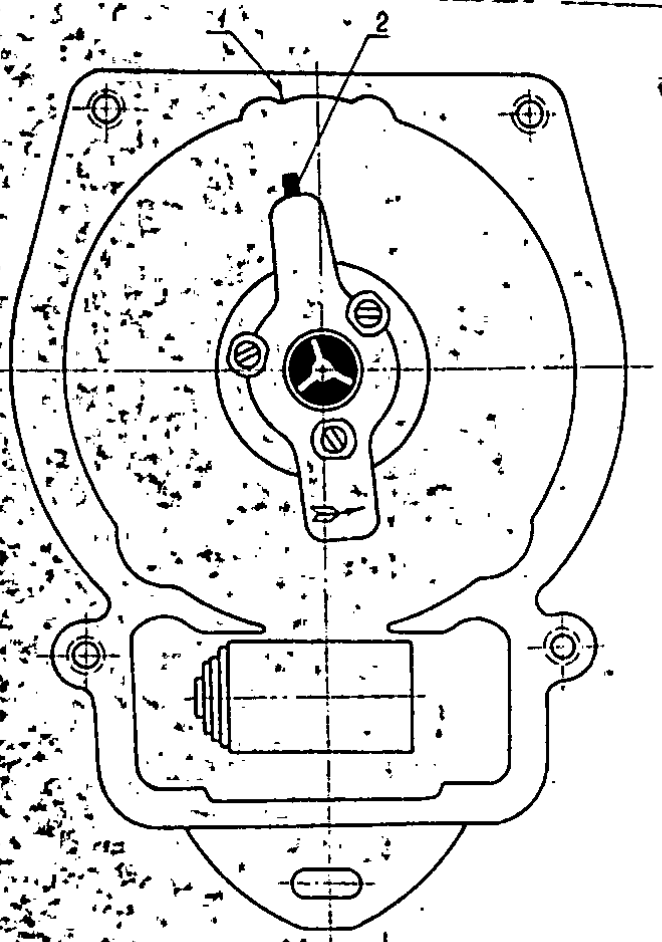


Fig. 17. Distributor finger position when installing the magneto.

1) Mark on the magneto rear cover;
2) finger electrod.

6. Install the magneto on the flange of the engine front section so that the drive shaft shall mesh with the magneto drive.

The place where the magneto flange contacts the engine must be thoroughly cleaned.

7. Turning the magneto on the studs to its extreme positions allowed by the oval holes in the mounting flange, note whether the breaker contact points close and open. Otherwise, remove the magneto, turn the distributor finger one or two revolutions and repeat the procedure for mounting the magneto on the engine trying to make the breaker contact points close and open. After this, place the washers on the studs and screw on the nuts by hand.

8. Insert a thickness gauge between the breaker contact points and turning the magneto to the right, clamp the gauge between the contact points; then slowly turn the magneto on the studs to the left until the thickness gauge is released.

With the magneto in this position, tighten the magneto attaching nuts, and making sure that the magneto has not shifted, while tightening the nuts, lock the nuts and place the distributing block with the shield in place.

9. While installing the magneto distributing block see that:

a) the carbon brush does not fall of its socket in the distributing block;

b) the distributing block is properly fitted on the key.

INSTALLING THE MAGNETO USING A TIMING DISC AND TOP DEAD CENTER INDICATOR.

Install the magneto with the help of the timing disc and top dead center indicator as follows:

1. Remove the unserviceable magneto;

2. Remove the front spark plug in cylinder 2;

3. Remove the fuel pump and place the timing disc on the flange of the fuel pump drive.

4. Insert the top dead center indicator into the spark plug hole of No.2 cylinder and determine the piston TDC in the compression stroke position. Note this position on the timing disc.

5. Rotating the engine crankshaft by the fan, set it according to the timing disc in the position in which the piston of No.2 cylinder fails to reach TDC on the compression stroke by $21^{0}\pm1^{0}$.

6. Depreserve the magneto to be installed, check the breaker contact points gap, and rotate the magneto drive shaft till working electrode 2 of the distributor finger is opposite the timing mark 1 on the flange of the magneto rear cover (see Fig.17).

With the distributor finger in this position, the breaker contact points are just beginning to open. This is checked by the thickness gauge clamped between the contacts.

7. Install the magneto on the flange of the engine front section so that the drive shaft shall mesh with the magneto drive.

8. Turning the magneto on the attaching studs to the extreme positions allowed by oval holes in the flange, check whether the breaker points close and open. Otherwise, remove the magneto, turn the distributor finger one or two revolutions and install the magneto again trying to make the breaker contact points close and open. After this, place the washers on the studs and screw on the nuts by hand.

9. Insert a 0.03-0.05 mm thickness gauge between the breaker contact points and shifting the magneto to the right, clamp the gauge between the breaker points, then slowly turn the magneto on the studs to the left until the thickness gauge is released. With the magneto in this position, tighten the magneto attaching nuts and check the accuracy of the magneto installation by turning the engine crankshaft. The contacts should begin to open the piston 21° ±1° before TDC on the compression stroke.

10. Lock the magneto attaching nuts and install the distributing block with the shield in place.

If a new distributing block is to be installed on the magneto, connect the ignition cables to it as follows: No.2 cylinder cable to No.1 terminal, No.11 cylinder cable to No.2 terminal, No.6 cylinder cable to No.3 terminal and so on, according to engine firing order (Fig.18).

11. Remove the timing disc and install the fuel pump in place.

12. Remove the top dead center indicator and screw in the spark plug.

ADJUSTING THE BREAKER CONTACT POINTS GAP.

1. To adjust the breaker contact points gap, loosen two screws 3 fastening the breaker plate (Fig.19) and, turning the eccentric screw 2, adjust the gap with the pad on the cam lug, then tighten the screw 3. The gap between the contact points should be within 0.2 and 0.3 mm.

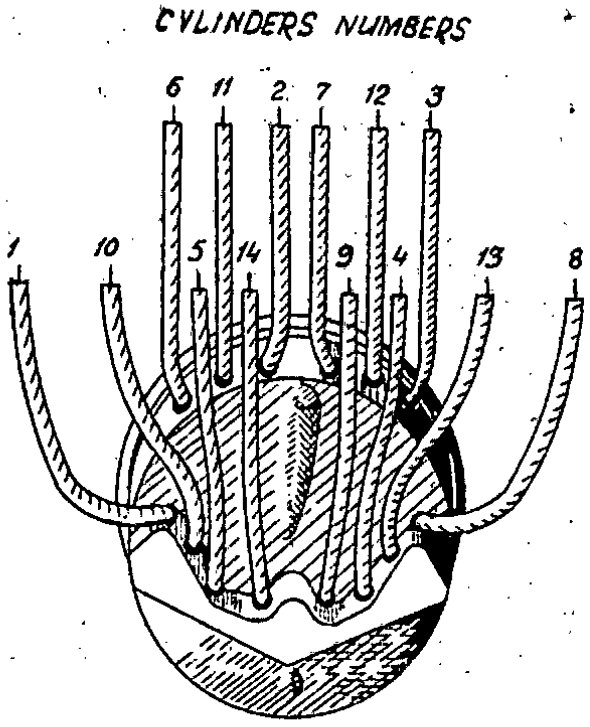


Fig. 18. Ignition wires - to - magneto distributor connection diagram.

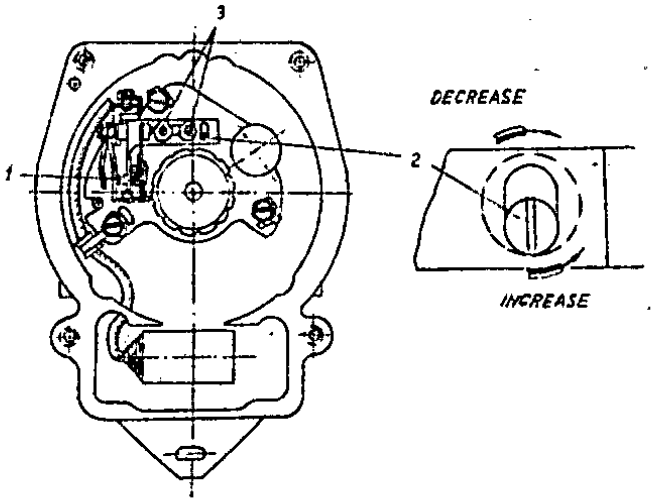


Fig. 19. Adjusting the magneto breaker contact points gap.

1) Gap 0.2-0.3mm with the breaker on the cam, lobe;

2) eccentric screw for adjusting the contact points gap;

3) breaker attachment screws.

CAUTION! Do not remove the breaker spring screw.

2. Each adjustment of the breaker contact points gap must be entered in the magneto certificate.

6. DEPRESERVING AND INSTALLING THE SPARK PLUGS ON ENGINE.

Depreserve and install the spark plugs on the engine as follows:

1. Wash out the protective coating from the spark plugs with clean gasoline, prevent the gasoline from getting into the cavity of the spark plug screen.

2. After washing, blow out the spark plugs with dry, compressed air, dry them up and check them for damages.

3. Check the spark plug hole in the cylinder head: the thread and the seat must be clean and without scores.

4. Place a new sealing ring on the spark plug: do not apply rings already used.

5. Coat the threaded part of the spark plug with graphit[illegible] lubricant grade CT/GOCT 5573-50/ preventing the lubricant [illegible] getting on the spark plug electrodes.

6. Spark plugs must be screwed into a cylinder head by [illegible] and tightened up by a torque wrench at a torque of not more than 6 kg-m.

7. Before screwing the elbow onto the spark plug, examine the contact assembly; the end of the contact spring must be bent inside, and the insulation bushing - undamaged. The coupling nuts of the elbows must be screwed on by hand and tightened up by a special wrench with a handle of 100 mm long.

7. INSTALLATION AND ADJUSTMENT OF HB-82B DIRECT INJECTION FUEL PUMP.

An HB-82B pump can be installed on the engine by the timing disc and according to the setting of the pump to be replaced.

PRRPARING THE PUMP FOR INSTALLATION.

1. Before installing an HB-82B pump on the engine, treat the pump, using the following procedure:

a) remove the grease from the outer surfaces by washing the pump with clean gasoline;

b) remove shipping caps, plugs and labels from the openings on the flange;

c) fill the HB-82B pump with clean gasoline through the fuel inlet connection. Simultaneously, turn the pump drive shaft by a special splined wrench until clean gasoline begins to flow from the pump fuel pipe connections.

CAUTION! Do not depreserve the PC-24B mixture control and ФВ-10К injector nozzle internally.

2. Before installing the HB-82B pump on the engine, visually inspect its outer surfaces, check the dial indicator pointer for smooth and free movement, move the manual control lever from the "Выключено" ("off") to "Максимальная подача" ("maximum feed") position and check the ball joints of all rods for free movement.

INSTALLING THE HB-82B PUMP ON ENGINE BY TIMING DISC.

The pump is installed on the engine by cylinder No.4 with the help of the timing disc as follows:

1. Remove the HB-82B pump if unserviceable.

2. Remove the front spark plug from cylinder No.4.

3. Remove the fuel pump, and place the timing disc on the flange of the fuel pump drive.

4. Insert the top dead centre indicator into the spark plug hole of cylinder No.4 and determine the piston TDC of this cylinder on the intake stroke. Note this position on the timing disc.

5. Rotating the engine crankshaft by the fan, set it by the timing disc in the position in which the piston of cylinder No.4 is $30^{\circ}\pm\frac{30}{20}$ past TDC on the intake stroke, which corresponds to the beginning of fuel injection into the cylinder.

6. Set the cam disc of the pump to be installed in the position corresponding to the beginning of fuel injection into cylinder No.4 (Fig.20).

For this purpose:

a) remove from the tappet housing the plug 2 covering the inspection eye of the 4-th plunger;

b) turning the pump drive end in the direction as indicated by the arrow (on the pump flange), set the cam disc of the pump in the position in which the missing spline of the drive end approaches the mark "I" on the pump flange, and mark "5" on the tappet of the 4-th plunger coincides with the mark "4" on the wall of the inspection eye (in this case the tappet should move from the pump flange to the fuel pipe connections).

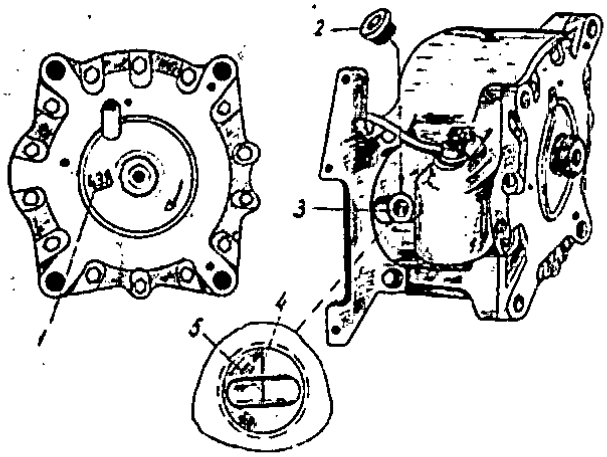


Fig. 20. Mounting the HB-82B pump.

1) Mark on pump casing flange; 2) plug;
3) inspection eye against the 4-th plunger tappet;
4) mark on tappet case; 5) mark on the 4-th plunger tappet.

7. With the engine crankshaft and the cam disc of the pump in the position indicated in paragraph 4, install the pump on the engine, to do this:

a) place a gasket on the drive flange so as not to close the oil inlet and outlet openings.

b) install the pump on the drive, press it by the drive end to the adjustment coupling of the drive and, turning the crankshaft by the fan blades within 28 - 33° before TDC on the intake stroke in cylinder No.4, mesh the pump drive end with the drive.

8. If the pump drive end fails to mesh with the drive coupling:

a) turn the crankshaft in the direction of rotation until the pump drive end slides over the splines into the adjustment coupling of the drive;

b) make sure that the marks on the tappet and the pump inspection eye coincide. Otherwise, turn the crankshaft against the direction of rotation and then by turning it in the direction of rotation make the marks coincide;

c) remove the pump, mark the position of the drive adjustment coupling by making marks with a pencil on the cover of the drive casing and the end face of the adjustment coupling;

d) set the crankshaft in the position corresponding to the beginning of injection (30° past TDC on the intake stroke in cylinder No.4. Simultaneously, the adjustment coupling turns and the mark on its end departs from the mark on the cover of the drive casing;

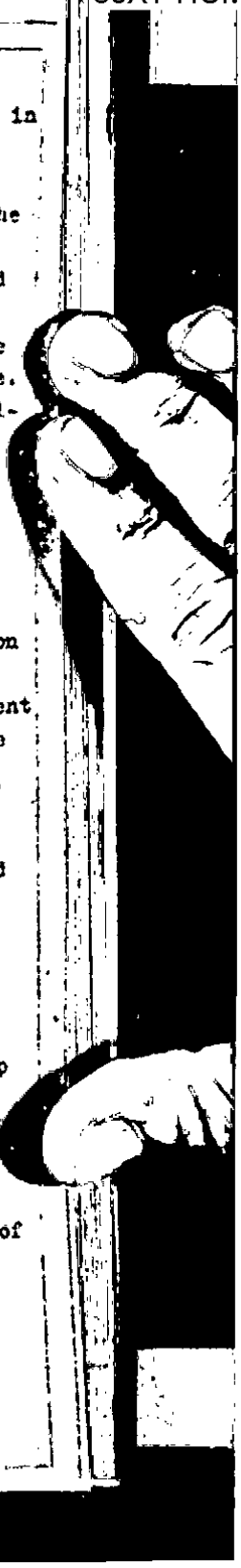
e) remove the adjustment coupling lock and by shifting the coupling, make the marks coincide;

f) set the adjustment coupling lock in place and, turning the crankshaft by the fan within the permissible limits for pump installation, mesh the pump drive end with the drive;

9. Secure the pump by two nuts located crosswise and check the pump for correct installation, employing the following procedure:

a) set the crankshaft in the position in which the piston of cylinder No.4 is in the TDC on the suction stroke;

b) turn the crankshaft in the direction of rotation until the marks on the tappet of the 4-th plunger and on the wall of the inspection eye coincide.



CAUTION! Ensure that the marks coincide during the injection stroke of the plunger tappet(in the direction from the pump flange to the fuel pipe connections).

c) determine by the timing disc the position of the crankshaft at the moment when the marks coincide. With the pump installed properly, this position should be obtained when the crankshaft is turned through 28-33° past TDC on the intake stroke in cylinder No.4;

d) secure the pump completely and mount the fittings. Screw in the inspection eye plug into the pump case.

INSTALLING THE MD-82B PUMP ACCORDING TO THE SETTING OF THE PUMP TO BE REPLACED.

If the pump to be replaced was installed properly, a new pump can be installed without the timing disc. In this case before removing the old pump, set the engine crankshaft in the position corresponding to the beginning of fuel injection into cylinder No.4, using the following procedure:

1. Unscrew the plug 2 of the inspection eye of the 4-th pump plunger and turn the crankshaft in the direction of rotation until mark 3 on the tappet of the 4-th plunger and mark 4 on the wall of the inspection eye coincide (with the tappet moving from the pump flange to the fuel pipe connections). (Fig.20).

2. Make marks on the fan and the guide vane assembly to indicate the position of the crankshaft at the moment when the marks of the 4-th plunger tappet and the inspection eye coincide, and remove the pump from the engine. Do not rotate the crankshaft until a new pump is installed on the engine.

3. Set the cam disc of the new pump in the position corresponding to the beginning of fuel injection into cylinder No.4 as indicated in paragraph 4 of the previous section.

4. With the engine crankshaft and the pump cam disc in the above described positions, install the pump on the engine as indicated in paragraphs 5,6 and 7 of the previous section.

INSTALLING THE INJECTOR NOZZLES AND HIGH-PRESSURE PIPES.

When installing the injector nozzles and high-pressure pipes, follow the rules listed below:

1. While installing the injector nozzles into the appropriate holes in the cylinders, place gaskets of soft annealed copper under

their lower ends: the gaskets are furnished with the injector nozzles. Before installing the injector nozzles in the engine, depreserve them externally.

2. Before replacing a high-pressure pipe, wash out a new pipe with clean gasoline under a pressure of 1-2 kg/cm^2; do not blow out the pipe with air to prevent clogging.

3. The pipes should be secured in rubber bushings to prevent their vibration. The pipes must not contact each other and the engine metal parts (the minimum allowable distance between the pipes and other engine parts - 5 mm.)

4. To prevent the high-pressure pipes breaking and cracking, hold the injector nozzle or the pipe connection by a wrench to prevent their turning while unscrewing the nipple nuts.

5. Lock all connections and attachments of the pipes after the nuts have been tightened up by a 2,7-3,5 kg. torque wrench.

CHECKING THE ENGINE FUEL CONSUMPTION WITH A FLOW METER.

Check and adjust engine fuel consumption with the flow meter during the ground testing of a newly installed engine after replacing the MB-82B pump, PC-24B mixture control or PC-24B emergency as follows:

1. Connect the flow meter to the fuel pipe line connecting the fuel tank with the 6HK-10KB pump (Fig.24).

2. Start the engine, throw in the clutch, warm up and test the engine according to paragraphs 4 and 5 of this instruction.

3. Measure fuel consumption with the flow meter at normal and 50% normal ratings. Measure fuel consumption after 5 minutes of engine operation at the rating checked, at the oil inlet temperature of 65° and cylinder heads temperature of not less than 140°C.

4. Determine the hourly fuel consumption by the formula:

$$C_{meas.} = \frac{Vfm \cdot 3.600}{\Delta t} \gamma f$$

Where

C meas. - measured fuel consumption

Vfm - volume of fuel flown through the flow meter, litres.

γf - fuel specific gravity at actual temperature.

Δt - fuel consumption time, sec.

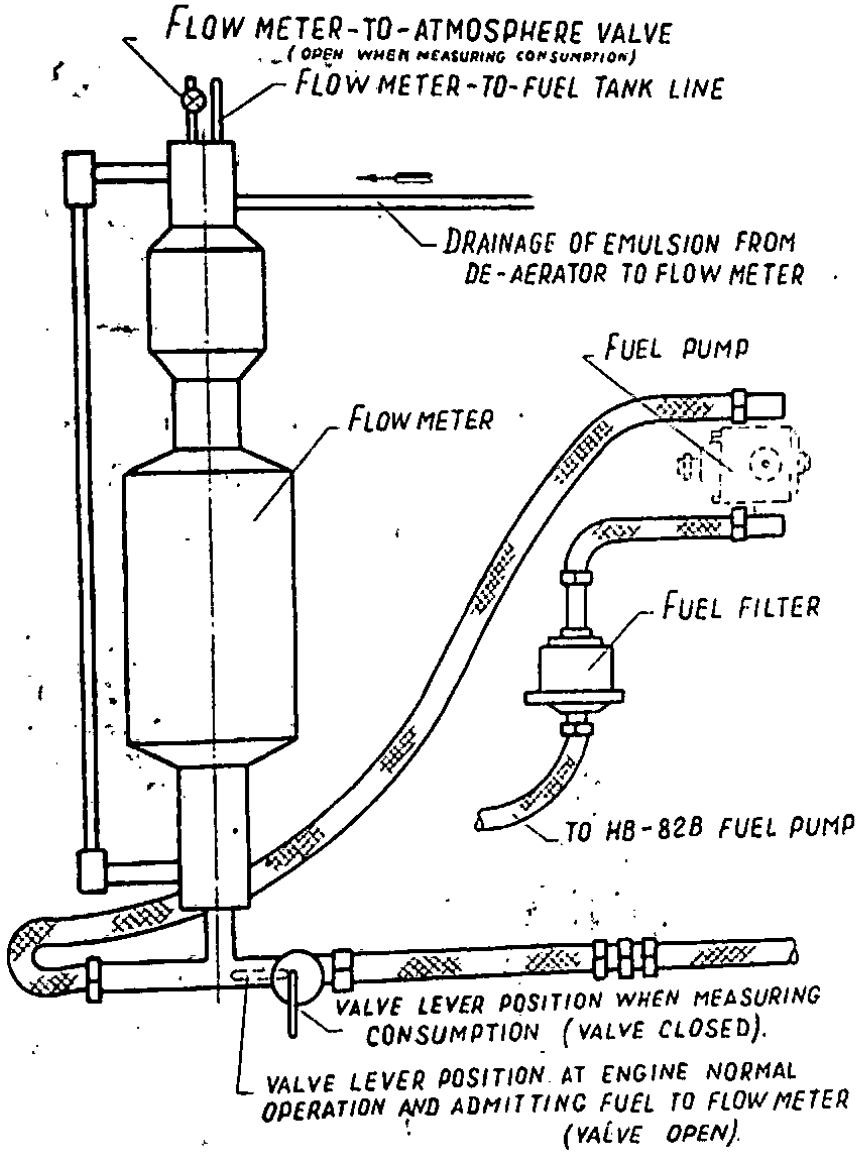


Fig. 21. Flow meter-to-fuel system connection diagram.

5. Determine the measured hourly fuel consumption by the formula:

$$C_r = C_{meas.} \frac{500+t°a}{515}$$

Where

C_r - reduced fuel consumption

t_a - ambient air temperature

Reduced fuel consumption must be within the limits:
at normal rating - 410-450 kg/hr.
at 50% normal rating - 155-170 kg/hr.

NOTE: While measuring the fuel consumption with the flow meter at ratings checked, read the HB-82B pump dial angles.

6. If hourly fuel consumption data measured with the flow meter do not correspond to the indicated limits, re-adjust the HB-24B mixture control and measure the fuel consumption again.

7. After checking and adjusting the pump, lock all the connections and seal the adjusting parts.

8. In the section "Works performed during engine operation" of the Log-Book make the following entries:

Engine test data:

1. At normal rating the reduced fuel consumption is....kg/hr., fuel injection pump dial angle is .....degrees.

2. At 50% normal rating, the reduced fuel consumption is .....kg/hr. Dial angle is .....degrees.

3. Ambient air temperature is.....°C.

CHECKING FUEL HOURLY CONSUMPTION ACCORDING TO THE HB-82B PUMP DIAL LEVER.

Check the engine fuel consumption when the fuel consumption is supposed not to meet the specifications or fuel consumption checking with a flow meter is impossible.

To check the hourly fuel consumption:

1. Determine the temperature of the air at the throttle box inlet.

2. Determine the hourly fuel consumption at the normal and 50% normal ratings by the formula:

$$G = \frac{G_{red.} \cdot 515}{500 + t_{meas.}}$$

Where

G - hourly fuel consumption at an air temperature taken at the throttle box inlet;

$G_{red.}$ - reduced fuel consumption according to the specifications at a temperature of 15°C. taken from the table (see section II, paragraph I,15);

$t_{meas.}$ - air temperature, measured at the throttle box inlet.

3. Determine the HB-82B pump dial lever readings at an air temperature measured at the throttle box inlet by the formula:

$$A = A^{o}\ cert + \frac{G - Gp}{k}$$

Where

A^{o} cert. - the dial lever readings taken from the table of the tested pump HB-82B certificate in the section "Acceptance Test" for the normal and 50% normal ratings at the supercharger 1-st speed;

G - calculated hourly fuel consumption;

G_p - hourly fuel consumption taken from the table of HB-82B pump certificate;

k - coefficient of hourly fuel consumption change in kg/hr. for each degree of the dial lever turning; for the normal rating k = 5.8 kg/hr and for 50% normal rating k = 3.1 kg/hr.

4. With the engine warmed up, determine the dial lever readings at the normal and 50% normal ratings. If the readings of the dial lever do not meet the limits calculated in paragraph 3, adjust the HB-82B pump as indicated in the section "Adjusting the HB-82B Pump".

Example. Determine the dial lever readings at the normal and 50% normal ratings at the throttle box air inlet temperature of 27°C:

I. Calculate the fuel consumption for the normal and 50% normal ratings by the formula.

For the normal rating:

$$G = \frac{410 \cdot 315}{500 - 27} = 447 \text{ kg/hr (minimum consumption)}$$

$G = \frac{450 \cdot 515}{500 - 27} = 490$ kg/hr (maximum consumption)

For the 50% normal rating:

$G = \frac{155 \cdot 515}{500 - 27} = 169$ kg/hr (minimum consumption)

$G = \frac{170 \cdot 515}{500 - 27} = 185$ kg/hr (maximum consumption)

2. Find in the certificate of the pump under test in section "Acceptance Test" the actual hourly fuel consumption and the dial lever readings corresponding to this consumption.

At the normal rating (400 r.p.m. man.press. 900 mm Hg.) the fuel consumption in the given instance is 431 kg/hr., the dial lever reading is 73 deg. at 50% normal rating (350 r.p.m. man. press. 630 mm Hg.) the fuel consumption is 166 kg/hr. the dial lever reading is 31 deg.

3. Determine the dial lever readings for the calculated fuel consumption.

For the normal rating:

$73 + \frac{447 - 431}{5.8} = 76°$ (minimum dial lever readings):

$73 + \frac{490 - 431}{5.8} = 83°$ (maximum dial lever readings).

For 0.5 rated speed:

$31° + \frac{169 - 160}{5 \cdot I} = 33°$ (minimum dial lever readings);

$31° + \frac{185 - 160}{5 \cdot I} = 36°$ (maximum dial lever readings).

If the quality of mixture has been regulated correctly for the given instance, the actual readings of the dial lever at the normal rating should be within 76-83 deg. and at 50% normal rating - within 32-36 deg.

ADJUSTING THE HB-82B PUMP.

The HB-82B pump is adjusted when the fuel consumption does not meet the specified limits.

Before adjusting the pump, make sure that the improper operation of the engine is only due to troubles in the mixture quality adjustment.

1. Adjust the HB-82B pump by means of the aneroid bushing and the adjusting screw of the PC-24B mixture control (Fig. 22). (see Tables 7 and 8).

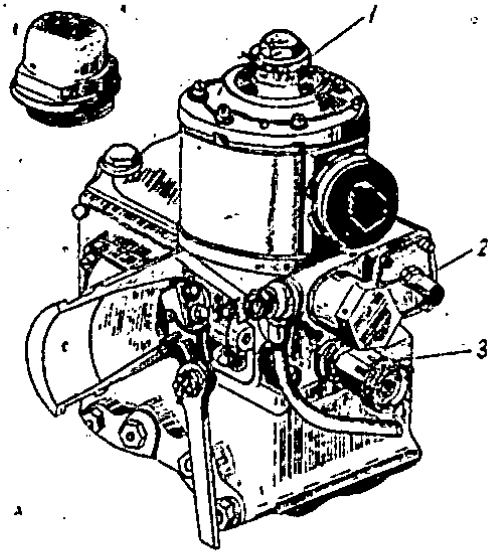


Fig. 22. PC-24B mixture control adjustment points (MB-82B fuel pump).

1) Aneroid bushing;
2) servo-drive stop screw;
3) adjusting screw.

Table 7.

Changes in fuel consumption in kg/hr. when the aneroid bushing is turned through 10 divisions (1/5 revolution).

Rating	50% normal rating	65% normal rating	75% normal rating	Normal rating	Take-off rating
Manual control lever position	auto. normal				
Engine r.p.m.	2,100	2,100	2,200	2,400	2,600
Fuel consumption changes	10	11	16.0	18	11.0
Change in the dial reading	2,1	2,3	3.0	3.0	2.0

Table 8.

Changes in fuel consumption in kg/hr. when the mixture control adjusting screw is turned through three notches (1/2 revolution)

Rating	50% normal rating	65% normal rating	75% normal rating	Normal rating	Take-off rating
Manual control lever position	auto.normal				
Engine r.p.m.	2,100	2,100	2,200	2,400	2,600
Fuel consumption changes	0.0	0.0	1.5	7.0	7.0
Change in the dial reading	0.0	0.0	0.3	1.2	1.4

2. When checking the test points at the normal and 50% normal ratings, it is found that the fuel consumption exceeds the required limits, make an adjustment as follows:

a) turn the aneroid bushing clockwise (towards "Lean") through the necessary number of divisions until the fuel consumption at 50% normal rating is within the limits.

b) after adjustment check the fuel consumption at the normal rating. If in this case the fuel consumption does not correspond to the required limits, make an adjustment with the mixture control screw.

To make mixture leaner at the normal rating, turn the adjusting screw clockwise and enrich the mixture-anti-clockwise.

NOTE: It is not recommended to adjust the fuel consumption at low speed without checking fuel consumption at other ratings.

3. The fuel consumption at low speed is adjusted by means of the stop screw of the servodrive (Fig.22). To enrich the mixture, turn the screw clockwise, to make it leaner-anti-clockwise. One revolution of the screw changes the fuel consumption by 4.5kg/hr.

Adjustment by the stop screw of the servodriver changes the fuel consumption at low speed only.

4. After adjusting the HB-82B pump, make entries in the engine log-book as to fuel hourly consumption, dial lever readings and ambient air temperature.

8. INSTALLING AND ADJUSTING THE РПД MANIFOLD PRESSURE REGULATOR.

Before installing the РПД regulator on the engine:

a) wash it with gasoline and wipe dry with a clean cloth;

b) remove the oil filter, wash it in gasoline and blow out with compressed air;

c) blow out the air passages of the regulator with compressed air under a pressure of not more than 1 kg/cm^2.

CAUTION: Do not submerge the РПД regulator in gasoline.

Mount the regulator on the engine as follows:

1. Remove the plug from the breather passage and screw in the breather pipe connection.

2. Install the paranite gasket on the flange under the РПД regulator on the crankcase rear cover without closing the РПД oil and air passages.

3. Install the РПД regulator on the flange of the crankcase rear cover, tighten it with nuts and lock it.

4. Connect the throttle control lever to the РПД control lever by rod 2 (Fig.23) ensuring complete opening and closing

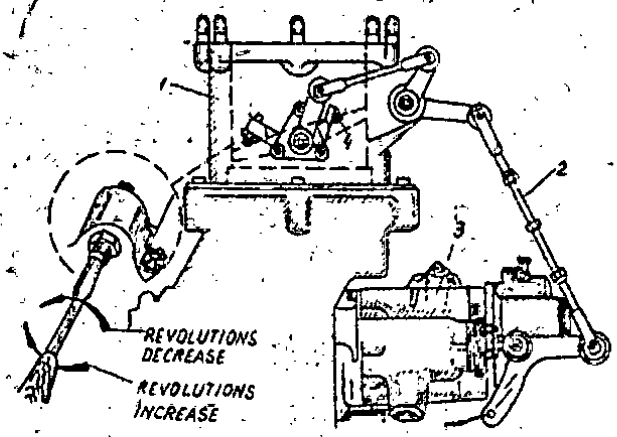


Fig. 23. Control rods mounting and r.p.m. adjustment at low speed.

1) Throttle box; 2) adjustable rod;

3) manifold pressure regulator;

4) stop screw for low speed adjustment.

of the throttle control with the РПД servodrive rod retracted or extended. The length of the adjustable rod must be 226±3 mm. After adjusting the length of the rod, make sure that the screwed-in ends of the rod close the check holes.

5. Install the throttle control rod leading to the control panel, observing the requirements indicated in the preceding paragraph.

NOTE. Since the РПД regulator is used on the helicopter to reduce the manifold pressure at take-off rating fix the РПД control lever at the take-off rating stop. (Fig.24).

6. Check the adjustment of the РПД regulator installed on the engine while testing the engine at take-off rating.

If the РПД regulator is properly adjusted, the manifold pressure at take-off rating should be 1,125±10 mm Hg. If the manifold pressure is below or above the indicated level, adjust it by stop screw 2 (Fig.24). One revolution of the screw clockwise decreases the manifold pressure, and anti-clockwise-increases it by 35 mm Hg.

Check the accuracy of adjustment during the next subsequent testing of the engine.

NOTE: An abrupt opening of the throttle wide up to the take-off rating or more may result in a temporary excessive supercharging up to 25 mm Hg. above the take-off rating which subsequently subsides to the normal during 7-10 sec.

9. ADJUSTING THE ENGINE LOW SPEED.

The engine r.p.m. at low speed are adjusted by means of the low speed screw 4 on the throttle box (Fig.23).

Unscrewing decreases the engine r.p.m. whereas screwing in - increases them.

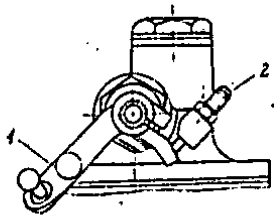


Fig.24. Take-off supercharging adjustment:
1) Control stick РПД; 2) stop screw for adjustment of take-off supercharging.

S E C T I O N VII.

ENGINE TROUBLES, THEIR CAUSES AND REMEDY.

No.	Cause of Trauble	Remedy
	Engine fails to start, starts with difficulty or stops after several firings.	
1.	Underpriming, when starting the engine.	Prime gasoline in quantity necessary for starting.
2.	Overpriming	Turn engine crankshaft by fan against direction of rotation 2 or 3 revolutions with throttle open and repeat starting.
3.	Insufficient heating (in winter)	Heat up engine before starting.
4.	HB-82B pump plungers in zero position (dial lever at 0°-6°)	Check "off" rod for reliable operation. When starting, HB-82B pump manual control lever in "автонормально" ("Auto.normal") position.
5.	Booster coil-to-magneto lead insulator damaged; lead poor contacts.	Check insulation and lead contacts for security.
6.	Oil in magneto; breaker contacts points oiled.	Wash magneto, clean breaker contact points.
7.	No or very small breaker contact points gap.	Adjust gap for 0.20-0.30 mm.
8.	Magneto improperly installed.	Check magneto setting and set spark advance angle of 21°+1° before TDC on compression stroke in cylinder No.2.
9.	Spark plugs oiled or damp	Remove spark plugs and check them. Wash and dry if necessary.
10.	Fuel filters clogged.	Wash out fuel filters.
11.	De-aerator to fuel tank hose clogged.	Flush out or replace hose if necessary.

Engine stalls at low speed.

1. Low speed stop on throttle box incorrectly adjusted.	Adjust throttle valve opening by stop screw.
2. Mixture quality at low speed incorrectly adjusted.	Adjust mixture quality at low speed by PC-24B stop screw.

Excessive engine R.P.M. at low speed.

1. Low speed stop on throttle box incorrectly adjusted.	Adjust throttle valve opening by stop screw.
2. Play in throttle box valve control system.	Remove play from control system.
3. Lean mixture at low speed.	Adjust mixture quality at low speed.
4. Seepage in suction system (induction pipe nuts not tightened up, no sealing rings, gaskets, etc.)	Check all sealings of suction system for tightening and presence of gaskets.

Friction clutch fails to engage.

(Engine and rotor R.P.M. do not coincide).

1. Insufficient oil pressure due to excessive dilution with gasoline or too high temperature of diluted oil.	Evaporate gasoline with main gearbox disengaged at 1,200 r.p.m. Decrease oil temperature.
2. Solenoid switch unserviceable.	Change switch.

Engine vibration or excessive speed drop when switching the magneto.

1. Spark plugs faulty.	Check spark plugs under pressure and change them, if unserviceable. If spark plugs are covered with oil, check compression in cylinder and, in case of low compression (below 3 kg/cm^2), examine cylinders and piston rings and change them if unserviceable.
2. Lean mixture.	Enrich mixture.

3. Rich mixture (vibration is particularly conspicuous, when switching on supercharger 2-nd speed in flight.	Make mixture leaner.
4. Breaker contact points gap improperly adjusted.	Adjust gap for 0.20-0.30 mm.
5. Breaker attachment screws loose.	Tighten screws. If screw connectors are loosened, replace magneto.
6. Magneto carbon brushes damaged.	Change carbon brushes.
7. Faulty magneto.	Change magneto.
8. Improper gaps between valve stems and rocker rollers.	Adjust gaps for $0.35^{+0.25}_{-0.10}$ mm.

Poor operating of individual cylinders

1. Spark plugs damaged	Change spark plugs.
2. Improper gaps between valve stems and rocker rollers.	Adjust gaps.
3. Injector nozzle clogged or damaged.	Examine and change injector nozzle if necessary.
4. Ignition wires insulation broken down poor wire contacts in block, poor fastening of wire contact spring, wires improperly connected.	Check contacts of ignition wires for security; perform ringing test. Replace wires if faulty.
5. High-pressure pipe damaged.	Change high-pressure pipe.
6. Fuel leakage through high-pressure pipe connections	Tighten up or change pipe connections.
7. HB-82B pump plunger return spring damaged, individual plungers seized (pump control lever moves with difficulty).	Remove pump and repair it by changing spring or pump plunger.

8. Cylinders and piston rings worn, leaky valves, piston scored and other defects in cylinders.	Check compression, fit valves if necessary. Change defective cylinder assemblies and parts.

Excessive r.p.m. drop when switching off a magneto.

1. Spark plugs defective.	Check spark plugs for sparking and tightness.
2. Improper breaker contact points gap.	Adjust gap for 0.20-0.30 mm
3. Rich mixture (excessive drop of r.p.m. on one magneto)	Control mixture quality
4. Insufficient spark advance angle.	Check spark advance angle. Set maximum angle (22° before TDC) if necessary.

Engine fails to develop full power output.

1. Rich mixture.	Adjust mixture quality.
2. Injector nozzles defective	Replace injector nozzles, if faulty.
3. Spark plugs damaged, foul or wet.	Replace spark plugs.
4. Insufficient breaker contact points gap, burned or dirty points.	Adjust breaker contact point gap, clean breaker contact points; change magneto if contact points severely burn
5. Magneto incorrectly installed	Install magneto. correctly.
6. Valve clearances improperly adjusted.	Adjust valve clearances.

Insufficient manifold pressure.

1. Supercharger speed control valve lever movement restricted.	Adjust supercharger speed control.
2. Throttle valve not fully open.	Adjust throttle valve opening.

Engine stalls when increasing r.p.m.

1. To heavy an oil in mixture control servodrive (in winter).	Heat up servodrive.
2. PC-24B mixture control adjustment, incorrect.	Adjust mixture control.
3. PC-24B mixture control aneroids damaged.	Change aneroids
4. Seizing of servopiston in low speed position or of servodrive slide valve in upper position.	Eliminate seizing.
5. MB-82B pump incorrectly installed	Install MB-82B pump correctly.

Engine smokes

1. Mixture control improperly adjusted (too rich a mixture).	Make mixture leaner
2. Aneroids shrunk or damaged, mixture control parts worn (too rich a mixture).	Change aneroids or mixture control
3. Valve clearances incorrect	Check valve clearances
4. Piston burned or scored.	Check compression, find damaged piston, remove cylinder and examine piston.

No or low oil pressure.

1. Too heavy an oil in oil pipe line to oil pump (in winter)	Heat up engine and oil tank and main pipe lin
2. Oil pump reducing valve improperly adjusted or seized.	Adjust pressure by reducing valve. Change reducing valve or re-assemble it.
3. Pressure gauge or its wiring defective.	Check wiring. Change pressure gauge.

4. Oil excessively diluted with gasoline.	Check percentage of gasoline in oil as indicated in Section V. Evaporate gasoline or change oil. Check to see whether gasoline leaks into ЗКР-3 oil dilution cock.
5. Low oil level in oil tank.	Replenish oil.
6. Oil pipe line not tight enough.	Eliminate leaks in oil line connections.

Oil overheating.

1. Oil freezing in oil cooler (in winter).	Heat up oil cooler.
2. Low oil level in oil tank.	Replenish oil.
3. Thermometer defective.	Change thermometer.
4. Oil cooler defective.	Change oil cooler.
5. Oil foaming.	Change oil.

Cylinder heads overheating.

1. Too lean a mixture.	Enrich mixture.
2. Valve stem to rocker roller clearance improperly adjusted.	Adjust clearances in all valves for $0.35^{+0.25}_{-0.10}$ mm.
3. Magneto incorrectly installed.	Install magneto correctly.
Note. Too high temperature readings may be due to the following causes: thermocouple, indicator or their defective wires; poor blasting of cylinder (spark plug) on which thermocouple is installed; exhaust gases blow on to thermocouple.	Check (calibrate) or change cylinder heads temperature gauge. Eliminate causes for poor blasting. Eliminate exhaust gases blow.

Oil leakage from breathers of supercharger front casing.

1. Oil tank overfilled	Check oil level in tank. Drain excessive oil.

2. Oil overheated .	Remedy as indicated above.
3. Piston rings or cylinders worn.	Check compression. Change worn parts.
4. Improper oil.	Change oil.
5. Oil excessively diluted with gasoline	Check ZKP-3 cock for tightness, change oil and replace cock if necessary.

S E C T I O N VIII.

MAINTENANCE OF ENGINE, P-5 MAIN GEARBOX AND MAIN DRIVE SHAFT.

Reliable operation of the helicopter power plant during the overhaul life can be ensured only when the operating rules outlined in this instruction are observed and thorough after-flight inspection and timely periodic maintenance operations are carried out.

After-flight inspection of the engine and the gearbox must be performed at the end of every flying day.

Perform periodic maintenance operations:

a) after the first test of the engine and the main gearbox.

b) every 50 hours of engine operation;

c) every 100 hours of engine operation.

1. AFTER-FLIGHT INSPECTION OF ENGINE AND P-5 MAIN GEARBOX.

1. At the end of every flying day or after every five hours of engine operation, before stopping the engine at 1,000 r.p.m. with the cam clutch engaged, throw in the friction clutch and run the engine at 2,000-2,100 r.p.m. for 3-5 min., then decrease the speed to 1,100 r.p.m. and throw out the friction clutch. Stop the engine.

2. Carry out the after-flight inspection of the engine as follows:

a) open the cowls of the power plant and check it for fuel and oil leakage;

b) feel the temperature of all cylinders to the touch; should any of them be insufficiently heated or overheated find and remedy the cause of trouble;

c) check the fan blades for dents and damages;

d) check the exhaust pipes to the cylinder head exhaust stacks for tightness and security of attachment;

e) check the intake pipes for security of attachment;

f) check the connections of the fuel and lubricating systems for leakage paying special attention to the high-pressure fuel pipe line leading from the HB-82B pump to the engine cylinders;

g) check the high-pressure pipes for cracks, see that the pipes do not contact each other and the engine parts;

NOTE: The clearance between the pipes and the engine parts must be not less than 5 mm. Vibrating and rubbing pipes must be fastened and the pipes with cracks and signs of wear replaced.

h) check the spark plug elbows for security and position in relation to the exhaust stacks. The clearance between the exhaust stack and the spark plug elbow should be not less than 25 mm;

i) check the engine-to-mount and the engine mount-to-helicopter structure attachment, and also the engine accessories, pipe lines and electrical wires attachment for security.

Check the engine accessories for fuel and oil leaks.

j) should radio interference lever be high during flight, check the ignition wiring shielding. The shielding conduits should be without damages and securily grounded;

k) check the dial lever of the HB-82B pump for free and easy movement up and down to the stops;

l) check the engine control system for smooth operation, freedom from plays, security of attachment and looking.

When checking the supercharger two-speed control make sure that the lever is moved easily from the stop "Первая скорость" (1-st speed) to stop "Вторая скорость" (2-nd speed). If the lever fails to reach the stops, the supercharger speeds will be engaged incompletely, which may cause damage to the two-speed drive.

m) check the oil and fuel drain pipes leading from the intake pipes and combustion chambers of cylinders No. 6,7,8 and 9 for cleanliness and security of attachment; check the fuel pump drain pipe for fuel leakage.

3. During the after-flight inspection of the main gearbox:

a) examine the gearbox-to-mount and the gearbox mount-to-helicopter structure attachment. Check the gearbox accessories, pipes and electric wires for security of attachment;

b) check the attachment of the oil lines to the gearbox oil sump for security and examine the sealings for oil leakage;

c) see that the oil pressure gauge tube does not contact the gearbox or helicopter structure;

d) check the attachment of the main drive shaft flexible couplings to the engine and main gearbox flanges for security.

Every 25 hours of operation remove and wash the throttle box air filter.

Coat the filter with a mixture consisting of 50% of gasoline and 50% of oil and install it in place.

2. PERIODIC MAINTENANCE OPERATIONS ON ENGINE AND P-5 MAIN GEARBOX AFTER FIRST TEST AND EVERY 50 HOURS OF ENGINE OPERATION.

1. Perform all operations included in the after-flight inspection.

2. While the engine is still hot, drain 0.5-1.0 litre of oil from the oil sump through the funnel with gauze No.24 (576 holes per 1 cm^2) and make sure that the gauze is clean and the oil does not contain shavings.

3. Remove the МФС-19, МФС-19-1, МФС-29 oil filters, РПД filter, auxiliary filter built-in the НВ-82В pump and see that there are no resin- deposits and metal shavings. Wash the filters in gasoline, examine the gauzes, coat with oil and install them in place.

4. Remove, examine and wash the fuel system filters and НВ-82В pump filter.

5. See that the throttle valve opens and closes fully.

6. Wash all hinged joints of the engine control rods with gasoline and coat them with technical vaseline.

7. Check the centering of the main drive shaft as follows:

a) unscrew one of the bolts attaching the shaft semi-coupling to the engine or gearbox flange;

b) insert a check plate "A" under the unscrewed bolt and secure it by this bolt;

c) attach a special clamp with an indicator to the semi-coupling outer flange as shown in Fig. 25.

d) watching the indicator pointer, turn the main drive shaft one complete revolution and make sure that the deflection of the indicator pointer does not exceed 0.65 mm;

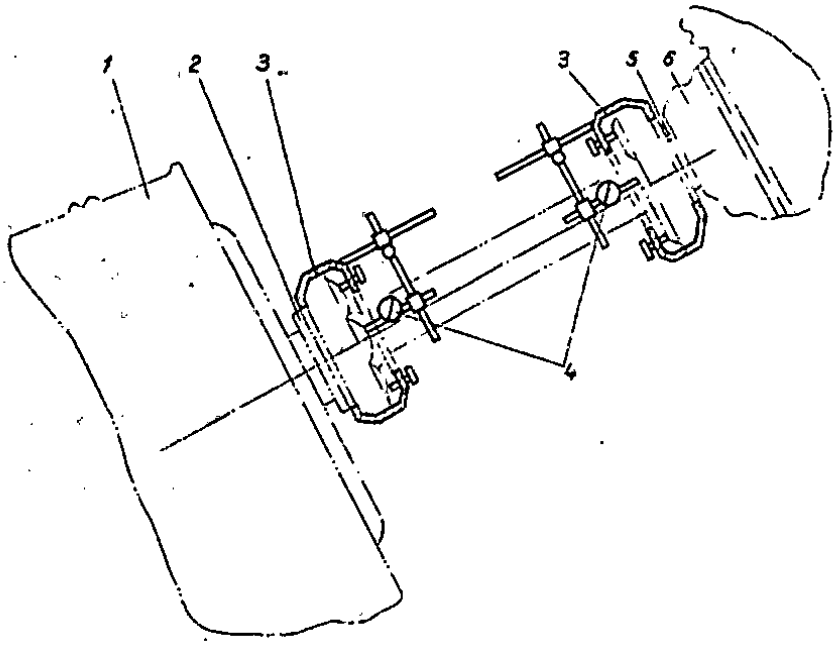


Fig. 25. Diagram of shafts centering check (of engine and gearbox shafts).

1) Engine; 2) clutch flange; 3) device; 4) indicator; 5) free wheel flange; 6) gearbox.

e) remove the clamp with the indicator and the check plate, screw in and lock the bolt;

f) proceed in the same way on the other flange of the shaft.

8. Remove the gauze filter of the oil pump pressure section of the P-5 main gearbox and be sure that the filter is free from resine deposits and metal shavings. Wash the filter in gasoline, examine the gauze, coat it with oil and install in place.

9. Every 50 hours of engine operation perform the following periodic maintenance operations on the starter:

a) remove the brush opening covers and blow the commutator and the brushes with dry air, preventing the dust from getting into the electromotor;

b) check the brushes length and make chamfers $0.5 \times 30^{\circ}$ on the front and rear edges of the working surface of the brushes.

The length of the chamfered brushes must be not less than 15 mm. Otherwise, replace the brushes by new ones from the individual set of spare parts.

Install the brushes in place and secure them.

3. PERIODIC MAINTENANCE OPERATIONS ON ENGINE AND P-5 GEARBOX AFTER EVERY 100 HOURS OF ENGINE OPERATION.

1. Perform all periodic maintenance operations prescribed after the first test and every 50 hours of operation.

2. Examine the magnetic plugs of the front oil pump and gearbox oil sump. Change oil completely in the engine and gearbox lubricating systems.

3. Check the clearances between the valve stems and rocker arm rollers in all cylinders. The clearances for the cold engine should be $0.35^{+0.25}_{-0.10}$ mm with the piston in TDC position on the compression stroke.

While adjusting the clearances, set the adjusting screws of all the valve rocker arms in the position in which the slot of the lever is between the marks on the adjusting screw (spaced at an angle of 120°) and the screw protrudes over the surface of the valve rocker arm as shown in Fig. 26.

When adjusting the clearances, turn the engine crankshaft manually by the fan blades after having screwed out one spark plug from each cylinder.

4. Check the tightening of all hose clamps of the engine and of the nuts attaching the induction pipes to the front section of the supercharger.

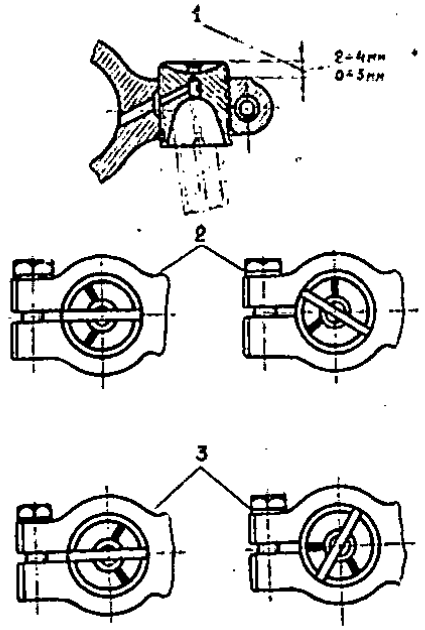


Fig. 26. Valve rockers adjusting screws installation.

1) Max. screw projection above the rocker (for exhaust valve rocker - 2-4mm for intake valve rocker - 0.5mm);
2) Correct position of the screw relative to the rocker slot;
3) Incorrect position of the screw relative to the rocker slot (screw oil passage coincides with the slot).

5. Check the magneto-to-crankcase front section attachment for security and examine the magneto visually. Remove the screen with the distributing block and check:

a) breaker contact points gap which must be within 0.2-0.3 mm and also all the screw joints (except the breaker hold-down screw);

b) the contact spring in the distributing block H.T. lead socket and the carbon brush with the spring for condition;

c) the high-tension lead and the attachment of the distributor finger for condition;

d) lubricant on the cam; if the cam is not lubricated clean it until it shines with a cloth moistened in turbine oil "Л" (oil dripping is not permitted) and apply 2-3 drops of turbine oil grade "Л" on the pad felt.

Do not wash the finger and the distributor with gasoline and do not rub them with a cloth moistened with gasoline.

6. Remove all the spark plugs from the engine. The spark plugs must be removed with a torque wrench when the temperature of the cylinder heads does not exceed 40°C.

All the spark plugs removed from the engine must be packed in individual boxes and sent for testing or repair. To check the spark plugs proceed as follows:

a) check the spark plugs for damage and change them if damaged;

b) wash the spark plug chamber with clean gasoline preventing it from getting into the screen;

c) remove the carbon deposit from the spark plugs by a sand blast device, blow them with clean dry air and dry them up;

d) check the spark plug electrode gap with a wire feeler gauge (the gap should not exceed 0.28-0.36 mm); the electrode gaps are adjusted only by a "ПК" gap setting device;

e) check the sparking and airtightness of the spark plugs by means of "ПМ" or "Искра" devices. The spark plug is considered serviceable if during test it sparks under a pressure of 10 atm and when air leakage occuring under a pressure of 25 atm applied during 30 sec. does not exceed 30 bubbles;

f) screw the spark plugs in the engine.

CAUTION! The used spark plugs must be subjected to preliminary sparking and airtightness test before being installed in the engine.

7. Perform the periodic maintenance operations on the TGP-3000M generator. To do this, check:

a) bolts and screws safety wire for security;

b) screws of the clamp fastening the screening braiding for tightening;

c) terminal nuts and bolts for tightening;

d) brushes for correct installation and free movement in the brush holders. The brushes worn to 17 mm of length or below are to be replaced. New brushes must be fitted to the commutator;

e) brush contacts for damage;

f) working surface of the commutator. If the commutator is burnt, clean it with a clean cloth slightly moistened in gasoline or with sand paper No.00.

A severely grooved or burnt commutator should be replaced.

4. WASHING THE OIL FILTERS, OIL TANK AND CHANGING THE OIL.

1. Examine and wash all the filters of the engine and the main gearbox lubricating systems after the first testing of a newly installed engine or the main gearbox and after every 50 hours of operation.

After the first engine test, inspect and wash the MFC-29 filter without disassembling its filtering element; after every 50 hours of operation, wash the filter with the filtering element disassembled.

2. When operating the engine and the main gearbox with diluted oil, the lubricating system filters must be examined every 10-15 hours of operation.

3. Change the oil in the engine and gearbox lubricating systems:

a) after hot depreservation of a newly installed engine or main gearbox;

b) after 100 hours of operation of the engine or main gearbox.

4. Drain the oil from the oil tanks and the whole lubricating system irrespective of the operating time when:

a) metal shavings appear in the engine or main gearbox;

b) resin deposits on the oil system gauze filter occupy more than 50% of the gauze area.

Fill fresh oil into the oil tank and the lubricating system after they have been thoroughly washed with gasoline.

S E C T I O N IX.

UNPACKING AND DEPRESERVING THE ENGINE AND P-5 MAIN GEARBOX.

1. UNPACKING AND DEPRESERVING ENGINE.

Unpack and depreserve the new engine as follows:

1. Remove the cover of the shipping box.

2. Remove the cover from the engine. Examine the engine and check it for presence of all the accessories according to the list furnished with the engine.

3. For better removal of the protective lubricant from the inner and outer parts of the engine, heat it up to 40-60°C by heaters equipped with blower fans.

WARNING: While depreserving the engine, protect the generator and the starter with oil paper or special cover and do not remove covers from the magneto till the external depreservation is completed to prevent the lubricant from getting into the accessories.

4. Remove the shipping plugs from the rear spark plug holes and remove the covers from the exhaust ports of all cylinders.

5. Turn the engine crankshaft by the fan until the protective lubricant is fully drained from the cylinders and the oil sump through the drain cock.

NOTE. For better removing of the protective lubricant from the HB-82B pump, turn the engine crankshaft by the fan with the dial lever of HB-82B pump set in the maximum feed position.

6. After depreserving the engine, spray through the spark plug holes 75-100 gm of clean MK-22 oil or MC-20 heated up to 60-70°C into each cylinder with the piston at bottom dead center (BDC). Screw in the spark plugs into the cylinders and connect the elbows of the ignition wires.

7. To protect the inner hollows of the engine from dirt, close all the openings of the engine and its accessories with plugs.

8. Wash away the lubricant from the outer surfaces of the engine and its accessories with gasoline using a brush or sprayer. Blow the engine over with compressed air.

WARNING: Do not wash the inner cavities of the engine with gasoline or other degreasing liquids.

9. Depreserve 5HK-10KB fuel pump by washing its outer surfaces with gasoline and then submerge it into a gasoline bath. Turning the fuel pump by its drive end, remove the protective lubricant.

NOTE: Do not depreserve other accessories including the HB-82B pump.

10. Install the engine in the helicopter and mount its equipment. The engine is lifted from the shipping box cradle by 1.9-ton pulley blocks.

To lift the engine use special cable hoist slings. To attach the hoist slings to the engine remove the nuts from the bolts of the exhaust valve rocker arms of cylinders Nos. 2 and 10 and intake valves of cylinders Nos. 1) and 14 and screw the nuts located in the hoist sling plates onto the rocker arm bolts. The plates of the long sling are to be attached to cylinders Nos. 9 and 4 and the plates of the short sling to cylinders Nos. 2 and 14 (Fig. 27). To set the engine in an inclined or vertical position use a cable slings whose plates are fastened by bolts to the flange of the clutch shaft.

11. After installing a new engine in the helicopter, remove the protective lubricant from its inner cavities, i.e. carry out hot de-preservation.

To do this:

a) check the whole equipment for proper installation and prepare the engine for starting;

b) heat up the engine by a ground heater until the temperature of the cylinder heads reaches 40-50° and fill the oil tank with oil heated up to 75-80°C;

c) start the engine;

d) after the engine has been started, run it at 1,200 r.p.m. for 8-10 min and then stop it;

e) drain the oil from the engine, the oil tank and the whole lubricating system and fill the tank with clean oil.

NOTE: The oil drained from the lubricating system after hot depreservation must not be regenerated and used for the engine or the main gearbox, for it contains protective lubricant.

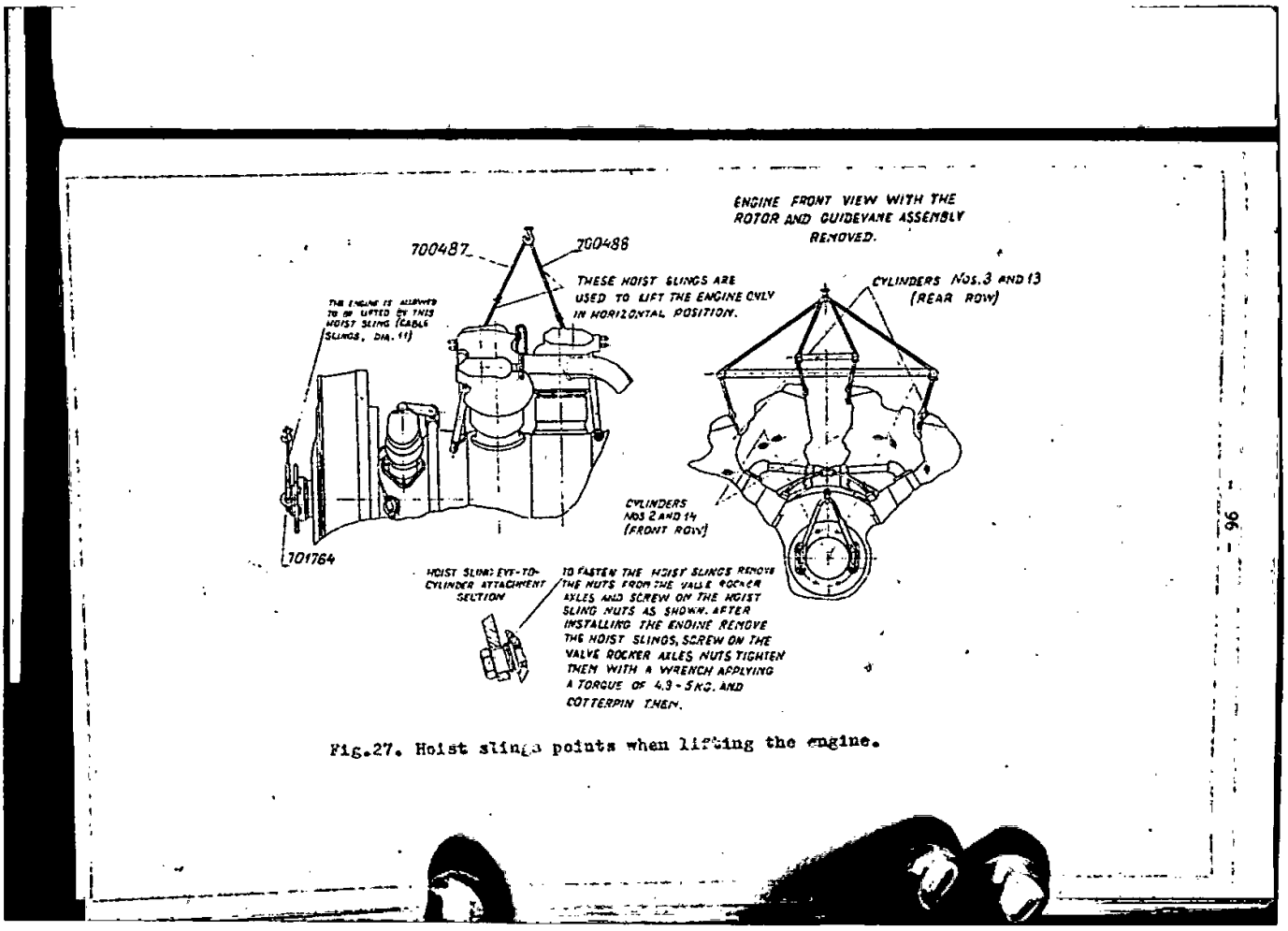


Fig.27. Hoist slings points when lifting the engine.

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2. UNPACKING AND DEPRESERVING THE P-5 MAIN GEARBOX AND MAIN DRIVE SHAFT WITH FLEXIBLE COUPLINGS.

1. Unpack the main gearbox.

2. For better depreserving of the inner cavities of the gearbox, heat it up with a heater. After the oil has been fully drained from the oil sump of the main gearbox, force hot oil into the gearbox by means of a special pump.

3. Wash away the lubricant from the outer surface of the gearbox with gasoline (using a sprayer or a hair brush) and blow the gearbox over with dry compressed air.

4. Remove all the gearbox plugs, magnetic plugs and the inlet and outlet filters of the oil pump pressure section.

5. Drain the lubricant from the inner cavities of the gearbox.

CAUTION! Do not wash the gearbox internally with gasoline or other degreasing liquids.

6. Install the filter, plugs and accessories on the gearbox.

7. Depreserve the main drive shaft with flexible couplings by wiping their outer and inner surfaces and mounting parts with a clean cloth moistened in gasoline, then blow the shaft over with dry compressed air.

CAUTION! 1. Prevent the protective lubricant and gasoline from getting on the rubber bushings of the flexible couplings.

2. After depreserving the main drive shaft coat the shaft splines with CT (ГОСТ 5573-50) lubricant before installing the flexible coupling.

6. Complete internal depreservation of the gearbox is carried out after its installation in the helicopter in the following manner:

a) heat up the gearbox by a ground heater to a temperature not lower than 15° (by the oil thermometer in the oil sump and oil pipe line) and fill the gearbox oil system with clean МК-22 or МС-20 oil heated up to 75-80°C;

b) force the oil to the gearbox and start the engine;

c) run the engine at 1,200 r.p.m. for 8-10 min. with the gearbox engaged;

d) drain the oil from the gearbox and the oil system and fill them with clean oil.

NOTE: The oil drained from the gearbox after depreservation must not be regenerated and used for the engine or the gearbox because it contains protective lubricant.

S E C T I O N X.

PRESERVING THE ENGINE AND P-5 MAIN GEARBOX INSTALLED IN HELICOPTER

I. GENERAL.

1. Alongside with other factors, corrosion may cause damage to the engine and gearbox parts during operation. It can result in premature wear of the parts, increase clearances between the moving parts and clog the oil passages.

Timely and correct preservation of engines and gearboxes ensures their serviceability and normal operation.

2. To preserve the temporarily inoperative engines and gearboxes it is recommended to use the following lubricants:

a) for engine internal preservation - lubricant No.58M (GOST 4807-49) (Do not preserve the engine and gearbox with oil diluted with gasoline);

b) for gearbox internal preservation - lubricant grade MK-22 or MC-20;

c) for engine and gearbox external preservation - lubricant No.59 (GOST 5699-51).

If lubricant No.59 is not available, use technical vaseline or gun lubricant.

3. Do not preserve varnish-coated parts with protective lubricant.

4. The front section of the gearbox shaft (with the rotor removed) is coated with technical vaseline or gun lubricant.

5. Engines and gearboxes installed in helicopters are stored in hangars or airfields and must be subjected to preliminary anti-corrosion treatment depending on the duration of the idling period.

6. The engine and gearbox may be stored without protective coating for 7 days with an ambient air temperature above -5°C and for 15 days if ambient air temperature (during the whole period of storage) is below -5°C.

7. If the idling period of the engine and the gearbox exceeds the time indicated, coat the engine, the gearbox and the shaft with protective lubricant for the required period after 7 or 15 days respectively. The engine may be run on pure gasoline without P-9 component with the gearbox engaged at 1,000-1,200 r.p.m. for 15-20 min. (not less until the oil inlet temperature reaches 40-50°C

2. PRESERVING THE ENGINE FOR ONE MONTH'S STORAGE AND DEPRESERVING IT AFTER STORAGE.

1. Drain the condensed fluid from the engine lubricating system (through the oil sump and oil tank cocks).

2. Drain gasoline with P-9 component from the fuel tanks and fill the tanks with gasoline without P-9 component.

NOTE: Instead of draining gasoline from the tanks, run the engine on pure B-70 gasoline taken from a separate container.

3. Run the engine on pure gasoline with the gearbox engaged at 1,000-1,200 r.p.m. for 15-20 min (not less) until the oil inlet temperature reaches 40-50°C. After this drain the oil from the oil tank to prevent its thickening at ambient air temperature below +10°C.

4. Remove the front spark plugs from the warm engine (with a temperature of the cylinder heads from 10°C to 40°C), open the throttle box valve and turn the crankshaft manually by the fan blades 3 or 4 revolutions to remove the products of combustion from the cylinders.

5. Spray into each cylinder 100-150 gm of fresh oil (Grade MK-22 or MC-20) heated up to 40-50°C. For even distribution of oil over the cylinder walls turn the crankshaft 2-3 revolutions.

The oil is sprayed into the cylinders by a syringe with a ball-nozzle with the engine pistons at BDC.

6. Spray again 100-150 gm of oil into each cylinder without turning the crankshaft.

7. Screw in the spark plugs.

8. Apply lubricant No.59 to the outer parts of the engine and its accessories unprotected with varnish and paint after wiping the whole engine dry with a cloth.

9. At an ambient air temperature above +5°C, turn the crankshaft manually by the fan four revolutions after every 10 days. Do not rotate the crankshaft at ambient air temperature below +5°C.

10. Do not store the engine for more than one month.

11. De-preserve the engines stored for a period of up to one month prior to starting.

12. If repeated preservation of the engine for one month or more becomes necessary, run the engine on pure gasoline without P-9 component at 1,000-1,200 r.p.m. with the gearbox engaged for 30 min. Then proceed to preservation of the engine for a required period.

3. PRESERVING THE ENGINE FOR TWO MONTHS' STORAGE AND DE-PRESERVING IT AFTER STORAGE.

1. Drain the condensed fluid from the engine lubricating system (through the oil sump and oil tank cocks).

2. Run the engine on pure gasoline without P-9 component at 1,000-1.200 r.p.m. for 15-20 min. (not less) with the gearbox engaged until the oil inlet temperature reaches 40-50°C.

3. Drain the oil from the engine and the whole lubricating system and the fuel from the fuel feed line. Leave the oil and fuel drain cocks open for complete draining.

4. Remove the front spark plugs from the warm engine (at a temperature of the cylinder heads of 10°-40°C), open the throttle box valve and turn the crankshaft by the fan four complete revolutions to remove the combustion products from the cylinders.

NOTE: To remove gasoline from the MB-82B pump turn the crankshaft after draining the fuel with the MB-82B pump dial lever set in the maximum feed position after having disconnected the flexible hose feeding fuel to the centrifugal de-aerator.

5. Spray into each cylinder 100-150 gm of 58% lubricant heated up to 15-30°C through the spark plug holes with the pistons at BDC.

6. Preserve the MB-82B pump with the mixture comprising 60% of pure gasoline grade B-70 and 40% of aircraft oil used for the engine.

Preserve the MB-82B pump installed in the engine in the following manner:

a) disconnect the flexible hose feeding fuel to the centrifugal de-aerator;

b) connect a hose leading from a 4-5 litre tank (or a funnel) to the fuel inlet connection;

c) set the pump "off" lever in the maximum feed position;

d) place the tank 0.5-1 m above the pump and fill it with 3.5-4 litres of oil mixed with gasoline;

e) turn the crankshaft by the fan 10-15 revolutions until the lubricant is fully fed into the MB-82B pump;

f) disconnect the hose from the fuel inlet connection and install the flexible hose feeding gasoline to the centrifugal de-aerator.

7. Spray again 100-150 gm of 58M lubricant into each cylinder through the spark plug holes without turning the crankshaft.

8. Plug the spark plug holes or screw in the spark plugs.

9. Close the air intake, exhaust pipes, breathers and other openings.

10. Wipe dry the engine with a cloth and coat with lubricant No.59 those outer surfaces of the engine parts and of the accessories which have no protective varnish and paint.

NOTE: Irrespective of the quality of preservation the engine must not be stored for more than 2 months.

De-preserve the engine in the following manner:

a) wash the engine external surfaces with gasoline and blow them over with compressed air;

b) remove the spark plugs and drain the protective lubricant from the bottom cylinders turning the crankshaft 3-4 revolutions.

If the engine is to be re-preserved, run it at 1,000-1,200 r.p.m. for 30 min. on pure gasoline with the gearbox engaged. Then preserve the engine.

Repeated preservation of the engine for two months without internal inspection may be performed only once.

At the expiration of the period of the second preservation and before the next preservation, carry out internal inspection of the engine.

To do this, remove one cylinder from each row to make sure that there is no corrosion there.

Make entries concerning the operations performed in the engine log-book.

4. PRESERVING THE ENGINE FOR SIX MONTHS' STORAGE AND DE-PRESERVING IT AFTER STORAGE.

The engine removed from the helicopter and preserved with application of dehydrator plugs and bags with silica gel may be stored for one year in polychlorvinyl envelope.

1. After stopping the engine, drain the oil from the lubricating system and the fuel from the fuel tanks.

2. Fill the oil tank with fresh MK-22 or MC-20 oil and the fuel tank with pure gasoline.

3. Run the engine at 1,000-1,200 r.p.m. for not less than 19-20 min. with the gearbox engaged until the oil inlet temperature reaches 40-50°C.

4. Drain the oil from the engine lubricating system and the fuel from the fuel tanks. To drain oil and fuel completely leave the oil and fuel drain cocks open.

5. Remove the front spark plugs from the warm engine (at a temperature of the cylinder heads of 10-40°C), open the throttle valve by operating the throttle control grip and turn the crankshaft by the fan four revolutions to remove the combustion products from the cylinders.

NOTE: To remove gasoline from the HB-82B pump turn the crankshaft after draining fuel with the HB-82B pump dial lever set in the maximum feed position and after having disconnected the flexible hose feeding fuel to the centrifugal de-aerator.

6. Spray 100-150 gm of 58M lubricant heated up to 15-30°C into each cylinder through the spark plug holes with the pistons at BDC.

7. Preserve the HB-82B pump with a mixture comprising 60% of pure gasoline grade B-70 and 40% of aviation oil.

Preserve the HB-82B pump with protective lubricant in the following manner:

a) disconnect the flexible hose feeding gasoline to the centrifugal de-aerator;

b) connect the hose leading from a 4-5 litre tank (or a funnel) to the fuel inlet connection;

c) set the pump lever in the maximum feed position;

d) place the tank 0.5-1 m. above the pump and fill it with 3.5-4 litres of oil mixed with gasoline;

e) turn the crankshaft by the fan (10-15 revolutions) until the lubricant is completely transferred from the tank into the HB-82B pump;

f) disconnect the hose from the fuel inlet connection and install the flexible hose feeding fuel to the centrifugalde-aerator.

8. Fill the inner space of the engine with 58M lubricant heated up to 15-30°C through the breather of the crankcase front section.

Fill the inner space of the clutch with fresh MK-22 or MC-20 oil through the breather of the clutch casing.

NOTE: After filling the crankcase with 58M lubricant when the engine (removed from the helicopter) is preserved for one year, place the engine with its fan upwards to provide better admittion of oil into all cavities.

Turn the crankshaft by the fan 8-10 revolutions, then drain all lubricant and oil from the engine into separate vessels.

NOTE: 58M lubricant may be repeatedly used for preservation, provided it is properly stored and free from foreign matter.

9. To preserve the fuel pump apply 100-150 gm of aviation oil heated up to 50-70°C through the inlet connection turning simultaneously the crankshaft 3 or 4 revolutions by the fan blades.

10. Run the oil (under a pressure of 5-6 atm.) and heated up to 60-80°C through the engine lubricating system simultaneously turning the engine crankshaft by the fan.

While running the oil through the engine lubricating system, throw the friction clutch in and out to fill it with oil.

Run the oil through the engine lubricating system using a ground pump unit. The oil is admitted through a filter installed in the supercharger rear casing instead of an oil gauze filter.

NOTE: Do not use the oil drained from the engine for its repeated running through the engine or regeneration since it contains the protective lubricant.

11. Spray again 100-150 gm of 58M lubricant into each cylinder through the spark plug holes. Do not turn the crankshaft.

12. Plug the spark plug holes or screw in the spark plugs.

13. Cover the air intake, exhaust pipes, breathers and all other openings with polychlorvinyl sheets.

14. Coat the surfaces of the engine parts free from varnish and paint with protective lubricant grade 59 with an addition of 1-2% of kerosine, technical vaseline heated up to 60-80°C or aviation oil with an addition of 4-10% of kerosine.

15. All engine preservation operations must follow each other without intervals.

Do not coat the engine and its accessories with protective lubricant under rain or snow.

16. Make entries in the engine log-book as to preservation performed.

17. Do not store the engine for more than six months. At the expiration of storage period, the engine must be de-preserved.

18. Depreserve the engine as indicated in Section IX.

5. PRESERVING THE P-5 MAIN GEARBOX AND MAIN DRIVE SHAFT FOR ONE-TWO MONTHS' STORAGE AND DE-PRESERVING THEM AFTER STORAGE.

1. When preserving the engine for 1-2 months' storage preserve the P-5 main gearbox and the main drive shaft. To do this, drain the oil from the warm gearbox (if the oil is diluted) and fill the lubricating system with fresh oil heated up to 75-80°C.

If the gearbox has been operated with undiluted oil at an ambient air temperature above +10°C) do not drain the oil before preservation.

2. Start the engine and run it for 15-20 min. at 1,000--1,200 r.p.m. with the gearbox engaged.

NOTE: Before engaging the friction clutch the temperature of oil in the oil sump and the oil line should be not lower than 15-20°C. Otherwise, heat up the gearbox to the indicated oil temperature.

3. Drain the oil from the gearbox lubricating system.

4. Wipe the outer surface of the gearbox and the accessible surfaces of the main drive shaft with a clean cloth dampened in gasoline, then blow them over with dry compressed air.

5. Apply lubricant No.59 to those outer parts of the gearbox and its units which are unprotected with varnish or paint and to the main drive shaft with the flexible couplings and the mounting parts of the flexible couplings.

NOTE: Prevent the gasoline and protective lubricant from getting on the rubber bushings of the main drive shaft flexible couplings.

6. Before starting the engine with the main gearbox and main drive shaft preserved, wash them with gasoline using a brush or cloth and blow them over with compressed air.

Fill the gearbox lubricating system with hot or diluted oil depending on the ambient air temperature.

If the gearbox is being de-preserved at an ambient air temperature below +10°C, heat up the gearbox for 30 min.(not less) up to 15-20°C by a heater, checking the temperature by the thermometer indicating the temperature in the oil sump and the oil line.

Start and test the engine with the gearbox engaged as indicated in sub-sections 3,4 and 5 of Section III.

6. PRESERVING THE P-5 MAIN GEARBOX AND MAIN DRIVE SHAFT FOR SIX MONTHS' STORAGE AND DEPRESERVING THEM AFTER STORAGE.

The gearbox removed from the helicopter and preserved with application of dehydrator plugs and bags with silica gel and placed into a polychlorvinyl envelope can be stored for one year.

1. If the gearbox is intended to be inoperative for 6 months:

a) change the oil in the engine and gearbox lubricating systems for fresh oil heated up to 75-80°C;

b) start the engine and run it for 15-20 min. with the gearbox engaged.

NOTE: Before engaging the friction clutch the oil temperature in the oil sump and the oil line should be not lower than 15-20°C. Otherwise, before starting the engine, heat up the gearbox to the indicated oil temperature.

c) drain the oil from the gearbox oil system;

d) preserve the inner parts of the gearbox with 58M lubricant heated up to 15-30°C applying it into the gearbox through the breather until the lubricant completely fills the gearbox. Then turn the rotor 3-4 revolutions;

e) drain completely the preserving lubricant through the drain cock and the magnetic plug hole of the oil sump.

NOTE: If 58M lubricant is properly stored it can be used several times for preserving the gearbox.

f) run fresh MC-20 or MK-22 oil heated up to 60-80°C under a pressure of 5.5-6.5 atm. through the inner oil line of the gearbox by a hand pump until the oil appears from the cock of the oil sump and simultaneously turn the rotor by the blades;

g) wipe dry the surfaces of the outer parts of the gearbox and the accessible surfaces of the main drive shaft with a clean cloth dampened in gasoline and blow them over with dry compressed air;

h) coat the outer surfaces of the gearbox and the units unprotected with varnish and paint, the surfaces of the main drive shaft, flanges and shaft of the unit drives with 59 lubricant, technical vaseline or neutral gun lubricant heated up to 60-80°C.

The preservation is performed by means of a sprayer or a brush.

2. All the operations to preserve the gearbox must follow each other without intervals. Do not preserve the gearbox under rain or snow.

3. The gearbox and main drive shaft are to be depreserved as indicated in Section II.